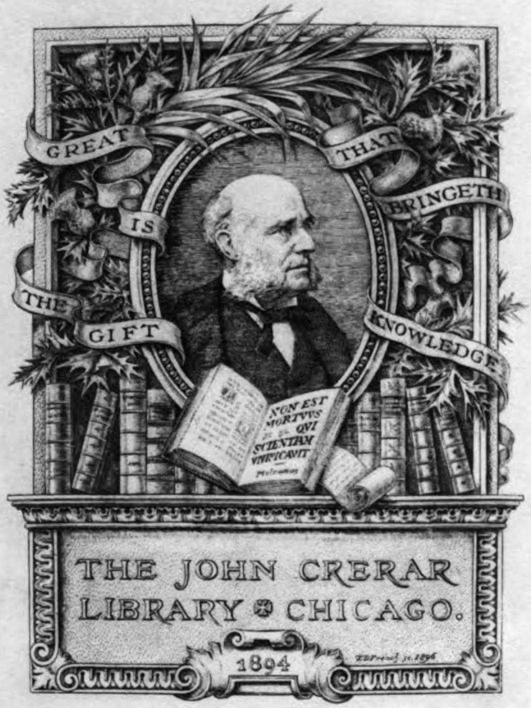
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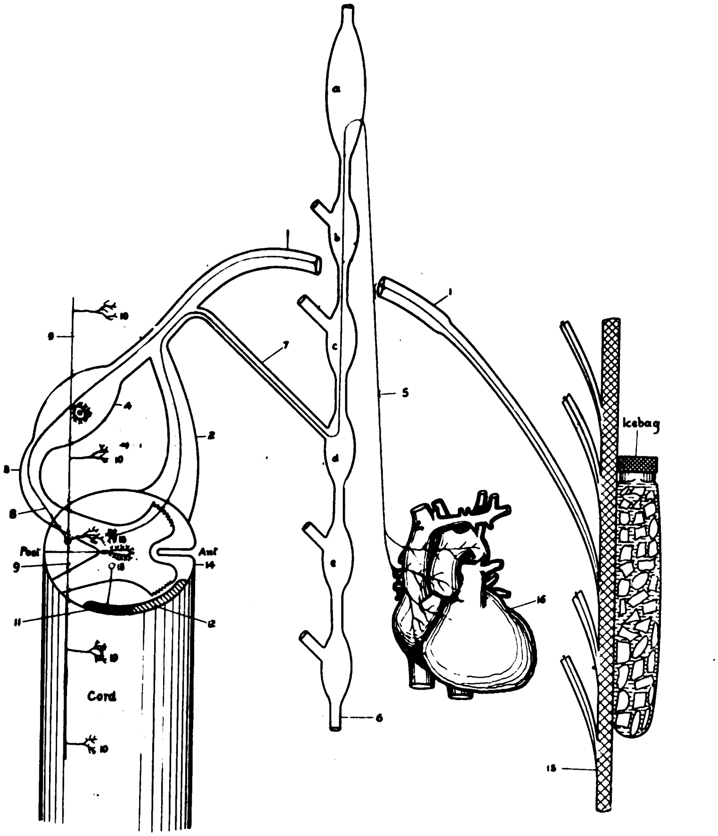

FRONTISPLATE

Reflex Arc from Skin to Heart

1. Third intercostal nerve.
2. Anterior root of spinal nerve.
3. Posterior root of spinal nerve.
4. Posterior root ganglion.
5. Inferior cardiac nerve.
6. Gangliated cord of lateral sympathetic chain. a—inferior cervical ganglion; b, c, d, e—first, second, third and fourth thoracic ganglia.
7. White ramus communicans.
8. Afferent sensory nerve of temperature.
9. The same in the spinal cord (posterior white columns).
10. Collateral branches of No. 9.
11. Direct cerebellar tract.
12. Gower's tract.
13. Clark's column.
14. Level of third thoracic segment.
15 Skin of precordia.
16. Heart with deep cardiac plexus.

PRINCIPLES AND PRACTICE

OF

HYDROTHERAPY

FOR

STUDENTS AND PRACTITIONERS

OF

MEDICINE

Embodying a Consideration of the Scientific Basis, Technique and Therapeutics of Hydrotherapy and some Allied Branches of Physiologic Therapy

BY

GEORGE KNAPP ABBOTT, A. B., M. D.

Dean of Faculty and
Professor of Physiologic Therapy and Practice of Medicine
in The College of Medical Evangelists
Superintendent of The Loma Linda Hospital

SECOND EDITION, REVISED AND ENLARGED
WITH 128 ILLUSTRATIONS

THE COLLEGE PRESS
LOMA LINDA, CAL.

PREFACE TO SECOND EDITION

THE kindly reception given the first edition of HYDROTHERAPY, in spite of its many faults, and the requests for a text thoroughly illustrated, have induced the author and publishers to prepare this revised and enlarged edition. The writer more than ever realizes the impossibility of making any text-book a complete treatise, and especially so in therapeutics, the science and art of which are advancing so rapidly.

Much new matter has been added, among which are: A chapter on *Insanity and Drug Addictions*, for which the author desires to thank Dr. Jessie H. Simpson of the Southern California State Hospital for the Insane; a section on *Prescription Writing and Treatment Combinations;* and one on *Hydrotherapeutic Apparatus and Treatment Rooms*. For conducting an original research into the effects of tonic hydrotherapy upon the metabolism of individuals on a low proteid diet, the author is indebted to his colleague, Dr. E. H. Risley.

Many of the new illustrations have been prepared in the Laboratory of Physiologic Therapy of The College of Medical Evangelists and in The Loma Linda Hospital. For aid in this work the author desires to acknowledge the helpful assistance of medical students, nurses and others, and especially medical students, Wm. Richli and L. D. Trott, in the preparation of drawings and charts. For diagrams and illustrations copied from medical literature we have endeavored to give full credit. For cuts furnished thanks are due to Dr. H. P. Coile, the Hoffmann & Billings Manufacturing Company, James B. Clow & Sons, the Boston Surgical Supply Company, and Mr. A. Campbell.

Last, but not least, thanks are due to The College Press for its endeavor to fulfill the wishes of the author in the preparation of a presentable text.

Loma Linda, California G. K. A.

PREFACE

NO apology need be given for the presentation of a work on hydrotherapy. In spite of the advances made in modern physiologic therapy in general, hydrotherapy is still a branch of therapeutics but little used by the general practitioner. The reason is not difficult to find. As a science, it receives but scant attention from teachers of therapeutics, and in the medical curriculum is usually allotted a few hours from the combined course on materia medica and therapeutics, which is already overcrowded by the presentation of a needlessly large number of preparations of doubtful or very limited usefulness. As an art, even less time is devoted to it. It must, however, be acknowledged that this brief consideration is a distinct advance over twenty years ago, when the medical curriculum was quite innocent of even a mention of physiologic therapy.

It is the author's firm belief, strengthened by years of experience in the teaching of both medical students and nurses, that the student or practitioner should first acquire a knowledge of the technique of hydrotherapy in the same way that nurses are taught, *i. e.*, by actual drill under an experienced instructor. Insistance upon accurate, personal observation of patients during their treatment will help to strengthen in the mind of the student the necessity for close clinical observation. In the management of disease, such observation can not be replaced by instruments of precision. In this connection we can not refrain from expressing our opinion that instruction in practical therapeutics and the care of patients should not be left to the later years of the medical curriculum.

With this practical knowledge of the visible results to be obtained, the student should devote careful study to the physiologic and therapeutic effects of each representative class of treatments. This study should include personal laboratory investigation into the effects of thermic and mechanical stimuli upon blood pressure, the heart rate and force, general changes in blood distribution and its cellular composition, muscular capacity, and metabolic changes as revealed by chemical examination of the excretions, particularly the urine.

In the presentation of the subject, the author has tried to preserve the closest connection between experimental physiology and therapeutic deductions and recommendations. We have at all times endeavored to seek out a reason for the results obtained in practice. It is only in this way that varying conditions may be successfully met.

The modern search for "specifics" has greatly aided in the development of scientific medicine. The same principles, however, must not, without modification, be applied to hydrotherapy. *Specific results* are to be sought by proper adaptation of the treatment to the individual case in hand, rather than by rigid adherence to this or that type of application. For this reason physiologic effects have been dwelt upon quite at length and have been considered apart from the technique.

The subject of therapeutics has been presented with a view to the elucidation of basic principles. It is the morbid physiologic or structural state present in a given disease that requires treatment rather than the "disease" as an entity. Diseases most amenable to hydrotherapy have, therefore, been grouped in classes according to the general principles involved in their treatment, after an explanation of which, each disease is given particular attention.

While hydrotherapy is the most important branch of physiologic therapy, it is not by any means a "cure all." The border line between physiologic and radical therapeutics can not be drawn by disease lists but must be settled by rational, conscientious consideration of the ends to be sought and the trend of the morbid condition in hand.

In presentation of this work, the author lays no claims to originality. In addition to personal experience, all available sources of information have been drawn upon. The text matter and diagrams are those used by the author in his lectures to medical students. The part on technique is an amplification of a brief treatise on the "Technique of Hydrotherapy" published by the author in 1908.

Loma Linda, Cal. G. K. A.

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PART 1

SCIENTIFIC BASIS AND PHYSIOLOGIC EFFECTS

CHAPTER I

THE PHYSICAL PROPERTIES OF WATER

IN the application of any therapeutic agent, it is essential to obtain an understanding of those properties of the agent itself, of which particular use is made in the treatment of disease. In the case of water, these essential properties may be discussed under the following heads:—

1. Its ability to communicate and absorb large quantities of heat by contact.

(*a*) *Specific heat.* (*b*) *Latent heat.*

2. Its great temperature-conducting capacity—thermic stimulation.

3. The perfect fluidity of water—its use in mechanical stimulation.

4. Its solvent properties and use in nutritive and metabolic changes.

5. Existence of water in the three states of matter within a short range of temperature—practicability of applying it to the body in all these three states.

1. The Communication and Absorption of Heat. Hydrotherapy consists chiefly in the application of heat and cold to the body by means of water. Its most helpful results are obtained from the heat applied. In its most scientific and practical phases it is a study of thermotherapy. This being true, in the power of water to communicate and absorb large quantities of heat, without itself undergoing a corresponding change in temperature, lies its most useful property. To rightly apply so powerful an agent, one should understand the physics of heat as it applies to water. A brief summary of this subject will not, therefore, be out of place.

PHYSICS OF HEAT

When heated, the particles of any substance separate slightly, thus moving more freely upon each other when hot than when cold. Solids are thus made softer, more porous, and pliable. With some solids this is so marked that they may be moulded into various shapes even before hot enough to become liquids. The body tissues are likewise made soft and pliable through the influence of heat. The skin is expanded, the muscles relaxed, and the blood-vessels dilated.

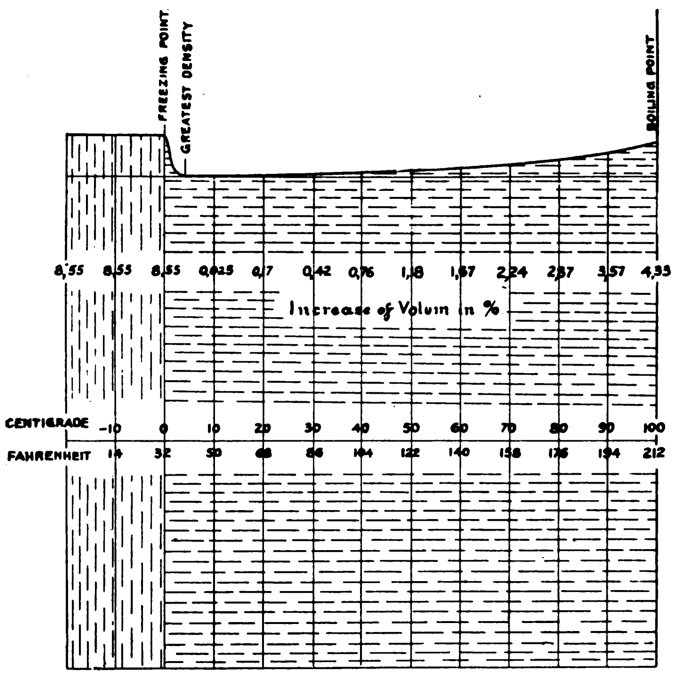

Fig. 1. Expansion of water at temperatures from 0° C. to 100° C.

In general, heat expands all substances, some, however, to a greater degree than others. Each metal, for example, shows a definite degree of increase in bulk when heated. Water expands, occupying more space as its temperature increases above 4° C. (39.2° F.). Nearly all substances continue to contract indefinitely under the influence of cold; *i. e.*, the withdrawal of heat. But water, after cooling to 4° C., expands until frozen. Four degrees C., or 39.2° F., is, therefore, said to be the point of maximum density of water. (*Fig. 1.*) At this temperature a given weight of water occupies (is crowded into) the least possible space. It is because of this change (expansion) in freezing that ice floats. If water continued to contract on freezing, it then being denser, would sink to the bottom, and so remain frozen for a much longer time, as solar heat loses its effect in penetrating so far. Did this occur, only very shallow bodies of water would ever entirely thaw out at temperatures common to temperate and frigid zones.

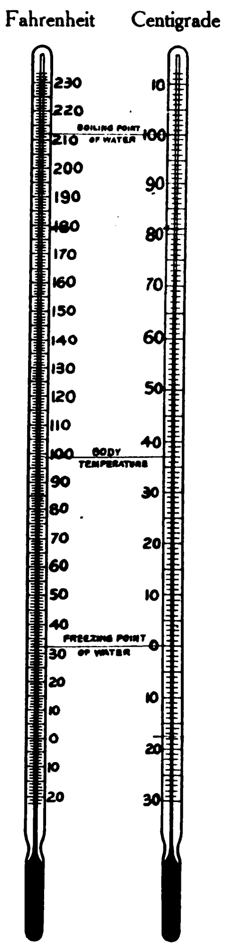

Fig. 2. Comparative thermometer scales.

Degrees or the Intensity of Heat. The *intensity* or degree of heat is measured by a thermometer, (thermo—heat, meter—measure). Only the Fahrenheit and Centigrade scales need be described. The Fahrenheit thermometer, more commonly used for domestic and clinical purposes will be described first. The *freezing point* of water is marked as 32° F., that is, 32° above the zero or starting point of this scale. Water boils at 212° F., *i. e.*, 180° F. above freezing.

The Centigrade thermometer is a more simple instrument, as the freezing point of water is marked 0°, while the boiling point is marked 100°. From this we see that 32° Fahrenheit corresponds to 0° C., and 212° F. corresponds to 100° C., and, therefore, 180 Fahrenheit degrees (212 minus 32) are the equivalent of 100 Centigrade degrees, or 1.8° F. equal 1° C. (*Fig. 2.*).

Equivalent Readings. To change a given reading on the Centigrade scale to Fahrenheit, it is necessary first to multiply by 9-5 (180-100). This gives the number of Fahrenheit degrees above the freezing point. Since this point on the Fahrenheit scale is 32° above zero, 32 should be added to the result to obtain the correct Fahrenheit reading. For example, find the Fahrenheit reading which corresponds to 35° C. Multiplying 35° by 9-5 gives 63° above freezing; adding 32° gives 95° F.

To obtain the correct Centigrade reading of a given Fahrenheit temperature, it is only necessary to reverse the process. Take, for example, 98.6° F., the normal body temperature by mouth. This is 66.6° (98.6 minus 32) above freezing; 66.6° multiplied by 5-9 equals 37° C. Since 0° C. is the freezing point, this is the correct Centigrade reading.

Condensed Rules:—

To change Centigrade to Fahrenheit, multiply by 9-5 and add 32.

To change Fahrenheit to Centigrade, subtract 32 and multiply by 5-9.

Heat Units or Quantity of Heat. (a) SPECIFIC HEAT. The *amount* of heat required to raise a gram of water 1° C. is called a heat unit, or *calorie.* The large Calorie (written with an initial capital) is the amount of heat necessary to raise 1000 grams (1 liter) of water 1° C., and is, therefore, equal to 1000 small calories.

The amount of heat that would raise the temperature of a given weight of water 1° C. would raise the temperature of the same weight of mercury 30° C. Therefore, one gram of mercury in being heated through 1° C. would absorb only 1-30 of a calorie, *i. e.*, 1-30 of the amount of heat absorbed by the same weight of water in being heated through 1° C. From this fact it will be seen that water absorbs a large amount of heat without manifesting a corresponding change in temperature; while a small amount of heat produces a considerable change in the temperature of mercury.

The heat necessary to raise a given weight of water 1° is greater than that of any other substance. Therefore, water is said to have a high specific heat. *Specific heat is the capacity of* *a substance for absorbing heat as compared with the capacity of a standard substance.* More accurately, it is the amount of heat a given weight of a substance absorbs in being raised in temperature 1° C. as compared with the amount of heat necessary to accomplish the same rise in temperature in the same weight of a standard substance. Since water absorbs more heat than any other substance, it is taken as the standard. A gram of mercury, absorbing only 1-30 the amount of heat absorbed by 1 gram of water, is said to have a specific heat of 1-30 that of water. Copper has a specific heat of 1-12 that of water.

It will be seen from the preceding discussion, that a large amount of heat is stored in hot water. It is this high specific heat of water that makes it especially valuable in applying heat to the body. A pound of hot water will communicate thirty times as much heat to the body as a pound of mercury. And conversely, a pound of cold water will abstract from the body thirty times as much heat as a pound of mercury. In each case the temperature of the water or the mercury will be changed only 1°. The hot water not only stores up a great amount of heat, but it communicates this very readily to things with which it comes in contact. Conversely, cold water very readily absorbs heat by contact with other bodies. Hence, if applied to the human body, it quickly cools the skin, adjacent tissues, and their blood current.

(b) Latent Heat. A thermometer placed on ice as it is melting and another placed in the water just after, register exactly the same degree or intensity of heat, *viz.*, 0° C. Since it requires heat to melt ice, a mere change in physical state, we may very naturally ask, What becomes of this heat when the solid changes to a liquid? It is not apparent nor manifest by a change in the thermometer. We may call it *hidden* or *latent* heat. By careful experimentation, it is found that an astonishingly large quantity of heat is absorbed in this process; in the melting of one gram of ice, sufficient, in fact, to raise the temperature of one gram of water 79.2° C. This gram of ice in melting, therefore, absorbs 79.2 calories, with no consequent rise in the temperature, as measured in degrees. This amount of heat is made latent. The latent heat of fusion, or melting of ice, is thus fixed at 79.2 calories. This is the reason ice cools the body so much more rapidly than cold water, every gram of ice that melts abstracting nearly eighty times as much heat as the same weight of water warmed through 1° C. The value of the ice rub is thus amply demonstrated. For the same reason an ice bag produces a greater intensity of effect than a cold compress.

The same principle applies to the boiling of water or the condensing of steam, except that a much greater number of heat units is respectively made latent or given off. Water at the boiling point registers the same degree of heat as steam just after it is formed; and yet this change from liquid to gas requires 537 calories to each gram of water. The latent heat of vaporization of water is, therefore, 537 calories.

When steam condenses it gives off this heat. In this phenomenon lies the explanation of the fact that a Russian bath gives a great intensity of effect, since much of the steam condenses, the water particles remaining suspended in the air of the room as a thick fog. For every gram of steam that thus condenses, 537 calories of heat are liberated. The intensity of burns produced by the condensing of steam directly on the skin surface is readily understood when this fact is kept in mind. The marked cooling effects of the evaporating wet sheet pack, or hot and cold sponging, are due to the large amounts of heat abstracted from the body by the process of evaporation.

With all these facts before one, it is apparent that the great value of water as a thermic agent lies in its exceedingly high specific and latent heat coefficients.

Specific heat refers to the amount of heat concerned in the *temperature changes* of matter *within a single state.*

Latent heat refers to the amount of heat concerned in the change of matter *from one state to another without any change in temperature.*

2. Temperature-Conducting Capacity of Water — Thermic Stimuli. It might, on first thought, seem that a thermic stimulus is identical with the communicating of heat. It, however, does not depend upon the amount of heat communicated to or absorbed from the body, but rather upon the impression made upon the nerves. In this respect the temperature of the body, or rather, that of the skin, may be said to be the zero of the *temperature sense*. Water of a temperature above this, creates an impression of heat, while water below this temperature gives a sensation of cold. A brief application of ice may give a sensation of cold as intense as one of longer duration. On the contrary, to abstract heat from the body to any appreciable extent, the application must be more or less prolonged.

These thermic stimuli are of the greatest value in hydrotherapy; we may say, equally so with the actual transfer of heat. Here, also, the thermic capacity of water makes it of inestimable value. "The temperature-conducting capacity of water is twenty-seven times greater than that of air. Water conveys to the skin much stronger thermic impressions than does air at the same temperature, a fact easily discovered in exchanging a room temperature at 75° F. for a tub bath at the same temperature."[1].

And again, the accuracy with which we may regulate the temperature of hydriatic applications and so gauge the thermic impressions as well as the heat communicated or absorbed, makes it doubly convenient and valuable.

3. Perfect Fluidity of Water—Mechanical Stimuli. The convenience with which water lends itself to the application of various mechanical stimuli is due to its most apparent physical property—*fluidity*. Because of this perfect fluidity, its application can be controlled to a nicety not possible with other agents. With the proper appliances, the amount and temperature can be accurately gauged. The *size*, *form*, *character*, and *pressure* of douches, sprays, and pours can be varied to suit the varying needs of a great variety of cases. It is these four factors that govern the mechanical effect in the class of treatments mentioned. Water may be applied under very great pressure, thus enhancing the thermic effects, or it may be applied with little or no pressure.

Not only may water itself be used to apply percussion, but its application may be advantageously combined with percussion and friction from other sources, as in the wet hand rub or cold

1 Baruch—Principles and Practice of Hydrotherapy, p. 31.

mitten friction. In this case it is the bare hand or rough mitten that is the chief source of friction. The Brand or cold rubbing bath is another example of this combination of mechanical and thermic stimuli, each enhancing each. It must not be supposed, however, that the marked effect of this form of bath is due merely to a *combination* of the *thermic* and *mechanical* stimuli. It is necessary that water be used. Apropos of this question, we quote the following from Baruch: "We would again insist upon the fact that neither in typhoid nor in cardiac inadequacy, can these effects, or anything like them, be produced by cold alone (for that has been thoroughly tried in both cases), by the temporary application of water alone, of whatever temperature, or by either dry saline or gaseous or mechanical irritants. It is absolutely necessary that, not merely cold, but *cold water* should be used, that the surface should be literally rubbed with this for a considerable length of time."[2]

The same may be said of the cold mitten friction. The astonishing results of this procedure can be obtained, neither by the application of cold alone nor by friction with the dry mitt. It is only by vigorous rubbing with the mitt, dipped in cold water, that the maximum effects are produced.

4. Solvent and Chemical Properties. That these properties are of less importance than the preceding will be granted by those familiar with hydriatic measures. The solvent properties of water are utilized in the shampoo, enema, etc. Its value as a solvent in the processes of osmosis and dialysis are likewise made use of in hypodermoclysis and saline enemata. As a means of combining thermic and chemical stimuli, it is used as a solvent in the Nauheim or effervescent bath, saline baths, etc.

Internal Hydrotherapy. Going a little further from the physical into the chemical activities, and almost outside of the range of hydrotherapy, unless it be in water-drinking, we may consider water in its relation to the nutritive and metabolic processes of the human body. It is the medium of all commerce and exchange in the carrying of nutrition to the tissues, and wastes from them to the excretory organs. It constitutes 75 per cent of the body weight. Without it life would be impos-

2 Baruch—Principles and Practice of Hydrotherapy, p. 12.

sible. Not only is it concerned in the mere physical interchange of nutrient and waste substances, but it is actually necessary in by far the greater number of all chemical changes which these substances undergo. Many body wastes are but sparingly soluble, and for this reason require large amounts of water to hold them in solution. The flushing of the system consequent on free water-drinking is, therefore, one of the greatest of all aids to elimination.[3]

The popular belief that particular virtue resides in the mineral constituents of water used for hydrotherapeutic purposes is almost wholly erroneous. This is rarely the case and is confined to a very few procedures such as the Nauheim bath above mentioned. The treatment of rheumatism and obesity at various hot springs derives but little advantage from minerals present in the water (unless it be that "faith" in these induces the patient to drink more water than usual). The results are due to the thermic effects of the hot water, combined with regulation of diet and copious water-drinking. Balneology—the use of mineral waters in the treatment of disease, therefore, adds little or nothing to the science of hydrotherapy.

5. Use of Water in Solid, Liquid, and Gaseous States. No other substance, capable of such diversified utility as water, exists in all the three states of matter in such a short range of temperature. The change from the solid through the liquid to the gaseous state is accomplished in a range of 180° F. (100° C.). Not only is this true, but it also changes readily from one form to another. It is possible to apply water to the body in any of these forms; even the application of the two extreme forms—ice and steam—is of practical utility. The ice bag is an indispensable adjunct to a great variety of treatments. The ice rub has also been mentioned. The use of Russian and similar vapor baths is well known. The steam douche has also acquired some degree of reputation as a therapeutic agent in certain conditions. This practicability of employing water in all three states of matter and its ready change from one to another within a comparatively short range of temperature, greatly enhances its utility as a therapeutic agent.

3 See Chapter XI, Hawk's observations.

CHART OF WAVE ENERGIES

in order of wave length and frequency.

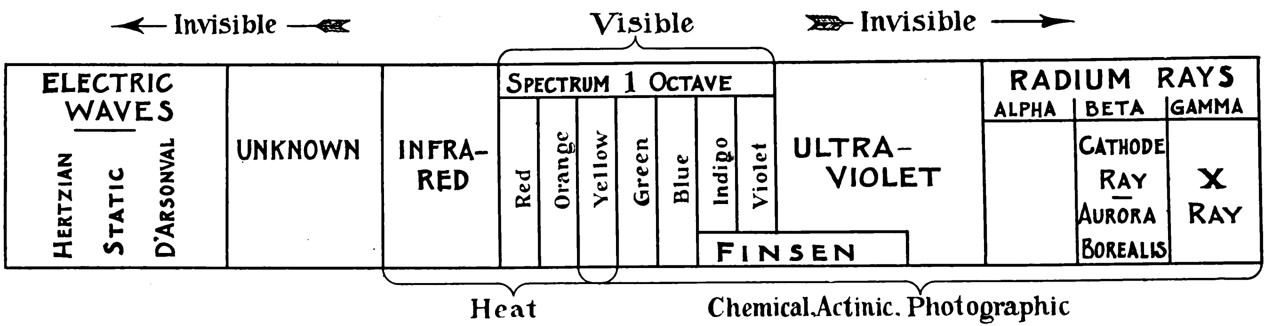

Fig. 3. The waves represented at the left end of the chart are of the greatest length but of low frequency. Proceeding from left to right, the wave length decreases while the wave frequency increases. The space marked "Unknown" is many times the length of the entire chart. Langley with his bolometer or platinum nerve found the infra-red end of the spectrum 13 times as long as the visible spectrum, i. e., 13 octaves in length. The wave length at the red end of the visible spectrum is .0,007,000 mm.; at the violet end .0,004,059 mm. The Finsen ray includes violet and ultraviolet radiations. The alpha group of radium emanations is not affected by a strong magnetic field and has but slight penetrating properties. The beta rays are identical with the cathode rays; they have greater penetrating properties but are deviated by a magnetic field. The gamma rays find their counterpart in the X-rays; they have great penetrating properties and are non-deviable by a strong magnetic field. Reasoning from Helmholtz' theory of dispersion, the waves of the X-ray are smaller than atoms. Upon this depends the property of non-refrangibility.

CHAPTER II

PRINCIPLES OF EFFECTS AND THERAPY

THE basic principles of hydrotherapy are found chiefly in an explanation of the effects of heat and cold. Viewed in this light, the science is that of thermotherapy. Effects similar to those produced by thermic impressions can be obtained by sunlight, friction, percussion, and in fact, all physiologic agents. This is most notably true of light, many of the physiologic effects of which run parallel with those of hydrotherapy. In fact, thermic and actinic energies are so closely related that they overlap each other in the visible spectrum (*Fig. 3.*). From the lowest limit of the scale of energies, up through electric energy, heat, light, and actinic rays to radium emanations and the X-ray, there is laid out before the physician a greater supply of efficient curative means than can be found anywhere else in the whole realm of therapeutics.

THERAPY FROM WITHIN

Those agents which, by their toxic action, arouse the body to resist their intrusion, can not be classed as physiologic means. They excite abnormal and unusual activities which are largely directed against the toxic agent itself, rather than heightening the normal activities which keep the body in health and repel the onset of morbid processes. Merely to relieve temporarily a distressing condition, without enabling the body itself to overcome that condition, is doing no permanent good. The sick can not always be applying special means. After recovery, they must depend upon the natural surroundings and ordinary agencies which keep the body in health. For example, to relieve pain by cocaine, an ice bag, pressure, or a fomentation is productive of no lasting good, unless that cocaine, ice bag, pressure, or fomentation causes *the body* to overcome the condition producing the pain; and its repeated application brings about such a change that the pain (or diseased condition) does not reappear after the curative agent is withdrawn. The body must be made to "cure" itself. The restorative power lies in nature. The natural God-given forces must be rejuvenated. The power from without must produce or arouse power from within.

WARM- AND COLD-BLOODED ANIMALS

The reason that thermic applications and impressions are so powerful in arousing body functions lies in the fact that life activities are carried on only within a certain limited range of temperature. With regard to body temperature, there are two general classes of animals, *viz.*, the warm- and the cold-blooded.

The temperature of so-called "cold-blooded" (poikilothermic) animals rises and falls with their surroundings. The organism is not injured by comparatively wide variations. The frog, for example, is lively in water at 70° F., and sluggish in water at 45° F., but it nevertheless lives and remains normal in either. These variations do not seriously depress vital activities. The organism is able to withstand such radical changes in the temperature of its blood and body generally, without this change being inimical to its life. The body temperature of these animals remains slightly above that of the cold water they may be in and slightly below that of warm water. Cold-blooded animals are principally aquatic and amphibian.

Certain other animals maintain a constant temperature under varying conditions. The surrounding air, whether hot or cold, does not materially alter their body temperature. The heat mechanism is so nicely adjusted that more heat is produced when the surrounding medium is cold, and less when the air or other medium is hot. This class of animals is called "warm-blooded" (homeothermic) because of the constant temperature at which their blood is kept. Arterial blood is slightly warmer than venous. The ordinary limits for man are about 101°—103° F.

Organs of constant activity, such as the heart, liver, and brain have a temperature 2°—4° higher than the average of the blood stream. At ordinary room temperature, the uncovered skin has a temperature of from 92°—95° F. This fact is of importance in the administration of neutral baths. The water should be 1° or 2° higher than that of the general skin temperature. This secures a full sedation by adding a slightly relaxing effect. As noted above, the internal temperature of warm-blooded animals is comparatively a fixed point, or varies within only very narrow limits, not more than one degree in health. Any radical or prolonged departure from this fixed point (98.6° F. by mouth) interferes with vital functions.

INTRINSIC EFFECTS

When the body becomes thoroughly chilled, as by a long ride in the cold, the pulse and respiration are slowed, the circulation is less rapid, the nerves benumbed, the muscles respond sluggishly and clumsily, the finer skilled movements are impossible, digestion is retarded, the body temperature is lowered. Cold is, therefore, in itself, a vital depressant, *i. e.*, it retards vital processes. This is its intrinsic effect. Kellogg records an experiment in which immersion of the body in water at 55° F. for ten minutes reduced the pulse rate from seventy-six to fifty per minute. Another, in which twenty minutes in water at 45° F., the patient being rubbed continuously, reduced the pulse rate from eighty to fifty-eight. Both experiments were upon healthy persons. In another experiment exposure to cold showed tactile sensibility decreased. Before the exposure the points of an esthesiometer were detected as two separate points at a minimum separation of 2 mm. After five minutes immersion in water at 40° F., the minimum distance was increased to 6 mm. Another, in which five minutes in water at 68.4° F., reduced the body temperature 0.8° F. These data serve to make definite, facts with which we are acquainted in a general way only.

It will be seen from this that an overactive process may be retarded and brought back *toward* the normal by an application of cold, continued until its intrinsic effects are manifest. The longer the duration of the cold application, the greater its effect. The same is true of the degree of cold. The lower the temperature, the more pronounced the effects.

While cold retards, heat stimulates vital activities. We know what it is to experience the vivifying effects of the warmth from a fire or sunlight after being in very cold air for some time. The circulation is quickened; the heart beats faster; respiration is more rapid; nerve sensibility is heightened; muscular action is quicker, more certain, and precise; and digestion proceeds more rapidly. In watching the activity of the white blood cell under the microscope, the stage must be kept warm or the movements will cease. The amœba, paramœcium, and other one-celled animals exhibit their peculiar movements only in the presence of a certain amount of heat. When cold, their movements cease entirely. Cold, *per se*, decreases oxidation and metabolic activities; heat increases the oxidizing capacity of the tissues and metabolic activities are hastened.

When the body is overheated its functions are abnormally increased and, if long continued, permanent injury may result. When heated only to a slight degree, however, sluggish activities are whipped up and, if the applications of heat are repeated at intervals, the retarded functions tend to return to normal.

REACTION

The most interesting and phenomenal results of hydrotherapy are due to that complex process—reaction, *i. e.*, the part which the body itself takes in its own recuperation and healing. This interesting phenomenon, in its entirety, is observed only in homeothermic animals. Cold-blooded animals, instead of reacting to their external medium, are subject to the vicissitudes of their environment. On the contrary, warm-blooded animals maintain more or less uniformity of function because of the perfect control exercised over vital processes by the nervous system. This control is more highly developed and complicated than in poikilothermic animals.

We have seen that the influence of cold is to depress vital activities; that is, if continued long enough, its intrinsic effect is manifest in depression. But let us notice the effects of a *brief* application of cold. A plunge into cold water increases the pulse rate and force, the skin becomes reddened because of a quickened peripheral circulation, and the respiration is deeper. The muscles are energized so that their capacity for work is increased. These heightened activities continue for a time, gradually returning to normal. This is reaction,—which may be defined as a group or series of changes inaugurated by the body because of some disturbing external agent. More briefly, it is the response of the organism to an external agent.

Rationale of Reaction. The explanation of these tonic and stimulating effects lies in the recognition of cold by the body as an agent which will depress its functions. Even though the contact be too brief to actually bring about this result, it immediately increases its activities in order to counteract the anticipated depression. The body tends to resist or overbalance attempts to alter its temperature. In doing so it is said to react against this change, or attempted change. Cold, in and of itself, causes depression. But the attempt on the part of the body to resist this depression results in heightened activity. This is spoken of as the reaction or reactionary effect. It is always the opposite of the intrinsic effect. Some very common examples of this will serve to illustrate the principle. An ice bag applied over the heart for five minutes slows the pulse rate; while slapping the chest with a cold wet towel, or the brief application of a cold douche to the chest, increases both the pulse and respiration rate. A long cold application, as a cold tub bath, lowers the body temperature, while a short cold application, as a cold plunge or cold douche, soon results in an increase of body temperature.

If the external cause is long continued, the reaction may not be apparent, may be lost, or obscured by the intrinsic effect.[1] The body reacts or attempts to react to even prolonged applica-

1 In discussing these two classes of effects, intrinsic and reactionary, some writers use the term "primary" as synonymous with intrinsic, and the term "secondary" as synonymous with reaction. Since the intrinsic effect of cold is neither primary in point of time, nor in all cases primary in importance, the term leads to confusion. The same may be said of the expression "secondary." The reaction often appears before the intrinsic depressant effect of the cold becomes manifest and so can not be said to be secondary as far as time is concerned. Also, if from a certain application a reaction is desired, then the reaction can not be said to be secondary in importance. For these reasons we object to the terms as demanding different definitions under different circumstances of use. They must, therefore, prove confusing.

tions of cold, so that what is seen as a result of these long applications is really a mixture of the intrinsic and reactionary effects. As to which shall predominate depends upon the intensity and duration of the application. With the more prolonged applications, the reaction is suppressed or obscured; while in those of intermediate duration, we often see as much of one as of the other.

With heat, as used in actual practice, we observe its intrinsic effects when the hot application is short, *i. e.*, of brief duration. The first effect of heat is that of a stimulant and tonic; but, if long continued, depression results. This depression is, by some, termed "a reaction." Baruch objects to this term as applied to heat. If we define reaction as the vital response to an external force, or the attempt on the part of the organism to counteract an external agent, we can see no great objection to the term, or to saying that the *reaction* to heat is of an atonic nature.

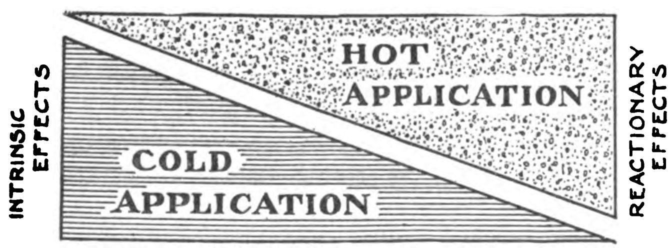

Fig. 4. Diagram illustrating the time factor in the obtaining of intrinsic and reactionary effects.

The accompanying diagram (*Fig. 4.*) illustrates the relation existing between the duration of the application and the obtaining of intrinsic and reactionary effects. The thick ends of the wedges indicate prolonged applications; the thin ends, brief applications. Intrinsic effects are shown at the left and reactions at the right.

Tonic effects are obtained from the: Intrinsic effects of heat (short); reaction to cold (short).

Retarding and depressant effects are obtained from the: Reaction to heat (long); intrinsic effects of cold (long).

It must not be concluded from the above grouping that the depressant effects of a long cold application (intrinsic) and those of a long hot application (reaction) are identical in nature. The depression is manifest in different ways. With cold the depression is in the nature of a simple retardation of vital functions, whereas with the heat the depression is manifest chiefly in the nervous and muscular systems,[4] and is perhaps best described as atonic. That this is largely a nervous phenomenon is apparent from the fact that a vigorous cold treatment following prolonged heat often quickly restores the patient to a normal condition.

Abrams[2] makes the following statement: "Respecting the physiologic effects of heat, it suffices to say, that a prolonged application of a high temperature is primarily an excitant, and secondarily a depressant; a brief application, however, is strongly excitant and the depressing effects, if any, are imperceptible." In discussing the effects of thermic stimuli (on secretion) Pope[3] says, "In general terms it may be stated that brief applications of thermic stimuli, whether hot or cold, stimulate secretion, differing in degree rather than *in toto;* long-continued applications depress."

Phases of Reaction. There are two important phases of reaction, *viz.*, the circulatory and the nervous. The *circulatory* is most apparent and is that by which we judge of the completeness of reaction. The skin should become ruddy and warm. The patient feels a warm glow over the entire skin surface. There should be nothing of stasis, no cyanosis, or goose flesh. The skin should be smooth, soft, and pliable. The *nervous* reaction is appreciated not only by the patient but by the observer. The dull, listless appearance of the eye and countenance generally, gives way to a decided brightening. If there is delirium or stupor, as in typhoid, pneumonia, etc., it may be replaced by quiet sleep. In fact, the salutary effects are visible in all the nervous functions of the body. With a neurasthenic patient the feeling of languor, restlessness and

2 Spondylotherapy, p. 175.
3 Hydrotherapy, p. 35.
4 Metabolic changes are hastened by prolonged heat.

weight in the abdomen is replaced by that of vigor and exhilaration. Another phase of reaction is that termed *thermic*. It is the response of the heat mechanism to stimulation. It is of less practical importance since it can not be conveniently utilized in judging of the completeness of reaction.

TYPES AND DEGREES OF REACTION

Suppressed Reaction. It is often desirable to suppress or limit the reaction arising from some application. This is especially true with long cold applications which are designed to delay vital activities or reduce fever. Of course, the body attempts to react to all such measures, as has been mentioned. The reaction may be limited, *e. g.*, by a cold application such as an ice bag to a part. The nervous excitability is lessened by the continuous and severe cold, so that the phenomena of reaction do not appear in their entirety and completeness. In the case of a Brand bath, the exciting stage soon gives way to a slower heart beat, slower and deeper respiration, etc., by reason of the continuance of the cold. In general, the suppression of the reaction depends upon the *intensity* of the cold and its *duration*, being greater with the lower temperatures and with the prolonging of the application.

Repeated Reaction. In the giving of alternate hot and cold treatments, the body is called upon to react several times. After two or three applications, the reactions are less complete. The oscillatory changes occurring in the blood-vessels become less and less in amplitude after each succeeding application. In order to produce complete reactions where the applications are repeated, it is necessary to increase the intensity of the stimulus. This may be done in the case of alternate hot and cold by using a higher temperature for the hot and a lower temperature for the cold, or by adding mechanical stimuli.

Incomplete Reaction. Applications not properly suited to the reactive ability of a patient will result in an incomplete reaction. Should this occur, the patient experiencies quite unpleasant symptoms, such as chilliness, shivering, cold feet, a feeling of fulness in the head, and even faintness and nausea.

These are due mostly to the internal congestion which has not been relieved or has been made more intense.

CONDITIONS INFLUENCING REACTION

Age and Vitality of the Patient. In either extreme of life the ability to react is quite limited. Neither infants nor aged persons bear cold treatment well. We have treated persons in advanced life who were utterly unable to react to even cool water as applied by the wet hand rub, and who invariably chilled after a cold mitten friction.

In certain diseases or states the vitality is so reduced as to render reaction extremely difficult. This is true of nearly all those diseases which produce a profound asthenia. In anemia and extreme emaciation the same conditions prevail. In all such cases it is necessary to thoroughly warm the body previous to the cold application and give vigorous friction during and following the treatment. Even these means will not always insure a reaction.

Exercise, sufficient to warm the body, promotes reaction. This is true whether taken before or after the treatment. It quickens the circulation and brings the blood to the surface. Body heat is increased so that the surface blood-vessels become dilated in order to increase heat elimination. Fatigue is not conducive to completeness of reaction. In case it is necessary to treat persons who are fatigued, a short hot application should be given first, quickly followed by some short but very vigorous cold treatment, accompanied by friction or percussion.

The Warmth of the Body. When the body is warm, reaction appears promptly. The internal heat of the body may be ever so much and yet reaction be impossible, if the skin is cold and clammy, pale, cyanotic, or goose flesh in appearance. The skin should be warm and, if possible, ruddy before cold applications are used. In case it is not, some sort of hot treatment should be used first, in order to draw the blood to the skin. The air of the room in which the patient is treated should be warm and he should remain in a warm room after treatment until reaction is complete. It may be necessary to give a drink of hot water in order to warm the body. More essential than all of these is the warmth of the feet. It is impossible to secure full reaction or the best possible results, if the feet are cold. It should, therefore, be a general rule that the feet should be warmed by a hot foot bath or alternate hot and cold foot bath or hot foot pack, previous to any and all treatment. In the giving of even an enema, this is necessary. After treatment it may be necessary to provide the patient with additional covering, either in the form of bedding or clothing, in order to secure full reaction.

Psychic Attitude. It is difficult to produce complete reaction in a patient that dislikes the measures used. That the mind does exercise an inhibitory influence over body functions can not be doubted by those whose practice brings them in contact with profound neurasthenia. Those under great mental strain, worry, or anxiety, react poorly.

Character of Treatment and Mode of Application. In all cases where reaction is likely to be tardy, the cold treatment should be preceded by a hot treatment. In ordinary cases the hot application should exceed in duration the cold application. It should thoroughly warm the body and make the cold a welcome change. The reaction is more prompt in its appearance if extreme cold is used and accompanied by friction or percussion. The colder the water, the greater the reaction. The cold treatment should be given quickly. The treating of one part at a time favors the quick appearance of the reaction. The larger an application or more general the surface treated, the less promptly will the reaction appear. Friction with the dry hand or a rough towel, following the drying, enhances the reaction. Percussion has the same effect. The drying from sprays and general applications of water should be done as quickly and as thoroughly as possible. If moisture is left on the surface, the resulting evaporation cools the body and reaction is delayed. The patient should be dried in a warm room near the place where the last application of water was made. To properly shape circumstances so as to favor reaction, requires much care and forethought on the part of the attendant nurse. A little carelessness may undo much or all of the benefit which should accrue from a given treatment.

Test of Reactive Ability. Ability to react to cold applications varies with the climate of usual residence, state of health, occupation, and habits of the patient. As to the reactive capacity little can be determined by questioning the patient. Often those who say they are unable to take cold baths react as well or better than those who affirm their ability to react. What one calls very cold another regards as only cool. Some persons consider that they have been taking cold baths when bathing in water at 90°—95° F. The response of a patient with anemia is usually in direct proportion to the degree of anemia. The state of the vasomotors and the readiness with which they react to mechanical stimuli serve as a rough test of the ability to respond to cold treatment. This test is mentioned by nearly all writers on hydrotherapy. Baruch[5] makes the following statement:—

"I have found that the response of the cutaneous circulation to mechanical excitation furnishes an index to the probable reactive capacity of the patient. Passing the back of the nail of the index finger rapidly but gently across the abdomen, and increasing the pressure of the nail with a second stroke parallel to the first, induces a more or less deep reddening of the irritated skin. The rapidity with which the red line develops after the nail is removed, and the pressure required to produce it, afford the trained eye a crude, but fairly correct, test of the patient's reactive capacity. By applying this test frequently before each procedure, one may readily train the appreciation of this test and thus avoid the necessity of slow development of the reaction by gradual increase of the intensity of the treatment which the author adopts in most cases."

COMMON NAMES OF TEMPERATURES

Heat and cold are relative, not absolute, terms and must needs be defined. This can not be done with accuracy, since patients differ in their toleration of heat and cold. What one designates as very cold may be only cool to another. The extent of skin surface exposed to thermic stimulation also makes a difference in the degree of the temperature impression re-

5 Hydrotherapy, p. 102.

ceived. For example, immersion of the hand in water at 70° F. will give an impression of cold; but, if the entire body is immersed, the water will seem *very* cold. Again, a full tub bath at 105° F. will seem very hot; while, if only one hand is immersed, the impression received is that of only *moderate* heat. The most satisfactory way of designating temperatures is to define the limits in terms of degrees. The table below has been found practical. The designations above neutral are those that would be used for full tub baths; those below neutral are such as would be used for partial immersion.

Very hot - - - -	104° and above
Hot - - - - -	100°—104° F.
Warm (neutral, 94°—97°) -	92°—100° F.
Tepid - - - -	80°— 92° F.
Cool - - - - -	70°— 80° F.
Cold - - - -	55°— 70° F.
Very cold - - - -	32°— 55° F.

CHAPTER III

ANATOMY AND PHYSIOLOGY OF THE SKIN

THE skin is the key-board of hydrotherapy. Comprising as it does such a large variety of tissue elements in an exceedingly complicated arrangement (*Plate I.*), every part of which is directly or indirctly connected with the functions of all other parts of the body, it is essential that its more important functions and their anatomic basis should be well understood. This is especially true of the vessels and nerves of the skin through which this connection with the internal organs is made; for by these connections, the physician is enabled to influence at will the circulation, and to a large extent, all the other functions of these organs. Only those points which serve to explain the practical applications of hydrotherapy will be noticed here.

The epidermal layer acts as a protection to the delicate and sensitive structures underneath.

The dermis contains those structures with which we are most concerned. It is made up of two fairly distinct layers—the pars papillaris, upon which the epithelium rests, and the pars reticularis beneath the former and lying next to the panniculus adiposis. The knob-like projections of the papillary layer are of two types, *viz.*, those containing blood-vessels (vascular papillæ) and those containing nerve endings (tactile papillæ). Both layers of the dermis consist of a reticulum composed of bundles of connective tissue, surrounded by elastic fibers.[1] For the most part, the fibrous bundles lie parallel to the skin surface. Those fibers nearer the surface are finer and more densely packed, producing a felt-like texture, while those of the

1 Bohm, Davidoff, and Huber—Text Book of Histology, p. 382.

deeper layers, nearer the subcutaneous fat, are coarser and more loosely arranged.

MUSCULAR AND ELASTIC TISSUE

Smooth muscle fibers are intimately associated with the elastic fibers. The two together constitute one of the most important anatomic arrangements in the skin, as we shall see presently. In many parts of the skin the muscle fibers are present in the form of a network, contracting diagonally.[2] The muscular tissue exists mostly as the erectores pilorum disposed in bundles in connection with the hair follicles and lying in an oblique direction through the thickness of the skin. These muscle bundles are surrounded and traversed by elastic fibers so that they are enclosed in a dense network of elastic tissue, threads of which serve as tendons to connect the ends of the muscular fasciculi to the connective tissue bundles of the corium.[3] The varied degrees of tension of the skin are due to the changes in this musculo-elastic mechanism. Baruch lays much stress upon these changes as being the chief cause of alterations in the cutaneous circulation, which are brought about by thermic impressions. Under medium temperatures the muscle fasciculi are at medium tension and the skin is ordinarily pliable. Cold causes contraction of these muscular bundles and they, embracing in their action the smaller vessels of the corium, especially the terminal capillary loops (both arterial and venous) of the papillæ, produce blanching of the skin. Heat relaxes the muscles; the tension being relieved, the elastic fibers return to their usual condition and the skin is again soft, loose, and pliable. Higher degrees cause increased relaxation up to a certain point, where heightened tension is again manifest. These facts explain the mechanism and the great importance of the contractility of the skin in the propulsive movement of both blood and lymph. This contractility supplies the place of the muscular coat of the blood-vessels which is absent in this situation. The elastic fibers, forming as they do a fine membrane around the blood-vessels and opposing the action of the muscular fibers, may be supposed to support vasodilatation.

2 Baruch—Principles and Practice of Hydrotherapy, p. 5.
3 Hyde and Montgomery—Diseases of the Skin, p. 35.

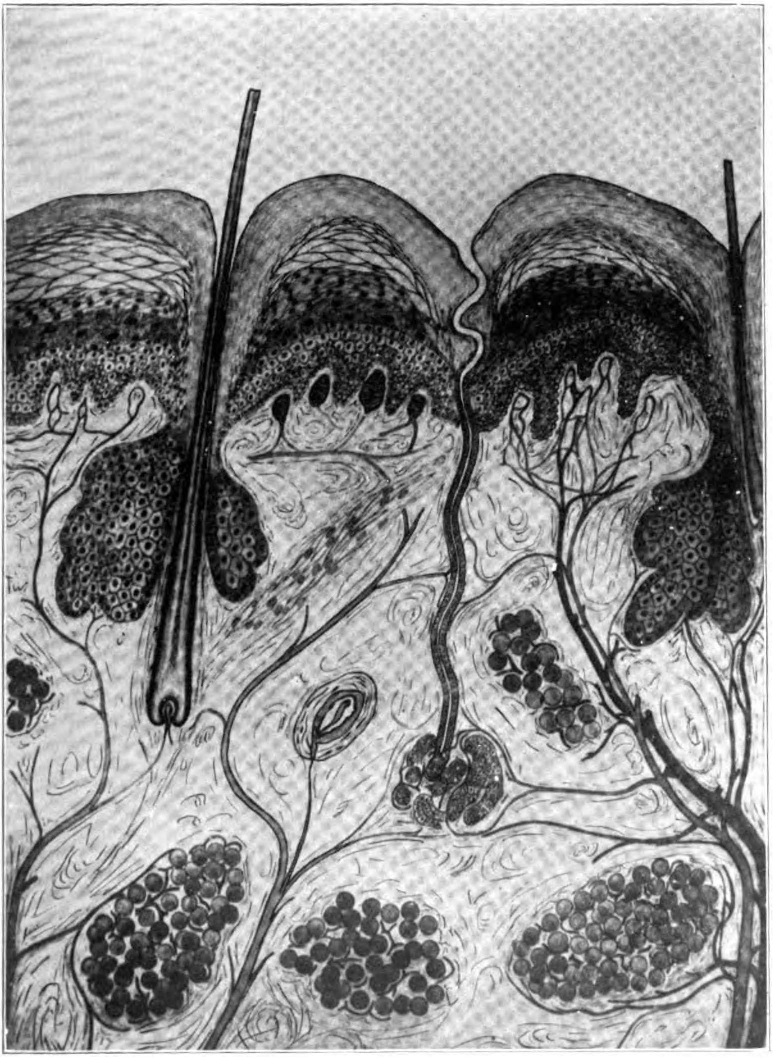

PLATE I. Diagrammatic section of the skin.

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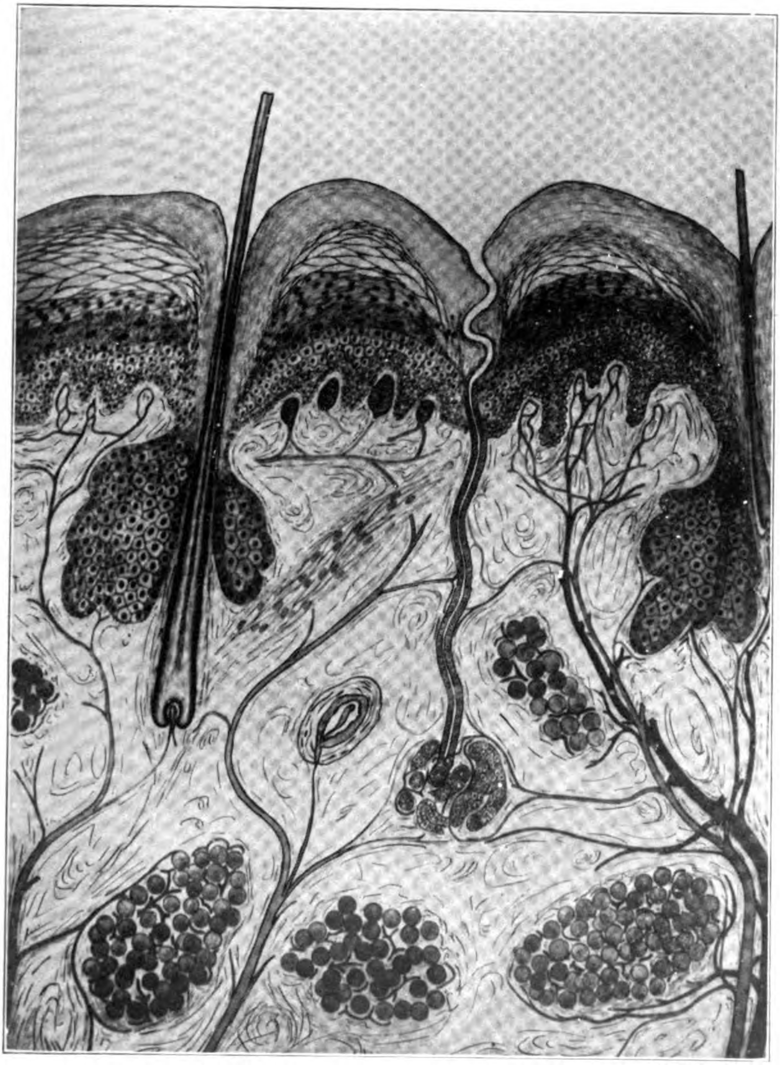

PLATE I. Diagrammatic section of the skin.

The disappearance of elastic fibers from the skin in arteriosclerosis (Meissner) where rigidity and high tension are essential accompaniments, may lend color to this view and possibly reveal something of the pathogenesis of high tension and subsequent vascular sclerosis.

THE BLOOD-VESSELS

The blood vascular system of the skin on the arterial side is arranged in two quite distinct horizontal networks—an upper and a lower, besides being especially abundant about the hair follicles and coil glands. The latter structures are surrounded by a basket-like network of blood-vessels. The lower or inferior plexus lies in the deepest part of the derma. It consists of comparatively large vessels. From this plexus, vessels extend more or less vertically upward to form the upper or subpapillary plexus. From this plexus, vascular loops extend directly into the papillæ above. "In the papillary vascular system the arteries are narrow and the veins wide."[4]

Baruch states that the papillary loop may be so filled with blood, that it may double and fold over in spiral windings until it occupies almost the entire space of the papilla. This capacity for increasing or diminishing the size of the papillary loop furnishes an important agency by which hydrotherapy may affect the circulation.[5]

Both papillary veins and arteries consist of an endothelial tube only. Near the middle of the subcutaneous tissue, the media and adventitia appear. In the veins the muscular coat is found earlier, *i. e.*, in the plexus at the base of the derma, where they also seem to possess valves.[6] In the case of the capillary vessels these coats are supplied by the musculo-elastic tissues of the skin itself, as mentioned above. Vasomotor nerves are twined around these vessels in all their ramifications.[7]

THE LYMPHATICS

"The lymph vessels of the true skin are also distributed in two layers—a deep and wide-meshed plexus (collecting trunks)

4 Hyde and Montgomery—Diseases of the Skin, p. 29.
5 Baruch—Principles and Practice of Hydrotherapy, p. 6.
6 Bohm, Davidoff, and Huber—Histology, p. 386.
7 Hyde and Montgomery—Ibid., p. 29.

in the subcutis and a superficial narrow-meshed plexus (capillaries) immediately beneath the papillæ."[8] The latter vessels (*Fig. 5.*) begin in the papillæ as an exceedingly fine meshwork of endothelial-lined and absolutely closed cul-de-sac spaces in the connective tissue. These culs-de-sac divide and anastomose in a very free manner. The capillaries of the subpapillary plexus also possess endothelial walls of their own. They are devoid of valves.

While the lymphatic capillaries communicate neither with the connective tissue spaces nor with the blood-vessels, they are nevertheless in very intimate physiologic relation with both these structures. Cellular migrations and osmotic exchanges take place readily, so that the capillaries fulfill their functions as drains, and according to Renaut, selective drains.[9] According to Unna, the interspinal spaces, delicate channelings in the cement substance between the epithelial cells, are in communication with the lymphatic spaces of the papillary region of the corium. But, as stated above, this is not an anatomic communication, but a physiological relation and is doubtless the path taken by substances which are absorbed from the skin surface. Some affirm that absorption occurs partly through the coil glands. The epithelium of excretory glands has, however, but slight absorptive powers. At their commencement in the capillaries, the lymphatics have a capacity equal to and greater than that of the veins. This diminishes, the nearer we approach to the thoracic duct, the calibre of which is much smaller than that of the vena cava.[10]

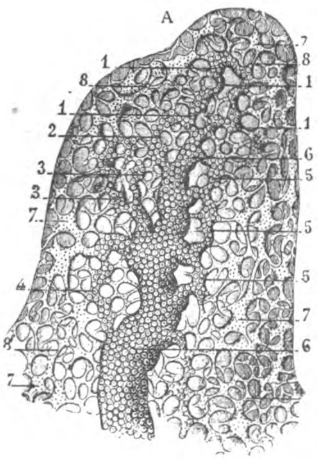

Fig. 5. Origin of lymphatic vessels in a papilla of the hand. (Sappey.)

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8 Bohm, Davidoff, and Huber—Histology, p. 387.
9 Pourier, Cuneo, and Delamere—The Lymphatics, pp. 74, 75.
10 Pourier, Cuneo, and Delamere—Ibid., p. 62.

The deep, wide-meshed plexus located in the subcutis, forms part of the superficial lymphatics (collecting trunks) of gross anatomy (*Fig. 6.*). They are larger, though very irregular and sacciform channels, dividing and anastomosing freely. The wall consists of endothelium, together with an elastic and muscular coat. They are provided with valves at variable distances. From the fingers to the axillary glands, Sappey counted sixty to eighty. These are crescentic folds of endothelium, resembling the aortic semilunar valves and arranged in pairs (*Fig. 7.*). The alternate constrictions and swellings which give the lymphatic vessels their beaded appearance are due to these valves. According to Delamere, the supravalvular enlargements are true contractile sacs, similar to the lymphatic hearts of batrachians. From the standpoint of hydrotherapy, the following statement by the same writer is significant. He says that because of the

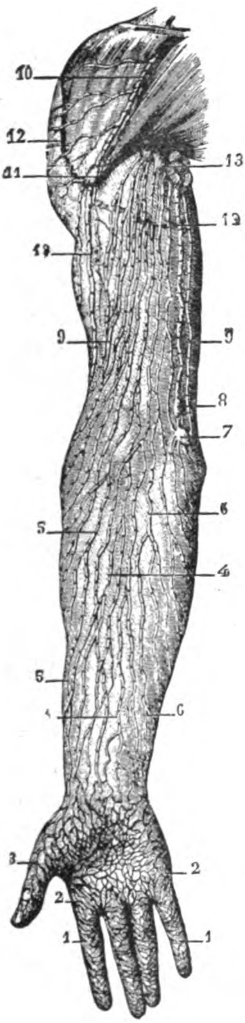


Fig. 6. Superficial lymphatics of the arm, anterior surface. Lymphatic network of fingers and palm. Collecting trunks of the arm and forearm. (Sappey.)

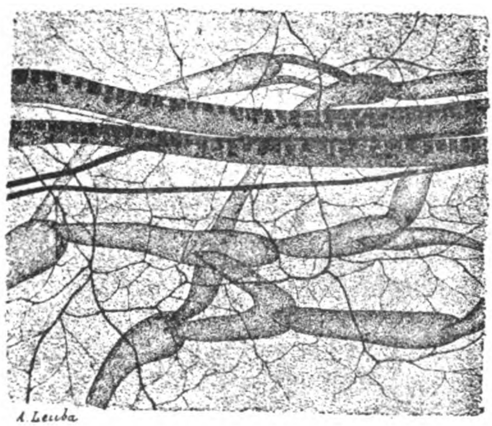


Fig. 7. Valves of the mesenteric chyliferous vessels of the new born cat. (Delamere.)

elastic fibers, connective tissue, and muscle, the lymphatic walls are, in spite of their fineness, resistant, extensible, and retractile. They withstand, without rupture, the pressure of a column of mercury of from thirty to forty centimeters.[11]

We have noted above the various structures by which the blood and the lymph vessels are rendered contractile. We ought now to consider briefly the contractility of the endothelium. This is of no little importance in those vessels, the blood and lymph capillaries, which possess no other coats. These endothelial cells contract and expand, causing changes in the calibre of the capillary channel. According to Foster[12] these contractions are allied to the changes in muscle fibers which constitute contraction. Landois[13] states that these motor phenomena are to be observed especially after irritation in the living animal. Schmetkin found nerve fibers distributed in the large blood-vessels, not only in the adventitia and media, but also in the intima.[14]

It seems, then, a well established fact that all parts of the vascular system, whether large or small, arterioles, capillaries or venules, whether blood or lymph vessels, of whatever size, all possess the power of contractility. Practically all the vessels of the body are under the control of the nervous system, through those filaments known as vasomotor nerves, or are played upon by such contractile mechanisms as the skin, which is itself influenced by stimuli similar to those of a vasomotor nature. These vasomotor fibers are said to be of two classes,—first, those which, when stimulated, produce vasoconstriction; second, those that produce vasodilatation. The controversy as to the existence of the latter, or whether vasodilatation is produced by a cessation of vasoconstrictor influences, does not concern us in the practical application of physiologic measures. While the vasomotors originate in more or less definite centers, and seem to be more abundant in certain localities and in certain nerve trunks, they are, nevertheless, distributed with other nerve fibers, and are found in all parts of the body.

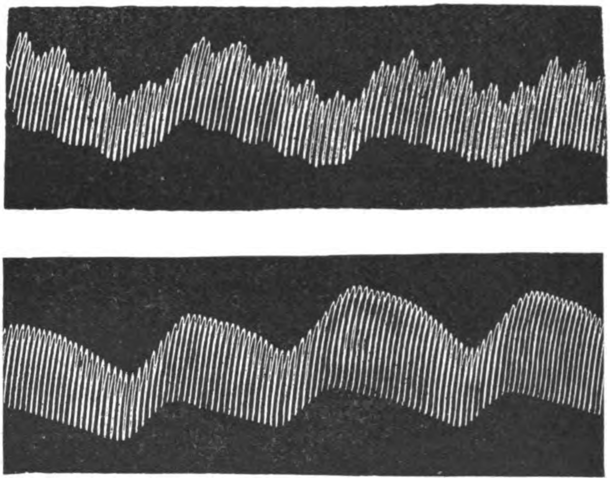
11 Pourier, Cuneo, and Delamere—The Lymphatics, p. 70.
12 Physiology, 1898, p. 289.
13 Human Physiology, 1905, p. 132.
14 Bohm, Davidoff, and Huber—Histology, p. 223.

CHAPTER IV

THE PERIPHERAL HEART

THAT the heart beat and mere mechanical elasticity of the blood-vessels (like the elasticity of rubber tubing) are not the only forces concerned in the propulsion of the blood has long been recognized. In a case of hemiplegia, following an apoplexy, there is a decided lowering of blood pressure on the affected side and a consequent stasis, as evidenced by the cyanosis and lowered temperature on this side. This can not, of course, be due to any difference in the propulsive power of the heart, since the opposite side reveals no such marked changes in its circulation. It can only be due to some disturbance of the vasomotor mechanism, resulting in changes in the blood-vessels themselves, since the causative lesion is confined to the nervous system. The writer was very forcibly reminded of this influence of the blood-vessels on blood pressure in a case of depressed fracture of the left cranial vault, the pressure from which involved nearly the whole of the Rolandic area on this side, including the speech center. The radial pulse on the right side (opposite the lesion) was scarcely perceptible, while that on the left side was strong and apparently about normal. Numerous other observations might be cited, showing the effects of vasomotor influences on blood pressure and the circulation.

We may well ask, What is the normal action of the blood-vessels which plays such an important part in the propulsion of the blood and the maintaining of blood pressure and which, when interfered with, results in such marked changes. These changes are, *a priori*, associated with and dependent upon alterations in the calibre of the vessels themselves. A lowering of pressure being due to a widening or dilatation of the vessels and an increase of pressure to the opposite condition, a narrowing or contraction of the vessels. The vascular condition entering into the normal rapidity of the circulation is neither the one nor the other extreme. A permanent widening of the vessels leads to stasis of blood, while a permanent narrowing results in heightened blood pressure, arteriosclerosis, and its resultant chain of disasters.



Figs. 8 and 9. Blood pressure tracings showing Traube-Hering curves taken from a dog. (Martin.) The upper tracing, taken while artificial respiration was being carried on, shows the three curves,—the pulse wave, represented by each double stroke; the respiratory wave, covering about five pulse waves; and the vasomotor or Traube-Hering wave, the slower undulations covering five respiratory waves. The lower tracing, taken just after the cessation of artificial respiration, shows only the pulse waves and the Traube-Hering waves.

Traube-Hering Waves. In health there are continuous and more or less rhythmic alterations in the calibre of the blood-vessels. Speaking along this line, Landois [1] says the diameter of the vessels "is subject to periodic variations, not only in the vessels provided with muscular tissue, but also in the capillaries—in the latter, in consequence of the spontaneous contraction of the protoplasmic cells that form their walls." More-

1 Human Physiology, 1905, p. 180.

over, Sir Michael Foster states that these changes which vary considerably, both in their rhythm and extent, occur without any obvious changes in either the heart beat or the general circulation, and when the animal (under observation) is apparently subjected to no disturbing causes. He regards them as spontaneous, although subject to vasomotor control.

In determining changes in the amount of blood in the arm by the plethysmograph, the fluctuations in volume, as registered by the kymograph, permit recognition of the following phenomena.[2] (*Figs. 8 and 9.*) 1. Pulsatory fluctuations due to each individual heart beat. 2. Respiratory fluctuations. 3. Certain periodic fluctuations dependent upon periodic-regulatory movements of the blood-vessels, particularly the smaller vessels.

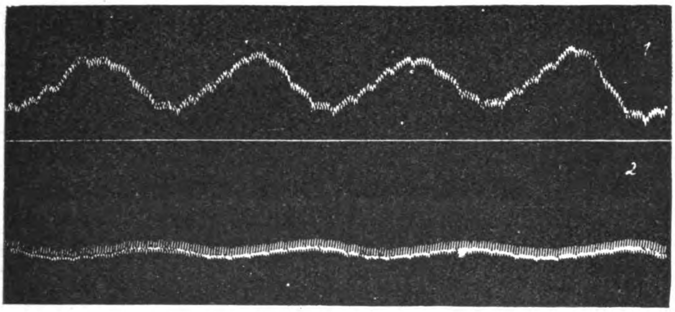


Fig. 10. Rhythmical vasomotor waves of blood pressure in a dog (Traube-Hering waves). The upper tracing (1) is the blood pressure record as taken with the mercury manometer; the lower tracing (2) is taken with a Hurthle manometer.

"Waves are often observed on the blood pressure curve, which must arise in a slow rhythmic variation of the constrictor impulses sent out from the vasomotor center. These waves are known as the Traube-Hering curves."[3] Relative to the blood pressure tracing as taken with a mercury manometer (*Fig. 10*) Howell[4] says, "The latter waves (Traube-Hering) are . . . due to a rhythmic action of the vasomotor center. During sleep, certain much longer, wave-like variations in the blood pressure also occur that are again due, doubtless, to a rhythmic

2 Landois—Human Physiology, p. 190.
3 Starling—Elements of Human Physiology, p. 276.
4 Physiology, 1908, pp. 564, 565.

change of tone in the vasoconstrictor center." Changes similar to those producing the Traube-Hering wave may also be observed in the spleen (*See Chapter X.*) and in heart muscle (*Fig. 11.*). The manifestation of periodic variations in tone is, therefore, common to the involuntary muscle of several different organs and structures. Some observers regard these tone waves as spontaneous, though subject to nerve control.

In discussing periodic variations in blood pressure Janeway[5] gives the following: "These are evident in the human being as in the animal. The respiratory and the Traube-Hering waves,

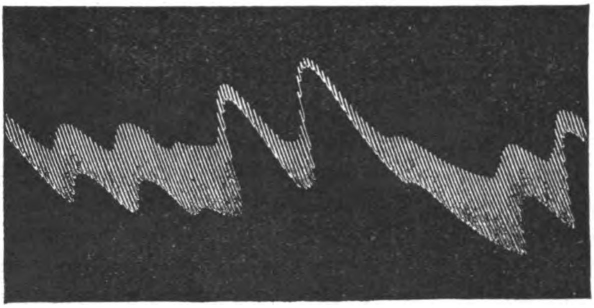


Fig. 11. Tone waves in heart muscle. The record shows contractions of a strip of the sinus venosus (terrapin's heart) suspended in a bath of blood-serum. In addition to the sharp contractions marked by the lines there are longer, wave-like shortenings and relaxations, irregular in character, which are due to variations in tone. (Howell.)

and the other less rhythmical but apparently spontaneous fluctuations in mean blood pressure, must be in mind during every clinical experiment. . . . Exact figures for the possible pressure variations due to these causes are hard to give, but their extent in animals, combined with my observations on the changes noted in patients from moment to moment, lead me to place 30 mm. Hg. as the probable maximum rise which may be attributed to them. One sees these larger fluctuations mainly in patients with hypertension. Ordinarily, 5—10 mm. would be a liberal estimate." In this connection Janeway gives a tracing (*Fig. 12.*) by Mosso, taken from a man at rest, in which the Traube-Hering wave covers on an average of fifteen pulse

5 Clinical Study of Blood Pressure, pp. 112, 113; see also pp. 16—21.

waves, thus showing a fluctuation recurring about four or five times a minute.

Events occurring in other parts of the body may give rise to large changes, so that the arterioles may become constricted almost to obliteration, or dilated to more than double their usual diameter. These observations apply to arteries, capillaries, and veins. In the vessels of the web of a frog's foot, direct treatment of the web may bring about the same changes.

Since these rhythmic vascular changes normally occur quite independently of the heart beat, we have here a factor in the circulation which, under proper physiologic stimulation, may be utilized to relieve that organ of much of its work, so that

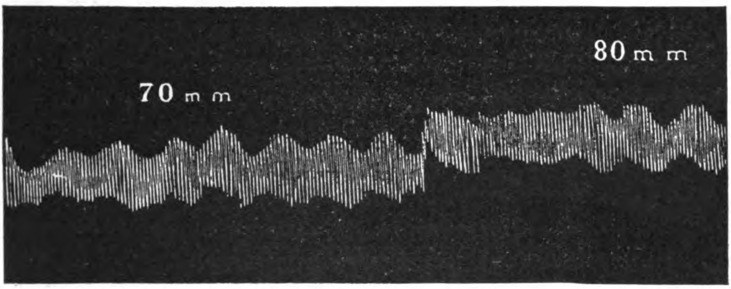


Fig. 12. Periodic fluctuations in the tracing of blood pressure taken from Doctor Colombo (at rest). (Mosso's sphygmograph.)

when overburdened, it may obtain needed rest through the slowing of the rate and the increasing of the force consequent upon this help. Landois,[6] in discussing blood pressure as altered by changes in the size of the vessels, mentions the application of heat and cold to circumscribed areas as influencing blood pressure through the vasomotor nerves. It is to the applications which bring about such changes as these that we now turn our attention.

THE PRINCIPLES OF VASCULAR EFFECTS

The underlying principle of applications calculated to awaken an activity of the circulation is found in the old dictum, *ubi irritatio, ibi affuxus*. Where there is an irritation, there is an

6 Human Physiology, p. 166.

afflux of blood. Rub vigorously the back of the hand and the skin becomes reddened with an increase of blood. Percussion or a dash of cold water produce the same results. These are examples of what we may term physiologic irritation. All forms of irritation produce an initial contraction of the blood-vessels, *i. e.*, the primary effect of an irritation from any source is contraction. The oscillatory changes which soon result (reaction) are different with the different kinds of irritation. In fact, it is this reaction with which we are principally concerned. In some cases the first effect is of no practical importance, while in others, it is utilized. Heat, for example, causes an initial vasoconstriction. The secondary vascular contractions are slight and become less and less the greater the duration of the application, so that a prolonged application of heat results in a maximum dilatation. The remote effect is not a reddening of the skin from quickened circulation, but a slight duskiness from stasis of blood (passive hyperemia). These are the effects of a fomentation, heating compress, radiant heat, etc. The reaction to heat is, therefore, of an atonic and depressing nature.

With a cold application to the skin, the first effect is a blanching (vasoconstriction), but this is soon followed by a reddening (active hyperemia) which, as we know, is maintained for a considerable length of time and does not result in a dusky color. Here, the oscillations in vascular calibre are stimulated in such a way that they are greater, more forcible and do not tend to passive dilatation. This is the reactionary effect of cold. Mechanical irritation, such as friction and percussion, give similar results. However, the two combined, as in the cold mitten friction, cold percussion douche, etc., give quicker, better, and more lasting effects.

Kellogg[7] records the following experiment as showing the advantage of mechanical irritation combined with cold. A cold compress and a percussion douche, both at 65° F., were simultaneously administered to opposite and corresponding parts for five seconds. After the cold compress the reaction appeared in forty seconds, whereas, after the cold percussion douche, the circulatory reaction appears in five seconds.

7 Rational Hydrotherapy, 1901, p. 1126.

As the cold application is prolonged, the amplitude of the vascular oscillations becomes less and less until the condition is more nearly that of a constant vasoconstriction. "Following the process to an extreme point, we find that, by intensely low temperatures, the circulation in the capillaries is at first accelerated and the number of blood corpuscles diminished, when the part becomes pale. Quickly following this acceleration there is a stasis in the capillaries, while in the smaller veins and arteries, the slowing of the circulation is followed by brief and rapid oscillations, which become slower and more infrequent. Slowly the vessels become more pale, less transparent, and finally the movements cease."[8] This is, of course, providing reaction occurs at all, as it usually does if the cold is applied to a limited area. If the reaction does not occur, as where there is a general application of cold without friction, the skin becomes blanched and goose flesh appears, due to the contraction of the erectores pilorum. In case an ice-cold application remains long enough on one part, paralysis of the vessels results and a consequent dilatation.

Saline substances and certain gaseous irritants, chief among which is CO_2, when applied to the skin, also produce an active dilatation and contraction of the blood-vessels which results in quickened circulation and increase of blood in the skin. Saline baths are often more effective than plain water. Carbon dioxide and salines are most effectively used in the combination constituting the Nauheim or effervescent bath. Here the cool water itself plays some part, since temperatures somewhat below neutral are used. "So marked is the effect of this skin tonic that in severe cases of dilatation (of the heart) the almost incredible result is attained, of causing the apex actually to retract three quarters of an inch toward its normal position in a single treatment."[9] The heart beat is decreased in frequency and increased in force; its previously labored beat gives way to a steady, easy movement and, in some cases, we have actually been unable to detect murmurs which were previously distinctly heard. These results are by all conceded to be due chiefly, if

8 Baruch—Principles and Practice of Hydrotherapy, p. 39.

9 Baruch—Ibid., p. 10.

not almost wholly, to the stimulation of the great vascular area of the skin, the so-called "peripheral heart" or "skin heart." When we consider the magnitude of this peripheral heart, it no longer becomes a wonder that its influence is so powerful. Vierordt estimates the combined calibres of the capillaries of the systemic circulation at 800 times that of the aorta in cross section. With this fact in mind, we may gather some idea of the magnitude of the effect produced by saline and gaseous irritants acting simultaneously upon such a great system of contractile tubes. Such results can not be obtained by digitalis or strychnine. That these results are not due to simple atonic vasodilatation is shown by the fact that these patients are frequently cyanotic, an evidence of already existing venous stasis and vasodilatation, while on emerging from the bath, the skin is of a brighter and more normal color. Neither vasodilatation nor vasoconstriction are conducive to a slower, easier heart beat. The result is, therefore, not a passive change, but an active one.

Electric currents applied to the skin also stimulate the vasomotors. Near the positive pole vasoconstriction is manifest, while in the region of the cathode vasodilatation occurs. With alternating or interrupted currents the vasomotors are much more powerfully stimulated. This stimulation is greatest with the sinusoidal current, the use of which in the obtaining of vascular effects will be mentioned more in detail in the part on therapeutics.

THE QUANTITY OF CIRCULATING FLUIDS

When we consider the total quantity of blood and lymph in the body, and the fact that the skin and adjacent tissues may contain a large share of this, or influence its distribution elsewhere, we see how powerful an agent the skin is in controlling the circulation of these fluids in the various organs.

About one-thirteenth of the body weight is blood. Of this, nearly 30 per cent may be contained in the skin under the influence of certain conditions and applications. Ordinarily, there is one-fourth of the blood in the heart, lungs, and great blood-vessels; one-fourth in the liver; one-fourth in the skeletal muscles; and one-fourth in other organs. The circulation of the skeletal muscles is influenced with that of the skin, and usually the same changes occur simultaneously in both.

The amount of lymph in the body is variously estimated from one-fourth or one-fifth to one-third of the entire body weight.[10] This enormous quantity of fluid is affected in the same way by physiologic applications as the blood.

Kowalski,[11] in 1901, reported a series of experiments undertaken to determine the effects of thermic irritants upon the movement of lymph and upon the vasomotor nerves of the lymph vessels. Briefly stated, his conclusions are as follows:—

Thermic irritants control the flow of lymph, not only indirectly, but also by altering the calibre of the lymph vessels. These changes are the same as those in the blood-vessels, *i. e.*, low temperatures contract them, while high temperatures dilate them. These effects are produced through the nervous system by way of the vasomotor nerves. The vasomotor nerves of the lymphatic vessels act independently of those controlling the blood-vessels and general circulation. It will be seen from this that the use of the alternate hot and cold leg bath for œdema is based upon demonstrated physiologic facts, the lymphatics as well as the blood-vessels taking part in the absorption of tissue fluids.

Experiments on the production of lymph in the limbs have also brought out in a very striking manner the rationale of massage in dropsy. In the resting limb there is no flow at all from the tissue spaces. Berlin blue injected under the skin finds its way into the lymphatics with extreme slowness, unless absorption is facilitated by kneading the limb or by carrying out passive movements. "Ludwig has shown that the lymphatics of the aponeuroses are so arranged that every movement, active or passive, tends to pump fluid from the tissue spaces into the lymphatics, and from the smaller into the larger lymph trunks. Experiments on the production of lymph in the limbs have, therefore, always to be associated with kneading or passive movements in order to get any lymph flow at all."[12]

10 Pourier, Cuneo, and Delamere—The Lymphatics, p. 7.

11 Blätter für klinische Hydrotherapie, January and February, 1901.

12 Starling—Fluids of the Body, p. 72.

CHAPTER V

ANATOMY AND PHYSIOLOGY OF THE SKIN

(Continued)

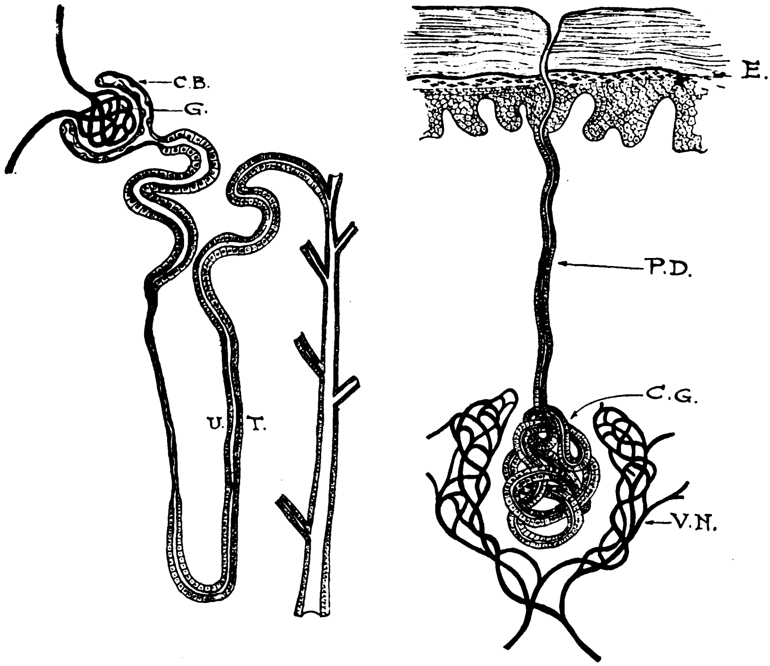
THE SUDORIPAROUS OR COIL GLANDS

THE sweat glands are distributed throughout the entire skin. They are most numerous in the axilla, palms, and soles, where they are also of unusual size. And, according to Krause, there are between 2000 and 3000 per square inch. The total number in the body is estimated at from 2,000,000 to 3,000,000, and their aggregate length uncoiled and placed end to end, as about eight miles; while the total surface of the ducts is estimated at 11,000 square feet. These figures serve to show the great importance of hygiene directed toward the maintaining of their normal functions and the tremendous effect of bad hygiene in causing disease.

The sweat gland consists of a long tubule, coiled at the deeper end. The globular coil (glomerulus) lies in the subcutaneous fat, or in the fat columns of the deeper part of the corium. Next to the epithelium in the coiled part of the tubule, are found smooth muscle fibers, disposed longitudinally, or spirally. These muscle fibers are doubtless concerned, along with the erectores pilorum, in the checking of perspiration which results from cold applications. Each tube is about four or five millimeters long. Three-fourths of this makes up the coil.[1] The sweat pore—that part of the duct lying in the epidermis—is a wall-less channel, spiral or straight in course. The outer end is funnel-shaped. The pore is in free communication with the juice spaces of the epithelium, as was mentioned in considering the lymphatics of the skin. It will be seen from

1 Bohm, Davidoff, and Huber—Histology, p. 397.

this fact that the drying of the skin is not alone a drying of the surface, but also a drying of the fluid found between the deeper cells of the epidermis. A capillary network of blood-vessels surrounds the coiled part of the gland. Nerves from the sympathetic neurons end in the secreting cells.



Figs. 13 and 14. Diagrams showing similarity in structure of the tubules and glomeruli of the kidney to the coil glands of the skin and their vascular network. As the uriniferous tubules are many times the length of the coil glands, no comparison of the size is indicated by the drawings. Fig. 13. U. T.—uriniferous tubule, C. B.—capsule of Bowman, G.—glomerulus. Fig. 14. Sudoriparous gland: E.—epithelium of skin, P. D.—perspiratory duct, C. G.—coiled portion of gland, V. N.—vascular network.

The secretion of the sweat glands varies with the character and amount of food and drink, the state of health, temperature and humidity of the air, etc. About 98 per cent is water,[2] the remainder being chiefly salines, pigment, and a small amount of fat. In twenty-four hours, one and one-half or two pints of water are excreted. This is approximately double the amount

2 Hyde and Montgomery—Diseases of the Skin, p. 46.

exhaled by the lungs. Contrary to the general notion, the skin does not excrete large quantities of deleterious substances. *In health* the poisons excreted by the skin are very small in amount.

Vicarious Functions of the Skin. There is a great similarity in the structure of the tubules and glomeruli of the kidney to the coil glands of the skin and their vascular tufts (*Figs. 13 and 14.*). This very similarity in structure suggests a similarity in function. The perspiration and urine are both excretions and, to a great extent, may replace each other. In disease this fact becomes very evident. When the kidneys become incompetent to excrete certain wastes, these are often found in the sweat and, *vice versa*, when perspiration is interfered with, more work is thrown on the kidneys. In warm weather excessive perspiration occurs, while the urine is scanty. In cold weather the perspiration decreases and the urine increases in amount.

Urea, normal in the urine to the extent of about 2 per cent, is found in normal perspiration to the extent of 0.1 to 0.2 per cent. Schottein, in certain cases of the uremia of cholera, saw the whole body covered with a thin white crystalline layer of urea.[3] In cases of pyemia, where the staphylococcus albus was present in the blood, the sweat induced by packs has shown abundance of the staphylococcus. The same is true of many other diseases in which there are germs in the blood (bacteriemia), the kidneys also excreting the germs. Bouchard[4] has called particular attention to the cutaneous eruptions which accompany auto-intoxication, especially with a dilated stomach, or after eating mussels, shell-fish, etc., as being due to ptomaines eliminated through the skin. In some forms of auto-intoxication various poisons excreted by the skin may be appreciated by their odors. The peculiar odors about prisons and asylums are doubtless more or less due to the volatile poisons of faulty nutrition which the skin exhales. In cases of jaundice bile pigments are found in the sweat so that sheets and bedding are stained by it. Sugar may be found in the sweat of diabetics and in the sweat of cases of forced glycosuria.

Dr. Herbert U. Williams of Buffalo has shown[5] that in

3 Baruch—Principles and Practice of Hydrotherapy, p. 26.
4 Auto-Intoxication in Disease, pp. 20, 162.
5 Journal of American Medical Association, April 17, 1909, p. 1276.

chronic nephritis the sweat glands are extensively altered in structure. He examined skin from various parts in seventy cases of chronic nephritis and found a variety of conditions including desquamation of the epithelium, cystic dilatation of the tubules, atrophy of the tubules, and cast-like material in the tubules. In fourteen cases arteriosclerosis of the arteries of the skin was present. In some cases hypertrophy of the epithelium was observed, even to the formation of two or three layers of cells. Dr. Williams states that these studies were undertaken because, from the earliest ages, faith has been placed in the efficacy of active skin excretion in cases of nephritis.

SUMMARY OF PERSPIRATORY INFUENCES

Factors which govern perspiration:—

1. Degree of internal or external heat.
2. Amount of water in the body.
3. Amount of blood in the skin.
4. Specific stimulation of secretory (sweat) nerves, as by electricity, shock (as cold sweat of fright, etc.), and drugs.

Conditions that give rise to increase of perspiration:—

1. Applications of heat, as hot air, hot water, steam, light.
2. Water drinking, especially of hot water.
3. Exercise.
4. Mechanical irritation, as friction or percussion.
5. Diaphoretic drugs.

Conditions that decrease perspiration:—

1. Chilling or cold applications.
2. Excretion of large amounts of water by the kidneys or bowels.
3. Certain drugs, as atropine.
4. Local applications of astringents, or cooling preparations, as alcohol, vinegar, talcum powder, etc.

The facts listed in the above outline are perhaps too evident as matters of every-day experience to need comment. In practice we usually combine two or more of these measures in order to secure quicker and better results. For example, the drinking of cold water before and during the electric light bath greatly enhances its results. The drinking of hot lemonade in conjunction with hot packs, vapor or Russian baths, likewise gives quicker results. Heat applied to the skin, not only increases the blood about the coil glands, but also stimulates, directly, the secreting cells. Cold, applied to the skin, causes a decrease in the amount of the blood in the skin and so lessens the available fluid which the sweat glands utilize for secretion.

It has been shown that drugs having a specific action upon the sweat glands, cause alterations in the structure of the secreting cells, thus proving detrimental to their healthy activity.

THE SEBACEOUS GLANDS

The sebaceous glands are sacciform in shape, found in connection with the hairs of the skin and pouring their secretion into the follicles of the hair and lanugo. The oil or sebum is produced by fatty degeneration of the gland cells themselves; more cells being produced next the basement membrane to take their place. It is designed to oil the hair and skin. The glands are situated next the hair follicle, between it and the piliary muscle. Heat softens the oil in the glands, and thereby brings about its extrusion. Oil is a non-conductor of heat. Covering the skin with oil hinders both the elimination of heat where the surrounding atmosphere is cold, and the absorption of heat where the atmosphere is heated.

ABSORPTION BY THE SKIN

We are not greatly concerned in hydrotherapy with the absorptive powers of the skin. Oily substances are most readily absorbed, watery solutions not at all. Absorption of oily substances, alcoholic or ethereal solutions is greater after a warm bath and cleansing of the skin, since the sweat pores are then open and the increased circulation favors absorption.

Guy Hinsdale[6] gives an excellent summary of the subject of cutaneous absorption from which we quote the following:—

"James Currie, who wrote one of the first and best books on hydrotherapy, states that there is no increase of weight in the bath, and while the skin remains sound and entire no absorption of solid, liquid, or aeriform elastic fluid takes place on the

6 Hydrotherapy, p. 21.

surface. In the instances that are supposed to favor the contrary opinion, it will be found that the article is forced through the epidermis by mechanical pressure, or that the epidermis has been previously destroyed by injury or disease."

Röhrig in experimenting with a bath to which potassium iodide had been added, found that full immersion in this for three-quarters of an hour gave rise to no iodine in the urine. Negative results have also been obtained by a number of other observers using various soluble substances. Substances causing injury to the skin may be absorbed, also ethereal solutions of certain alkaloids, but R. Winternitz found no evidence of the entrance of these substances from watery solutions.

One must, therefore, conclude that the mineral constituents of water—other than strong salines and gaseous constituents—have no effect whatever upon the human system when applied to the unbroken skin. Hinsdale makes a very apt statement of the case, "We are thus forced to the conclusion previously enunciated,—that the mineral waters, the analysis of which are quoted with such particular exactitude unto the third or fourth decimal place of grains per gallon, are neither more or less efficacious on that account."

CUTANEOUS RESPIRATION

To a limited extent, the skin acts as a respiratory organ when the temperature is above 85° F. About 0.5 per cent of the total gaseous exchange of the body occurs in this manner. The amount of CO_2 exhaled at 91.4° F. may be doubled at 93° F., increasing in about the same ratio as the watery excretion. Hot moist applications to the skin increase the elimination of CO_2, since diffusion of gases is hastened by the moistening of the surface and the larger amount of blood brought to the skin. It is said that, in diseases of the heart and lungs, where there is diminished excretion of CO_2 in the expired air, cutaneous exhalation is increased. In asthmatic dyspnœa when the skin becomes flushed and perspiration free, the dyspnœa is somewhat relieved. General perspiration produced by hot applications also relieves dyspnœa. In either case, however, the result is probably due more to the increased rate of the circulation of blood through the lungs reflexly produced by the application, thus increasing the amount of oxygen there absorbed, than to increase of cutaneous respiration.

THE SKIN A HEAT REGULATOR

This will be considered again under the subject of heat regulation. The skin itself takes part in heat loss only, although through nerve connection, it is one of the most important means in controlling heat production. "The loss of heat by the skin amounts to about 77 per cent of the total heat loss."[7] It is, therefore, the most important factor in the elimination of heat. The regulation of heat loss by the skin is accomplished by variations in the amount of heat radiation and evaporation of sweat.

It will be seen that heat applied to the skin increases heat loss in two ways: first, by dilating the surface vessels and quickening cutaneous circulation, thus increasing heat radiation and convection; second, by inducing free perspiration and the consequent loss of heat by evaporation. Conversely, cold applied to the skin decreases heat loss by driving the blood inward and checking perspiration.

It is chiefly through the temperature nerves of the skin that this organ influences heat production. So profound is this influence that extensive burns, covering more than two-thirds of the body, are fatal through destruction of the sensory nerve terminals. Not only is heat elimination interfered with, but metabolism becomes excessive and heat production is immensely increased. Internal congestion and inflammations result, with a fatal termination.

After a drunken debauch the unfortunate victim is in great danger from exposure to cold, because the sensibility of the nerves is temporarily destroyed, so that the heat-regulating centers are not apprised of the danger. The boy who died from gilding of the skin to represent an angel is an example of the disturbance of the heat mechanism due to interference with the regulatory functions of the skin. After varnishing of the skin the temperature at first rises and then falls accompanied by symptoms of poisoning due to defective oxidation.

7 Starling—Human Physiology, p. 505.

NERVES OF THE SKIN

We have already considered the secretory and vasomotor nerves of the skin. The third set of cutaneous nerves of importance in hydrotherapy are those already mentioned as forming the connection by which the skin regulates heat production and loss, *viz.*, temperature nerves. These nerves are not uniformly distributed in the skin. They are more numerous in certain localities than in others, and where more numerous, the temperature sense is more acute, such as the tips of the fingers, the cheeks, and backs of the hands. These are the parts we instinctively use to test the safety of hot-water bottles and other hot applications.

The recognition of heat is confined to the "hot spots" and that of cold to the "cold spots," as can readily be proven by experiment. Lightly resting the point of the pencil on the skin will produce a sensation of heat or cold according as it rests on a hot or cold spot. The two sensations are appreciated by different end organs and travel by different fibers.

Applications to certain localities produce more intense temperature sensations than to others. Applications to a large area produce a greater intensity of sensation than applications to a smaller area. These facts are utilized in controlling the circulation reflexly and mechanically (*q. v.*). The temperature sense is more acute when the skin is warm or after warm applications. This fact is utilized to prepare the body for cold applications, so that the reaction will be greater and appear more promptly. As has been mentioned, the temperature of the skin is the zero of the temperature sense.

The skin contains also the end organs of tactile sensation. They are more numerous in certain localities than in others, as are the temperature nerves, and likewise serve to make the connection by which cutaneous applications influence internal parts.

CHAPTER VI

THE CIRCULATION—REFLEX EFFECTS

DURING health, there are vasomotor influences constantly playing upon the arteries in all parts of the body. These influences hold the vessels in "tone," *i. e.*, control the rhythmic oscillations in calibre, so that blood pressure is maintained. These influences seem to emanate from a vasomotor center which is located in the medulla oblongata in the floor of the fourth ventricle. "Irritation of this center causes contraction of all the arteries and, in consequence, increase in arterial blood pressure." "Paralysis of the center causes relaxation and dilatation of all the arteries, with enormous reduction in blood pressure. Under normal conditions the vasomotor center is in a state of moderate tonic excitation."[1] While this center exercises a controlling influence over all, it is not the only vasomotor center. "Centers for the vascular nerves, both vasomotor and vasodilator, are distributed throughout the entire spinal axis." (*Plate II.*) "They can be excited reflexly, although they are subordinated to the dominating centers in the medulla oblongata."[2] "It is obvious that such a mechanism as that described . . . is susceptible of reflex stimulation through sensory nerves, and according to our general knowledge we should suppose that a tonic center of this kind may have its tonicity increased (excitation) or decreased (inhibition)."[3] It is to the reflex stimulation of these centers that we now wish to turn our attention, for through this channel, hydrotherapy produces some of its most important effects.

1 Landois—Physiology, 1905, p. 762.
2 Landois—Physiology, p. 735; see also Howell—Physiology, p. 564; and Foster—Physiology, 1898, p. 285.
3 Howell—Physiology, p. 560.

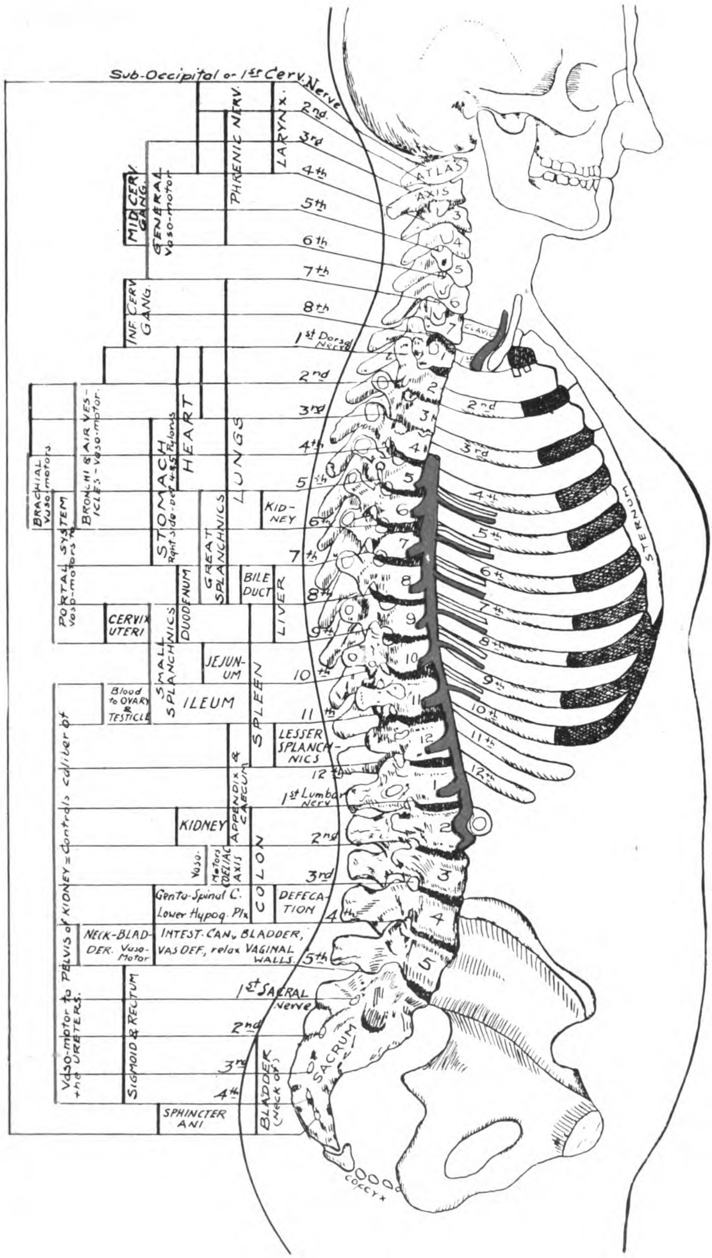


PLATE II. Visceral sympathetic nerves. Diagram showing the areas of exit from the spine of the sympathetic nerves controlling the various organs of the body. The red lines in the table indicate vasomotor areas. Stimulation of the centers from which these sympathetic nerves originate affect the organs supplied by them. (Pilgrim.)

Maximilian Schüller,[4] in experimenting on trephined rabbits, observed that severing single nerve trunks on one side of the animal produced a distinct (though transient) dilatation of the pial vessels on the corresponding side, thus proving that the blood-vessels of the piamater are held in steady tone by continuous excitation from the cutaneous sensory nerves. This result was observed only on the side of the severed nerve so that it could not have been due to shock or pain.

"Naumann has demonstrated clearly that the effects of external irritants upon the circulation within the body are really reflex. He separated the head of a frog from the body, leaving them connected by the medulla oblongata only. He next severed one leg, after preventing loss of blood by tying the vessels, so as to leave it connected with the body by the sciatic nerve. Now he applied thermal, chemical, and electric stimuli to the foot of the partially severed leg, while he observed, under the microscope, the mesentery of the frog. Shortly after gentle irritation of the peripheral endings of the sciatic nerve in the foot, the circulation in the vascular network of the lungs and mesentery was accelerated, and resumed the former condition slowly after the withdrawal of the irritant. A more severe irritation produced retardation of the flow, and even stasis occurred, as if the heart had become temporarily paralyzed. A strong irritant produced dilatation; a feeble one, constriction of the vessels. The effect of these peripheral irritations on the heart was also noted. A strong irritation of the skin weakened its circulation; a feeble irritant strengthened it. As there was no possible vascular or nerve channel from the part irritated to the part thus visibly affected, the conclusion is inevitable that the effect is entirely reflex. Hot water acted precisely as other irritants."[5] These experiments also prove that there are two reflex means by which the circulation may be influenced, *viz.*, reflex stimulation of the vasomotors, producing changes in vascular calibre, and reflex stimulation of the heart muscle itself. Another point, brought out by the experiments of Röhrig, is that when intense cutaneous irritants pro-

4 Deutches Archiv für klinische Medicin, No. 4, 1874.

5 Baruch—Principles and Practice of Hydrotherapy, p. 37.

duce considerable slowing of the heart beat, they also increase its force. This is the effect of a prolonged cold application, whether general, as with the Brand bath, or local, as with the ice bag to the precordia.

REFLEX AREAS

The fact of reflex stimulation being established, we may next consider the location (topography) of the various reflex areas. While the brain, heart, and other viscera may be reflexly influenced by stimuli applied to many different cutaneous areas, some even very remote from these organs, the maximum effects are produced by stimulation of certain very definite and well recognized areas. In general, it may be said that the skin over an organ is reflexly related with that organ. In most cases, it is not difficult to trace the nerve connection.

"In general, the skin overlying an organ is reflexly associated with it, which is the reason why applications of electricity over an organ usually influence it, and not altogether because the current is passed through the organ. When these areas are studied comparatively, it is noted that they are practically the same as those regions pointed out as showing reflex pain, which would suggest a nervous path from the organ to the skin and from the skin to the organ, the terminations of which are in the same visceral and cutaneous fields."[6] So definite and circumscribed are some of these areas that B. G. A. Moynihan has frequently observed, in cases of duodenal ulcer, a small hypersensitive spot in the skin covering the abdomen, directly over the ulcerated area. It is no larger than a six-pence and he attaches much value to this phenomenon in differentiating ulcer.[7]

It must not, however, be supposed that the reflex path from the viscera to the skin over which pain is referred is the same path as that utilized in therapeutics for reflex effects upon the internal organs. Nor are the skin areas to which pain is referred *always* the same areas that should be utilized to

6 S. D. Ludlum—The Relationship between the Spinal Cord, the Sympathetic System and Therapeutic Measures—Journal of American Medical Association, May 2, 1908, pp. 1401—1405.

7 W. D. Haines—The Differential Diagnosis of Duodenal Ulcer and Gall Stones—Surgery, Gynecology, and Obstetrics, March, 1908, p. 279.

influence reflexly the organ in which the cause of pain is located. For example, in the case of liver and gall-bladder disease, there is frequently a pain in the region of the right shoulder or shoulder blade, but it is not to this region that applications are made to relieve distress due to hepatic or biliary affections.

The various cutaneous areas to which the pain or tenderness, due to visceral disease, is referred, are spoken of as the *dermatomes of Head.* They are in some cases of considerable service in diagnosis and are sometimes serviceable as a guide in the placing of therapeutic applications. They can not, however, be implicitly relied upon for either purpose. Relative to this unreliability Abrams[8] says, "The elicitation of the dermatomes of Head is a tedious method of examination and not always accompanied by satisfactory results for the reason that a great amount of experience is necessary. Alsberg in the examination of two hundred women (with gynecological affections) found cutaneous areas of hyperalgesia in only seventeen, ten of whom were hysterical. Therefore, he could attribute no diagnostic import to the zones in question beyond commenting on the fact that hysterical stigmata must be excluded before the zones of hyperalgesia could be regarded as trustworthy." Diagnosis and therapeutics based on para-spinal tenderness must, therefore, be of a highly imaginative character and especially so when approached from the standpoint of a prejudgment as to the causes of disease and consequently its treatment.

The law that the skin over an organ is reflexly related with that organ may be regarded as an *amplification* of Hilton's law: *The principal nerve to a joint not only supplies the articular surfaces but also some of the main muscles that move that joint and the skin over these muscles.*[9] In the case of the viscera, however, the deeper part of the reflex arc consists of a sympathetic neuron.

THE REFLEX ARC

The reflex arc consists of several parts (*Frontisplate and Fig. 15.*). In general, the following is the path taken by a stimulus arising in the skin from a thermic application and traced as a

8 Spondylotherapy, p. 71.
9 Treves—Applied Anatomy, 1901, p. 209.

reflex stimulus to the organ underlying the skin surface treated. From the skin it is conveyed by a sensory (temperature) nerve along a nerve trunk to the posterior root of the spinal nerve; entering the posterior root ganglion, where the fiber is seen to be the distal axon of a T-cell, it passes on through the central axon of the T-cell into the posterior side of the spinal cord. On entering the cord, the fiber immediately divides into an ascending and descending branch, both located in the posterior white columns and which give off collaterals to the gray matter.[10] The ones we are concerned with end in tufts about the cells of the column of Clark. According to Starling,[11] the vasomotor center in the medulla corresponds in position to the column of Clark which is doubtless that which represents the vasomotor center throughout the rest of the cord. From these cells, axons pass either into Gower's tract and end in the cerebellum,[12] or pass out with the anterior root, and through the white ramus to the ganglion of the lateral sympathetic chain.[13] Passing directly through this or up or down through an adjacent ganglion, they end in a peripheral ganglion from which the viscus is supplied.

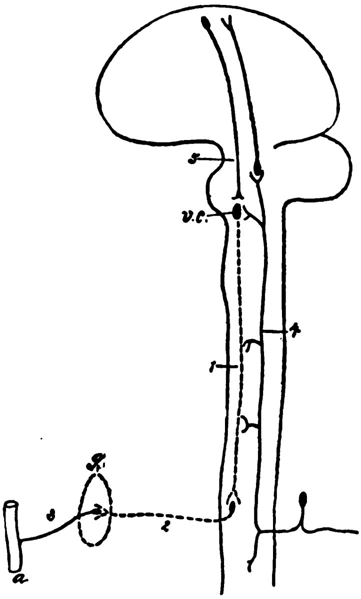


Fig. 15. Diagram to show path of vasoconstrictor fibers from vasoconstrictor center to the blood-vessels and the path for reflex stimulation. v. c.—the vasoconstrictor center, 1.—the central neuron of the vasoconstrictor path, 2.—the spinal neuron (preganglionic), 3.—the sympathetic neuron (ganglionic), a.—the arteriole, 4.—the sensory fibers of the posterior root connecting by collaterals with the vasoconstrictor center and subcenters, 5.—fiber from cortical cell acting upon the vasoconstrictor center. (Howell.)

"The fibers of the white ramus which pass through the ganglion and go to the periphery are known as the *splanchnic efferent*

10 Whitaker—Anatomy of the Brain and Spinal Cord, p. 38.
11 Physiology, p. 259.
12 Ludlum—Journal of American Medical Association, May 2, 1908, p. 1403.
13 Whitaker—Ibid, p. 39.

fibers, and constitute the *secretory* fibers of the splanchnic glands and the *motor* fibers of the *muscular* tissue of the splanchnic *blood-vessels* and *viscera*.''[14]

By studying carefully the above reflex path, it will be noted that a stimulus may affect (be shunted to) cells either above or below (*Fig. 15.*) the level at which it enters the spinal cord. And again, the fiber that conveys the reflex stimulus to the viscera may pass up or down in the gangliated cord. This fact is of importance in explaining why cutaneous nerves are connected reflexly with splanchnic nerve trunks not arising in the same segment of the cord.[15]

Of the many reflex paths, we may pick out two as serving to quite fully illustrate reflex effects. First, let us study the reflex arc concerned in the effect produced by an ice bag applied to the precordial region. And second, the arc concerned in the reflex between the skin of the epigastrium and the stomach.

The Heart. Before considering the reflex arc, we should understand that the heart is supplied with nerves from two sources. (*Plate III.*) First, through the vagus nerve (fibers of accessory part of the spinal accessory nerve) with inhibitory fibers, *i e.*, fibers which when stimulated slow the heart beat and increase its force. Second, by accelerator fibers, which when stimulated increase the rapidity of the heart beat through the cardiac sympathetic nerves from the inferior cervical ganglion. The accelerator fibers emerge from the spinal cord in the anterior roots of the second, third, and fourth thoracic spinal nerves and, according to some authors, are found also in the first and fifth thoracic nerves.[16] From these spinal nerves they pass to the corresponding sympathetic ganglia of the lateral chain through the white rami communicantes, and thence upward to the inferior cervical ganglion.

The ice bag applied to the precordia covers the skin supplied by the second, third, fourth, and fifth thoracic nerves. The stimulus (of a depressing nature), produced by the cold applica-

14 Gray's Anatomy, 1905, p. 1071.

15 Each segment of the spinal cord may be regarded as a unit and possessed of sensory, motor, vasomotor, secretory, and trophic functions. The roots and peripheral nerves derived from a given segment are an integral part of that segment. The connection of one segment with another does not interfere with this conception.

16 Howell—Physiology, 1908, p. 542.

tion, is carried to the spinal cord by the nerve fibers of these thoracic nerves which end in the same segments in which the accelerator fibers of the heart arise. (*Frontisplate.*) The reflex stimulus produced by the afferent impulse (sensation of cold) upon the cells in the column of Clark is conveyed outward by the axons of these cells through the anterior roots and by way of the white rami reaches the sympathetic ganglia through which they pass to the inferior cervical ganglion, and thence by the inferior (sympathetic) cardiac nerve, to the deep cardiac plexus and the heart muscle. The accelerator mechanism being depressed, the heart beats slower and with greater force from the proportionately greater action of the inhibitory nerves.

An ice bag over the heart produces its action by depressing the accelerator (sympathetic) nerves and not by stimulating the vagus, as has been claimed by some; which latter, it will be seen, would be impossible, since the prolonged cold of the ice bag exerts a depressing and not a stimulating effect, which latter must be the case were slowing produced through the vagus.

The Stomach. The skin over the pit of the stomach is supplied by the seventh and eighth intercostal nerves.[17] The great splanchnic nerve is formed by branches from the thoracic ganglia between the fifth or sixth and the ninth or tenth. It terminates in the semilunar ganglion of the solar plexus.[18] From the solar plexus, (cœliac part) fibers accompany the blood-vessels to the stomach.

"The nerves supplying the abdominal muscles and the skin are derived from the lower intercostal nerves and are intimately connected with the sympathetic nerves supplying the abdominal viscera through the lower thoracic ganglia from which the splanchnic nerves are derived."[19]

These reflex arcs may be traced out in the case of other organs and areas. While an application to the skin over an organ gives a maximum effect, applications to even very distant areas may be quite effective. For example, hot applications to the feet do not, under ordinary conditions, influence reflexly the circulation of the brain. But under conditions of vasomotor

17 Gray's Anatomy, 1905, p. 997.
18 Ibid, p. 1079.
19 Ibid, p. 997.

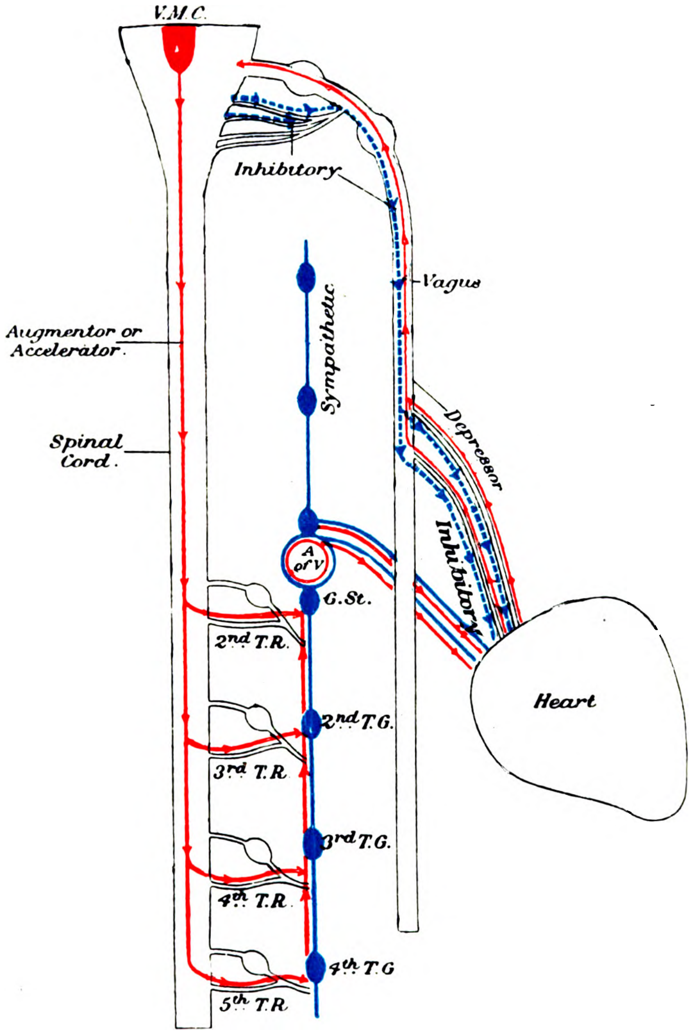


PLATE III. The innervation of the heart. (Powell.)

instability, such as that following a sunstroke, a hot foot bath may cause congestion of the brain (personal observation).

SPECIAL REFLEX AREAS

The following are the principal reflex areas employed in hydrotherapy (*Fig. 16.*):—

1. The skin areas of the face, scalp, and back of the neck are reflexly related with the brain.
2. The skin of the neck is reflexly related with the pharynx and larynx.
3. The back of the neck is reflexly related with the mucous membrane of the nose.
4. The skin of the chest (front, back, and sides), dorsal region, and shoulders has reflex relations with the lungs.
5. The precordia is in very perfect reflex relation with the heart through its accelerator nerves.
6. The hands are related with the brain and nasal mucous membrane.
7. The skin over the lower right chest, with the liver.
8. The skin over the lower left chest, with the spleen.
9. The skin over the lower third of the sternum, with the kidneys (Kellogg.).
10. The mid-dorsal spine (from fifth to seventh vertebræ) is related with the stomach.
11. Lower dorsal and lumbar spine, with the kidneys and intestines.
12. The lower lumbar and sacral spine, with the pelvic organs —uterus, ovaries, bladder, and rectum.
13. The epigastrium, with the stomach.
14. The skin of the entire abdomen, especially that of the umbilical region, is reflexly related with the intestines. The fact that the pain of colic, appendicitis, etc., is referred to the region of the umbilicus is an evidence of a similar nervous connection.
15. The lower abdomen, including the groin and also the upper inner surfaces of the thighs are reflexly related with the pelvic organs.
16. The skin of the feet and legs is reflexly related with the

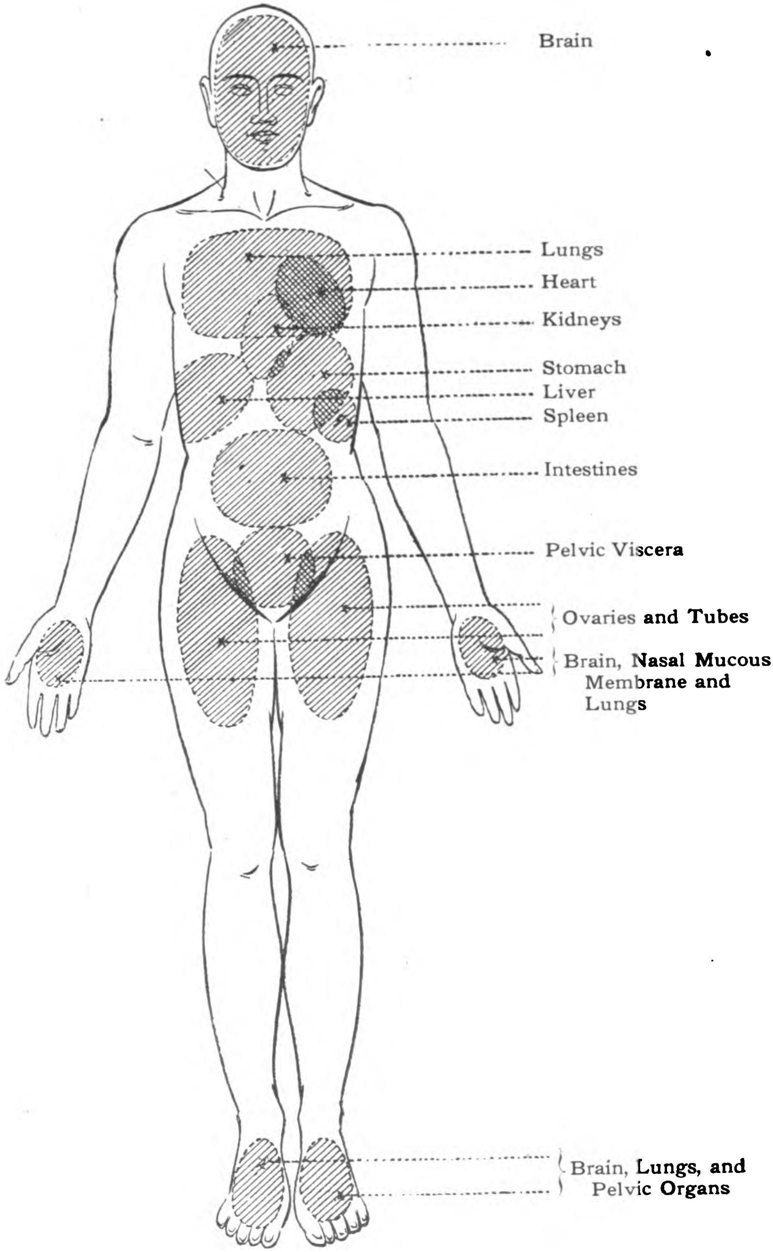


Fig. 16. Anterior reflex areas. (Kellogg.)

brain, lungs, and pelvic organs. This is not as powerful a reflex area as some others.

More practically stated, the circulation, secretory, and muscular activities of the viscera may be influenced *reflexly* by applications as follows:—

1. The brain, by applications to the *head*, *face*, *back of neck*, hands, and feet.
2. The nasal mucous membrane, by applications to the *face*, hands, and *cervical* and *upper dorsal spine*.
3. The lungs, by applications to the *chest*, *shoulders*, and dorsal spine.
4. The heart, by applications to the *precordia* and upper dorsal spine.
5. The stomach, by applications to the *epigastrium* and mid-dorsal spine.
6. The liver, by applications to the lower right chest and the abdomen.
7. The spleen, by applications to the lower left chest and the abdomen.
8. The kidneys, by applications to the lower third of the sternum, lower dorsal and lumbar spine.
9. The intestine, by applications to the *abdomen*, and lower dorsal and lumbar spine.
10. The bladder, by applications to the *lower abdomen*, *inner surfaces of thighs*, and the feet.
11. The uterus, by applications to the lumbar and *sacral* regions, *lower abdomen*, *inner surfaces of thighs*, *breasts*, feet, and cervix.

In the large majority of cases, the ventral areas give stronger reflex effects than the dorsal areas. This is doubtless for the reason that, with a ventral area, the effect is concentrated upon a single organ, while in the case of a dorsal area, limited to the region of the spine itself, the effect would be spread out over several organs, or possibly, the viscera of both the chest and abdomen. "If an ice bag is placed in contact with the whole length of the spine, the same effect on the heart and lungs is produced as that which is desired on the intestines, and the whole process is negatived, whereas, if limited anteriorally to the sixth segment, the effect is localized on the abdominal viscera.''[20]

Definition of Reflex. A reflex effect is then an indirect effect produced through nerve connection. An application to one part of the body which influences, through nerve connection, another part of the body is said to exert a reflex effect. Abrams[21] gives the following definition: ''A reflex refers to involuntary production of activity in a part brought about by conduction of a stimulus along an afferent (sensory) nerve to the motor cells in the cord or medulla. This stimulus is converted into an impulse by the motor cells, which impulse is then conducted to a part by means of an efferent (motor) nerve.''

CLASSES OF REFLEX EFFECTS

Having established the fact of reflex action and traced out some of the reflex arcs, let us now consider the nature of the various reflex effects. We have already noted that there are three kinds of fibers which make up the splanchnic efferents: *viz.*, the *secretory*, *viscero-motor*, and *vasomotor*. These are also the chief functions of the various viscera and by these, metabolism itself and all other functions are controlled. ''By applying heat or cold or other stimuli to the segment of the skin whose endings are in a segment in which arise visceromotor, vasomotor, or other activities, we can reflexly affect the organ supplied by these tracts. That this can be done has been shown by the researches of Brown-Sequard and others, . . . chiefly through the vasomotors. The change may be observed by heat and cold, impact of water, hand pressure (steady or alternated), electricity, mechanical stimulation or, other means, yet the underlying principle remains the same. The application of these physical forms of therapy must be made more and more accurately to get the best effect.''[22]

There are two general classes of effects produced by these applications. They may be designated as *pressor and depressor*, as *stimulant and calmative*, or *excitant and sedative*. Because

20 S. D. Ludlum—Journal American Medical Association, May 2, 1908.

21 Spondylotherapy, p 26.

22 S. D. Ludlum—Ibid, pp. 1403, 1405.

the *pressor*, *stimulant*, or *excitant effects* are usually mild and tend to restore to a normal tone, they are frequently designated as *tonic*.

SPECIAL REFLEX EFFECTS

In general, the reflex effect of an application is the same as its direct effect upon the skin. That it may be somewhat less quantitatively would be a natural result. The following is a comparison of the direct and reflex effects of prolonged cold.

1. Direct effects upon the part to which the application is applied,—

(*a*) The blood-vessels of the skin or mucous membrane are contracted.

(*b*) The cutaneous sensibility is lessened and reflex excitability is decreased and slowed because of this.

(*c*) Glandular activity is decreased.

(*d*) The skin muscles are contracted.

2. The reflex effects,—

(*a*) The blood-vessels of the deep (internal) organ are contracted and remain so.

(*b*) The nerve irritability of the internal organ is lessened.

(*c*) The glandular activity of the deep part is decreased and secretion is lessened.

(*d*) The muscles of the deep organ are caused to contract more firmly.

The reflex effect obtains as long as the application is in place and for a variable length of time after its removal. The duration and intensity of reflex effects depend upon the duration and intensity of the application. The vasoconstrictor effects of prolonged cold may not be very marked in health, but in the case of a congested organ, an ice bag applied to the reflex area produces an astonishing result.

Special Reflex Effects of Prolonged Cold. *A long (continuous) local application of cold causes contraction of the muscles and decreases the vital activities of the surface treated and the internal part reflexly related therewith.*

1. Cold applied over the trunk of an artery causes contraction of the artery and its distal branches. (*Figs. 17 and 18.*) Example,—ice bags applied over the carotid arteries decrease

the blood going to the brain and head generally. Such an application is called a *proximal application*, since it is located between the heart and the part supplied.

2. Prolonged immersion of the hands in cold water causes contraction of the vessels of the brain and nasal mucous membrane.

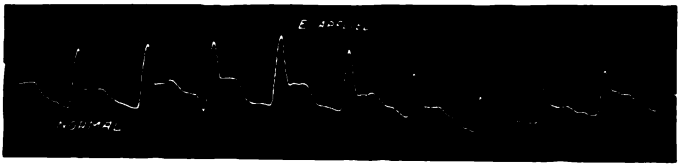


Fig. 17. Sphygmographic tracing of radial pulse showing contraction of the vessels of the forearm resulting from application of ice to bend of elbow. (Kellogg.)

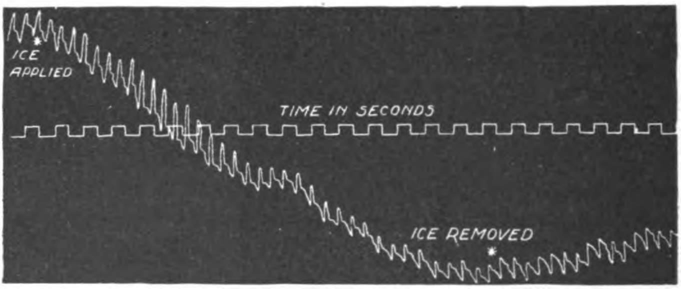


Fig. 18. Plethysmograph tracing showing diminution in the volume of the forearm resulting from application of ice to elbow. (Kellogg.)

3. Prolonged cold to the cervical and upper dorsal region causes contraction of the vessels of the nasal mucous membrane and lungs.

4. An ice bag applied to the precordia slows the heart rate, increases its force, and raises arterial blood pressure.

5. An ice bag applied over the thyroid gland (in parenchymatous goitre) decreases its vascularity and lessens its glandular activity.

6. Long cold applications to the chest, at the back, front, or sides, contract the blood-vessels of the lungs, (*Figs. 19 and 20.*) slow respiration, and increase its depth.

7. An ice bag to the epigastrium or mid-dorsal region causes contraction of the vessels of the stomach and lessens gastric secretion, while the application continues.[23]

8. A long cold application to the pelvis, groin, or inner surface of the thighs contracts the blood-vessels of the pelvic organs.

9. A long cold sitz bath causes firm contraction of the uterine muscle, thereby reducing subinvolution.

10. A much prolonged, very cold application to the sacrum, such as a large ice bag, dilates the blood-vessels of the uterus, thus increasing menstrual flow and inhibiting pain. This

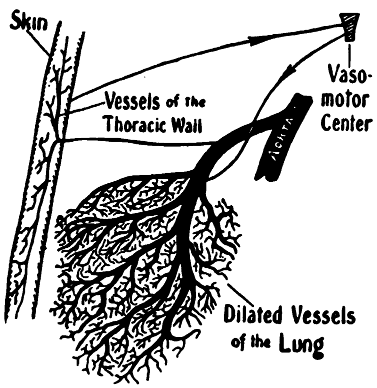


Fig. 19. Diagram showing congestion of the lungs.

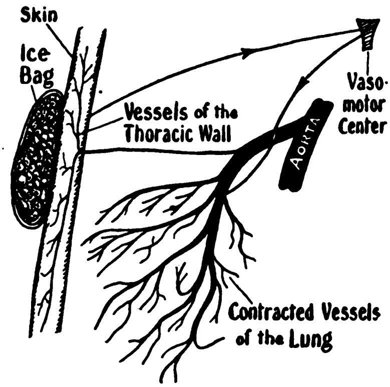


Fig. 20. Diagram showing reflex action of an ice bag in decreasing congestion of the lungs.

paralyzes the reflex. The posterior reflex area being in less perfect relation with the uterus than the anterior area, makes this possible.

11. Long cold applications to the face, forehead, scalp, and back of the neck cause contraction of the blood-vessels of the brain.

12. An ice bag to the lower third of the sternum or over the lower dorsal and upper lumbar regions causes contraction of the blood-vessels of the kidney.

13. Ice bags applied to the sides of the neck just below the jaw contract the blood-vessels of the pharynx.

23 See experiments by Kasanski in chapter on peptogenic effects.

Special Reflex Effects of Short Cold. *Short cold applications to a reflex area produce tonic and stimulating effects in the deep part by virtue of the reaction which soon follows. The same is true of alternating applications of heat and cold.*

1. Short cold applications to the face and head stimulate mental activity.
2. A short cold application to the chest, as a cold rub, friction, or cold douche, at first increases the respiration rate. Soon it results in deeper respiration with a somewhat slowed rate.
3. A cold douche to the precordia or slapping the chest with a cold towel increases both the heart rate and force. After the cessation of the application the rate decreases, while the force remains increased.
4. A short very cold percussion douche to a reflex area causes active dilatation of the blood-vessels in the related viscera,—as a short cold douche to the sacrum or feet causes dilatation of the vessels of the uterus.
5. Short or moderately prolonged cold applications to the breasts cause vigorous contractions of the uterus—of use in inertia uteri.
6. Short very cold applications to abdomen, hands, or feet cause contraction of the muscles of the bladder, bowels, and uterus.
7. A short cold douche or ice bag intermittently to the lower third of the sternum causes increased renal secretion.
8. A very short cold douche to the liver causes active dilatation of its vessels and increases its glandular activity.
9. The reaction from a moderately prolonged cold application to the epigastrium causes increased gastric secretion.[23]

Reflex Effects of Hot Applications.

1. A very much prolonged hot application to a reflex area produces passive dilatation of the blood-vessels of the related organ.
2. Long hot applications to the precordia and to many other parts increase the heart rate, decrease its force, and lower blood pressure.

3. Hot moist applications to the chest facilitate respiration and expectoration.

4. Long, moderately hot applications over the stomach after meals increase gastric secretion and hasten digestion. The same, if given before a meal, decrease gastric secretion because of the atonic reaction which ensues.

5. Prolonged hot applications to the abdomen lessen peristalsis, and in case of intestinal colic, relieve pain due to muscular spasm.

6. Prolonged hot applications to the pelvis, as a fomentation, hot pack, or sitz bath, relax the muscles of the bladder, rectum, and uterus and dilate their blood-vessels, thus relieving tenesmus in these organs and increasing the menstrual flow.

7. A large, hot application to the trunk, as a hot pack, in biliary or renal colic, relaxes the muscles of the bile ducts, gall bladder, or ureters and aids in relieving the pain due to spasm of these muscles.

CHAPTER VII

THE CIRCULATION—HYDROSTATIC EFFECTS

NOT all of the circulatory effects occurring in organs and parts distant from an application can be explained by reflex action. In fact, many of the effects produced by hydriatic applications are quite contrary to what we might expect, were the results due alone to reflex stimulation. When Schüller, in the course of his experiments upon trephined rabbits, placed a sponge dipped in cold water (52° F.) upon the trunk of a peripheral nerve, he observed narrowing of the pial vessels. This was the same result as that obtained by pieces of ice applied to the dura. In both, there was vasoconstriction of the vessels of the pia; and we have seen that, by reflex stimulation, the same effects are observed internally as occur externally in the skin area treated. But when he applied to the belly or back of the rabbit a wet compress of the same temperature, it always produced a prolonged and decided dilatation of the pial vessels, just opposite to the effect obtained in the first experiment quoted, and which we know was due to reflex stimulation. Again, he found that the application of warm water to the nerve trunk produced dilatation of the vessels, while warm water applied to the general skin surface by immersion, produced a narrowing of the pial vessels. Since these effects are directly opposite, both can not be explained by reflex action. Moreover, Schüller observed that *immersion* in warm water produced a more decided narrowing of the vessels than a warm *compress;* and *immersion* in cold water, a more decided dilatation of the vessels than a cold *compress*. *These effects were in exact proportion to the extent of surface immersed.* When the ears of the animal were kept out of cold water, they likewise filled with blood in common with the pial vessels, but when they were also dipped into the water, the vessels of the pia filled still more.

The explanation of these contrary effects is quite obvious and will occur to anyone acquainted with the principles of hydrostatics. When the warm compress was applied to the animal, the cutaneous vessels dilated, thus increasing the flow of blood to and amount of blood in the skin area treated. This left less blood to flow to the brain and, in consequence, the blood-vessels of the pia were less completely filled. When a greater surface was treated, as by immersion in warm water, a greater number of blood-vessels were dilated and much less blood left to flow to the head, resulting in an increased narrowing of the pial vessels.

Considering the experiment with the cold compress and bath, we have the same underlying principles. The cold compress produced blanching of the skin and a decreased amount of blood in the periphery, with a resulting increase in the filling of the blood-vessels of the brain because of retrostasis.

Schüller observed that rectal injections of cold water always produced some dilatation of the vessels of the pia. These effects have been confirmed by the experiments of Vinaj, Naumann, Winternitz, and others.

That these results are hydrostatic or mechanical, and not reflex, is also confirmed by the changes in blood pressure observed at the same time. In dilatation of the blood-vessels due to *vasomotor* action, there is a *fall* of blood pressure. Quite the opposite occurred when the pial vessels dilated because of a *cold compress* or *cold immersion*, *i. e.*, a decided *rise* in arterial pressure. This we know is associated with vasoconstriction and can not, therefore, be due to paralysis of the vasomotors. But when we consider that the cold application produced blanching of the skin and vasoconstriction over quite a large area and consequently an increase in blood pressure, the whole process is quite apparent. The retrostasis and increase of blood pressure causes the cerebral vessels, which are not under the influence of the cold, to fill in order to accommodate the blood.

The opposite group of conditions prevailed with the hot application, *viz.*, narrowing of the pial vessels with a fall in blood pressure. The same principles apply here as above, opposite conditions resulting from opposite causes. The hot bath produced afflux of blood to the skin through vasodilatation, with a consequent decrease in blood pressure, the cerebral vessels narrowed because of a relative anemia. If the narrowing of the pial vessels had been due to reflex action, there should have been a rise instead of a fall in blood pressure.

Schüller observed that prolonging the warm application produced an increasing constriction of the cerebral vessels. This may be explained by the fact that a passive and extreme dilatation of the cutaneous vessels occurs where the heat is maintained for a long time. This is the effect of a long hot pack which, in practice, we utilize where decided derivation is desired.

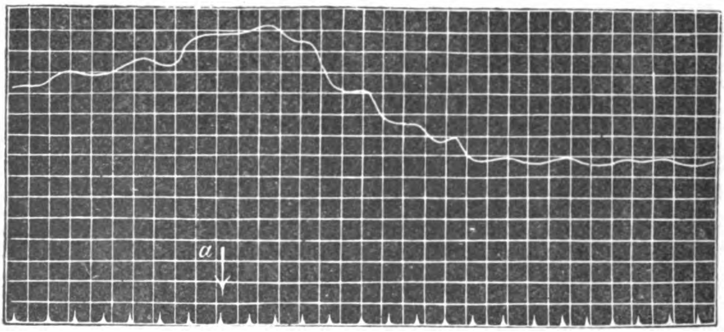


Fig. 21. Volume curve of right arm during a sitz bath at 110° F., showing derivative effect. (Winternitz.)

The hydrostatic effects of both *derivation* and *retrostasis* have been demonstrated by Winternitz[1] by clinical experiments. By means of the plethysmograph he determined the volume curve of the forearm during a hot sitz bath and also during a cold sitz bath. The hydrostatic results are graphically shown in *Figs. 21 and 22.* The cold sitz bath caused an increase in the volume of the forearm, due to *retrostasis*, consequent on contraction of the vessels under the influence of the cold water. In the case of the hot sitz bath the blood-vessels under the influence

1 Winternitz—Physiologische Grundlagen der Hydro- und Thermotherapie, pp. 43, 44.

of heat dilated, and being more completely filled, caused a fall in the volume of the forearm because of the *derivative* effect.

Secondary Hydrostasis. When the cold applications were prolonged Schüller observed the widening of the pial vessels give way after a time to narrowing. In the case of *compresses* this change occurred *after two or three minutes*, with *immersion after five to ten minutes*. It is apparent to all that a cold compress, after two or three minutes, becomes a heating compress,

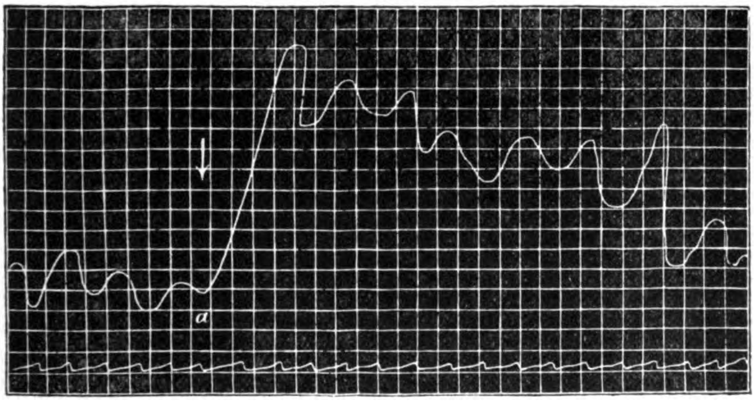


Fig. 22. Volume curve of right arm during a sitz bath at 50° F., showing retrostatic effect. (Winternitz.)

because of the cutaneous reaction and hence, a warm compress, which brings about the narrowing of the cerebral vessels. The same is true of the cold bath. When reaction sets in the skin becomes reddened, its vessels are filled with blood, and the cerebral vessels contract. This secondary hydrostatic effect is of great importance in the practical application of derivative means.

A hot and cold percussion douche to the feet reduces cerebral congestion because of blood being drawn to the extremities by the reaction in the feet.

When congestion in an organ has been reduced by a hot pack the derivation may be secured (made more lasting) by completing the treatment with a cold mitten friction, thus retaining the blood in the skin.

The accompanying chart summarizes the hydrostatic effects of heat and cold.

The Hydrostatic Effect of
- Heat—draws blood to the surface—derivation
- Cold
  - Primary—drives blood to the interior—retrostasis
  - Secondary—draws blood to the surface—derivation

Law of Antagonism. These hydrostatic effects are well recognized by physiologists. There is an antagonism between the vessels of the skin and viscera, between the internal and external vessels, so that, when the periphery is well filled, there is a relative anemia of the viscera, and *vice versa*. The so-called Dastre-Morat Law of Antagonism is thus stated by Sir M. Foster,[2] "Moreover, the vascular changes in the skin are accompanied by corresponding vascular changes in the viscera (chiefly abdominal) of the reverse kind. When the vessels of the skin are dilated, those of the viscera are constricted, and *vice versa;* so that the blood ebbs and flows, so to speak, according to circumstances, from skin to viscera and from viscera to skin."

These mechanical effects are necessarily produced solely by vascular connection and not by nerve connection. A reflex effect is an indirect or distant effect produced through nerve connection. A hydrostatic effect is a distant effect produced through vascular connection. The extent of this effect depends upon nothing so much as upon the extent of the surface involved, as was shown by the experiments with the compresses and baths. This action is not confined to the blood vascular system, but applies to the lymphatic system as well. A warm application which causes vasodilatation will, of necessity, draw blood from all other parts of the body; and conversly, a cold application, causing vasoconstriction, will, in the nature of the case, drive the blood elsewhere, principally to the

2 Physiology, p. 287.

interior. In either case the blood is driven into or drawn from the deeper parts. In the normal body these hydrostatic effects are more or less evenly distributed over the entire vascular system, so that the effect in any one part is not so marked. For example, a hot bath or pack in health draws the blood more or less equally from all the viscera; but in case of congestion of some particular organ, that organ will be affected more than others by either derivation or retrostasis. A common example is found in the increase of pulmonary congestion, produced by cold drafts on the shoulders. In a healthy person this might not result seriously, but in one susceptible to colds or with an already existing congestion, it may cause an extreme congestion in a very short time. In the same condition a hot pack will draw proportionately more blood from the lungs than from other parts. Again, a large fomentation to the loins or a hot pack would, under normal conditions, withdraw from the kidneys only a small amount of blood; but when these organs are congested there is a marked depleting effect manifest. *The patient is bled into his own limbs and skin.*

Not only may areas quite distant from a part be utilized for depleting that part, but in many cases skin areas nearby may be used to advantage. That this is not a new principle in therapeutics will be seen by referring to "leech" bleeding. It is directed that the leech be applied to the skin over the inflamed part. It sucks blood from the superficial branches of the same vessels that supply the deeper inflamed part. If, by hot applications, the arteries of the superficial set of branches be widened out, there will be less blood to flow into the deeper branches. Thus will a fomentation draw blood from a part nearby that receives its blood from the same large artery. Where there are large thick muscles under the skin area treated the total vascular capacity of both, when filled to the limit, may produce a very decided derivation.

AREAS FOR DERIVATION

The various viscera are mechanically related to superficial and other areas as follows. In most cases these areas are utilized for depleting (derivative) effect, but the opposite condition (retrostasis) may obtain where these areas are chilled.

1. The Brain. Blood may be withdrawn from the brain by hot applications to the feet, legs, or entire lower limbs, also to the spine or entire surface of the trunk. It is not practical to utilize the emissary veins of the cranial circulation for this purpose, since the reflex effect in dilating the cerebral vessels would be greater than the depleting effect. In cases of severe sunstroke the vasomotors are so unbalanced that even a hot foot bath may reflexly produce cerebral congestion rather than depletion, and must, therefore, be avoided.

2. Spinal Cord. Congestion here, if not too extreme, may be relieved by large fomentations to the spine (entire width of the back). This diverts the blood from the spinal arteries into the posterior divisions of the intercostal and lumbar arteries, also by hot applications to the feet, legs, or the skin surface of the trunk. In cases of acute cerebro-spinal meningitis it is best to utilize the more distant areas.

3. Eye. Applications may be made to the forehead and side of the face, thus dilating some of the terminal superficial branches of the carotids, and depleting the deeper branches.

4. Middle Ear and Mastoid. By applications to the entire side of the head, also by very hot applications to the legs, abdomen, and spine.

5. Pharynx and Larynx. By applications to the neck, thus depleting the deeper organs and congesting the surface vessels.

6. Lungs. The feet and lower limbs, skin surface of the trunk and hips, also the hands, arms, and shoulders. Where the congestion is limited to a small area, as in circumscribed pleurisy, a fomentation may be used directly over that area. This dilates the posterior, lateral, and anterior cutaneous branches of the intercostal arteries, thereby withdrawing blood from the inflamed pleura.

7. Kidneys. The circulation in these organs is decreased by hot applications to the back, thus dilating the posterior branches of the lumbar and lower intercostal arteries, and leaving less blood to pass from the aorta to the renal arteries. In extreme congestion of the kidneys it is necessary to utilize much larger areas, as the entire surface of the trunk, hips, and legs, or one of these areas alone.

8. Stomach. By large applications centering at the epigastrium, but extending over the lower chest and sides of the abdomen and well down over the umbilical region, also to the entire trunk.

9. Liver. By applications over the liver also to the lower dorsal spine of the right ride, extending forward and covering the epigastric and umbilical regions. The skin area of the lower limbs and hips is as important, if not more so, than the nearer areas.

10. Spleen. Similar to the liver, on the opposite side, also lower limbs.

11. Pelvic Organs—bladder, uterus, ovaries, tubes, rectum, and prostate. To deplete these organs two principal areas are utilized,—first, the entire skin surface of the hips, pelvis, etc., as in a hot sitz bath or hot hip pack; second, the lower limbs, as in a hot leg bath or hot leg pack. Both areas may be utilized by the use of the hot hip and leg pack or hot half bath.

The student who is familiar with the anatomy of the circulatory system will be able to figure out the vascular connections between the organs mentioned above and areas named with each. In nearly every case it is quite obvious. These areas are of importance, not alone in ordinary congestion, but of almost inestimable service in actual inflammation of these parts, as shown later. (See treatment of inflammations.)

CHAPTER VIII

THE CIRCULATION—BALANCE BETWEEN REFLEX AND HYDROSTATIC EFFECTS

BY reference to the observations recorded under reflex and hydrostatic effects, it will be seen that thermic applications to the surface exert two classes of effects—a reflex and a hydrostatic effect—which are directly opposite and, therefore, conflicting. Probably an application produces more or less of both, though one or the other usually predominates. Since they are opposite, one will neutralize or overshadow the other. Kellogg[1] makes the following statement: "Doubtless both of these effects are always produced. When the application is general the mechanical effect is dominant; when the area involved is limited, the reflex effect is prominent. In general applications, the primary reflex effect is quickly effaced by the succeeding mechanical effect, due (in case of cold) to the inrush of blood from the periphery. This diversion of blood from the surface vessels to the interior of the body is termed retrostasis. Marked retrostasis is produced only when the cold application is made simultaneously to a very large cutaneous area." These are essentially the views of Schüller, who considered that, at the beginning of the application, the pial vessels were affected reflexly, which effect is soon overbalanced by the thermic effect upon the vessels of the skin.

"If the surface area to which the application is made is small, the reflex effect may be confined to the internal area in sympathetic relation therewith, and will be greater and more prolonged for the reason that the reflex influence is concentrated upon a circumscribed area; while the mechanical effect is distributed over the rest of the body, so that it does not overshadow and

1 Hydrotherapy, p. 103.

wipe out the reflex effect on the smaller area involved." Baruch's comment[2] upon this subject is as follows: "Baths and other procedures without mechanical excitation, when applied to large portions of the body, doubtless have a hydrostatic effect; while *douches*, which impinge on limited portions, and are combined with mechanical effects (*irritation*), act chiefly by reflex influence."

Is it possible to determine which result will be greater in a given case, or which will be practically the only effect from a certain application? In reply to this very natural question, we may state that there are definite laws governing these opposing actions. By them one may so time and regulate applications as to secure a desired and definite result.

LAWS OF BALANCE

The following are the laws; other things being equal, the results stated obtain:—

1. Size of Area. (a) When an application covers a small area the effect is chiefly reflex, and is concentrated upon the internal part in reflex relation with the surface treated.

(b) When applications are made to a large area the hydrostatic effect predominates, and the larger the area treated the greater the hydrostatic effect.

2. Location of Area. (a) The chief effect of an application to certain areas (example, the head or the precordia) is a reflex effect.

(b) The principal result of an application to certain other areas (example, the feet and legs) is hydrostatic.

Duration and Intensity of Application. The duration and intensity of the effect, either reflex or hydrostatic, depend upon the duration and intensity of the application. The intensity of an application is gauged by the degree of heat or cold and by the form and pressure of douches, or the degree and amount of friction.

Examples: The prolonged application of an ice bag (small application of intense cold) to the precordia (special area) produces a (reflex effect) prolonged slowing of the rate of the heart beat, and a decided increase in its force for the same length of

2 Principles and Practice of Hydrotherapy, p. 48.

time. There is no tendency to produce retrostasis of blood or engorgement of the heart (hydrostatic effect).

A hot trunk pack (large area) withdraws blood from the viscera (hydrostatic effect) rather than producing dilatation and engorgement of their vessels (reflex effect).

A hot and cold dourche to the chest (small intense application) stimulates the heart and respiration (reflex effect) rather than having any decided hydrostatic effect upon the blood current of these organs. Applications to the head (special area), whether hot or cold, have a reflex effect almost entirely.

Many other examples might be given, but the principles involved in the above are the same as those which govern other applications. It will be seen that, although reflex and hydrostatic effects directly oppose each other, the *reflex overshadows* and obliterates the hydrostatic when *certain areas* are involved, and especially when *these areas are small.* The *hydrostatic effect wipes out* the reflex effect when the application is to certain other areas, and especially when those areas are *very large.*

We have so far discussed these two classes of effects as to their opposing results. Reflex and mechanical effects may be made to assist each other in securing depletion when diverse applications are made to different areas simultaneously. This will be discussed under the head of derivation.[3]

Double Effects. In the case of hot applications applied over congested organs, certain phases of both the reflex and the hydrostatic effect may prevail. This is expecially noticeable with large fomentations or hot packs over the liver or kidneys. These reflexly relax (and dilate) the blood-vessels of the internal organ while hydrostatically they draw blood from the organ thus leaving the vessels of that organ relaxed but only partially filled with blood, *i. e.*, partly collapsed. This double effect from a single application is of great importance in acute congestions of the kidneys and liver as in eclampsia where vascular tension is high but the organ functionally inactive. The tension being relieved by relaxation of the muscular coat (reflexly) and the congestion depleted (hydrostatically), the blood again circulates more rapidly and functional activity begins almost at once.

3 See chapter on inflammation and antiphlogistic effects.

CHAPTER IX

THE CIRCULATION—BLOOD PRESSURE

IN order that the reader may gain a practical knowledge of therapeutic effects upon abnormal blood pressure, we shall discuss somewhat at length the fundamentals of this subject and of thermic applications on normal blood pressure.

Blood pressure is governed by the following three factors:—

1. The heart beat.
2. The amount of blood.
3. Vascular calibre and action.

1. The Force of the Heart Beat, its rapidity, and the volume of its output are secondarily influenced by the other two factors. So closely related are these three, that practically one can not be studied without studying the other two. Influences which bring about a change in any one of these factors, produce through that factor a change in the remaining two. For example, an increase in the peripheral resistance increases the output and volume of the ventricles. (*Fig. 23.*) Within certain limits an increase in the volume of the circulating fluid likewise increases the output and volume of the ventricles. (*Fig. 24.*)

General hot baths, such as hot air, electric light, Russian, and full hot tub baths, increase the heart rate and decrease its force. This is due to reduction in the peripheral resistance occasioned by the extensive vasodilatation which is itself the direct cause of the lowered blood pressure. General cold baths, or even fair sized cold applications, increase blood pressure because of the resulting vasoconstriction.

Those things which directly affect the heart beat come principally through reflex stimulation. All sorts of cold applications to the precordia increase the muscular contractions and

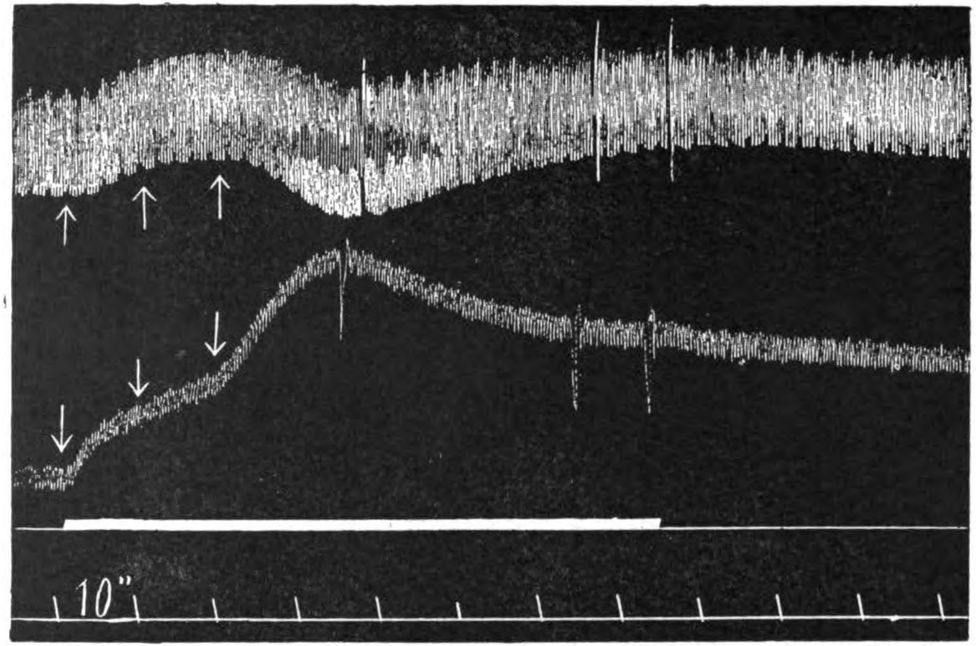


Fig. 23. Curve showing the effect of a sudden rise in the arterial resistance on the output and volume of the ventricles. Systole causes a downward movement of the lever. The lower border of the white tracing represents the systolic volume; the upper border, the diastolic volume. (Starling.)

so raise blood pressure. After a brief rise, hot applications to the precordia decrease blood pressure. Short cold applications to the precordia increase the heart rate, while long cold applications decrease the heart rate. In the normal person both results are associated with a rise in blood pressure. Rapidly alternating hot and cold applications to the precordia have much the same effect as short cold applications, except that the stimulation, being greater, causes a greater rise in blood pressure. This rise is less permanent than that accompanying prolonged cold applications to the precordia. These points have been thoroughly discussed elsewhere.

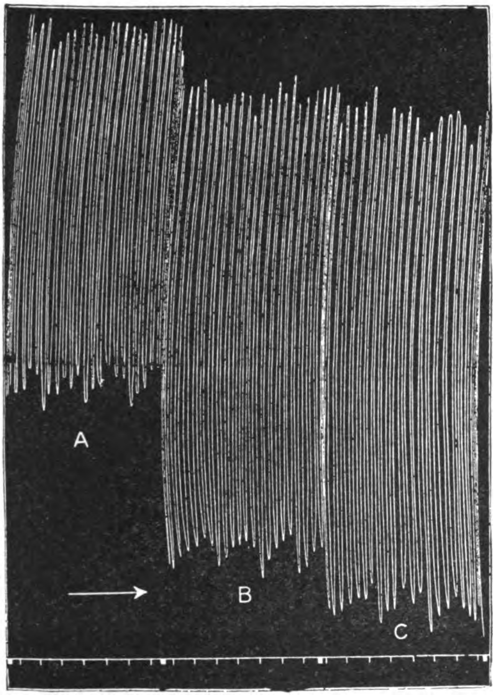


Fig. 24. Cardiometer tracing from a dog's heart showing effect of increasing the volume of circulating fluid on the total output and volume of the heart. Between the parts A and B 30 c. c. of warm physiologic salt solution were injected intravenously, and between B and C 20 c. c. more. Both the systolic and diastolic volume are increased, i. e., the heart is more distended during diastole, and does not contract to its normal size in systole. The result is a very largely increased output. (Roy.)

2. The Amount of the Circulating Fluid. An increase in the quantity of blood in the vascular system, other things being equal, increases blood pressure. In order to intelligently apply those therapeutic measures which are designed to maintain blood pressure through changes in the amount of the circulating fluids, it is necessary to obtain an understanding of the laws governing the intake and output of body fluids and also the absorption of extra-vascular tissue fluids. Modern knowledge of the fluids of the body has been summarized by E. H. Starling.[1] From this source we have drawn much of the following information.

The absorptive membranes of the body possess a discriminating or irreciprocal permeability to fluids, *i. e.*, fluids containing certain saline substances are readily and rapidly absorbed, while fluids containing other salts are either not absorbed, or only after long contact.

"If the solutions contain sulphates or tartrates, *i. e.*, salts to whose anions the gut wall is relatively impermeable, the course of events is very much the same as that which would occur if these solutions were separated from blood plasma by a dead wall of parchment paper. If they are hypertonic they increase in amount by the attraction of water from the circulating fluids, until their molecular concentration is equal to that of blood plasma."[2] By long contact they are finally absorbed. "Very different is the fate of solutions of substances such as sodium chloride. These are rapidily absorbed even when they are slightly hypertonic. If the solutions are strong, *i. e.*, two or three per cent NaCl, they at first increase in bulk by the diffusion of water into them. From the moment of their introduction, however, salt is passing from them into the blood, circulating through the intestinal wall, and as soon as their total osmotic pressure is reduced to a point a little above that of the blood plasma, both water and salt begin to be absorbed."[3]

This selective action is found to depend upon the vitality of the cells composing the membrane, since it ceases when the cells have been damaged by certain chemicals. The fate of fluid introduced into the gut then seems to depend entirely upon its concentration. The epithelial cells composing the mucous membrane of the intestine possess the power of pumping water and salts from one side of the cell to the other. "This con-

1 Herter Lectures, New York, 1908.

2 Starling—The Fluids of the Body, p. 53.

3 Ibid, p. 53.

clusion is confirmed by certain experiments of Reid and Cohnheim, in which two identical solutions of sodium chloride were separated from one another by a membrane consisting of the whole living intestinal wall. In these experiments it was found that there was active transference from the inner to the outer side of the membrane."[4] The same was found to hold true with the skin. When brought in contact with deleterious substances, the cells of the skin behaved like ordinary dead membrane, the irreciprocal permeability and the active transference of fluid totally disappearing.

Saline solutions, somewhat less in concentration than blood serum, are very rapidily absorbed from the intestine, somewhat more so than even isotonic solutions. The rapid absorption of hypotonic or isotonic solutions introduced into the bowel, is then shown to be due to the specific activity of the epithelial cells, aided by the greater osmotic pressure of blood serum in the case of hypotonic solutions. The ready and constant absorption of fluid which occurs with the Murphy method of enteroclysis is a most effectual means of maintaining blood pressure at an even point. In case of much loss of fluid or lowering of blood pressure, after a fairly normal amount of fluid and degree of blood pressure has been secured by the absorption of the saline fluid, the salt solution, if injected slowly, is eliminated by the kidneys at the same rate at which it is absorbed.[5]

The laws of osmosis when working in connection with the intestinal wall above referred to, account for the hydrogogue action of hypertonic solutions of such substances as Epsom salts, Rochelle salts, and honey, when injected into the bowel. Strong solutions of these substances cause an exosmosis, *i. e.*, when they remain a comparatively short time water is drawn from the circulating fluid and increases the bulk of the injected fluid. This "washing" through the mucous membrane clears it of mucus, helps dislodge mucous casts, etc. These observations furnish a rational basis for the use of the hypertonic saline enema, and the honey or molasses enema, in mucous colitis.

In regard to the absorption of interstitial fluids, and of fluid

4 **Starling—The Fluids of the Body, p. 57.**

5 **Ibid, p. 139**

introduced by hypodermoclysis, Starling concludes that this occurs mostly by the blood rather than the lymphatics, as has long been supposed. Indigo, carmine, or methylene blue injected into the pleural or peritoneal cavities, may appear in the urine within six minutes after the moment of injection at a time when the lymph in the thoracic duct is free from color. Strychnine or other drug injected under the skin of a limb exerts its poisonous effects on the nervous system long before the drug itself appears in the lymph flowing from the limb. It has been shown that blood returning from an edematous limb is more dilute than blood returning from a normal limb. The experiment conducted by Starling[6] is as follows: By means of cannulas inserted into the femoral artery and vein, defibrinated blood of the same osmotic pressure as normal blood serum, was caused to pass through the arteries, capillaries, and veins of the normal leg of a dog. The same was done with the opposite leg made edematous by the injection of a one per cent solution of NaCl. Blood which had been led through the normal leg twelve to twenty-five times was unaltered or suffered trifling change, while that led the same number of times through the edematous leg had in all cases absorbed fluid. "From these experiments we may affirm with certainity that isotonic salt solutions can be taken up directly by the blood circulating in the blood-vessels."[7] Hypodermoclysis is the most rapid method (aside from direct vein injection) of introducing fluid into the circulation. Increase in the amount of fluid in the vascular system results in heightened venous pressure, which, in turn, produces an increase in diastolic filling, systolic output and arterial pressure, and greatly hastens the velocity of the circulation. (*Fig. 24.*) "Blood with its lower viscosity passes readily through the dilated arterioles and capillaries, so that the velocity of the blood-flow may be easily increased from six to ten times."[8] Injecting salt solution equivalent to 50 per cent of the total blood has been found to augment the velocity of the blood six to eight times the normal rate.[9]

6 Starling—The Fluids of the Body, p. 95.
7 Ibid, p. 97.
8 Ibid, p. 138.
9 Starling—Physiology, p. 284.

The rise in blood pressure occasioned by the absorption of fluid introduced by either hypodermoclysis or proctoclysis is of special advantage in various conditions where the blood pressure has fallen very low, such as in collapse (after hemorrhage), in peritonitis, etc. The Murphy method of proctoclysis is especially recommended in the treatment of peritonitis after the institution of surgical drainage. It is designed to flush the drained surfaces, and so aid in getting rid of septic material and infection. We believe its beneficial action is, however, due as much to the maintenance of blood pressure, as to the flushing of the absorbents and drained surfaces.

Given in the order in which they most rapidly increase the volume of the blood, the methods of introducing fluid into the circulatory system may be listed as follows:—

(a) Hypodermoclysis.
(b) Proctoclysis.
(c) Water-drinking.

3. Vascular Calibre and Action. We have seen that a hot application dilates the blood-vessels, producing an afflux of blood to the skin and superficial parts, increasing with the prolongation of the application. It has also been shown that the reaction to a cold application produces an afflux of blood to the skin. In both cases there is a hyperemia established, but the two are of an entirely different nature. With the hot application there is a fall of blood pressure because of a loss of tone in the vessels (passive dilatation) and a preponderance of venous blood in the part; while the dilatation which comes with the reaction to a cold application is accompanied by an increase in blood pressure, the tone of the vessels is preserved, and there is a preponderance of arterial blood in the part. These conditions are respectively known as *venous or passive hyperemia* and *arterial or active hyperemia*. It is important to distinguish the physiologic difference between the hyperemia of cold and that of hot applications. At first both produce an arterial hyperemia. In the case of the hot application the end result is a slowing of the circulation, a stasis of blood, which necessarily results in an increase of the venous over the arterial blood in the part. With the cold application, after the initial vasoconstriction and anemia have given way, the return to a normal condition (reaction) is accompanied by an increase of from three to five times in the rapidity of the circulation.[10] The blood flows rapidly through the part and consequently, arterial blood predominates. The remote result is the same; there is no after-tendency to stasis. This is no small factor in nutrition and healing. In fact, it is upon the blood that they depend; they are carried on and hastened in proportion to the amount of arterial blood, *i. e.*, nutrition and oxygen, supplied to the tissues.

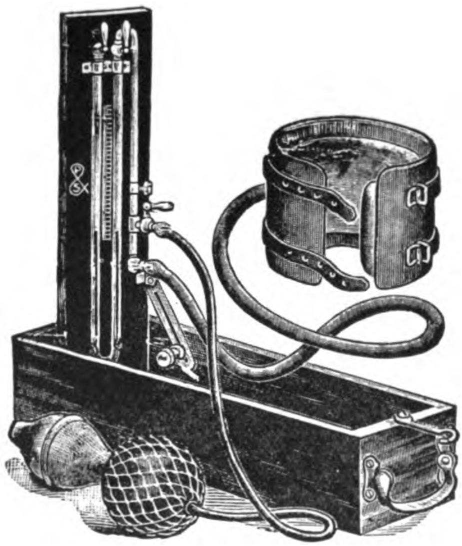


Fig. 25. Faught's sphygmomanometer.

Bier, in his work on the treatment of disease by hyperemia, claims for the tissues a selective action, *i. e.*, that they have the power to select arterial in preference to venous blood. It would appear irrational to suppose anything else. The essential feature is not in the *selective* action, but in the supplying of sufficient arterial blood, so that the tissues may *manifest* their selective action. The cold has also a direct action on the hemoglobin in producing a higher degree of oxygenation, *i. e.*, a

10 Baruch—Principles and Practice of Hydrotherapy, p. 55.

greater oxygen-carrying capacity and upon the tissues, making it possible for them to appropriate more oxygen.[11]

The pumping action of the arteries under the influence of reaction to cold drives the blood into the veins. Because of this, the right side of the heart is more completely filled, and there results a fuller output to the lungs and from the left side of the heart. These forces tend to produce a slower and more vigorous systole, and so the entire cycle of changes brings

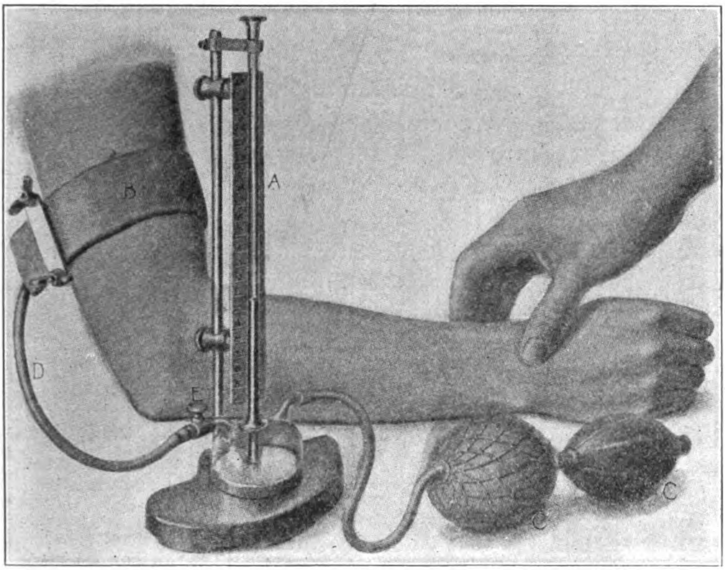


Fig. 26. Riva-Rocci Sphygmomanometer.

about a heightened blood pressure. These facts demonstrate the great value of the cold mitten friction in surgical shock.

Mueller's Laws. In 1902 Müller, in experimenting with baths of different temperatures, arrived at definite conclusions regard-

11 This active arterial hyperemia is undoubtedly due to the action of cold on the tissues, hemoglobin, and the blood-vessels themselves. This has been confirmed by Ritter, who performed two very interesting experiments to demonstrate this fact. By means of an ethyl chloride spray he froze a spot on the arm. After it had thawed it became bright red from the reaction. He then applied an elastic bandage to the arm above the spot. The whole arm became dark blue, while the previously frozen spot remained bright red. He reversed the experiment by first producing cyanosis and venous stasis, and then freezing a spot on the arm below the bandage. After thawing, it became bright red, while the rest of the arm remained blue.

ing the effects of thermic applications upon blood pressure.[12] The pressure was tested by means of the Riva-Rocci sphygmomanometer (*Fig. 26.*). Briefly stated his conclusions are as follows (*Plate IV.*):—

1. Effects of Cold. Baths and thermic applications, not accompanied by mechanical irritation, if given *below the temperature of the skin*, produce increased blood pressure with slowed pulse rate.

2. Effects of Heat. Thermic applications *above the skin temperature*, after a brief rise, produce a fall in blood pressure which later rises. Hot baths above 104° F. persistently increase blood pressure and the pulse rate.

3. Effects of Neutral Temperatures. Neutral bath's equalize or regulate blood pressure.

4. Effects of Mechanical Stimuli. With douches and other procedures, where the mechanical irritation is the predominant factor, there is a rise of blood pressure less enduring than with cold applications. "Every hot or cold douche calls forth an increase of blood pressure, paradoxical as it may seem."[13]

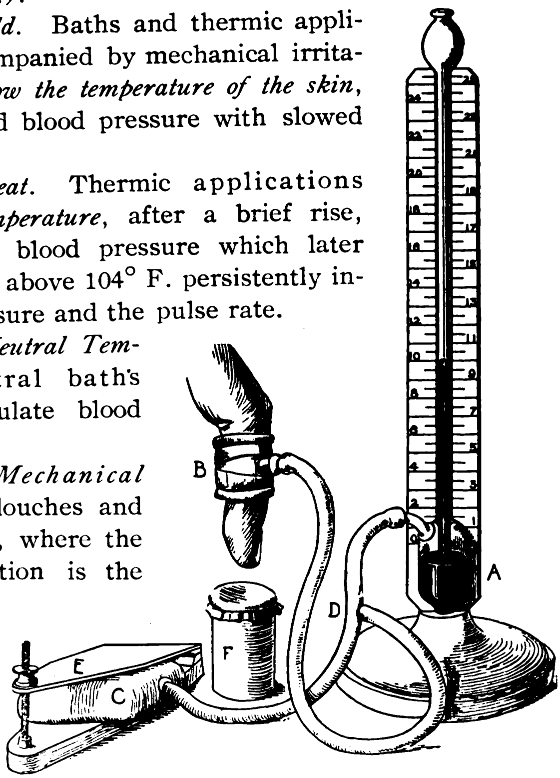


Fig. 27. Gärtner's Tonometer.

The experiments of Schüller, already quoted, sustain these observations. Many other experiments along this line might be quoted. Kellogg[14] records an experiment in which the drinking of a large quantity of cold fluid (50° F.) raised the

12 Müller—Deutsch. Arch. für klin. Med., 1902, Vol. 74.
13 Hinsdale—Hydrotherapy, p. 48.
14 Rational Hydrotherapy, p. 1115.

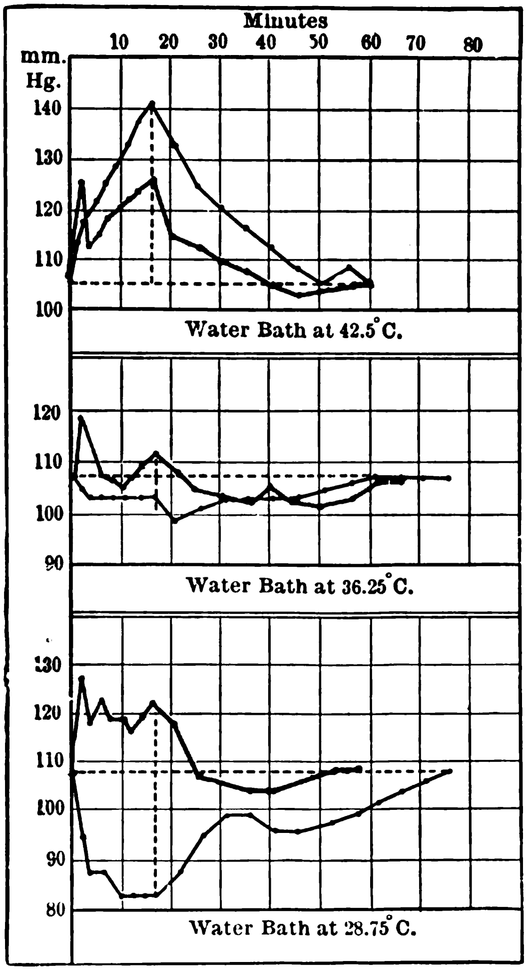


PLATE IV. Chart showing influence of baths of different temperatures on blood pressure and pulse rate in a healthy man of twenty-six: red lines—blood pressure, black lines—pulse rate. (Riva-Rocci's sphygm.) (Müller.)

capillary arterial tension, as taken by Gärtner's tonometer (*Fig. 27.*) from 13.5 cm. to 14.5 cm. The first observation was made immediately before, and the second immediately after the drinking of the cold water. In another clinical experiment[15] an initial arterial tension of 9 cm. was, by an electric light bath, raised to 10 cm. within one minute. At the end of five minutes the tension had fallen to 8 cm. and in twenty minutes to 7 cm. In another case[16] fifteen minutes in a full bath at 102° F. reduced the blood tension from 9 cm. to 6 cm. as shown by Gärtner's tonometer.

Hot air baths decrease blood pressure as shown in a series of observations by Tuttle[17] the average decrease in twenty cases was 12 mm. of mercury. Cold douches following this, quickly raised the blood pressure to normal, slightly below or slightly above.

Carbonated baths have a tendency to raise blood pressure, although J. M. Swan[18] has shown that this effect is not constant. The marked results of the artificial Nauheim bath are probably due more to the stimulation of vascular *activity*, *i. e.*, of the peripheral heart than to vasoconstriction. The same may be said of the oxygen bath, though the majority of observers agree that its most usual result is a lowering of blood pressure.

The breathing of cold air raises the blood pressure. B. R. Hoobler[19] observed a gradual increase of the low pressure in children suffering from tuberculosis, when these children were transferred to the open air. The raised pressure became more and more permanent as the out-door treatment was continued. These matters are discussed further in the part on therapeutics in connection with the treatment of various diseases.

15 Kellogg—Rational Hydrotherapy, p. 1122.
16 Ibid, p. 1128.
17 American Journal of Insanity, October, 1904.
18 Archives of Internal Medicine, August 15, 1912, p. 73.
19 American Journal of Diseases of Children, November 20, 1912.

CHAPTER X

THE CIRCULATION—CHANGES IN THE COMPOSITION OF THE BLOOD

CORPUSCULAR ELEMENTS

SUCH a large volume of experimental work has been reported along this line that we can not do more than tabulate the principal results observed. The investigations of Professor Winternitz, and those of Strasser, undertaken at his request and reported in 1893, are considered the basis of our knowledge of these changes. The results obtained by all observers are so uniform as to leave no doubt of their reliability. After all sorts of cold procedures, involving the general skin surface and associated with mechanical procedures, after hot baths or douches when followed by cold applications, the blood counts reveal an increase in both the red cells and white cells, and a marked change in their ratio. In Winternitz' experiments the greatest increase in red cells amounted to 1,860,000 per cubic millimeter; in white cells, from 200 to 300 per cent; and in hemoglobin, 14 per cent.

On the first and third bath days of Strasser's experiments, referred to in *Chapter XI*, blood counts were taken after the cold douche and after the graduated half bath. The counts were as follows:—

Effects of Cold Douche	Before	After
Red cells - -	4,570,000	5,200,000
White cells - -	4,600	6,400
Hemoglobin (*Fleischl*)	85%	95%

Effects of Graduated Half Bath	Before	After
Red cells - -	4,880,000	5,420,000
White cells - -	5,400	8,400
Hemoglobin - -	85%	95%

The results in detail of some of the experiments performed by Winternitz are given in the accompanying chart (*Fig. 28.*) and table.[1]

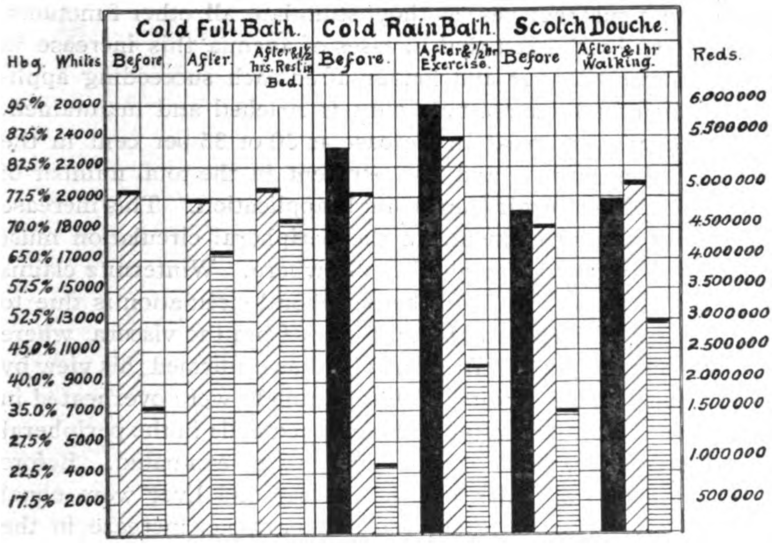


Fig. 28. Chart showing the effects of hydriatic procedures on the blood count and hemoglobin. Upright blocks with diagonal lines—red count, blocks with horizontal cross lines—white count, blocks in black—hemoglobin per cent. (Winternitz.)

Cold Full Bath	Red Cells	White Cells	Hgb
Before - - - - -	5,380,000	8,400	70%
Immediately after -	5,222,000	16,700	
After plus 1-2-hr. rest in bed	5,422,000	21,640	
Cold Rain Bath			
Before - - - -	4,820,000	4,500	87%
After plus 1-2-hr. exercise	5,510,000	10,600	95%
Scotch Douche			
Before - - - -	4,460,000	7,400	74%
After plus 1-hr. exercise	5,000,000	11,600	77%

1 B. Buxbaum—Lehrbuch der Hydrotherapie, II Auflage, p. 35.

These changes were maintained for from one-half hour or one hour up to two hours or longer after applications, gradually returning to normal. The increase in the white cells was maintained longer than the increase in reds. These observations have been confirmed by Thayer, Baruch, and Kellogg, in this country.

Where do these cells come from? Repeated cold applications stimulate hematogenesis, as they stimulate all other functions, as is shown by the fact that in cases of anemia this increase in cells continues longer and longer after each succeeding application until finally a normal count is reached and maintained. But, of course, so great an increase as 30 or 35 per cent in the total number of reds and 200 per cent in the total number of whites could not result from a single application. This increase in the corpuscular elements in the peripheral circulation must be at the expense of the number elsewhere. Winternitz claims that this increase of cells in the peripheral circulation is due to the driving of large numbers of cells from the viscera, where stasis has taken place. Breitenstein[2] has confirmed this view by experiments upon rabbits. These animals were overheated in a hot box, before and after which the red cells in the peripheral circulation (ear) and viscera (liver) were estimated. Before the heating process, the cells in the ear and liver were equal in number. After it, there was an enormous increase in the red blood cells in the liver. Tschlenoff observed a decrease of 50 per cent in the white cells in rabbits subjected to a temperature of 42° C. for five or six hours. These experiments also confirm the observation of Winternitz and others, that general hot applications, much prolonged, decrease the blood count and the hemoglobin per cent, the white cells suffering a greater diminution than the reds.

Not the least interesting of the observations made by Winternitz is that relating to the local increase in the blood count taken from circumscribed areas treated by cold or hot and cold douches, partial baths, etc., while counts taken from a distant part showed a decrease in both the red and white cells. Prolonged local applications of heat not followed by cold, while

2 Archiv. für Exper. Path. und Pharm., Bd. 32, 1896.

resulting in a local decrease of red cells and hemoglobin, in most cases produced an increase in the leucocytes in the same part.[3] This experiment furnishes a rational basis for the local use of thermic applications to an infected part.

Massage as well as hydrotherapy produces an increase in the number of the blood corpuscles, as shown by counts taken before and after treatment. The effect is at first temporary, but lasts longer and longer as the massage is continued from day to day or week to week until finally the improvement becomes permanent. Astonishingly good results have been reported by Mitchell[4] in cases of anemia.

Mechanism of Distribution. The change in the distribution of the red and white cells produced by cold applications is to a great degree due to the stimulation of the peripheral circulation. This is not, however, the only factor in bringing about an increase of cells in the surface circulation. The viscera and their blood-vessels are subject to the *reflex* stimulation produced by cold applications. The contraction of the viscera and the visceral blood-vessels, caused by cold applications, drives their contained corpuscles to other parts, and these are taken up by the increased activity of the peripheral circulation and so redistributed. In both the liver and spleen the blood cells are especially prone to accumulation and stasis. The blood-vessels of both may be rendered very active; but owing to the additional muscle fibers in the capsule and trabeculæ of the spleen, this organ exerts a greater effect upon the blood current than any other viscus except the heart.

"The most definite facts known about the spleen are in connection with its movements. It has been shown that there is a slow expansion and contraction of the organ synchronous with the digestion periods. After a meal the spleen begins to increase in size, reaching a maximum at about the fifth hour, and then slowly returns to its previous size. This movement, the meaning of which is not known, is probably due to a slow vasodilatation, together, perhaps, with a relaxation of the tonic contraction of the musculature of the trabeculæ. In addition to this slow movement, Roy has shown that there is a

3 Even in general hot applications a pronounced leucocytosis was often observed.

4 Journal of American Medical Association, October 9, 1909, p. 1183.

rhythmical contraction and relaxation of the organ, occurring in cats and dogs at intervals of about one minute.

"Roy supposes that these contractions are effected through the intrinsic musculature of the organ,—that is, the plain muscle tissue present in the capsule and trabeculæ,—and he believes that the contractions serve to keep up a circulation through the spleen and to make its vascular supply more or less independent of variations in general arterial pressure. The fact that there is a special local arrangement for maintaining its circulation, makes the spleen unique among the organs of the body, but no light is thrown upon the nature of the function fulfilled. The spleen is supplied richly with motor nerve fibers

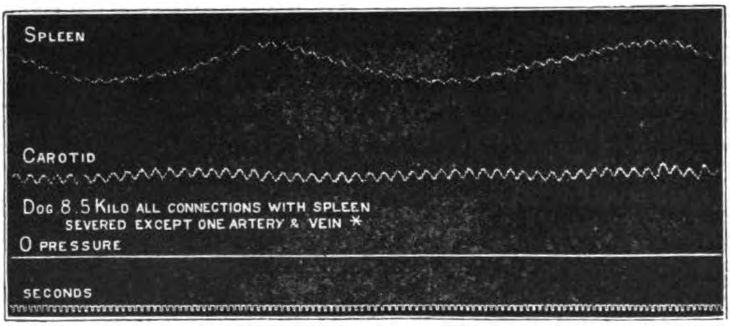


Fig. 29. Plethysmographic tracing of spleen (upper curve) from dog showing the spontaneous rhythmical contractions of this organ. (Schäfer after Starling.)

which, when stimulated either directly or *reflexly*, cause the organ to diminish in volume. According to Schäfer these fibers are contained in the splanchnic nerves, which carry also inhibitory fibers whose stimulation causes a dilatation of the spleen." [5]

The blood of the splenic veins contains a much greater number of white cells than the arterial blood supplied to the organ. Miescher [6] experimenting with Rhine salmon found four times as many leucocytes in the splenic blood as in the cardiac blood. This increase in the cellular elements increases the viscosity,

5 Howell—Physiology, 1909, p. 800.
6 Bunge—Physiologic and Pathologic Chemistry, Second English Edition, p. 229.

and consequently tends to diminish the rate of blood flow. The gathering up of these cells, together with the closeness of the splenic meshwork in which the blood circulates, makes necessary some mechanism for additional propulsive force.

"It is evident that the blood must meet with considerable resistance in passing through the close meshwork of the splenic pulp. To ensure a constant circulation through the gland, we find that the muscular tissue of the capsule and trabeculæ has the property of rhythmic contraction. If the spleen be inclosed in a plethysmograph, or splenic oncometer, and its volume be recorded by connecting this with the oncograph, it will be seen that it is subject to a series of large, slow variations, each contraction and expansion lasting about a minute, and recurring with great regularity (*Fig. 29.*). Superposed on these large waves are seen the smaller undulations due to the respiratory variations of the blood pressure, and on these again the little excursions corresponding to each heart beat. The contractile power of the spleen is under the control of the nervous system, and a rapid contraction may be induced by stimulation of the splanchnic nerves."[7]

The use of cold applications, especially when accompanied by mechanical stimulation, such as the cold mitten friction to the abdomen and the cold splenic douche, have a decidely stimulant effect upon the movements of the spleen. The same is true of the revulsive compress and the alternate hot and cold douche to the splenic region and abdomen. Such stimulation increases the extent and force and greatly enhances the efficiency of the splenic contractions, thereby proving a powerful means of accomplishing the even distribution of the blood cells, especially the leucocytes.

VISCOSITY

Grawitz and also Burton-Opitz[8] have shown that cold applications increase the viscosity and specific gravity of the blood, while warm applications decrease both. This thinning of the blood continued even after prolonged heating with free perspi-

7 Starling—Elements of Human Physiology, 1907, p. 514.
8 Journal of Experimental Medicine, January, 1906.

ALKALINITY OF THE BLOOD

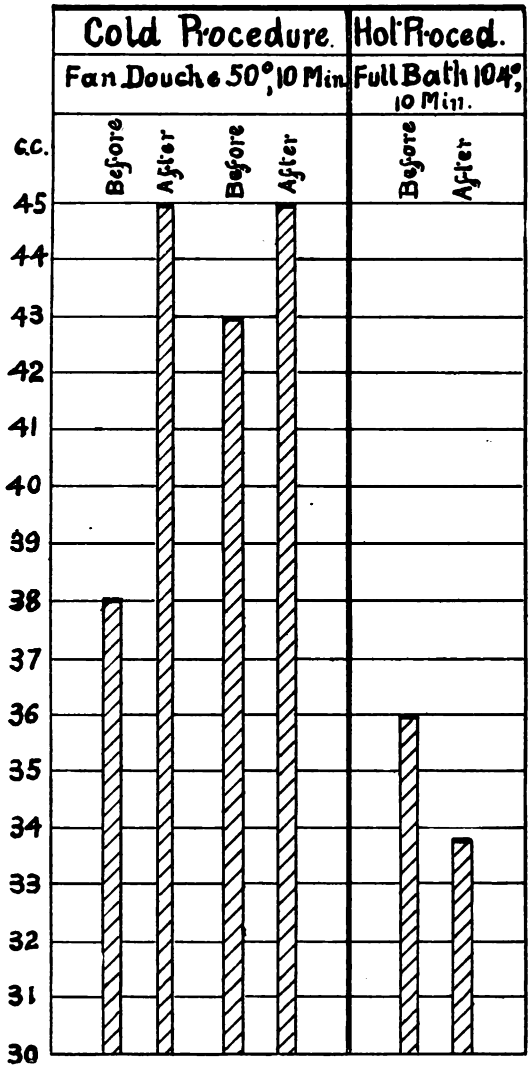


Fig. 30. Chart showing changes in the alkalinity of the blood under thermic procedures. Figures at left refer to alkalinity of 100 c. c. of blood serum in terms of c. c. of decinormal NaOH. (Strasser and Kuthy.)

ACIDITY OF THE URINE

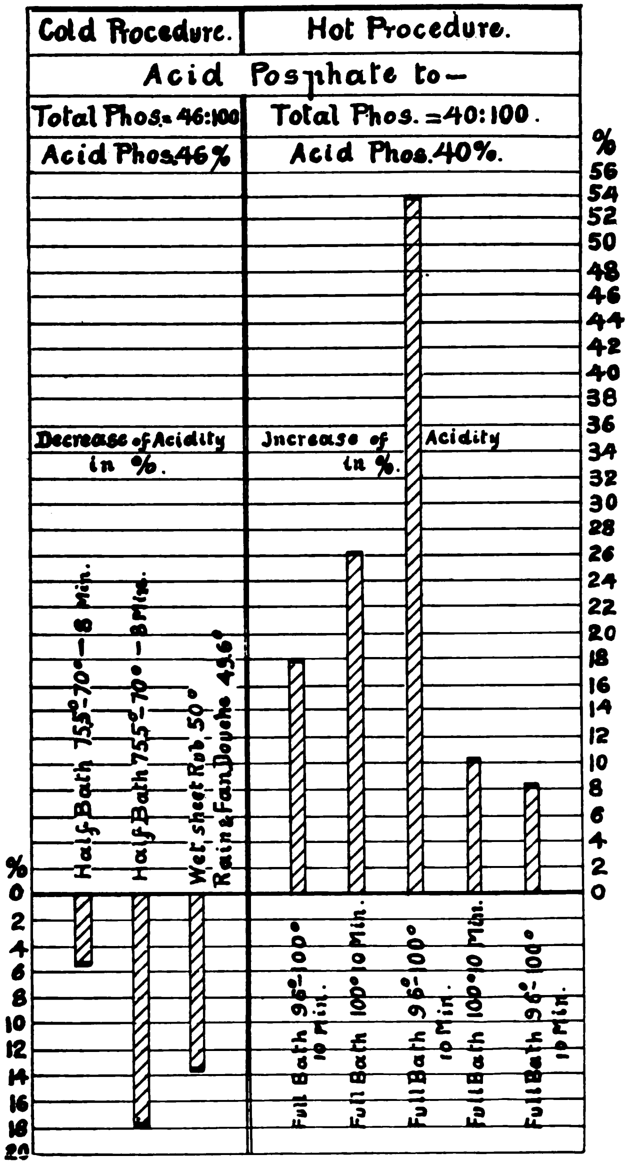


Fig. 31. Chart showing changes in the acidity of the urine under thermic procedures. Figures at the left refer to per cent of decrease in acidity under cold treatment; figures at right, to per cent of increase in acidity under hot treatment. (Strasser and Kuthy.)

ration. This result Burton-Opitz attributed to the blood becoming relatively richer in serum at the expense of the tissues. These facts have been confirmed by Löwy and agree with the deductions of Winternitz and Knöpfelmacher.

In general, it may be said that conditions that produce vasoconstriction, increase the number of corpuscles in the vessels constricted, together with an increase in the specific gravity and viscosity of the blood. Conversely, conditions that relax the blood-vessels, decrease the corpuscular elements in the dilated vessels, together with a thinning of the blood.

REACTION

Strasser and Kuthy[9] performed experiments to determine the effect of hydriatic procedures upon the chemical reaction of the blood and urine. They found that procedures raising the body temperature, *i. e.*, much prolonged heating measures, result in lessening the degree of alkalescence of the blood: also that cold stimulating procedures increase the alkalescence (*Fig. 30.*). Strasser concludes that the result in the case of cold baths is due to an increase of oxidation over disintegration, *i. e.*, to completer burning of acid organic substances, and hence to their disappearance. This is precisely what happens to the organic acids and acid organic salts of fruits and green vegetables. The organic radicle undergoing oxidation, largely into CO_2 and H_2O, leaves in the blood and body fluids the alkaline base of the salt and, therefore, raises the alkalinity of these fluids. While heating procedures increase oxidation, they bring about a greater disintegration of tissue, *i. e.*, partial combustion and so result in an acidification, which acid products remain to be excreted as such in the urine.

That Strasser's deductions are correct is shown by the changes in the acidity of the urine accompanying these changes in the alkalinity of the blood. (*Fig. 31.*) In the case of cold procedures there occurs a decrease in the acidity of the urine parallel with the decrease in the acid of the blood (increase of alkalescence), thus proving that the acidifying substances have, to that extent, wholly disappeared. Conversely, in the heating

9 Deutsche Medizinal-Zeitung, June 15, 1896, quoted from B. Buxbaum—Lehrbuch der Hydrotherapie, II Auflage, pp. 38, 39.

procedures an increase of acid in the blood (decrease of alkalescence) is accompanied by a like increase in the acidity of the urine, showing an actual increase in acidifying substances unoxidized, and hence coming to excretion as such.

PRACTICAL APPLICATION

Some of the most beneficial results of hydriatic measures are due to the facts recorded above. In the majority of diseases, there is a reduction in the alkalinity of the blood. This is particularly true of fevers and infectious diseases. An agent which will tend to restore the blood to its normal alkalinity will hasten all the processes of repair and raise vital resistance by supplying a more normal medium for the phagocytes.

The role of the leucocyte (phagocytosis) in combating infection is now an established fact. The admirable researches of Metchnikoff along this line leave no doubt that the white cell itself is the prime factor (and that not excepting opsonin) in phagocytosis, the production and maintenance of immunity and the body's general resistance to bacterial invasion. He has shown [10] what signal disaster to the production, and even the continuance of immunity, results from the administration of alcohol, quinine, opium, and other medicinal substances; this disaster being manifest by a diminution in the number and especially in the activity of the white blood cells. He further recommends the discarding of medicinal substances and the use of hygienic measures in the prophylaxis and treatment of infectious diseases. We have every reason to believe that cold hydriatic applications not only increase the number of leucocytes in the peripheral circulation, but also energize their action—amœboid movements, phagocytosis, and the production of antibodies. This we might safely infer from the results obtained by cold applications in increasing muscular capacity, glandular activity, etc. All protoplasm, whether of muscle cells, glandular epithelium, or leucocyte, responds alike to the tonic influence of short vigorous cold applications. The writer has repeatedly seen infections of the hand and arm clear up in four to six days, or even less time, when treated by alternating

10 The New Hygiene.

extreme hot and cold immersion, while other cases not so treated have required a month to accomplish the same results.

Since the blood and tissue cells are the source of opsonin, agglutinins, lysins, and other antibodies concerned in immunity, it is but reasonable to expect an increase in these as a result of the cellular stimulation produced by cold or alternate hot and cold applications. This has been partially demonstrated by Graziani,[11] who found that of rabbits injected with the filtrates of typhoid cultures, and kept at different temperatures (plus 38, 37, 2, and minus 4° C.), those kept at low temperatures developed more agglutinin than those kept at higher temperatures. He also experimented with rabbits kept at 32° C., bathing half of the number morning and evening, in water at 20° C. for thirty minutes. The animals treated by bathing produced more agglutinin than the others.

These facts demonstrate the truth of the Scripture statement that *the blood is the life*. The statement has not only its spiritual application, but is also founded upon demonstrated physical facts.

"*Notwithstanding the many antiseptics, germicides, etc., that have been vaunted for the treatment of infectious diseases, the white blood cell itself is the most efficient germicide known, and will always retain its high place in the defence of the body against bacterial invasion; furthermore, the agent which assists the body by augmenting its natural powers of defence will never occupy a place secondary to purely artificial and chemical means of destroying the invaders.*"[12]

11 Centralblatt für Bakteriologie. 1907. I. XLII. 633.

12 Abbott—Elements of Hydrotherapy for Nurses. p. 54.

CHAPTER XI

NITROGENOUS METABOLISM AND EXCRETION

TISSUE changes lie at the foundation of all functional activity. There can be no vital action without corresponding qualitative and quantitative changes in tissue composition. It must, therefore, follow that agents, such as thermic impressions, in awakening functional activity, should at the same time produce profound alterations in absorption, metabolism and excretion. Without giving undue prominence to this phase of the subject, it would be impossible to discuss it here in anything like a complete manner. Those desiring to become more thoroughly conversant with the behavior of metabolism under hydriatic therapy should study the original reports of such research. Along the line of nitrogenous metabolism none are more instructive than those of Dr. Alois Strasser, assistant to Prof. W. Winternitz in the Allegemeine Poliklinik of Vienna, from whose monograph entitled, "The Behavior of Metabolism under Hydriatic Therapy,"[1] is drawn much of the data for the following discussion.

Cellular activity is affected reflexly in the same way as other body functions. Tissue changes occur in all parts of the body, but those metabolic activities with which we are chiefly concerned may be traced to the muscles as the seat of the great majority of oxidative processes. The liver is also to a large extent concerned in metabolism, both nitrogenous and carbonaceous. It is not necessary that the muscles be excited to

1 Das Verhalten des Stoffwechsels bei hydratischer Therapie—Fortschritte der Hydrotherapie, Festschrift zum Vierzigjahrigen Doctorjubilaum des Prof. Dr. W. Winternitz, herausgegeben von Dr. A. Strasser und Dr. B. Buxbaum, Wein, 1897.

perceptible contraction in order to effect metabolic changes. Through the innervation of the muscles, oxidation is controlled and may be greatly increased by hot or cold applications, without visible contractions. This conclusion was arrived at by Röhrig and Zuntz who further confirmed their opinion by experiments upon animals "in which the innervation of the muscles was held in obeyance by arrow poison. In such animals tissue change was not only not increased by cold, but was even reduced one-half."[2] Other stimuli than cold also affect tissue changes. The *relative* value of various cutaneous stimuli, varying degrees of heat, and the quantitative response of metabolism is best studied with carbonaceous metabolism (*q. v.*).

EFFECTS OF COLD

Strasser conducted two series of experiments at different times. In the *first* series two young men were selected as subjects. The daily ration, urine, and feces were carefully measured, and from chemical analyses and estimations from these, the results were obtained. The procedures were such as would ordinarily be administered to patients. In the *second* series a single individual was chosen. In this series the intake contained 122 gm. of proteid (19.0 gm. nitrogen) besides carbohydrate and fat. The output in feces and urine was measured for five days in order to establish the normal quantities of the various constituents for the individual under experiment. "The bath period lasted three days. On each day the man received in the morning at 8 o'clock a friction at 14° R. (63.5° F.). Forenoons at 11:30 a general cold rain bath with moving fan douche, and afternoons a half bath at 22° cooled to 18° R. (81.5° to 72.5° F.) of four minutes duration. Moderate exercise followed each procedure, as much as seemed necessary for warming, *i. e.*, the attainment of a good reaction."

The results of the *first* work as tabulated by Strasser are as follows:—

1. Increase of nitrogen metabolism, *i. e.*, increase of the nitrogen excretion in the urine; a simultaneous decrease in fecal nitrogen.

2 Baruch—Hydrotherapy, p. 80.

2. Absolute and relative increase in the excretion of urea.

3. High absolute increase in the excretion of uric acid, with relative proportion almost unchanged.

4. High absolute and relative increase in phosphorus excretion.

5. Small relative fluctuations in ammonia excretion.

6. Decrease in the sum of the extractives to a minimum.

The results in the second series of experiments entirely confirmed the findings in the first, and are of the same general character.[3]

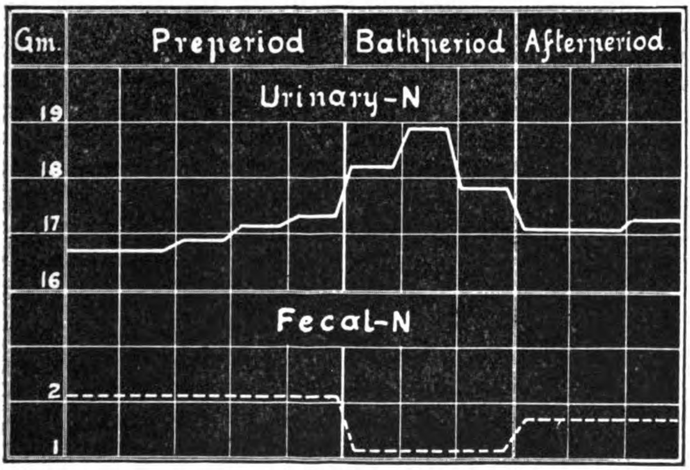


Fig. 32. Showing the effect of cold treatment on fecal and urinary nitrogen—reveals a heightened assimilation of proteid. (Strasser.)

Nitrogen Economy. The excretion of nitrogen (*Fig. 32.*) on the first bath day was increased 8.3 per cent over the average of the preperiod; a maximum increase of 11.4 per cent was reached on the second day, and on the last 6.0 per cent, thus averaging 8.6 per cent. The increase continued throughout the after-period. In the two first cases the average increase was respectively 10 and 16.4 per cent. The fecal nitrogen shows a corresponding decrease. The subject of the experiment remained practically in nitrogen balance throughout the experi-

3. Unless otherwise stated the charts and estimations refer to the second series of experiments.

8

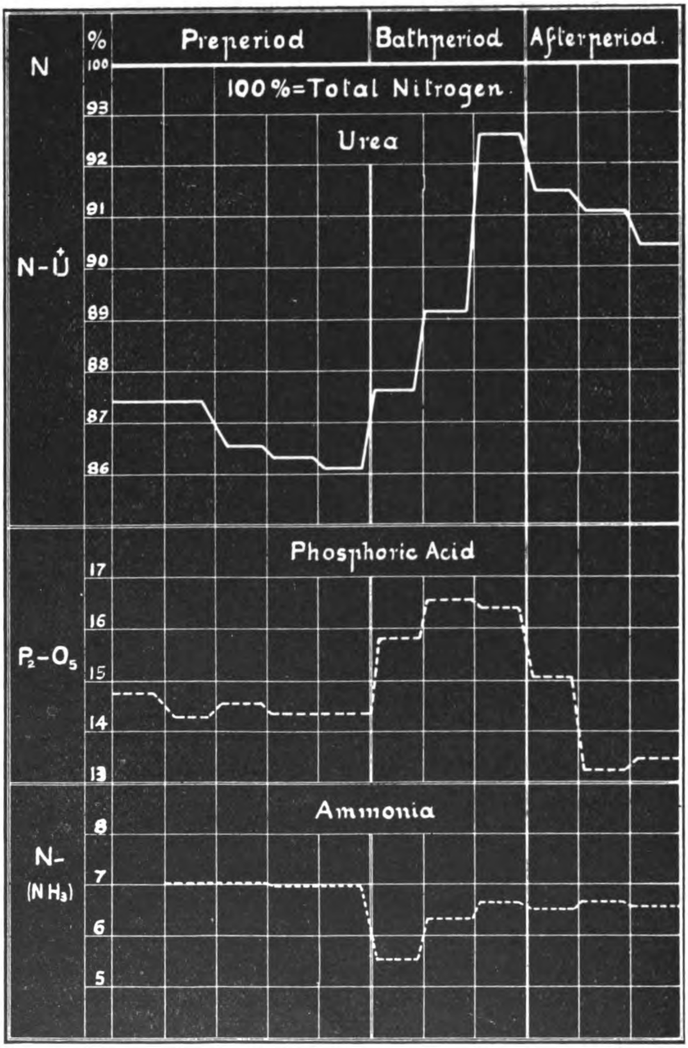


Fig. 33. `Showing relative increase of urea and the phosphates and relative decrease of ammonia. (Strasser.)

ment. The decrease in fecal nitrogen is to be explained by an increased absorption of proteid.

The tonic influence of the reaction to cold procedures brings about an increased digestive efficiency, hastens the processes of absorption and assimilation and renders them more complete. Clinical observations have also established the fact that hydriatic treatment properly suited to the patient's reactive ability decidedly and enduringly enhances assimilation.

Urea and Ammonia. In Strasser's experiments there was an absolute increase of urea in all cases. In the second series this increase averaged 12 per cent during the bath period and 6.5 per cent during the after-period. In the first series the greatest increase in the two cases was, respectively, 18 and 25 per cent and the averages 10 and 21.1 per cent. Relative to the total nitrogen, there was also an increase as graphically shown in *Fig. 33*. From an average proportion of 86.9 per cent of the total nitrogen in the preperiod, the nitrogen content of urea rose to a maximum height on the third bath day of 92.5 per cent of the total nitrogen.

Ammonia being a precursor of urea, and both being derived from proteid, it might be expected that its amount would bear some definite relation to the amount of urea excreted. In the first cases there was both an absolute and a relative increase in the excretion of ammonia. The absolute increase in one case reaching as high as 52.5 per cent and averaging 42 per cent in one and 36 per cent in the other. In the after-period one sank to 33 per cent below the level of the preperiod, and in the other it remained 30 per cent higher than in the preperiod. In the second series it sank to normal in the after-period. Relative to the total nitrogen, the increase was less than might be expected and in the second series there was even a slight relative decrease. Strasser concludes that organic acids ordinarily derived from proteid by incomplete oxidative processes (decomposition) and which so powerfully contribute to lessening the alkalinity of the blood, have, under the influence of the thermic stimulus, been burned up into carbon dioxide and water. This decreased amount of organic acids would, he reasons, require less alkali (ammonia) for their neutralization and so lessen the relative amount of the latter formed.[4]

Uric Acid and Purin Bases. The accepted theories of nuclein metabolism are perhaps too well known to need explanation here. An increase in purin excretion may arise from either endogenous or exogenous purins. That the increased excretion of uric acid is due to heightened activity and breaking up of the leucocytes and, therefore, bears a definite relation to the leucocytosis which always accompanies the reaction to cold procedures, can be correct in part only. The excreted purins must of necessity come from all the nuclear nitrogen of the body as well as from the leucocytes. The more complete oxidation of exogenous purins and the hastening of their excretion may also account for the increase in uric acid.

The results obtained by different experimenters all agree as to the absolute increase in uric acid excretion under the influence of thermic procedures. It runs parallel with the excretion of urea. In Strasser's experiments there was an immediate increase of uric acid on the first bath day, which reached a maximum of 25 per cent on the third bath day and an average of 22 per cent during the entire bath period. The increase, though somewhat less in per cent, continued throughout the entire after-period at an average height of 12.7 per cent above the level of the preperiod. The results in the two cases of his first series entirely coincided with this. In these cases the increase in the total purin averaged 10.4 per cent during the bath period and even a higher stage was reached and maintained during the entire three-day after-period.

Relative to the total nitrogen, there was also a slight increase. Of 100 parts of total nitrogen the nitrogen of the uric acid constituted 1.52 per cent in the preperiod, 1.71 per cent in the bath period and 1.68 per cent in the after-period.

4 It would seem, however, that the small relative increase of ammonia is due to the relatively more complete conversion of ammonium carbonate into urea, its end product. As a product of proteid metabolism it is subject to increased oxidation in common with other nitrogen derivatives, a larger relative increase is prevented by the increased vigor of hepatic activity tending to push the change beyond ammonium carbonate to the formation of urea.

Inorganic acids require alkali for their neutralization as well as organic acids and the former are not only not decreased in amount, but are actually increased. For further discussion of the requirement of organic acids for ammonia and fixed alkali see Graham Lusk—Metabolism in Diabetes—Journal American Medical Association, December 17, 1910.

Of particular interest in connection with nuclein metabolism is the behavior of the purin bases. As the uric acid excretion increases in amount the purin bases progressively decrease, until on the third bath day the entire purin excretion consists of uric acid, the bases having wholly disappeared. At the close of the treatment the purin bases again rise, to reach on the third day

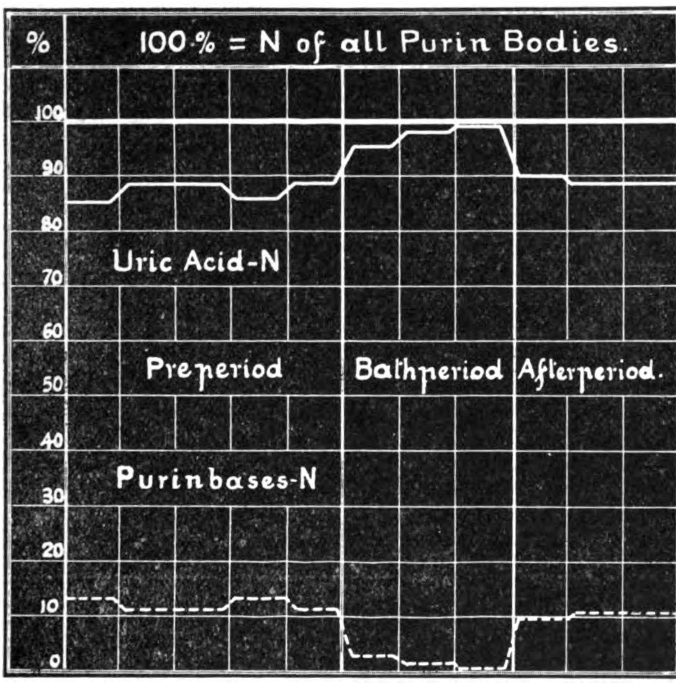


Fig. 34. Showing effect of cold treatment on the oxidation of purins. (Strasser.)

of the after-period, the height of the preperiod. This change in the proportion of the two constituents of purin excretion is graphically shown in *Fig. 34*. Letting 100 per cent represent the total purin nitrogen, 85.5 per cent appears as uric acid and 14.5 per cent as purin bases. On the bath days the per cent of uric acid rises to 96, then to 98 and finally to 100 per cent. The nitrogen content of the bases sinks to 4, then to 2 and finally to 0 per cent.

With the composition of uric acid and the bases in mind, the explanation of the above changes is not difficult. Uric acid is trioxypurin, while the bases all contain less oxygen, being mostly mono- or dioxypurin, with amine or hydrocarbon side groups. Uric acid is, therefore, the most highly oxidized of the purin bodies. It is plain to be seen that the stimulus of the hydriatic procedures has resulted in oxidation of the bases to uric acid, a distinct cumulative effect being manifest by the progressive completeness of this oxidation, until on the third bath day no bases are left, all purin nitrogen appearing as uric acid.

This result is of no little importance in the treatment of the gouty diatheses. With a kidney permeable to uric acid as it is in uncomplicated gout, the purins may be made to come to both complete oxidation and complete excretion. The increase in the alkalescence of the blood and body tissues also resulting from cold applications greatly favors these changes.

The condition in uratic diathesis in reality consists of an accumulation of all the purin bodies (uric acid plus bases). Because of this Kolisch proposed the term "purin diathesis" instead of uric acid diathesis. The excretion of the bases exercises a deleterious effect upon the kidneys, and the altered kidney is in turn less capable of excreting basic purin. This *vicious circle* would be done away with, were the bases excreted in a more completely oxidized state, *i. e.*, as uric acid. As remarked by Strasser, tonic hydrotherapy breaks through this vicious circle and completely changes the aspect of purin auto-intoxication. The excretion of a waste, not as such, but in an altered and less toxic state may be considered "the removal of poison par excellence."

Extractives. A summary of the relation of the nitrogenous extractives to the total nitrogen shows that they constitute respectively 3.86 per cent in the preperiod, 2.17 per cent in the bath period and 0.56 per cent in the after-period. As already mentioned, on the third bath day they disappear entirely and urea, uric acid, and ammonia claim the whole nitrogen for themselves.

Phosphoric Acid. The phosphorus of the urine arises from certain proteids in common with nitrogen and hence gives an added index to the processes of proteid metabolism. Strasser's experiments reveal an increased absorption of phosphorus as well as of nitrogen, as shown by the decrease in fecal phosphorus

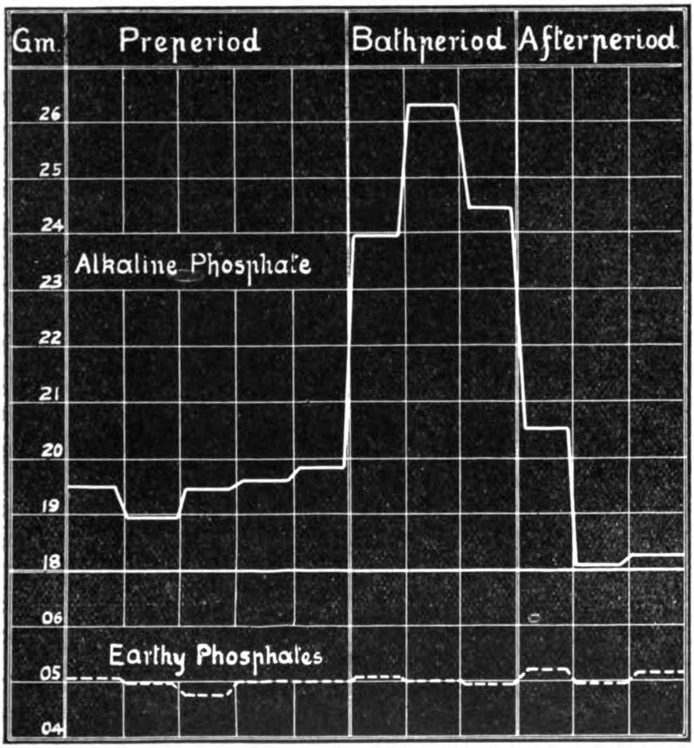


Fig. 35. Showing effect of cold treatment on the alkaline and earthy phosphates. (Strasser.)

during the bath period and an equal and simultaneous increase in urinary phosphorus. The absolute increase in the phosphoric acid of the urine reached a maximal height of 28 per cent on the second bath day. Compared with the total nitrogen, there is also a relative increase as shown in *Fig. 33.* This relative increase may be accounted for by the fact that phosphorus comes from lecithin as well as certain proteids. In the first experiments the relative increase lasted throughout the whole of the after-period. It is significant that only the more labile phosphates take part in the increase. This increase in urinary phosphorus is wholly in the alkaline phosphates, the earthy phosphates remain unchanged (*Fig. 35.*).

Sulphates and Chlorides. The sulphur of the urine also comes from proteid substances and the urinary sulphates are, therefore, another end product of proteid metabolism and should increase with the nitrogen. The average increase was 10.4 per cent during the bath period, which height was maintained during nearly the whole of the after-period. The increase in the sulphates was almost entirely in the mineral sulphates, the ethereal sulphates suffering but a trifling change. This might be expected since more complete digestion and assimilation of proteid, together with completer oxidation, would tend to decrease putrefactive changes and so lessen the relative amount of ethereal sulphate. Hawk observed decreased intestinal putrefaction as a result of copious water-drinking. This result was measured by the indican output. It seemed to be due to more complete intestinal absorption.

The increase in the excretion of sodium chloride was chiefly on the first bath day (15 per cent) and did not outlast the bath period. The excretion of sodium chloride in œdema is a matter of no little importance. In this condition hydriatic applications produce an increase in chloride excretion in two ways; first, by increasing the absorption of interstitial fluid, and second, by stimulating kidney activity.

EFFECTS OF HEAT

The reported researches regarding the effects of heat upon metabolism are somewhat conflicting in their results. This is doubtless due to differences in the mode of application, the intensity, duration, and frequency of repetition of the treatment as well as in the reactive response of the organism. Formanek observed that a single hot bath scarcely changed the nitrogen, but after two or more such baths on successive days there occurred a decided increase of nitrogen elimination. It would seem that a single hot bath, if not too prolonged, should decrease the elimination of nitrogen for the time-being, as a result of the atonic reaction and the lessened amount of water excreted by the kidney.

In general this agrees with the results obtained by two different observers,[5] one working with the Turkish bath and one with the Russian bath.

Effects of Turkish Bath at 122° F. for 50 Minutes

	Day before Bath	Day of Bath
Amount of urine 24 hours	1,567. c. c.	950. c. c.
Specific gravity	1,018.8	1,027.
Urea	45.47 gm.	39.9 gm.
Uric acid	0.683 gm.	0.860 gm.

Effects of Russian Bath at 113° F. for 25 Minutes

	Day before Bath	Day of Bath
Amount of urine 24 hours	1,683. c. c.	900. c. c.
Specific gravity	1,021.	1,027.
Urea	52.68 gm.	38.7 gm.
Uric acid	0.858 gm.	0.980 gm.

Bastels, Naunyn, and Schleich found an increase of urea and total nitrogen excretion which later showed diminution. It is altogether possible that these opposite results may also be accounted for by the differences in the amount of water ingested by the subjects during the respective experiments. Loss of water through sweating decreases the tissue fluids and therefore the urinary solvent, if this loss is not replaced by water-drinking. It has been shown by Hawk[6] that copious water-drinking increases the excretion of nitrogen in the form of urea, due to the washing out from the tissues of preformed urea. He also observed a greater phosphorus excretion. The maximum increase occurred regularly on the second day of the experiment.

The secondary diminution in the nitrogen excretion observed by Schleich would tend to show that the metabolized nitrogen in the case of hot baths comes more from the *tissue albumen* than from any increase in the intestinal absorption of proteids.

5 Hinsdale—Hydrotherapy, pp. 22, 23.
6 University of Pennsylvania Medical Bulletin, 1905.

In case prolonged hot applications increase the efficiency of absorption, there should be a gradual return of the curve of increased excretion to the normal. Instead of this, lessened excretion occurs in an effort to restore the nitrogen balance. This also agrees with clinical experience. A course of hot baths unaccompanied by the tonic of cold applications results in loss of weight. It is true this is largely a loss of fat, but the tissue proteids are also concerned in the increased oxidation.

All observers seem to agree that the excretion of uric acid is increased by hot baths. This being true, both hot and cold baths should be useful in gout.

EFFECTS ON LOW PROTEID DIET

Strasser's experiments were all conducted upon individuals subsisting upon a high proteid diet—122 grams of proteid. In May of 1912 Prof. E. H. Risley[7] conducted, at the request of the writer, a series of experiments to determine the effects of stimulating hydriatic procedures upon the nitrogen metabolism of healthy individuals subsisting upon a low proteid diet (Chittenden standard).

Six medical students were chosen. The diet contained daily 61 grams of proteid and, including carbohydrate and fat, possessed a total calorific value of 2,525 calories. As all were accustomed to a non-flesh dietary, this was no great change from their usual fare. The excretions for the first day of the standard diet were discarded. For the nine days following, estimations were made of the quantity, specific gravity, acidity, urea, ammonia, creatinin, uric acid, total purin, and total nitrogen of the urine; also the total nitrogen of the feces.

The preperiod, the treatment period, and the after-period each lasted three days. During the treatment period, three treatments daily were administered to each man. These were as follows: At 6:30 A. M. was given a cold shower or spray, or a hot and cold shower, with temperatures according to the ability of the individual to react. The forenoon treatment at 10 A. M. consisted of an alternate hot and cold leg bath, with

7 E. H. Risley, M. D., formerly professor of chemistry in the College of Medical Evangelists. Doctor Risley's long experience in studies in diet and metabolism assures the accuracy of the results.

three changes of heat and three of cold. The hot leg bath was administered at 116°—125° F. for two minutes, and the cold at 58°—60° F. for twenty seconds. This was followed by a dripping sheet rub, the sheet being wrung from a pail of water at 60° F. and the pail pours being given at 55° and 50° F. respectively. The afternoon treatment at 4 P. M. consisted of an alternate hot and cold percussion douche to the spine and legs. The hot was given at 116°—125° F. and the cold at 60° F. This was followed by a cold shallow bath at 60° F. the usual procedure being given twice and the bath lasting altogether about four minutes.

In all cases except one the men maintained their weight. This individual appeared to have overstocked with nitrogenous food and the loss of four pounds in weight and the change of diet was accompanied by an increased feeling of well being—he felt "brighter in every way."

The results as obtained by averaging the analyses for all six men showed no remarkable changes in the excretion of nitrogen nor in any of the nitrogen-containing urinary constituents, except possibly in the purin, in either the treatment period or the after-period. With the exception of purin, in which there was a considerable decrease, the fluctuations were all minimal. The changes in fecal nitrogen were also small. The results can be explained upon no other basis than that the diet supplied but little surplus nitrogen. Neither was the system (except in the one case referred to) stocked with unnecessary nitrogen which might be siezed upon by the oxidizing effect of the thermic stimulation. Even the extreme stimulating measures resorted to failed to change greatly the accustomed nitrogen metabolism of the individuals under experiment. All or nearly all of the urinary nitrogen, as well as the ratios in nitrogen partition must be regarded as the result of usual and normal metabolism, *i. e.*, as necessary conditions in healthy persons subsisting upon a low proteid diet.

These studies are helpful in explaining the significance of the results obtained by Strasser in whose experiments the diet contained an excess of 61 grams of proteid and hence nitrogen which, not being required by the body, was subject to large changes without encroaching at all upon the more stabile or necessary nitrogen required by normal body functions. It is, therefore, to be confidently expected that hydrotherapeutic measures should have their greatest effects, both qualitatively and quantitatively, in disorders of proteid metabolism and in individuals who have for years been accustomed to a high proteid diet, *i. e.*, an excessive ingestion of nitrogen.

This view of the matter is entirely consistent with the fact that the nitrogen of the food does not serve primarily as fuel for the supply of energy, but is utilized in tissue building and in tissue repair. Neither changes in season nor in the amount of muscular work produce appreciable changes in the metabolism of *tissue* nitrogen. On the other hand changes in season and the amount of muscular work performed produce large changes in the amount of non-nitrogenous food required. Likewise thermic and mechanical stimulation produce most conspicuous changes in carbonaceous metabolism. It is to these changes we shall now turn our attention.

CHAPTER XII

RESPIRATION, RESPIRATORY CHANGES AND CARBONACEOUS METABOLISM

IN THE previous chapter, we have considered tissue change solely from the standpoint of proteid metabolism and chiefly as regards the nitrogenous moiety. There remains of course a certain amount of carbohydrate when urea is spilt off from the proteid molecule, also the carbohydrate taken as such and the fat, all of which contain no nitrogen. Their metabolism is so intimately associated with respiratory interchanges that we shall consider them together; the respiratory excretion being quite as much a guide to these changes as is renal excretion to nitrogenous changes.

RESPIRATORY EFFECTS

We have noted that all sorts of stimuli applied to the skin produce more or less pronounced vasomotor and cardiac changes, through reflex action. The respiration is more readily affected by cutaneous stimuli than is any other function. One of the most efficient means of resuscitating the new born infant is the use of heat and cold. The same method, *i. e.*, the alternate application of heat and cold to the chest, is scarcely less effective in the adult. The sudden application of either extreme heat or cold, especially if accompanied by percussion, produces an initial deep respiration, which is almost as suddenly interrupted, this being followed by other spasmodic efforts, so that the respiration assumes a staccato type. With prolonged applications of either heat or cold, the respiration soon becomes regular, the rate and depth depending upon the temperature of the application.

Kellogg records the following experiments[1] as illustrative of the effect of thermic stimuli upon the volume of tidal air. To a subject whose tidal air measured 28 cubic inches, a wet sheet rub at 40° F. was administered. Immediately after the treatment, the tidal air measured 35 cubic inches, an increase of nearly 26 per cent.

To another subject, with an initial tidal air volume of 33 cubic inches, a cold mitten friction was administered at 45° F. Immediately after, the tidal air measured 51 cubic inches, an increase of 55 per cent.

In a third subject the amount of tidal air before the treatment was 27 cubic inches. A wet sheet pack wrung from water at 45° F. was applied and continued for one hour. After the initial warming, the pack was kept at the neutral stage. Two minutes after the sheet was applied, the volume of the tidal air was 36 cubic inches, an increase of 33 1-3 per cent. In 15 minutes it was 33 cubic inches. The volume gradually decreased until at the end of the hour it was 28 cubic inches. During the entire period, there was an average increase of 18 1-2 per cent.

In a fourth subject a heating compress wrung from ice water was applied to the chest only. The tidal air immediately rose from 507 c. c. to 751 c. c., an increase of 48 per cent. At the end of 20 minutes the tidal air measured 604 c. c., 20 per cent more than at the beginning. The average increase was 170 c. c., or 33 per cent.

Another subject, whose tidal air was 43 cubic inches, was immersed in a hot bath at 108° F. After 12 minutes the tidal air had decreased to 27 cubic inches, or a decrease of 37.2 per cent. Ten minutes after the bath, it had risen to 33 cubic inches; 30 minutes after, to 37 cubic inches. The loss in the volume of respired air amounted to 37 1-2 per cent.

Brief, sudden applications of cold produce spasmodic respiration. The reaction to cold applications is accompanied by a slowed rate and greater depth of respiration, as shown by the above experiments. The rate is slowed and the amplitude of movement increased in proportion to the completeness of reaction.

1 Rational Hydrotherapy, pp. 1122, 1133.

Warm baths or hot moist applications to the chest increase the ease of respiration, at the same time somewhat increasing the rate. Long, hot baths produce frequent, shallow breathing. Here again the conflicting results which have been reported are doubtless due to varying modes of applying the hot applications, also to the degree and duration of the heat. The inhaling of dry air produces difficult breathing. This may be due to the drying of the membranes, thus compelling deeper or more frequent respiration in order to obtain the same amount of oxygen. Inhalations of steam greatly facilitate respiration. It is decidedly beneficial in almost all forms of dyspnœa. The moisture favors gaseous interchange, while the heat dilates the blood-vessels, thus increasing the surface presented for the interchange. The steam may be made the vehicle of some volatile drug, so enhancing its antidyspnœic properties.

The rule then prevails that cold applications increase the amplitude of the respiratory movement, *i. e.*, the depth of respiration and the volume of tidal air. The breathing of fresh cold air produces the same result. This being the case, cold applications to the skin surface, especially to the chest, also the breathing of cold air should be of great service in all febrile conditions since oxygen absorption and oxidative changes are much interfered with in fever.

Hot applications decrease the amplitude of the respiratory movement and the volume of the tidal air, while moist heat greatly aids in gaseous interchange and thus eases difficult respiration. Such applications are, therefore, of great service in painful dyspnœa, especially in pleurisy as a means of lessening the respiratory excursion.

GASEOUS INTERCHANGE

Having considered the physical changes in respiration, we may pass to the alterations observed in the chemical activities of the respiratory function. Since it has been shown that both hot and cold baths increase nitrogenous metabolism, we might expect the same effects upon the oxidation of carbonaceous material. This is precisely what occurs.

Rubner[2] (1903) has given us some observations which are of a very practical nature, since the results obtained were after hot and cold applications given as they are ordinarily applied in practice. The following table shows the effect of short baths upon the consumption of oxygen and the elimination of carbon dioxide:—

Bath at	Volume of Air	CO_2	O_2	Resp. Quot.[3]
61° F.	plus 22.9%	plus 64.8%	plus 46.8%	0.86 : 1.00
86° F.	" 7.3	" 31.0	" 16.2	0.95 : 0.93
91° F.	" 1.8	minus 1.8	" 6.2	0.87 : 0.90
104° F.	" 16.1	" 3.9	" 3.2	0.86 : 0.90
111° F.	" 18.8	plus 32.1	" 17.3	0.86 : 1.00

H. Winternitz (1899) in seven experiments upon the same individual, observed that hot baths continued 30 minutes produce during that time an average increase in the consumption of oxygen amounting to 78 per cent and in CO_2 elimination of 91 per cent. Observations made on an average nearly an hour after the bath, still revealed an increase of 22 per cent in the oxygen consumed and 16 per cent in CO_2 exhaled. Rubner has shown that metabolism is at a minimum under temperatures from 91.4° to 95° F. (33° to 35° C.). A fall of every 1° C. in the surrounding temperature increases metabolism by 2 or 3 per cent.

From the above observations we may deduce the law that applications below the skin temperature increase respiratory changes in proportion to the degree of cold. Neutral temperatures exert but little influence. Temperatures above that of the skin surface again increase the respiratory function in proportion to the degree of heat.

Rubner[4] found in his experiments that a douche produced more than double the change produced by a bath at the same temperature, each continued for the same length of time, *viz.*, 3 1-2 to 5 minutes. The accompanying table shows the increase in per cent.

2 Archiv für Hygiene, 1903, Bd. 46.

3 The normal respiratory quotient is 0.9 and is found by dividing the amount of oxygen inhaled by the amount of carbon dioxide exhaled.

4 Archiv für Hygiene, 1903, Bd. 46, p. 390.

	Douche at 61° F.	Bath at 61° F.
Volume of air	plus 54.5%	plus 22.9%
CO_2 exhaled	" 149.4	" 64.8
O consumed	" 110.1	" 46.8

These observations prove the immense advantage of mechanical stimuli combined with thermic and also of exercise following hydriatic treatment, especially when taken in the open air. A swimming bath or cold rubbing bath produces more decided tissue change than quiet immersion for the same reason. The same is true of massage following baths of whatever temperature. At Aix-les-Bains a specialty is made of what is called the massage douche. This consists of deep-kneading of the muscles given while one or more streams of water are pouring over the parts treated. The Turkish shampoo following a Turkish or Russian bath also combines many of the procedures of massage, and is very popular with the obese. All such combinations of extreme thermic with vigorous mechanical stimulation are of great advantage in the treatment of obesity since the resultant oxidation of carbon compounds is more than double that produced by thermic stimulation alone. The lung gymnastics produced by hydriatic applications are by no means the least important factor in the results produced by hydrotherapy.

CHAPTER XIII

MUSCULAR CAPACITY

THE restorative effect of warm baths in relieving the sense of fatigue, and the tonic effect of the cold douche or spray in overcoming the effects of fatigue, are familiar to all who are acquainted with the practical application of hydriatic procedures. These effects are extensively used by athletes in overcoming the exhaustion of severe or prolonged exertion. And medically considered, they are by no means the least important of the results obtained by hydriatic applications.

In 1892 and 1893 Vinaj and Maggiori[1] reported a series of experiments undertaken to show the effect of hydriatic measures upon the capacity of the muscles for work and their resistance to fatigue. These investigations were made with Mosso's ergograph (*Fig. 36.*). This instrument is so constructed as to hold the hand and forearm stationary in the body of the apparatus, while one finger is left free for flexion and extension. The forefinger, or middle finger, is usually employed so that, by means of a cord over a pulley, it raises and lowers a weight. This is kept up until the muscles are fatigued and unable to contract longer. A writing point makes a graphic record on the drum of an upright or horizontal kymograph. Their experiments were done with a weight of three or four kilograms, raised every two seconds.

In one experiment (*Fig. 37A.*) the middle finger of the right hand was, under normal conditions, able to execute fifty contractions, representing a work of 5.139 kilogrammeters. After a cold bath at 50° F. for fifteen seconds the same group of muscles executed, before fatigued, seventy-four contractions representing a work of 9.126 kilogrammeters (*Fig. 37B.*).

1 Blätter für klinische Hydrotherapie.

A graduated bath beginning at 96° F. and ending at 68° F. increased the number of contractions from thirty-nine, representing a work of 3.603 kilogrammeters, to eighty-seven contractions, the equivalent of 9.349 kilogrammeters of work (*Fig. 38.*).

When the muscles are already fatigued from active work, by cold applications they may be restored to their usual power. This restorative effect is well illustrated in *Figs. 39 and 40.*

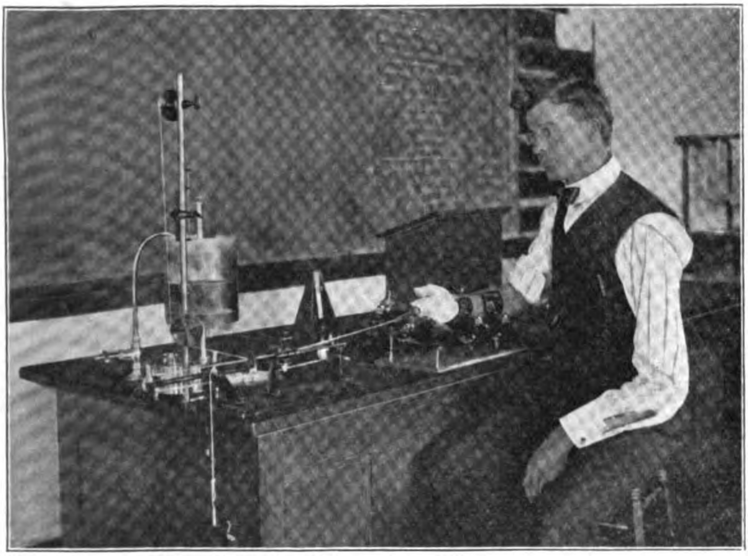
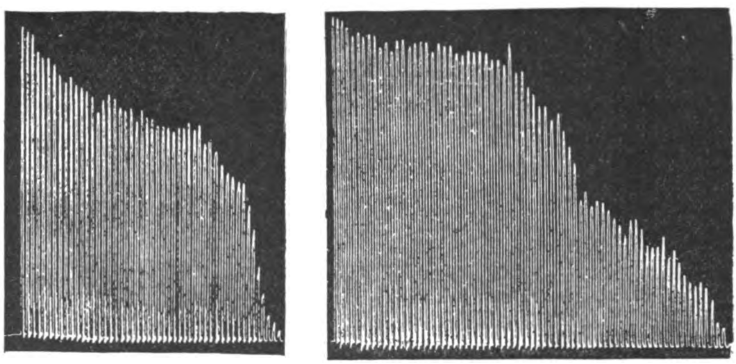


Fig. 36. Mosso's Ergograph.

In *Fig. 39* the first tracing (*A*) represents the fatigue curve of the normal muscle. The second (*B*) is the fatigue curve taken following active work, *i. e.*, at a time when muscular capacity has already been partially exhausted. The third tracing (*C*) shows the restorative effect of a graduated bath given following the fatigue of active work. In the case of the cold wet sheet rub following fatigue (*Fig. 40C.*) the muscular capacity has been increased to a point even above the normal.

With hot baths the opposite effects prevail. There is a decided lessening of the muscular capacity, amounting in one of Kellogg's experiments to a decrease of 44 per cent. His experiments cover a wide range and are very instructive. He used both Mosso's ergograph and the dynomometer; the latter a machine of his own design. The following table is compiled from his experiments with Mosso's ergograph:—[2]

Subject			Hot Treatment			Cold Treatment		
AGE	WEIGHT	INITIAL STRENGTH	DEGREE	TIME	RESULT	DEGREE	TIME	RESULT
21	140	4.994	Spr. 113°	15 Min.	4.432	Spr. 60°	10 Min.	6.094
26	150	5.395				D. 60°	1 Min.	6.925
Not stated		1.312	D. 115°	5 Min.	0.927	D. 55°	15 Sec.	1.527
26	151	8.282				D. 60°	3 Min.	11.966
26	151	6.371	Gen. D. 112°	15 Min.	4.155	Gen. D. 56°	15 Sec.	8.448
26	151	8.033	B. 104°	20 Min.	4.459			
26	151	5.817				Gen. D. 55°	15 Sec.	8.642
26	151	5.817	Neutral bath		5.789			
21	140	5.761				Shal. B. 65°	2 Min.	7.589
21	140	4.791				W. S. P. 60°	20 Min.	5.456



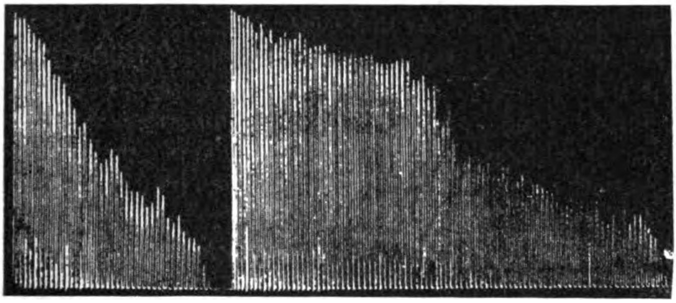
A B

Fig. 37. Fatigue curve of right hand. A—normal, B—after bath at 50° F. for fifteen seconds.

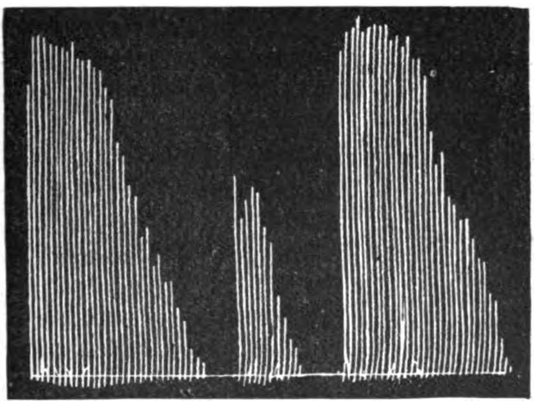
Considering both the dynomometer and ergograph experiments, there was, after cold procedures, an average gain in muscular capacity of about thirty per cent, and after hot applications, an average loss of thirty per cent in the work accomplished. Cold, therefore, increases the muscular working capacity; while warmth, not combined with mechanical effects, diminishes muscular power. *After fatigue* a simple warm bath may slightly increase muscular power, although this effect is

2 Recorded in Rational Hydrotherapy.

not decided (*Fig. 41A.*). Warm procedures when combined with friction or percussion, as in douches, produce an increase in muscular power (*Fig. 41C.*), but to a less extent than cold. In practice alternate hot and cold douches, when so given that



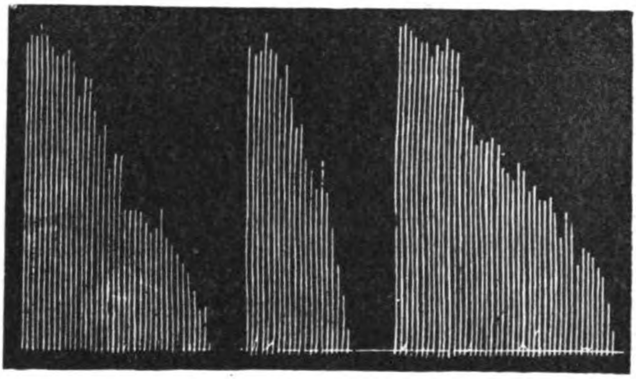
A B
Fig. 38. Fatigue curve. A—before. B—after graduated bath, 96° to 68° F.



A B C
Fig. 39. Effect of work and graduated bath upon fatigue curve. A—normal. B—after active work. C—after work followed by bath.

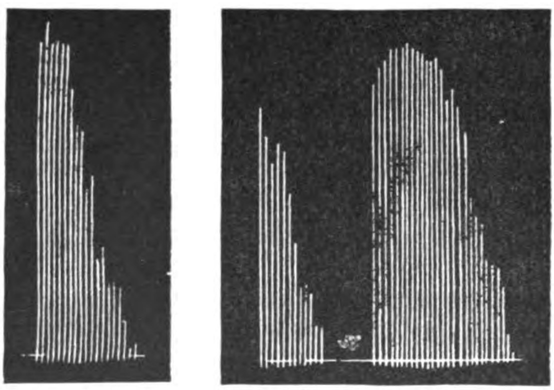
the hot is short and used only to prepare the body for cold, produce the greatest increase in the working power. Mechanical effects alone, such as massage, also raise the working capacity of the muscles but to a less extent than cold procedures.

To what are these tonic and restorative effects due? This question may be somewhat difficult to answer; but it would



A B C

Fig. 40. Effect of labor and cold wet sheet rub upon fatigue curve. A—normal, B—after labor, C—after labor followed by wet sheet rub.



A B C

Fig. 41. Effect of simple warm bath and of warm douche on fatigued muscles. A—muscular fatigue followed by warm bath. B—after fatigue only. C—after fatigue followed by warm douche.

seem that the restoration of the muscle to its normal working power is due to more than one change. Among these changes may be mentioned the restoration of *tone* to the nerve and its central cell brought about by the cold application. It is probably due also to washing out and oxidizing of the *fatigue poisons* consequent on the quickening of the circulation; and third to the return of the blood to a condition of more normal *alkalinity*.

FATIGUE POISONS

The last two of these changes deserve more than passing mention. Experimental fatigue due to contractions of excised muscle is accompanied by an increase of lactic acid, while freshly excised resting muscle yields very small quantities of lactic acid. So far as at present demonstrated lactic acid is the chief substance normally produced in fatigued muscle. This of course gives rise to a lessening in the alkalinity of the blood flowing from such fatigued muscles. In the presence of an abundant supply of oxygen this lactic acid disappears. We have already learned that these acidifying substances also disappear under the stimulus of cold procedures, due to an increase in oxidation.

On the contrary, heating procedures are conducive to acidification as also already shown in the previous chapter. Confirmatory of this is the following statement from Fletcher and Hopkins:[3] "The amount of lactic acid produced in full heat-rigor is constant for similar muscles. This 'acid maximum' of heat-rigor is not affected by a previous appearance within the excised muscle of lactic acid due to fatigue, or by a previous disappearance of acid in the presence of oxygen, or by alternate appearances and disappearances several times repeated."

It is thus amply demonstrated that lactic acid is a fatigue poison. Procedures which cause its disappearance bring about, by this disappearance, a restoration or heightening of muscular power. On the contrary, procedures which increase the lactic acid content of muscles do by this increase bring on the phenomena of fatigue, and so lessen muscular capacity.

There is some clinical evidence which goes to show that lactic acid is not the only substance which may cause the appearance of fatigue. Certain products of nitrogenous metabolism and

3 Quoted from "Further Advances in Physiology," edited by Leonard Hill, p. 214.

particularly of the metabolism of nuclear proteid seem to exercise the same effect. Since the amount of these from the organism itself is small and fairly constant the effects are most apparent in the case of ingestion of much purin with the food (exogenous purin). The premature appearance of fatigue in meat eaters and users of coffee and tea is scarcely to be accounted for on any other basis.

It is a well known fact that the fatigue curves of vegetarians reveal a high degree of ability to sustain continuous and prolonged effort; while on the contrary the fatigue curves of meat eaters show a great susceptibility to fatigue, and hence its early onset in endurance tests. Buttner's recent compilation of

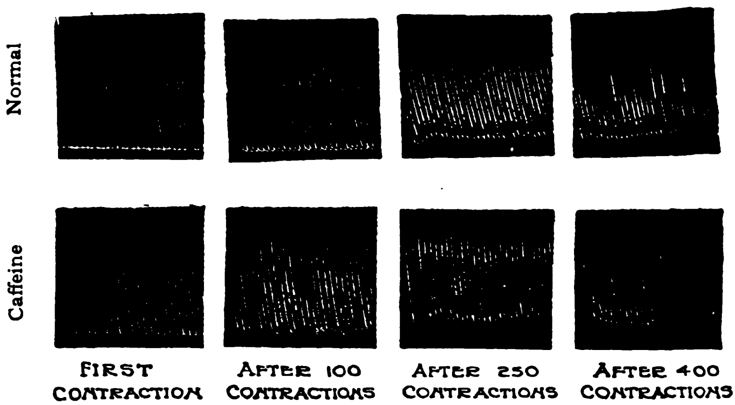


Fig. 42. The effects of caffeine on voluntary muscle. The two tracings are from the two gastrocnemii of a frog. The muscle which recorded the upper one was kept in a physiologic salt solution, the lower one in a dilute solution of caffeine. (Wood.)

experimental work in this line in his treatise on "A Fleshless Diet" leaves no question as to the finality of these conclusions. The data there given are most interesting and important and should claim the attention of all who undertake to advise or prescribe in matters dietetic.

That the early onset of fatigue in meat eaters and coffee users is due largely or wholly to purin substances is very well shown by the experiments of H. C. Wood, Jr.[4] He experimented with the voluntary muscle of a frog, using a solution of

4 Pharmacology and Therapeutics, p. 36.

caffeine (trimethyl xanthin) which is one of the basic purins. The result was at first an increased height of the muscular contraction and hence an increase of the work performed. Later, fatigue set in earlier and the contractions showed a much diminished amplitude and greater irregularity than in the normal (*Fig. 42.*). These observations agree with the effects observed in meat-eating athletes who excel vegetarians in a "spurt", *i. e.*, a short contest, but who invariably fall out before the finish or come in behind in cases of prolonged effort.

THERAPEUTIC APPLICATION

The therapeutic points of practical importance which one may gain from the facts brought out by the above experiments are these: Hot applications are useful in decreasing the tonicity of hypertonic muscles, lessening their irritability and relieving either clonic or tetanic spasm. These effects bring about relaxation and rest. The nervous system is quieted and the nervous manifestations of extreme fatigue disappear so that ideal conditions for sleep are produced. These sedative effects are discussed further in the part on therapeutics. The heat leaves no bad after-effects. There is no feeling of drowsiness or languor the following forenoon as is so common after sleep induced by trionol, veronal, etc. Unlike morphia or the bromides, heat does not cover up or mask important symptoms. It does not poison or anesthetize the nerve centers or endings.

In cold applications properly graduated to suit the needs of various conditions we possess the most useful muscular stimulant and tonic known to medical science. The stimulating effects of strychnine are not comparable with it. The stimulation produced by strychnine is not constant or uniform. Its toxic action becomes manifest in even small doses. Its frequent repetition soon wears out the response, and depression results. When frequently repeated the stimulating stage is of very transient duration and later is absent altogether. It produces a feeling of exhaustion and irritability, rather than exhilaration. "On the whole, *strychnine must be looked upon only as a temporary remedy*. It must be remembered that it does not in any way permanently improve the condition of the central nervous system, nor does it increase any of the functions except reflex irritability. It is doubtful whether the permanent maintenance of this artificially raised irritability is ever of benefit."[5]

In the case of caffeine the stimulating effects are entirely different from those of cold and are in no way comparable with them. Caffeine deadens the sense of fatigue and by an irritant action heightens the tonicity of voluntary muscle so that its response to stimulation is, for a time, greater than normal and it responds to a feebler stimulus. Thus more work is performed on the mere stimulation of a cup of coffee, often when the body is already fatigued and should rest. Thus caffeine gives a false sense of energy and as a result the individual neglects to take the proper amount of food which only is the ultimate source of muscular energy. Hence the system, exhausting its supply, draws on its future resources and in time the constitution is undermined.

5 Sollmann—Pharmacology, p. 175.

CHAPTER XIV

THE HEAT MECHANISM

ALL THE energy liberated in the body by the decomposition and oxidation of food appears as work or heat. Next to the muscles in importance as a source of bodily heat is the liver. The temperature of the blood in the hepatic vein is higher than in any other part of the body. This is doubtless because of the magnitude of metabolic changes which occur in the liver.

"On the processes of metabolism—the decomposition and oxidation of foodstuffs—depend the maintenance of life. Hence all living animals are continually producing heat and imparting it to the surrounding bodies; and unless this heat production is more than counterbalanced by loss of heat in surface evaporation, they must have a higher temperature than the surrounding medium, although the difference may not amount to more than two or three degrees in cases where metabolic processes are going on sluggishly.

"The temperature of an animal is the algebraic sum of two factors—the amount of heat produced and the amount of heat lost in a given time. If, while the heat production remains constant, the amount of heat imparted to the surrounding medium be increased, the temperature will fall. If, on the other hand, heat loss remaining constant, heat production be raised, the temperature will rise in the same proportion. So the temperature may be regulated by alterations in the heat production or in the heat loss; and if the temperature is to remain constant, there must be an accurate correlation between the two processes.

REGULATION OF HEAT PRODUCTION

"It has already been mentioned that, if a frog or other cold-blooded animal be exposed to a higher temperature, its internal temperature will also rise. If, at the same time, we measure the respiratory interchanges of the frog, we find that at the higher temperature more carbon dioxide is evolved and more oxygen taken up, showing that in this case a rise of temperature in the surrounding medium causes a rise in the temperature of the frog, and at the same time, increases the activity of its metabolic changes. Cooling has the reverse effect. If a frog be cooled to 0° C., the chemical changes in its tissues are so reduced that in may be kept alive for some days in an atmosphere devoid of oxygen. The case is quite otherwise with warm-blooded animals. Exposure of one of them to a cold medium raises the amount of carbon dioxide given off and oxygen taken in, while the temperature of the animal remains unaltered. This power of the animal to *react* to changes in the temperature of the surrounding medium is dependent on the integrity of the nervous system and its connection with the muscles. If a dog or rabbit be poisoned with curare (which paralyzes the muscle end-plates), or if its spinal cord be divided just below the medulla, its temperature sinks continuously. It is then found that the animal reacts to changes in the temperature of the surrounding medium precisely like a cold-blooded animal—rise of the external temperature causing rise of the internal temperature and increased elimination of CO_2, while a fall of the external temperature has the reverse effect."[1]

It has been shown that metabolism and heat production are proportional to the skin area of the animal under observation. The temperature nerves of the skin constitute the mechanism by which thermic impressions are received. Quantitative results as regards heat production are, therefore, dependent upon the area stimulated. An animal whether of little or much weight, produces heat not according to its weight but according to the extent of the skin surface exposed to the surrounding medium.

1 Starling—Physiology, 1907, pp. 500—503.

REGULATION OF HEAT LOSS

From the standpoint of hydrotherapy, however, of more importance than the regulation of temperature by the production, is regulation by heat loss. Heat is lost from the body in three ways. Only the last two of these are of any practical importance and the third is of the greatest utility, for it is largely through this avenue that febrile temperatures are controlled. The three ways are as follows:—

1. By the Urine and Feces. About 3 per cent of the total heat lost from the body leaves it with the excretions.

2. By the Expired Air. "The inspired air is taken in at the temperature of the surrounding atmosphere, and contains only a small amount of aqueous vapor. The expired air has a temperature of about 1° lower than the body temperature, and is saturated with water vapor. Heat is, therefore, lost in respiration in two ways: first, in warming the inspired air; second, in the evaporation of large quantities of water. These two sources of loss constitute about 20 per cent of the total heat loss."

3. By the Skin. "Here again the loss of heat is affected in two ways: first, by radiation and convection. By these means, an interchange of heat takes place between the surface of the body and surrounding objects, tending to cool the body under ordinary circumstances when the external temperature is below 98.4° F., or 37° C., or to warm the body when the external temperature is higher than this, as during the hot season in the tropics or in a Turkish bath. The amount of interchange of heat between two bodies is directly proportionate to the difference of temperature between them. Thus, the warmer the surface of the body in comparison with that of surrounding objects, the greater will be the amount of heat interchange which in this case implies a loss of heat to the body. Since very little heat is generated in the skin itself, its temperature is intimately dependent on the amount of blood flowing through it, and this in its turn on the condition of the blood-vessels of the skin. When these are dilated, there is a constant supply of warm blood from the deeper parts of the body to the skin, which therefore, is kept warm and feels warm, both subjectively and objectively. Hence dilatation of the blood-vessels of the skin under normal circumstances brings about increased loss of heat. If, on the other hand, the vessels are constricted, the small amount of blood supplied to the skin rapidly becomes cooled and the skin is also cool, and the loss of heat small.

"Second, by the evaporation of the sweat. In the conversion of water into watery vapor, a large amount of heat becomes latent. This principle is made use of in making ice, or in cooling a bottle of water by surrounding it with damp cloths which are exposed to a draught of air to facilitate evaporation. If the secretion of sweat is small, it evaporates as it is secreted and the skin remains dry. This is spoken of as insensible perspiration. If the secretion be very copious, it may be formed faster than it can evaporate, and appears on the skin as drops of sensible perspiration. The formation of sensible perspiration depends then on two factors—the amount of sweat secreted and the rapidity of evaporation, which latter again is dependent on the amount of saturation of the surrounding atmosphere with watery vapor.

"The loss of heat by the skin amounts to about 77 per cent of the total heat loss, and is, therefore, the most important of all the channels for the discharge of heat. The regulation of the total heat loss is also effected chiefly by changes in the loss through the skin. The nervous channels by which this is carried out are the vasomotor and the sweat nerves. If the external temperature be below that of the body, the loss by radiation and convection may be sufficient to get rid of the excess of heat produced. If, however, the external temperature be higher than that of the body, radiation and convection will serve only to warm the body still further, and the sole loss of heat that can be affected is by the evaporation of sweat, which is accordingly, under such circumstances, secreted in large quantities (*Fig. 43.*).

"Often, especially after severe muscular exercise, radiation and convection are not sufficient to carry off the excess of heat produced, and hence there is a copious secretion of sweat as well, even though the external temperature may be cool."[2]

2 Starling—Physiology, pp. 504—506.

The relative values of the different means of heat loss are estimated by Vierordt as follows:—

1. By urine and feces - - - - -	1.8	per cent
2. By expired air: warming of air - -	3.5	" "
Vaporization of water from the lungs	7.2	" "
3. By evaporation from the skin - -	14.5	" "
4. By radiation and conduction from skin	73.0	" "

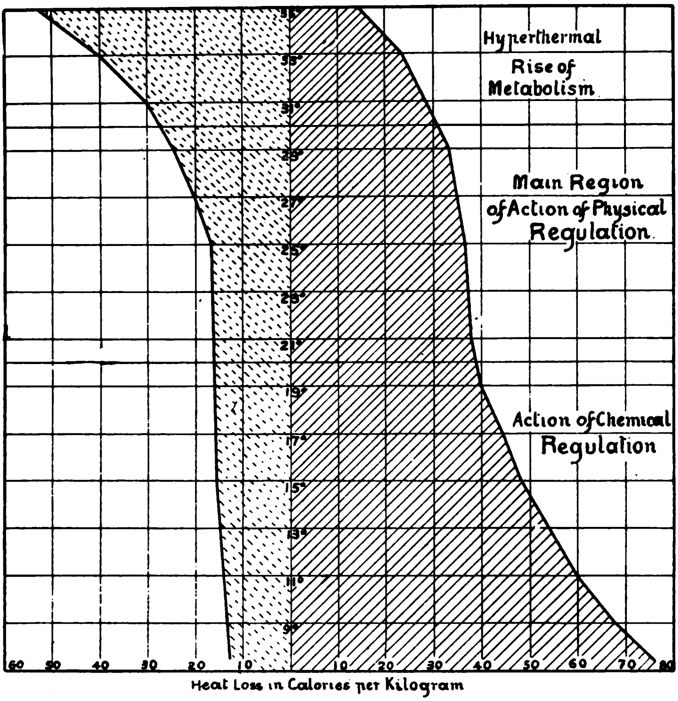


Fig. 43. Rubner's chart showing the manner of heat loss at different room temperatures in the dog. - - - - - - -, heat loss in calories through evaporation of water; ————. heat loss in calories through radiation and convection.

"So perfect is the adaptation of the heat loss to the heat production, that a man may travel from the poles to the equator, may eat or fast, take exercise or rest, without causing any lasting alteration in his temperature of 1° C., though violent exercise may induce in many individuals a temporary rise of temperature of 2° C."[3]

3 Starling—Physiology, p. 506.

"We may at present adopt the conservative view that heat production and heat dissipation in the body are controlled not by a special heat-regulating apparatus, composed of heat centers and heat nerves, but by the coordinated activity of a number of different centers in addition to the voluntary means already specified. The unconscious regulation of the body temperature is effected chiefly through the following:—"[4]

Heat Dissipation.

1. The sweat centers and sweat nerves.
2. The vasoconstrictor centers and their nerve fibers to the skin.
3. The respiratory center.

Heat Production.

1. The motor nerve centers and the motor nerve fibers to the skeletal muscles.
2. The quantity and character of the food.
3. Secretory and other glandular nerves.

The principal parts of this heat-regulating mechanism and their relation to each other are well shown in the accompanying diagram (*Fig. 44.*).

EXPERIMENTS IN HEAT PRODUCTION AND ELIMINATION

In the clinical study of the heat mechanism it is necessary to understand something of the means employed in such study. To ascertain the heat output of any organism some form of calorimeter is used. The most accurate calorimeters are those that utilize water for the absorption of the heat communicated from the body. From the total volume of the water and the change in its temperature it is an easy matter to figure the number of calories absorbed by it, and consequently the amount of heat given off from the body under experiment in a given length of time. This of course is the quantity of heat eliminated. If the temperature of the organism remains constant during the experiment, then its heat production is equal to its heat elimination. If the temperature rises or falls, the increase or decrease of heat production above or below the heat elimination can be estimated from the weight of the body and change in the temperature.

4 Modified from Howell—Physiology, 1908, p. 866.

The construction of the calorimeter for animal experiments can be readily grasped from a study of *Fig. 45*. For rough clinical work a bath tub of water may be utilized. The temperature of the water serves to make the thermic application with which it is desired to experiment and its volume, together with the changes in its temperature serve as the basis for figuring the heat elimination in calories. It has the disadvantage of being unsuitable for estimating the after results of thermic

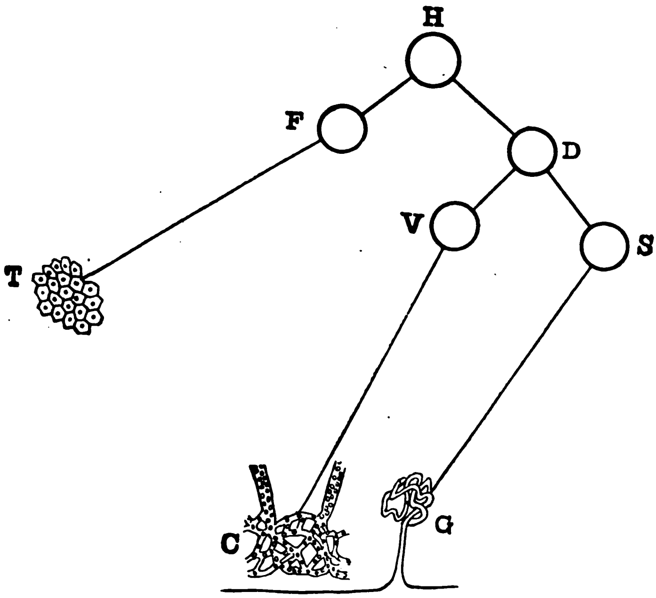


Fig. 44. Diagram showing heat-regulating mechanism. H—heat-regulating center, F—center for heat formation, D—center for heat dissipation, V—vasomotor center, T—thermogenic tissues, S—center for sweat glands, C—capillary blood-vessels of skin, G—sweat gland. (Wood.)

applications. For after results relative values may be obtained by the d'Arsonval calorimeter. This instrument is a large upright cylinder of heavy pasteboard or other good non-conductor. The upper end is closed except for an opening in which is fitted an anemometer and the lower end also except for small openings to admit air. The subject of the experiment stands in this cylinder, the heat of the body causing a movement of air which is registered by the anemometer. The results are of course only relative but are of value in determining an increase or decrease of heat elimination.

For our purpose no time need be spent on experimental proof of the effects of muscular, glandular, and other vital activities on heat production and elimination. We wish, however, to quote more or less at length the experimental basis of

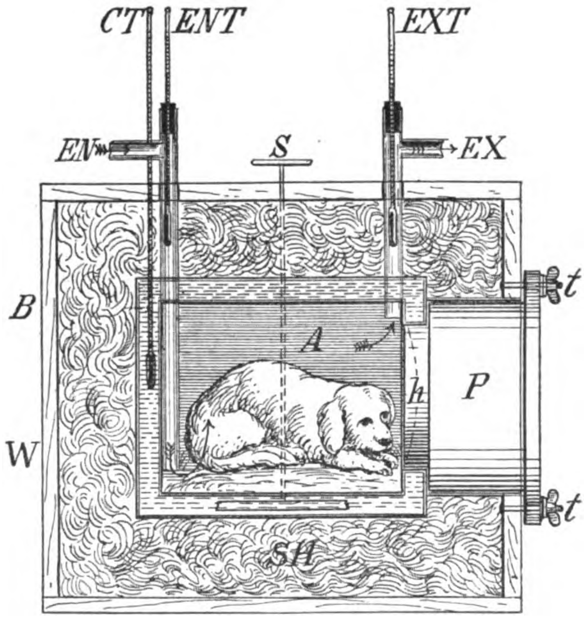


Fig. 45. Reichert's water calorimeter.

the physiologic effects of hydriatic applications upon heat production and heat loss. Kellogg's experiments[5] along this line are very practical since the tests were made after applications of the intensity and duration actually employed in practice.

W. was given a cold percussion douche for thirty seconds. The change in rectal temperature immediately after revealed an increase of nearly ninety heat units and this in spite of the increased heat elimination resulting from the reaction. Another

5 Rational Hydrotherapy.

experiment upon a subject A. revealed the fact that while quiet immersion in a bath at 82° F. for five minutes absorbed heat from the body, it did not cause any material increase in heat production above the normal amount or rate. When the same subject was placed in a bath at 77° F. and rubbed constantly during the five minutes, heat loss was increased three times and heat production six times the normal amount. P. was given a short hot spray at 106° F. By means of a bath tub calorimeter it was estimated that heat production had been decreased 22.7 per cent. By means of a d'Arsonval calorimeter it was shown that oiling the skin decreased heat elimination 45 per cent.

A series of four tests with the d'Arsonval calorimeter were made upon W. In a room temperature of 70° F., when placed in the calorimeter, the elimination of heat from his body produced, as shown by the anemometer, an air movement at the rate of 123 feet per minute. After an electric light bath sufficient to redden the skin without sensible perspiration the air movement increased to 140 feet per minute. After an electric light bath to profuse perspiration the rate of air movement was 170 feet per minute. After a cold percussion douche at 60° F. for two minutes the air movement was 70 feet per minute. In ten minutes, when reaction had taken place, it was 110 feet per minute.

By means of a bath tub calorimeter it was ascertained that a certain subject when immersed in water at 70° F. imparted heat to the water to the extent of raising its temperature 0.72° in five minutes. When friction was applied the temperature of the water rose at the rate of 1.08° F. in five minutes, or an increase of 50 per cent in heat elimination.

The giving of copious enemata at 70° F. at intervals of twenty-five minutes for an hour and a half to a subject S. reduced the mouth temperature from 98° to 96.9° F., and the rectal temperature from 100° to 95.2° F.

The drinking of seven glasses of lemonade at 58° F. in the case of M. produced in twenty minutes the following changes:—

Temp.	By Axilla	By Mouth	Per Rectum	On Epigastrium
Before	97.7°	98.7°	99.2°	97°
After	96.1°	98.0°	98.0°	92°

It has already been mentioned that for every fall of 1° C. in the surrounding temperature there is an increase of metabolism amounting to 2 or 3 per cent. Rubner, experimenting with a bath of one hour's duration, obtained the following results in the case of a man weighing sixty kilograms and in whom there was a normal heat production of 91 calories per hour.

Effects of Bathing on Heat Production

Temperature of Bath	Increased Heat Production	Increase of Metabolism in Grams of Fat	Total Effects During and after Bath
95° F.	7 calories	0:7 grams	0.7 grams
86° F.	77 "	7.0 "	9.0 "
77° F.	167 "	18.0 "	22.0 "
68° F.	297 "	31.0 "	37.0 "
59° F.	407 "	43.0 "	52.0 "

In regard to the heat loss it is estimated that in a bath at 86° F. the heat loss is doubled; in a bath at 77° F. it is tripled; and at 68° F. it reaches five times the normal. It is interesting to note that more than half, and sometimes as high as two-thirds of the total heat loss in a cold bath occurs during about the first third of the treatment. In a cold bath at 80° F. of fifteen minutes duration and with a total heat loss of 75 calories, 43 calories of this heat loss occurred during the first five minutes. In another case with a cold bath at 63° F. of two and one-half minutes duration and a total heat loss of 65 calories, nearly 44 calories of this were lost during the first minute. Because of these facts short cold baths are, proportionately to their duration, more effective in heat elimination than long cold baths.

The reason for the greater heat loss early in the course of a cold bath is doubtless due to the fact that the body is unprepared to resist the abstraction of heat, consequently the high heat loss. But very soon the heat-regulating centers set in motion vascular and other changes which are intended to economize the body heat as far as possible, *i. e.*, resist heat loss as well as provide for increased heat production. The body tends to resist the abstraction of heat brought about by contact with cold water by making more unfavorable the conditions for heat elimination.

The activity of the surface circulation being the essential factor in the loss of heat during a cold bath, it follows, therefore, that whatever increases the amount of blood in the skin and the rapidity of the circulation in the skin will markedly increase heat loss during a cold bath. This is one of the chief reasons for the use of short hot applications preparatory to the use of the cold bath.

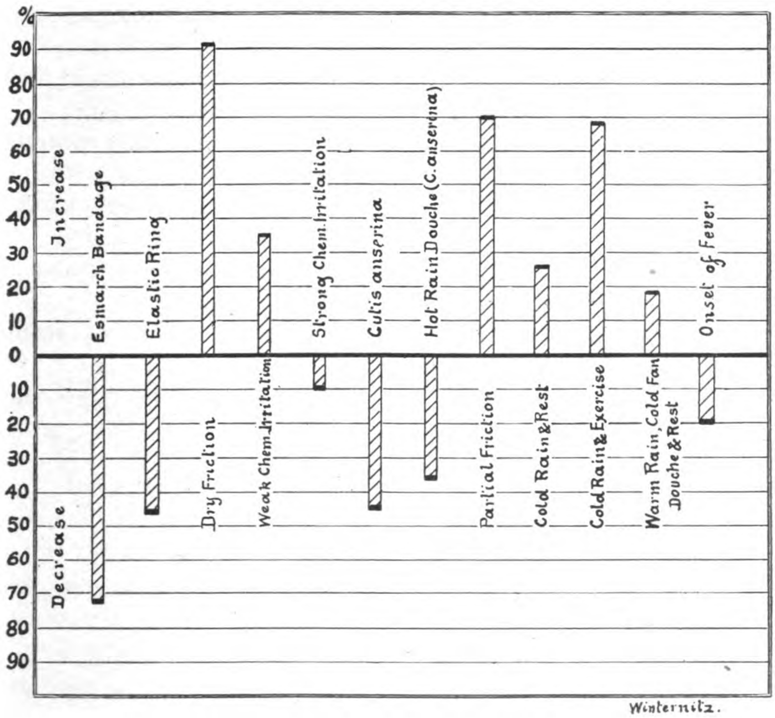


Fig. 46. Chart showing heat elimination by the skin as affected by various physical measures, thermic applications, etc.

The following are some of the results claimed by Otto Pospischl as a result of his work as assistant to Professor Winternitz. (*Fig. 46.*)[5]

1. Displacing the blood and arresting the circulation in a part of the body lessens heat loss as much as 70.6 per cent.

5 Buxbaum—Lehrbuch der Hydrotherapie, II Auflage, p. 48.

2. Hindering the circulation through the production of passive hyperemia lessens heat loss as much as 46.2 per cent.

3. Mechanical irritation may occasion an increase of heat loss up to 95 per cent.

4. Weak chemical irritation produces an increase of heat loss to 40 per cent, strong irritation on the other hand a decrease up to 8 per cent.

5. Thermic influences which cause goose flesh decrease heat loss as much as 44.5 per cent.

6. A hot rain bath may through the production of goose flesh cause a lessening of heat loss up to 38.7 per cent.

7. Partial cold wet friction may raise the heat loss as much as 80 per cent.

8. Cold rain baths and rest following produce after a transitory decrease of heat loss an increase up to 23 per cent.

9. Cold rain baths with exercise following raise heat loss as much as 66.6 per cent.

10. Warm rain baths with cold fan douche and rest following raise the heat loss up to 16 per cent.

11. In two illnesses with increasing fever the heat loss was decreased as much as 25.4 per cent.

SUMMARY

Heat Production (Thermogenesis)

The following are some of the conditions and measures that increase heat production:—

Vital activities such as,—

1. Glandular activity.
2. Muscular activity.
3. Digestive activity.
4. Mental activity.

External conditions,—

5. Reaction to cold applications (either long or short).
6. Friction.
7. Low atmospheric temperatures.
8. High atmospheric temperatures.

The following conditions and measures decrease heat production:—

1. Fasting.
2. Sleep and rest.
3. Reaction to short hot applications.

Heat Elimination (Thermolysis)

The following conditions increase heat elimination; the agents or means which produce these conditions are listed as subordinates.

1. Dilated surface vessels and rapid circulation,—
   (a) Heat.
   (b) Short cold (reaction).
   (c) Friction.
   (d) Exercise.
   (e) Weak chemical irritants.

2. Increased perspiration (by evaporation of water),—
   (a) Heat.
   (b) Friction.
   (c) Exercise.
   (d) Water-drinking.

3. Increased rate of respiration.

More or less prolonged applications of cold, whether cold water or cold air, abstract heat from the body by conduction; but they tend to make the body resist this effect; that is, it attempts to counteract heat elimination.

The following measures, while they cause the body to make attempts at decreased heat elimination, do, by contact, abstract heat:—

1. Cold baths.
2. Cold enemata.
3. Cold water-drinking.
4. Breathing cold air.

Conditions that decrease heat elimination:—

1. Contracted surface vessels and slowed circulation (as in goose flesh).
2. Decrease of perspiration (lessened evaporation).

3. Decrease in volume of tidal air, slow or shallow respiration.
4. Very high atmospheric temperatures.
5. Oiling of the skin.

There are two local applications of cold whose chief effect upon the body temperature is not by the abstraction of heat. These are the ice cap applied to the head and the ice bag applied over the heart. Their action is reflex. The former influences heat production through its reflex effect upon the thermogenic centers of the brain. The latter reflexly slows the heart beat and thereby the general circulation, which in turn decreases heat production. Of course, as previously stated, these effects are very slight in health but of inestimable value in febrile diseases.

Heat Regulation (Thermotaxis)

The normal temperature of the body is maintained by the nicety of the balance between heat production and heat elimination. Increased heat production does not necessarily mean a rise of body temperature, since under normal conditions the heat is dissipated as rapidly as produced. The natural conditions that tend to increase heat production usually stimulate the elimination of heat as well, and so a balance is maintained. For example, the body is exposed to a draft of cold air. The skin assumes a goose flesh appearance by contraction of the involuntary muscles; it is pale and contains less blood. While the cold air abstracts or conducts heat from the body, this lessened circulation in the skin decreases the amount of heat lost from the surface. The perspiratory glands are less active, and the consequent lessened evaporation of water from the skin also decreases the amount of heat eliminated. At the same time the sensation of cold influences the thermogenic centers, and they cause the tissues to produce more heat. Even the shivering which follows the exposure to cold, being muscular action, is one method of producing heat.

Thus the temperature of the body is maintained at a constant point rather than lowered by the cold atmosphere. The converse is true of a short moderately warm bath. This would communicate heat to the body, and so tend to raise the temperature; but the body reacts in such a way as to preserve the balance. The skin is relaxed, the blood-vessels dilated and the perspiration increased, so that more heat is lost by dissipation from the surface. At the same time this relaxing effect causes loss of tone in the tissues generally, and so less heat is produced. These results are due to the control exercised by the heat-regulating centers before mentioned.

It must not be supposed, however, that heat always decreases heat production. Very high temperatures markedly increase heat production, so much so that fatal poisoning may occur in such conditions as heatstroke. Serious cases never wholly recover from the effects of the high external temperature and the internal heat produced by it. They are ever after extremely susceptible to even the moderate heat of tropical climates or direct sunlight.

While an agent may increase both heat production and elimination at the same time, one is usually increased to a greater extent than the other. For example, a cold mitten friction at first abstracts heat from the body, but the reaction causes increased heat production, as shown by the "warming effect." The increased circulation of the skin, which is part of the reaction, causes more heat to be lost. The total effect, however, is an increase of heat in the body, because heat production is stimulated more than heat elimination.

As we have seen, thermic applications produce decided changes in heat production and elimination. However, these changes do not, in health, produce wide alterations in the body temperature. On the contrary, the same influences applied in febrile conditions produce decided alterations.

From the preceding experiments it will be seen that water at the varying temperatures and in the different ways in which it may be applied to the body, is capable of any and all possible variations and degrees of effect upon the heat mechanism. No possible alteration of heat production or elimination can be conceived of that water is not capable of producing. It is this versatility of application and effect that makes hot and cold water of so much service in fever and disturbances of the heat mechanism.

On the contrary, drug action is particularly monotonous, and ideal combinations impossible to make. If they seem to act in a rational manner upon one part of the mechanism, it will be found that they have an adverse action upon another part. And usually this adverse action more than outweighs any good which may be accomplished. There are no drugs which increase heat production by stimulating oxidation which are at all safe to use. Those drugs such as acetanilid and quinine, which decrease heat production, do so by a toxic action upon the thermogenic centers and tissues, so that there is an increase of the toxic products of metabolism rather than a decrease. On the other hand the drugs, such as alcohol and aconite which bring about greater heat elimination by dilating the surface vessels, accomplish this by paralyzing the vasomotors, a result which is not only undesirable in fevers but often positively dangerous, as will be shown under the subject of fever and antipyretic effects.

PART II

THERAPEUTICS

CHAPTER XV

THE REALM AND LIMITATIONS OF PHYSIOLOGIC THERAPY

THERAPEUTICS is the science and art of healing. Disease is an abnormal state of the body manifest in a morbid condition of structure or function. The departure from the normal nearly always begins in some mild way. Even in acute diseases the predisposition is laid in previous unhygienic habits or surroundings. There are two general types of disease usually recognized, *viz.*, the functional and the organic. In the former the actual structure of the diseased organ or part has not greatly deviated from the normal. The condition is manifest in a derangement of the function of the part. However, even in many so-called functional diseases it is possible, by careful microscopic examination, to detect more or less of pathologic change. But even in this case the alteration in structure has not gone on to such an extent as to preclude the possibility of a restoration to normal more or less complete.

In the case of organic disease such gross structural changes have been produced as to be readily detected, and of such a character as to preclude the possibility of a return to the normal. In this case physiologic therapy can accomplish only aleviation of the symptoms and such building up of the general vitality and resistance of the patient as to more or less counterbalance the effects of the structural lesion. In many cases where no indispensable part is involved radical means may be used, such as the removal of a malignant neoplasm, or some operation may de done to overbalance or palliate the results of the disease, as in the case of Talma's operation for hepatic cirrhosis or Edobohl's operation for renal insufficiency. Purely functional diseases are, however, nearly always best treated by physiologic means.

In the course of many diseases a point is reached beyond which a return to the normal is impossible without the intervention of some radical procedure. This is especially the case in inflammations. In certain grades, stages, and types of inflammation it is entirely possible, by *natural means*, to aid or affect the return to normal structure without the intervention of radical measures. This is true of such an inflammation as dry or serous pleurisy, pneumonia, or a simple surface infection, but where these inflammations have gone on to the formation of a suppurative focus or an abscess, physiologic means alone are unable to accomplish the full return to the normal condition. True, in time, the abscess might work its way to the surface, and so evacuate, but in most cases it is a long, tedious process and the patient is very much reduced in vitality by such delay, which delay may prove fatal from the absorption of toxic products. It is necessary, by some radical means, to accomplish the speedy evacuation of the pus and free drainage of the abscess cavity. The old dictum, *ubi pus, ibi evacua*, is just as true now as when it was first enunciated. Translated into terms of activity, it means, where there is pus, provide an outlet. It is necessary that evacuation be provided for. This, nature itself seeks to accomplish; but unaided, its attempts are accompanied by great destruction of tissue and much delay. By vigorous treatment, systematically applied, it is often possible to obviate the necessity for radical interference. But when the stage of suppuration has been reached or is imminent, surgical intervention is just as much an assistant to nature as physiologic means and therefore just as rational.

The same principles apply to the use of vaccines and antitoxines. If the body has sufficient reserve power and the infection does not progress too rapidly, the system may provide adequate means of cure. Yet the course of certain infections teaches us that such circumstances can not always be relied upon. Where available and of demonstrated value, no one would think of omiting the use of serum therapy. When it is used, physical means should not be left out simply because other procedures are more essential in a given case. All measures of value should be used in order to still further assist the body in combating the infection.

We may then, in general, say that where physiologic means are unable to aid the organism in reestablishing the normal structure and function, radical interference is necessary. This division line can best be determined by careful consideration of the usual trend of the particular disease in question. Experience has shown that a certain type of inflammation in one organ or location may early tend to a serious issue, such as abscess or gangrene, while in another organ or location, there is less immediate danger, the inflammation tending to become chronic. For example, we may cite the case of appendicitis on the one hand and of salpingitis on the other. In both cases, physiologic means *may* accomplish a return to the normal, but in the case of appendicitis, this return is not to be relied upon for permanent cure. The tendency is to recurrence and even, in a single attack, to perforation and peritonitis; while with the pelvic inflammation, physiologic means produce a safe issue which can better be relied upon for permanency; *i. e.*, if taken early, there is little, or at least less, tendency to rupture and abscess formation. Even in the case of formation of pus in the tube, it is best to delay surgical interference until the acute inflammation has subsided and, if possible, the temperature has returned to normal. At best, it is dangerous and conducive to spread of infection if salpingectomy be done during the continuance of the acute inflammation.

It is quite otherwise with appendicitis. Not only does operation in the acute stage give good results, but because of the inability to determine the immediate issue, it is imperative to interfere as soon as possible. True, a patient may go through a number of acute attacks, all of which subside without serious complications, but this can not be relied upon to continue. In each succeeding attack there is greater liability to perforation.

Considering all, we may, then, draw the conclusion that rational therapy is based upon three things,—experiment, experience and judgment,—the latter for the purpose of applying to the individual case the general laws and deductions relative to that condition. It requires an extreme nicety and perfect balance of judgment to determine whether a given border line case should be treated by physiologic or radical therapy. This faculty has been termed "surgical judgment." But its application requires more than a knowledge of operative technique. The surgeon who is pre-eminently a physician and whose armementarium is well stocked with physiologic means, will meet with the best success. Let not the surgeon be over enthusiastic about operative treatment nor the physician so confident of natural means as to procrastinate when prompt surgical interference offers the best hope of speedy and permanent recovery.

In some organic diseases the principle involved in physiologic therapy is that of calling into requisition certain vicarious functions, of stimulating structures which may relieve the diseased tissue or organ of part of its work. This is notably the case in valvular heart lesions and in the various forms of Bright's disease. In valvular heart disease the blood-vessels may be made to assume much of the circulatory function and so relieve the central heart to that extent. To a limited degree the sweat glands may in Bright's disease be made to supplement the work of the kidneys.

We have already learned that the basic principle of physiologic therapy lies in bringing into requisition the natural forces of the organism, of toning up and stimulating its natural powers of defense, making the body itself take part in its own healing. To do this most effectively the physician must become thoroughly conversant with normal and abnormal physiology and spend his best efforts in studying the methods naturally pursued by the organism in defending itself against a given cause or pathogenic agent. These natural methods of defense we shall endeavor to point out in connection with the treatment of the various diseases which are amenable to physiologic therapy.

BASIC PRINCIPLES OF THERAPY

The philosophy of the practice of therapeutics is summed up in three things. The proper application of these may be considered *rational medicine.*

First, removal of the cause.

Second, treatment of the existing conditions.

Third, relief of such symptoms as, by their severity, in turn become causes.

After removal of the cause many functional diseases right themselves (*sublata causa, tollitur effectus*)[1] without further treatment, since perverted habits of function have not become fixed. In the large majority of cases in addition to the removal of the cause, it is necessary to direct attention to the existing perversions of function and structure. Usually, the measures found most successful in the treatment of a disease meet all three of these indications. It is, therefore, seldom necessary to direct treatment to each separately. For example, in typhoid fever the cold bath increases phagocytosis, thus combating the cause —infection; it relieves internal congestion; increases the oxidation and elimination of toxines; it relieves the nervous symptoms; sustains the heart and circulation; and lessens the fever. A single procedure meets all three indications and thus proves itself the *summum bonum* of therapeutics in the treatment of this disease. The same is true of many other diseases.

1 When the cause is removed, the effect disappears.

CHAPTER XVI

FEVER AND ANTIPYRETIC EFFECTS

CAUSES AND SYMPTOMS OF FEVER

FEVER is a disturbance of the heat mechanism in which there is a more or less prolonged rise of temperature above the normal. The principal cause is the circulation of unusual toxic substances in the blood. It is the result of a protective effort, an attempt on the part of the body to cope with these poisons; but the organism may be overwhelmed by them and so be unable to oxidize them with sufficient rapidity to protect the body. Or, because of the nature of these poisons, the heat-regulating centers and the vasomotor centers are disturbed and the balance unsettled. If heat elimination were to keep pace with the heat production, even though the latter were greatly increased, there could be no rise of temperature. Many toxines cause a sensation of chilliness and thus decrease the heat loss, and fever results. While the body attempts to protect itself, its efforts are not always well directed or governed.

The poisons producing pyrexia are of various origin. They may be formed in the body or introduced from without. In the former case the toxemia may be due to the accumulation of body poisons, *i. e.*, those which are normally produced in health by ordinary metabolism, but are usually eliminated as fast as formed. These poisons are called *leucomaines*. They do not produce the higher types of fever, nor fever of long duration. The poisons due to anger, worry, and other nervous disturbances are classed under this head, although they are not normal to the body.

Prominent among the leucomaines, as a cause of fever, are the purin bases. Apropos of this subject we quote the following from Lusk:—[1]

1 Science of Nutrition, 1906, p. 267.

"However, there is a very noteworthy record made by A. R. Mandel that the rise of temperature in aseptic or surgical fevers is accompanied by a large increase in the purin bases in the urine of patients fed with milk. The temperature rises and falls with the quantity of purin bases eliminated. The uric acid elimination is reduced.

"That the purin bases can be the cause of the rise of temperature is indicated by the experiments of Burian and Schur who found that when nucleoproteid was administered intravenously to a dog a rise of temperature followed. Mandel showed that a subcutaneous injection of 40 milligrams of xanthin caused a marked rise in the temperature of a monkey, and that the administration of a strong decoction of 60 grams of coffee (containing trimethyl-xanthin) to a man unused to coffee-drinking, was followed by a febrile temperature."

Toxines may be produced by saprophytic bacteria (those of decomposition), growing in the body or in the alimentary tract. These conditions are known as *sapremia* and *auto-intoxication*. Foods decomposed by bacterial action may serve as the source of poison, as in the eating of decomposed meat, cheese, etc. Such products of bacterial decomposition are known as *ptomaines*. *Bacterial toxines* produced by pathogenic bacteria, growing within the body itself, are the most usual causes of fever and those with which we are most concerned in the treatment of this condition.

Ultimate Causes of Pyrexia. The following outline is modified and abridged from Sollmann.[2]

Fever may be due to,—

1. Exposure to excessive external heat as in sunstroke. Also internal heat (over-oxidation) as in excessive muscular exercise.

2. Certain drugs, such as the convulsants, cocaine and strychnine, by the production of convulsions or spasm of the muscles.

3. Toxic proteins.
   (a) Bacterial toxines of infectious diseases.
   (b) Ptomaines.
   (c) Auto-intoxication (intestinal, biliary, urinary, etc.).

2 Text Book of Pharmacology, 1901, p. 394.

(d) Absorption of unconverted digestive products, as albumoses and peptones in a diet too rich in proteid; or due to digestive disorders.

Manifestations of Fever. In addition to the causes of fever, it is necessary to consider the symptoms, since these are an indication of the real condition of the patient and may be of such a magnitude as, in turn, to become a cause of additional trouble; in which case, special treatment must be directed toward their relief or palliation.

The toxines, or the high temperature, cause the following symptoms, recognized as characteristic of fevers:—

1. Nervous disturbances, such as malaise, headache, backache, insomnia, delirium, etc.
2. Hot dry skin, or cold clammy skin.
3. Increased pulse rate and blood tension.
4. Increased rate of respiration.
5. Excessive thirst.
6. Loss of appetite, foul breath, coated tongue.
7. Constipation.
8. Urine scanty, highly colored, high specific gravity, increase of urea.

PRINCIPLES OF TREATMENT

Since oxidation is one of the means of getting rid of toxines, this burning is to be encouraged rather than hindered. The fever should be controlled, not combated. The system is to be aided in its attempt to oxidize and eliminate the poisons. This is where failure in the protective mechanism is especially manifest in febrile diseases. While the decomposition and destruction of body tissue is much increased in fever, true oxidative changes are nearly always decreased. For this reason the system is compelled to cope not only with the toxines of direct bacterial origin but also with those of decomposition and incomplete metabolism.

The idea that the reduction of temperature is the sole object in the treatment of fevers has become so firmly fixed in the minds of physicians and laymen that it is hard to eradicate. It was this idea that led to the use of the medicinal antipyretics, the giving of which is not only wholly irrational, but productive of very serious complications and sequellæ. To a great extent, the same idea also prevails with regard to the use of the cold bath in fever, much to the discredit of hydrotherapy and rational therapeutics. Many, too, regard the reduction of fever as the only asset of hydrotherapy, and fever as the only condition in which hydriatic measures are applicable. That both ideas are erroneous has already been shown and will be made plainer as we consider the rationale and results of hydrotherapy, not only in fever, but in a host of other maladies.

The basic object in the treatment of fevers is the same as in all other diseases, *viz.*, the removal of the cause. This can be accomplished only by decreasing the toxemia. In only a few febrile diseases has medical science discovered a direct antitoxine or perfected a workable system of producing immunity. We are, therefore, under the necessity of directing our efforts toward increasing the oxidation and hastening the elimination of these bacterial toxines; increasing phagocytosis; and assisting and conserving the powers of the tissues in the production of antitoxines, antibodies, opsonin, etc., this latter action being largely the work of the phagocytes themselves, upon the integrity and activity of which immunity depends (Metchnikoff).

In addition to this basic object—the removal of the cause—it is necessary to prevent the over accumulation of heat, a thing which is accomplished by the same means. And third, to mitigate the symptoms, especially those referable to the nervous system; combat headache, malaise, insomnia, delirium, etc. This also is done by the cold bath and other cold applications. In fact, all of these results can be and are obtained by properly applied hydriatic measures as has been demonstrated by the experiments cited in the previous part of this work.

RATIONALE OF HYDROTHERAPY IN INFECTIOUS FEVERS

The principal object to be sought in the treatment of fever is the combating of the infection. The antiseptic treatment of infections has proven a failure. There are no germicides known which have given anything like even moderate success in dealing with bacteria. A few like hexamethylenamin are valuable aids, but of limited range. The chemical destruction of bacteria within the human organism is a disappointment and, as remarked by one, "we aim at the germs and hit the patient." The organism is hindered more than it is helped. Concerning methods of treating infections W. J. Mayo[3] has the following to say: "Experience soon taught us, however, that in combating infectious disease, it is even more important that we familiarize ourselves with those conditions of the body by which nature combats disease." Upon the physicians knowledge of these natural methods depends to a large extent his ability to employ physiologic therapy in a rational way.

The body itself must be aroused to combat the infection. This is most effectually accomplished by those means which increase the vital resistance of the body, conserving its power, and especially by those means which increase the number and efficiency of the phagocytes. It has already been shown how this may be accomplished. It will also be noted that cold applications as suited to the varying needs of different diseases, compass all of these results. We have seen that cold produces a leucocytosis, restores the diminished alkalinity of the blood, produces an active arterial hyperemia, increases and sustains blood pressure, so that life giving, energizing blood circulates more rapidly where previously there was stasis, venous hyperemia, leucopenia, lowered alkalinity, and a blood laden with leucomaines, toxines, and acid poisons. The elimination of toxic products of bacterial life is hastened and their oxidation increased by cold. The phagocytes and body tissues are so energized that the histogenous production of antitoxines, bacteriolysins, opsonin, etc., is increased. While all these changes are being brought about, the lessened toxicity of the body fluids relieves the nervous system and it is quieted and invigorated by the tonic influence of the cold. Restlessness, insomnia, or delirium gives way to clear coordinated action or undisturbed sleep. The hot dry skin, or the cold clammy skin, is replaced by the warm moist surface. This remarkable group of changes, all of which are beneficial and derived from a single

3 Mayo Clinic, 1910, p. 118.

agent—cold water—it is impossible to bring about by any other known therapeutic agent or combination of agents. It is simply unique in the realm of therapy.

Toxic Vasomotor Paralysis. Further in regard to the connection of the circulatory system with the general manifestations of fever and especially with regard to the circulatory complications which contribute so largely to the mortality, experimental pathology has laid a very firm foundation for the use of hydrotherapy in fevers of infectious origin. The researches of Romberg and Pässler are considered the basis of our knowledge of the state of the heart and blood-vessels in these diseases. The reports of their work[4] have shown conclusively that circulatory failure is not primarily due to the heart itself, but to paralysis of the blood-vessels, brought about by damage to the vasomotor centers. In this connection we can not do better than quote from the brief resume of these researches given by Janeway and from remarks made by Forchheimer.[5]

"They studied the fatal collapse which occurred in rabbits after infection with the pneumococcus, the bacillus pyocyaneus, and the diphtheria bacillus; the first producing a true septicæmia, the latter a local lesion with general toxæmia. All of the 250 animals used were autopsied, and the heart and other important organs examined microscopically. Their method consisted in observing the mean carotid pressure at different stages of the disease, and the effect upon it of (1) abdominal massage, which increased the work of the heart by supplying it with more blood; (2) compression of the aorta above the diaphragm, which makes the work of the heart maximal; (3) irritation of the nasal mucous membrane with a Faradic current, which causes extreme reflex vasoconstriction; and (4) short asphyxia (thirty seconds), which acts similarly only on both medullary and spinal vasomotor centers; while sensory stimulation affects only the center in the medulla. They reasoned that, should there be no rise in pressure from sensory

4 Romberg and Pässler—Deutsch. Archiv. für klin. Med., 1895, LXIV, pp. 652—763; also Pässler—München. Med. Wochenschrift, 1901, XLVIII, No. 8.

5 The Clinical Study of Blood Pressure, pp. 155, 156; and Cardiac and Vascular Complications in Pneumonia—Journal of American Medical Association, Oct. 30, 1909, p. 1450.

irritation or suffocation, while abdominal massage and ligature of the aorta still called forth a well marked one, then the heart must be functionally capable and the vasomotor mechanism paralyzed. To determine whether the central or peripheral vasomotor mechanism was at fault, they used injections of barium chloride, which cause constriction of the arteries by purely local action upon them.

"Their experiments showed that the blood pressure and the response to all the procedures remained perfectly normal throughout the early stage of the disease, being unaffected by the fever. The greatest elevation of pressure was obtained on stimulating the mucous membrane of the nose. When the animals showed signs of impending collapse in their behavior, the blood pressure, though still normal, began to sink, while the heart beat more forcibly. Hand in hand with this went a great reduction in the rise of pressure from sensory irritation, a moderate decrease in the asphyxial elevation, but as high a pressure as before after abdominal massage. In many cases the pressure did not fall until the reflex rise had been almost abolished, evidently being maintained by increased cardiac energy, in spite of the vascular dilatation. Finally in complete collapse, which developed very rapidly, the aortic pressure fell to the lowest level, as after destruction of the spinal cord; no reflex rise could be obtained, but abdominal massage gave an immediate elevation. It was evident, therefore, *that the circulatory disturbance at the height of the infection depended absolutely upon a paralysis of the vessels, not upon any damage to the force of the heart.*

"As regards their reaction to compression of the thoracic aorta, the diphtheria animals showed a divergence from the pneumococcus ones; the latter evincing practically normal cardiac reserve force, while the former showed a distinct falling off. Anatomically, also, the diphtheria hearts had suffered damage, parenchymatous degeneration being well marked, as in clinical diphtheria. The pneumococcus animals had scarcely any change in their cardiac muscle. Thus evidence of weakness in the heart muscle in diphtheria was of minor importance, the real cause of death in all cases being the complete loss of vasomotor tone. By intravenous injections of barium chloride they proved decisively that this was due to central paralysis. Their conclusions were, that all three organisms used damage the circulation through paralyzing the vasomotor centers throughout the medulla and cord; this vasomotor paralysis leads to a fall in blood pressure, and further, to a changed blood distribution; the splanchnic circulation is overfilled, the brain, muscle, and skin vessels are empty; the heart is not affected, except secondarily through insufficient blood supply."

Forchheimer's discussion on this latter condition—splanchnic congestion—is as follows: "Long ago it has been shown in animals, that on section of the splanchnic nerve, an enormous quantity of blood accumulates in the intestine, which is followed by intense anemia in other organs, especially in the central nervous system, which may cause death. The splanchnic nerve is the vasomotor nerve of the intestines, and its section causes paralysis of vasomotor function and enormous dilatation of the blood-vessels. In paralyzing the vasomotor center with the pneumococcus the same result follows in man. In brief, in man there is first, dilatation of blood-vessels in the splanchnic area; the blood pressure which sooner or later is normally low in pneumonia, sinks; the heart, which is supplied by an insufficient quantity of blood, which is gradually becoming stationary in the affected area, continues to draw blood from other places, the liver, the skin, the muscles and central nervous system, and becomes more and more rapid and ineffectual, 'bleeding itself into the splanchnic area,' and finally stops. The intracardiac pressure is reduced so that the myocardium ceases to contract, moreover, the various cardiac and vasomotor centers become asphyxiated, and therefore paralyzed."

By reference to the chapter on blood pressure in the first part of this work it will be seen that the above quoted facts and discussion very clearly demonstrate the rationale of hydrotherapy in infectious diseases, and clinical experience has proven what experiment has demonstrated. The vasomotor stimulation which results from hydriatic procedures amply meets the needs of the situation, which need it is impossible to meet by medicinal therapy of any sort.

THE EFFECTS OF MEDICINAL ANTIPYRETICS

1. Drugs having a Collapse Action, such as Aconite and Viratrum Viride. These lessen the force of the heart beat and dilate the blood-vessels, so lowering the blood pressure. Heat production is decreased, because of this latter action. Vasodilatation favors the loss of heat from the skin. This is not a tonic but an atonic dilatation and so, in no way restores the lost tone to the circulatory system. Both these drugs decrease fever at the expense of the heart's action and so prove dangerous in asthenic fevers, or where there is cardiac weakness, dilatation, or incompetency already existing.

2. Alcohol. The only beneficial (?) action of alcohol, as relied upon in fever and as given in so-called therapeutic doses, is upon the smaller blood-vessels, in which it causes an atonic or paretic dilatation and consequent loss of heat from the skin. At the same time, it dilates the visceral capillaries which are already congested in febrile conditions. Their paretic condition renders the viscera much more liable to suffer from retrostasis when the body is exposed to cold. Alcohol decreases metabolic processes and oxidation.[6] The tissues are less active so that toxines, instead of being more rapidly oxidized and eliminated, tend to accumulate in the system. Alcohol lessens the phagocytic activity,—the natural defence against infection, and discharges immunity. Delearde has shown that the absorption of alcohol is a grave obstacle to immunization against hydrophobia. Abbot, in experimenting on animals, proved that those subjected to the influence of alcohol were more susceptible to the harmful effects of streptococci, bacillus coli and other bacteria. Both Delearde and Laitinen found it impossible to vaccinate against anthrax, animals that had been given alcohol on several successive days.

3. The Coal Tar Products, as Acetanilid, Phenacetin, and Antipyrin. These decrease heat production by the direct toxic action of their aromatic radicles on the heat centers in the

6 "Alcohol in excessive doses and prolonged anæsthesia both paralyze the heat-regulating mechanism. A man who is 'dead drunk' resembles a cold blooded animal; exposure to cold produces not an increase but a decrease in combustion, and his temperature steadily falls. It is not surprising, therefore, that death from exposure chiefly occurs in the case of intoxicated persons." (Hutchison—Applied Physiology, 1908, p. 67.)

brain and on the processes of oxidation and proteid metabolism.[7] This is shown by the decrease in tissue destruction, lessening of urea, etc. This effect is most marked in fever, where the rational procedure is to increase the burning up of poisons, (purins, toxalbumens, bacterial toxines, etc.) in order to get rid of them. Neither do these drugs increase the elimination of poisons. They are very powerful cardiac depressants and possess a decided collapse action. This is most marked with acetanilid. They cause breaking up of the red cells with the formation of methemoglobin, thus in a second way, preventing oxidation by limiting the oxygen-carrying capacity of the blood. The movements of the whites are arrested. Phagocytosis is prevented. This is another example of drugs that render the body less able to resist infection.

4. Quinine. This drug lowers temperature by decreasing heat production. Its action is said to be chiefly peripheral upon the thermogenic tissues, in decreasing nitrogenous metabolism. This decrease may reach as high as 39 per cent with large doses.[8] The drug probably owes its toxicity to its aromatic nucleus, the same as the coal tar products. It not only hinders the destruction of nitrogenous toxines, but is a powerful poison to the phagocytes, arresting their movements immediately on contact with them. This result obtains when only 0.5 to 1 part in 1000 of solution is used. A somewhat larger dose causes their destruction (Binz, Sollmann). According to recent experiments by Manwaring and Ruh, larger amounts than 0.008 per cent of quinine cause complete suppression of phagocytosis. Since 1-13 of the body weight is blood, an individual weighing 130 pounds possesses 10 pounds of blood, totalling 70,000 grains. If, at any one time, there should be in the blood of a person of this weight, ten grains of quinine, there would then be acting upon the phagocytes an amount nearly double the minimum toxic dose. Quinine frequently causes hemoglobinuria. Metchnikoff[9] makes the following statement: "It is not only opium and alcohol which

7 White and Wilcox—Materia Medica and Therapeutics, 1900, p. 300; also Sollmann—Text Book of Pharmacology, 1901, p. 355.

8 Sollmann—Ibid, p. 346. See also Adami—Inflammation, 1907, p. 152.

9 New Hygiene, p. 28.

hinder the phagocytic action. A number of other substances regularly employed in medicine, cause the same results. Even quinine, the . . . effect of which in malarial fevers is indisputable, is a poison for the white blood cells. One should, therefore, as a general rule, avoid as far as possible the use of all sorts of medicaments, and limit one's self to the hygienic measures which may check the outbreak of infectious disease. This postulate further strengthens the thesis that the future of medicine rests far more in hygiene than therapeutics."

5. *Diaphoretics, as Pilocarpin and Dover's Powder.* These lower febrile temperature by producing sweating. This in itself, is not irrational. In the case of the former, it has recently been shown that this is at the expense of the heart's action. The latter drug contains opium which has the same action on the phagocytes as alcohol, quinine, and coal tar products.

6. *Refrigerants, such as the Alkaline Citrates, Organic Acids, and Acid Organic Salts.* The alkalescence of the blood is diminished in auto-intoxication and infectious diseases. Bouchard failed to neutralize the excess of acid in the blood by the administration of inorganic alkalies. The citrates, tartrates, etc., do, however, favor kidney activity (diuresis) and sweating (diaphoresis), and so aid in the elimination of toxines. Experience demonstrates that the natural fruit juices, containing these acids and their salts, give better results in these respects than artificial preparations and do possess a true refrigerant action.

No great discernment is necessary to decide that antipyretic drugs are harmful in fever. The majority of fevers are due to infections, *i. e.*, are bacterial toxemias. These drugs in no way remove the cause, nor do they assist the body to overcome the infection. On the contrary, they destroy or cripple the agents of natural defense—the leucocytes, rendering them an easy prey to bacteria.

ANTIPYRETIC EFFECTS OF THERMIC APPLICATIONS

Let us now turn our attention to the differences in the effects of the various thermic applications used in the treatment of fevers. The following classification will be found helpful:—

1. Applications of cold.

(a) Prolonged—direct antipyretic, by abstracting more heat than is produced.

(b) Short—stimulate heat production as much or more than they increase heat elimination.

2. Applications of heat.

(a) Prolonged—antipyretic by increasing heat elimination through profuse sweating.

(b) Short—an adjuvant, prepares the body for cold applications.

The physiologic effects of the four classes may be studied under the two following heads:—

1. Effect on heat production.
2. Effect on heat elimination.

Prolonged Cold. The Brand bath may be taken as a type of this class of hydriatic antipyretics, the effects of which are as follows:—

1. Heat production is decidedly increased. This is due to the thermic stimulus arising from contact with the cold water. Oxidation and nitrogenous metabolism are both increased. There is not only an increase in the oxidation and consequent destruction of poisons, but their elimination in an incompletely oxidized state is hastened. This is proven by the decided increase in the toxicity of the urine after a cold bath, as shown by Bouchard, Roque and Weil.

2. Heat is transferred from the body to the water and in greater quantity than the heat produced, so that a fall of temperature results. This is made doubly necessary because of the above mentioned increase in heat production which would tend to increase the height of the fever if it were not combated. This is by purely mechanical means, *i. e.*, conduction. The heat of the body is transferred to the water which will take up an exceedingly large amount without being greatly warmed.

Heat elimination is increased by friction, *i. e.*, the body is constantly kept in a condition favoring the abstraction of heat. The rubbing produces vasodilatation and quickens the circulation. These conditions bring more blood to the surface which is exposed to the cold water. The same conditions and the friction itself serve to give a sensation of warmth to the skin and so prevent chilling and the resulting retrostasis of blood.

Indications. These effects are indicated in long continued asthenic fevers, such as typhoid, typhus and in hyperpyrexia. The treatment must be frequently repeated over a considerable length of time, since it can not be hoped that the source of toxemia will be eradicated by a few applications.

Short Cold applications are almost always accompanied by mechanical stimuli. The cold mitten friction is the best example of this class.

1. Heat production is increased by reason of the action of the thermic and mechanical stimuli on the heat centers.

2. The contact with the cold water is of too brief duration to abstract much heat from the body. The cooling is not manifest except on the skin. Later, heat elimination is increased because of the vascular reaction in the skin.

Indications. Short sthenic fevers, as grippe, colds, etc., or where the skin is cold and clammy, for the purpose of warming the skin and raising the blood pressure. This sometimes occurs in typhoid.

Long Hot. Any of the sweating treatments used in fevers serve to illustrate the effects of this class of measures.

1. Heat production is increased during the treatment at least to some extent. The atonic reaction which follows may result in decrease of heat production.

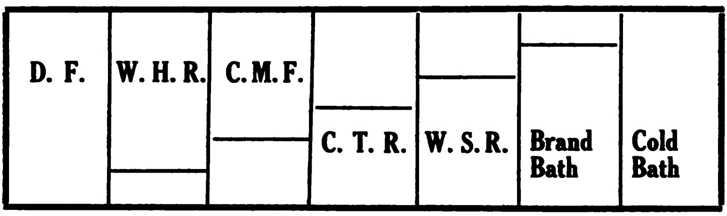
2. Heat is communicated to the body. This is the chief cause of the initial rise of temperature before perspiration becomes well established and general. Later, heat elimination is enormously increased because of the increased circulation in the skin and especially by the evaporation of the perspiration. This latter is the essential effect of sweating treatments.

Indications. Sweating treatments are indicated in the first stage of nearly all fevers, *i. e.*, at the onset. It is at this time that the initial chill occurs. They are useful at this stage in such fevers as measles, influenza, scarlet fever, etc.

Short Hot. Fomentations, short hot packs, hot sponging, and the hot evaporating wet sheet pack are examples of this class of antipyretics. Their special advantage is the preparing of the skin to properly react to succeeding cold treatment. The skin is warmed and heat elimination is increased through the warming effect. Some heat is communicated to the body. Heat production is little, if at all influenced. Wherever there is chilliness, cyanosis, or goose flesh in febrile disease, some form of hot application must be used before resorting to cold, since in the absence of the former, the cold may have a decidedly adverse effect.

In addition to the effects noted in the general classes of treatments discussed above, it should be understood that by proper variations in the manner of giving hydriatic treatment, it is possible to produce any desired effect upon the heat mechanism

Temperature-raising value.



Temperature-lowering value.

Fig. 47. Diagram showing quantitative relation between the temperature-raising and the temperature-lowering capacity of different treatments.

and upon febrile temperature. In the case of cold treatments these variations are produced by changes in the degree of friction used and in the quantity of cold water brought in contact with the skin surface. The more the friction and the less the contact with cold water, the greater the temperature-raising capacity. The larger the amount of cold water brought in contact with the body, provided reaction be maintained, the greater the temperature-lowering capacity. This relation is graphically shown in *Fig. 47*. The proportion of each block below the cross line indicates the relative value of the treatment in lowering temperature as compared with its temperature-raising value indicated by the proportion of the block above the line.

THE HEAT MECHANISM IN FEVER

The mechanism of the production of fever is a large subject and one somewhat outside of the scope of this work. There are, however, a few points that should be noted in order to gain an understanding of the principles involved in the treatment of fever, *i. e.*, in order to treat such conditions intelligently.

Graham Lusk[10] gives the following discussion:—

"A high fever may be accompanied by an increased metabolism of only 15 per cent. The cause of the fever must therefore be due to diminution in the ability to discharge the heat produced. In further support of this, Senator has shown that the fever following pus injections in a dog begins with a retention of heat within the body. Nebelthau found that when the heat discharge of a normal rabbit was called 100, during the first twelve hours of infection in which the temperature rose from 38.6°—40.1°, the discharge of heat was but 96.3. Assuming the heat production to have been the same in these two periods (as was actually the case in the rabbits of May), then the heat retained would account for the pathological increase in temperature. At a later stage the discharge of heat rose to equalize its production at the higher temperature."

In the state of lessened heat elimination manifest at the beginning of most fevers lies the reason for the *initial* use of hot applications so frequently advised in the subsequent pages of this work.

"Nebelthau has shown a fall in temperature and heat production in a rabbit whose cord was divided between the sixth and seventh cervical vertebræ, and has also demonstrated that under these circumstances infection with erysipelas of the pig had no influence on temperature or heat production. The inference is that the febrile toxines act through the higher vasomotor centers, whose regulatory control is lost in the above experiment.

"A kindred interpretation may be placed on the experiments of Mendelsen, who was unable to produce fever through pus injections when the dog was under the influence of chloral or morphine, although such treatment in a normal animal caused

10 Science of Nutrition, p. 255.

a rise in temperature of from 36.3°—39.9° in forty-five minutes. Mendelsen also finds a constant constriction of the renal blood-vessels in fever.

"In intermittent fever profuse perspiration is certainly an important factor in the reduction of temperature at the end of the febrile stage.

"It may be concluded, as Krehl emphatically states, that insufficiency of water evaporation plays a not unimportant role in the febrile rise in temperature. The body might be cooled were the sweat glands freely active.

"The production of heat in fever may be greatly increased during a chill, and a rapid rise in temperature may follow. This was shown by Liebermeister in a case of malaria. The temperature rose from 36.9° in the first half hour to 39.5° at the end of another hour, while the carbon dioxide expired rose from 13.85 grams to 34.20 grams per hour. This was a case of chill with shivering. This increased metabolism is due to the mechanism of chemical regulation. The blood is driven from the skin by vasoconstriction, those end-organs of the skin which are sensitive to cold are strongly stimulated, with the result that there is a reflex increase of heat production. That this is true is shown by the fact that if the cold stimulation be removed by supplying a warm environment, the attending phenomena pass off (Krehl)."

VARIATIONS THAT PRODUCE FEBRILE TEMPERATURE AND THEIR RELATION TO TREATMENT

Any unbalancing of thermo-regulation whereby there is more heat produced than is eliminated will cause a rise of temperature. It will be seen from this that there are several possible variations in these two elements which might be the cause of fever. In a majority of fevers the greater difficulty at first is in the faulty heat elimination. A rise of temperature will follow any of the conditions listed below:—

Heat Production		Heat Elimination
1. Increased	-	normal
2. Increased	-	increased, but less than heat production
3. Increased	-	decreased
4. Normal	-	decreased
5. Decreased	-	decreased, but more than heat production

Clinical Antipyresis. These variations are, perhaps, largely of theoretical interest. However, there is a practical application to be made of the signs and symptoms which indicate a *decided over-production of heat or a marked decrease in heat elimination*. The former contra-indicates vigorous tonic measures, such as the cold mitten friction, which are not accompanied by heat abstraction, *i. e.*, more or less prolonged contact with cold water. The latter are of especial importance in revealing a condition which absolutely contra-indicates the use of long cold applications, and in many cases even the short cold friction unless preceded by hot applications. In cases of pyrexia the following signs indicate a great increase in heat production:—

1. Full pulse and flushed face.
2. A hot dry skin.

A consideration of these will at once reveal the fact that a cold mitten friction would be inappropriate, since it has no tendency to lower blood pressure, also because the treatment stimulates heat production; but the contact with cold water is of too brief duration to abstract much heat from the body. Neither would a hot application or a sweating treatment best meet the condition. It is necessary to abstract heat from the body by some more or less prolonged cold application.

On the other hand, the following symptoms show a decided decrease in heat elimination:—

1. Cold skin, whether dry, or moist and clammy.
2. Cyanosis.
3. Goose flesh appearance.
4. Chilly sensations.
5. Shivering.

Again, consideration of these conditions reveals the fact that cold applications, unless accompanied by vigorous friction, and not even then in some cases, will greatly increase the anemia of the skin and the internal congestion which exists because of the chilling. In these cases hot applications or sweating treatments must be used until the cyanosis is overcome and the blood brought back to the surface, thus relieving the internal congestion and, at the same time, imparting a sensation of warmth to the body and consequently checking the shivering. This is also indicated in the first stage of many fevers where the chill has actually begun or where chilly sensations indicate its approach. In this case the hot sweating treatment should not be repeated, at least not frequently, as it is too weakening. Its frequent repetition does not increase the vital resistance, but rather decreases it. It decreases phagocytosis and the production of antibodies. Malaria is an exception to the general rule of the use of hot treatment at the onset. Here it is a detriment rather than a benefit. On the other hand, in acute nephritis much sweating treatment should be used all through the course of the disease.

In general then, it may be said that long cold applications should be used where great increase of heat production is the chief cause of fever; and hot applications where the decided decrease of heat elimination is a prime factor in the fever.

Table of Therapeutic Classification

	Group A	Group B
Symptoms	Full pulse, flushed face, hot dry skin	Cold skin, wet or dry, cyanosis, goose flesh, shivering
Chief condition present	Great increase in heat production	A decided decrease in heat elimination
Indications	Abstract heat by long contact with cold	Warm the skin, combat internal congestion
Treatment	Long cold applications	Hot applications until blood is brought back to skin

The following lists of hot and of cold treatments are those that are most useful in fevers. When properly selected and suited to the individual case, the cold treatments meet the first indication and the hot treatments the second indication.

Cold applications useful in febrile conditions:—

1. Brand bath.
2. Graduated bath with friction.
3. Tepid or cool bath.
4. Evaporating wet sheet pack.
5. Cold towel rub.

6. Ice rub.
7. Cold sponging.
8. Cold affusions.
9. Cold to head and neck.
10. Ice bag or cold compress to heart.
11. Cold compress to abdomen.
12. Cold water coils to head and abdomen.
13. Cold rectal irrigation or enema.
14. Cold water drinking.
15. Fresh cold air in the sick room.

Hot applications which may be used to reduce fever or assist the cold applications:—

1. Hot blanket pack.
2. Hot bath (very short).
3. Hot evaporating sheet.
4. Hot sponging.
5. Fomentations to spine.
6. Fomentations to abdomen.
7. Hot water drinking.
8. Cold mitten friction (reaction simulates the effects of a hot application).

CHAPTER XVII

THE TREATMENT OF FEVERS

TYPHOID FEVER

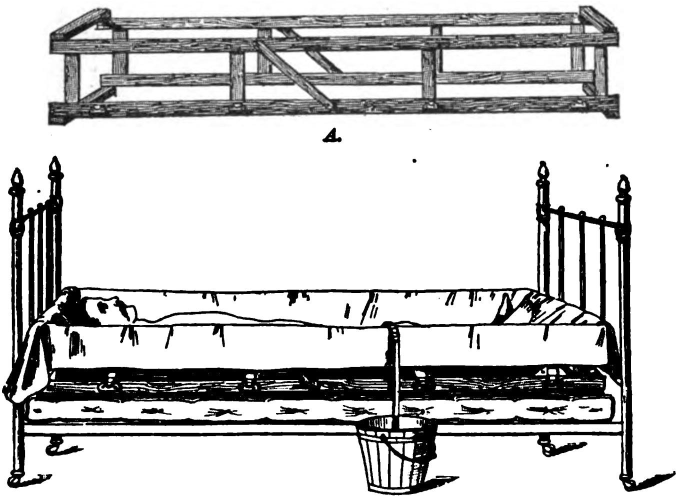
TYPHOID fever is an acute infectious disease, more or less self-limited, characterized pathologically by a localized inflammation of the lymphatic structures of the intestines and a general distribution of the bacteria (bacteriemia); clinically, by fever of rather long duration which, at the onset, rises gradually in stepladder-like increase and gradually subsides; diarrhea, and a special tendency to hemorrhage and perforation. We say that the disease is self-limited because it is one of those infections which arouse the body to the production of antitoxines, bacteriolysins, agglutinins, etc., so that when the system has had time to produce these, the infection is overcome and the patient recovers. It is not possible to abort typhoid fever by therapeutic means. The so-called abortive type of typhoid fever is due to some peculiarity of the individual or of the infection and not to any treatment.

The chief object to be accomplished in the treatment of typhoid fever is not the reduction of the temperature, but the sustaining of vital resistance until such time as the system has had opportunity for the production of antibodies. This building up of vital resistance is accomplished chiefly in two ways:—first, by increasing the efficiency of the protective mechanism. This is accomplished by stimulating the process of phagocytosis, *i. e.*, increasing the number and efficiency of the leucocytes in the peripheral circulation, in order that they may combat the infection, the bacteria themselves: and by stimulating the production of antibodies, such as agglutinin, which also act directly upon the bacteria; second, the decrease of the toxemia by increasing the oxidation of the bacterial toxines and hastening their elimination in an incompletely oxidized state. The body poisons, the leucomaines, are taken care of in the same way and by the same means. These are the two principal objects to be attained in the treatment. The reduction of temperature is only incidental to these and serves as a practical guide to the completeness of these results. However, in the use of medicinal antipyretics, the degree of the fever in no way runs parallel with the accomplishment of these essential objects. With both quinine and the coal tar products, phagocytosis is interfered with, if not wholly abolished and the toxemia is increased because of a decrease in the oxidation and elimination of the poisons. Under the use of hydrotherapy, rationally employed, typhoid fever presents an entirely different clinical picture from that which we have been taught to regard as characteristic of this disease. The cold bath meets practically all of the conditions and symptoms which require special attention. The heart and circulation are sustained and invigorated, the nervous system is aroused, and the nervous symptoms, usually regarded as an invariable accompaniment, either do not appear or are mitigated in severity. The emunctories are sustained so that elimination is greatly increased.

Treatment

Since the cold friction bath is the best means of treating typhoid, our consideration of this disease will largely be a discussion of the methods, rationale, and results of this measure. The original cold friction bath, as devised by Brand, consists in the full immersion of the body in water at a temperature of not less than 65° F. nor more than 70° F. As advised by Brand, it continues fifteen minutes, during which time the entire skin surface immersed in the water, with the exception of the abdomen, is rubbed vigorously by the attendants. The object of the friction is the production of reaction so that the sensation of chilliness is abolished, and the circulation of the skin maintained, thus favoring the cooling of the blood. If at any time the patient becomes cyanotic, or real chilling occurs, as indicated by continued shivering and chattering of the teeth, he must at once be removed from the bath. The Brand bath is to be repeated whenever the temperature of the patient exceeds 102.5° or 103° F. In practice it has been found that this means every three or four hours.

As to the appliances necessary, it has been found that some form of portable bath is most convenient. Of these, there are two forms worthy of description,—the bath tub on wheels and the bed tub. The former (*Plate V.*) is of ordinary bath tub



A.

B.

Fig. 48. Burr portable bath. A—frame, B—complete.

construction and sufficient in length to allow the full extension of the patient while immersed in the water, and of such depth that the patient is covered with water up to the chin. This tub can be wheeled to the side of the bed, being placed a sufficient distance from the side of the bed to allow of two attendants reversing the patient in carrying him from the bed to the bath, or it may be placed close to the bed and the patient lowered directly into the tub by hand or by means of a special raising and lowering device (*Plate VI.*).

The Burr portable bath (*Fig. 48.*) is probably the best type of the bed bath. It consists of two parts—a large rubber sheet with rings near the margin for fastening to the frame by tapes, and a light wooden crib capable of being folded into a compact bundle. The rubber sheet is first slipped under the patient and brought up over the pillow, being tucked along the sides of the body. The frame is then unfolded, placed down over the patient so as to rest on the mattress, surrounding the patient, pillow, and rubber sheet. The edges of the sheet are then drawn up over the top rail and fastened to the lower rail by its rings. When complete it is capable of holding about twenty gallons of water. It may be filled by either a pail or hose attached to a faucet and emptied by a siphon. This arrangement demands less moving of the patient than any other form of bath.

There has recently been devised another type of bed tub—the Coile bed bath (*Plate VII.*). This is a collapsible tub of rubber sheeting, the walls of which consist of four superimposed pneumatic rings. When deflated this can be placed under the patient in the same manner as the rubber sheeting of the Burr bed tub. It is then inflated by means of a large bicycle pump, and is ready to receive the water. It is emptied by a sleeve outlet as shown in the illustration.

Before being immersed in the cold water, the head and face of the patient are bathed in ice water. If the tub is used, it is necessary to provide an invalid ring for the head and a similar cushion or water pillow should support the nates. If the patient's skin is warm on entering the bath and the friction is vigorous and kept up during the entire period of immersion, there is little danger of chilling or collapse. If at any time this should occur, the patient must be immediately removed and placed in a dry blanket, the surface being vigorously rubbed until the skin is warm and reaction fully established. A complaint of chilliness on the part of the patient may not be an indication for removal from the bath. The appearance of goose flesh, however, necessitates removal. The patient should not be allowed to remain in the bath until the appearance of cyanosis or any other decided symptom of untoward effects.

While the Brand bath seems to give the best results with young vigorous persons, where treatment can be begun during

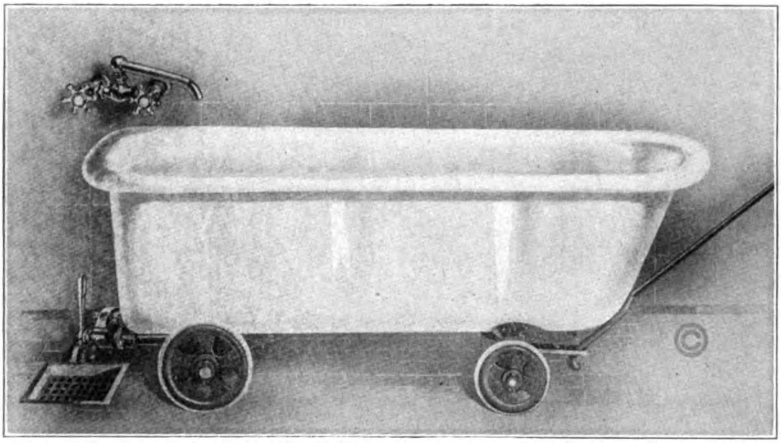


PLATE V. Portable tub on wheels showing wall faucets for filling and floor drain for emptying the tub.

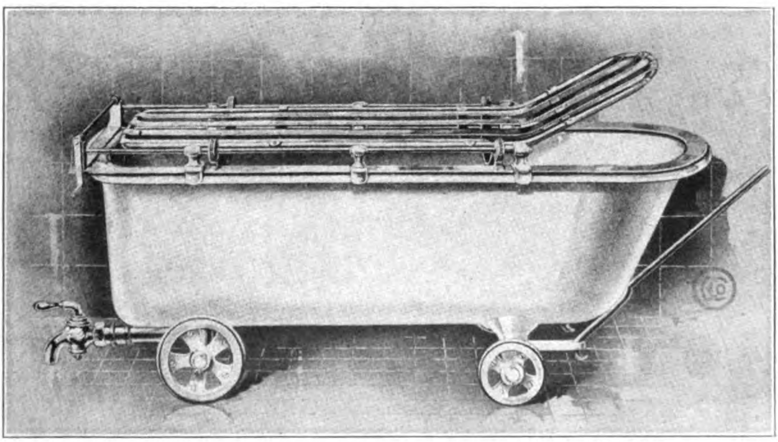


PLATE VI. Portable tub with steel raising device.

the first week, yet this method is not applicable to those cases which apply for treatment during the second or third week, since they have already become so weakened that there is not sufficient vitality to fully react to so vigorous a means. The Brand bath is also contraindicated in cases of much reduced vitality from any other cause, and in the very young and in the aged. In regard to the use of measures other than the strict Brand bath Buxbaum[1] inclines to the view that the essential feature is the obtaining of the reaction by suiting the treatment to the needs of the individual case. He says, "With reference to the special measures to be employed, the desired result can no doubt be attained with the most varied hydriatic procedures, provided the thermic and mechanical stimulations are graduated in accordance with the indications of the individual case. Hence there can be no invariable and exclusive routine."

With many patients it is better to employ a bath at a higher temperature, *the graduated bath* of Ziemssen or the wet sheet pack, cold sponging, compresses, etc. A graduated bath begins at a temperature of 98°, *i. e.*, 3°—5° lower than the body temperature or even 90° or 95° F. and continues for half an hour or longer, during which time the temperature is gradually lowered by the addition of cold water, friction being employed as soon as the patient complains of any chilliness. The temperature may be decreased to between 70° and 80° F., according to the condition of the patient. This bath is just as effective as the Brand bath in the reduction of the fever; in fact, it is a mistake to suppose that the colder the bath, the greater is the reduction in temperature. This is not the case. A higher temperature for a longer time may reduce the fever just as effectively as a lower temperature for a shorter time. There is, however, this very essential difference, that the stimulating of the body functions is greater in proportion to the degree of cold. With the graduated bath, as efficient and thorough stimulation is not obtained as with the Brand bath. But on the other hand, because of this extreme stimulation, thermogenesis is markedly increased and, following the Brand bath, the temperature rapidly regains its former height, so that

1. Cohen—System of Physiologic Therapeutics, Vol. IX, p. 134.

it is necessary to repeat the bath very frequently. With a graduated bath in which the temperature of the water is not lowered below 85° F., and especially when it is continued for thirty minutes to an hour, the temperature of the patient does not so quickly regain its former height and the bath need not be repeated so frequently.

Of other methods the following are useful in special cases or where the ideal treatment can not be carried out:—

1. The Wet Sheet Pack is perhaps less objectionable to the patient than a cold bath. Liebermeister claims that four wet packs of ten minutes duration each are equivalent to a cold bath of ten minutes; and Baruch, that six such packs are equivalent to a Brand bath. The sheet should be wrung from ice water or very cold water. It is applied in the usual manner, and after the initial warming, maintained at the evaporating stage, being renewed by sprinkling of more cold water on the sheet. The rapidity of evaporation may be increased by fanning.

2. The Cold Towel Rub given with a towel well filled with very cold water is an excellent substitute for the wet sheet pack. The use of the wet sheet pack necessitates more or less moving of the patient, which is not the case with the cold towel rub. The wet towel may be applied several times to the same part, and even ice water used.

3. The Ice Rub. H. A. Hare has employed the ice rub with good success. A flat piece of ice is wrapped in thin linen or gauze, and by rapid movements different parts of the body are gone over. He recommends this application to the back only, avoiding the extremities. Others, however, utilize it as a general measure in place of the cold bath.

4. Cold Sponging and Cold Affusions are of decided advantage in those cases where the bath or pack can not be used. Cold affusions to the head are of great service in delirium and, in fact, whenever nervous symptoms are unduly prominent.

5. The Cold Abdominal Compress is an efficient means and should be kept in place between other treatments. The best results from this are obtained when the Winternitz coil is placed over one layer of the compress. The steady flow of cold

water through the coil renders unnecessary the constant renewal of the compress, which requires so much time on the part of the nurse. It also avoids the shock from the renewal which prevents the patient from completely relaxing for any length of time.

6. The Leiter Coil or Cold Winternitz Coil to the head is a very efficient means both of preventing the rise of temperature and alleviating the nervous symptoms. It should be used between other treatments. Cold applications to the head decrease heat production by acting upon the thermogenic centers. The ice bag or Leiter coil over the heart is also serviceable, especially where the pulse is very rapid and weak.

7. The Cold Enema, or continuous rectal irrigation, is another very efficient means. Since it has been shown by Shüller that the cold enema always produces more or less retrostasis, this treatment may be productive of harm. It should not be used where lung complications exist. Kellogg mentions a case with a temperature of 104.2° F. in which three large enemata at 66°, 62°, 62° F., given in rapid succession, reduced the temperature to 99.2° within one hour. Such rapid and extreme reduction of temperature may be dangerous and is hardly to be recommended for general use. However, if given at a temperature of 75°—85° and continued for thirty to forty-five minutes, it is a very grateful and efficient means of controlling the fever.

The Daily Program. Instead of depending upon any one form of procedure the author prefers what may be called a combination method. It must be admitted that "tubbing" every three or four hours entails more disturbance to the patient than is for his best good.[2] Nor is such oft repeated stimulation a necessity for the sustaining of the circulatory system, the relief of the nervous symptoms, etc. For these reasons it is better to provide some means of continuous cooling such as the cold water coils to the head and abdomen (*Plate VIII.*) regulating the temperature of the water and the rate of flow according to the necessities of the individual case. Rectal irrigation is another convenient method of cooling and one which does not

2 The almost continuous attention together with the extra nurse required at the time of the bath demand so much help that in some hospitals the method is almost prohibitive.

disturb the patient. If kept up long at a time the water should not be very cold but rather tepid or cool. It has also the advantage of stimulating diuresis and the consequent elimination of toxines through the aborption of water from the bowel.

These means effectually control the temperature. For general cutaneous stimulation the patient should be given one or two tub baths daily, preferably one in the forenoon and one in the afternoon. This may be a modified cold rubbing bath or a graduated bath. Where tubs are not available, the cold towel rub, the ice rub, or the evaporating wet sheet rub may be used for the same purpose. In practice such a combination of methods appears to give the best possible results.

Hot Treatment. In those cases where chilliness and cyanosis are produced by the cold bath and other cold applications, or in which this condition is more or less constant, it is necessary to thoroughly warm the skin, bringing the blood to the surface and effectually reducing the extreme internal congestion before any cold application can be made with success. For these preliminary hot treatments one may use fomentations, the hot pack, the hot evaporating sheet or hot sponging, according to the circumstances and indications. They may be aided by hot water-drinking. During the cold treatment hot-water bottles and spine bags should be used to keep the limbs warm and prevent chilling. The skin should be red and warm and the patient feel warm before any cold treatments are given. The cold mitten friction and the cold towel rub are valuable adjuncts to the hot applications, since they increase the warming of the skin more than they cool the blood. Cold applications, such as ice bags and ice caps, should be applied to the head and over the carotids whenever any decidedly hot applications are made. These help to prevent any rise of temperature while the patient is being prepared by the hot treatment in order to react to the succeeding cold.

The Diagnostic Bath. Baruch and Kellogg claim for the cold bath a certain value as a diagnostic means when employed during the first week of the fever. Baruch uses the following method: When the rectal temperature reaches 103° F. and other symptoms indicate typhoid fever, the patient is tubbed in

PLATE VII. The Coile bed bath.

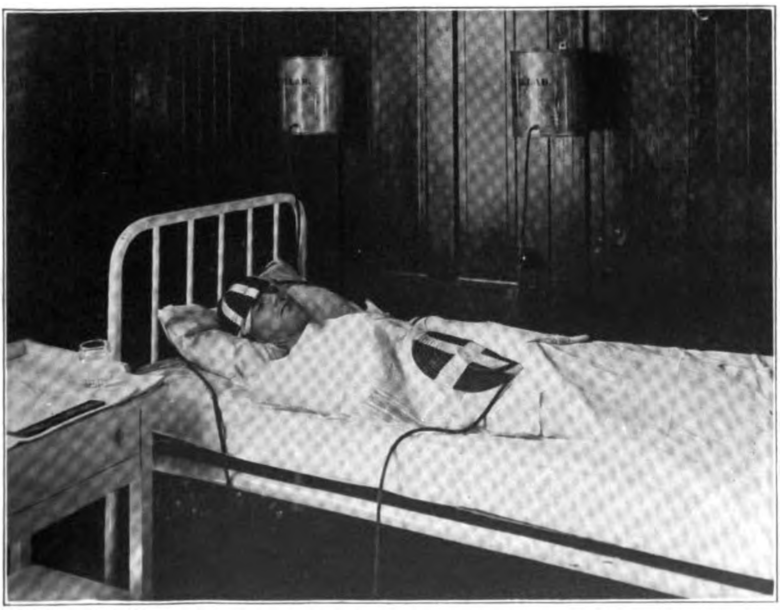


PLATE VIII. Author's method of continuous cooling in typhoid fever.

water at 90° for ten minutes, being rubbed continuously. The patient's temperature is taken one-half hour after the bath and again four hours after the bath. If, at the termination of this time, the temperature still registers 103° or over, the patient is bathed in water at 85°, and the temperature recorded as before. If it still remains at 103° or above, a third bath at 80° is given, and the fourth time at 75°, employing friction with each. Baruch's experience with this bath leads him to believe that, if the temperature is reduced more than two degrees, typhoid fever is improbable; while, if there is little or no reduction, the diagnosis becomes more positive.

Rationale of the Cold Bath. The brunt of the infectious process and toxemia in typhoid fever falls upon the nervous system, the circulatory system, and the kidneys.

1. The Nervous System. In fever it is largely because of the imperfect action and control exercised by the nervous system that many of the body functions are deranged. It fails to control the heat mechanism, the vasomotors are disturbed, glandular activity is depreciated. The toxemia is the principal cause of the derangement of the nerve centers. The congestion about these centers which occurs in nearly all fevers only increases the volume of toxines in the blood supplying them. The nerve cells are benumbed and lethargic, or they are irritable, restless and overactive in an irregular sort of way. The high temperature adds to the intensity of this state. It is necessary to eliminate the toxines and arouse the nervous system from its stupor, stimulating it to a normal activity and by tonic means, relieving its irritability so that rest may be secured.

All these effects are produced by the cold bath. The more profound the stupor and intense the delirium, the more marked the relief experienced. Quiet refreshing sleep usually follows each tubbing or other vigorous cold treatment. Subsultus and carphologia are relieved. Headache, hebetude, and apathy are succeeded by a brightening of the mental powers. Post-febrile insanity and mental weakness are less liable to occur where hydrotherapy is systematically employed.

All of the medicinal antipyretics dull and stupify the nervous system. The centers are not apprised of the danger and so can not properly regulate protective functions.

2. The Circulatory System. Heart failure is that to which we have been taught to ascribe all the failures in the circulation; and it is toward the heart muscle that many medicinal agents, designed to act upon the circulation, are directed. This idea has resulted in the deluging of the system with strychnine, digitalis, and the like, and the already overworked heart has been compelled to do double service to no avail. That this idea is almost wholly erroneous has been quite fully discussed in the previous chapter.

Romberg and Pässler have shown that the chief danger to the circulation in infectious diseases comes through paralysis and derangement of the vasomotors, and is not due to any damage to the heart itself. Pässler further claims that this derangement is caused by loss of the control exercised by the vasomotor centers in the medulla and spinal cord, the peripheral vasomotor nerves and the muscles remaining intact. Reflex effects are still possible. The heart is not at fault, but there is an absence of the natural physiologic resistance normally maintained by the proper tone of the blood-vessels, together with the loss of the rhythmic action of the peripheral heart. Hare very aptly compares the heart and vasomotors of the circulatory system respectively to a locomotive and the resistance offered to its driving wheels. He says, "The locomotive is intended to meet and stand any resistance, and if the resistance is removed by slippery rails, the wheels fly around ineffectually, racking the machinery and destroying its usefulness. From the above, some important diagnostic and therapeutic facts are learned: (1) that a rapid pulse may be due in no way to a disordered heart, but to vasomotor relaxation; (2) that the proper way to treat this rapid pulse is to put sand on the track and increase the resistance, and not to make more steam—or give digitalis—which only cause the engine, or heart, to work away on slippery rails with more wear and tear, and make no progress." That this wear and tear may be considerable and result in a weaker and more rapid pulse, any one may observe who will, after 1-60 grain of strychnine has been administered to a typhoid patient every three hours for a week or more, discontinue the drug, recording the blood pressure before and after discontinuance of the strychnine by means of some accurate blood pressure instrument. Indeed the change for the better is so marked that it can be very readily appreciated by the finger without other aid. In one case that came under the author's observation, this was so marked and appeared so promptly, that it was observed at once by both the day and the night nurses.

The cold friction bath meets the indication presented by the deranged vasomotors more fully than is possible with any other means. It stimulates the blood-vessels to normal, rhythmic action and relieves the heart of the excessive burden imposed upon it by their failure. In typhoid fever, the blood is very much reduced in quality. The red cells and hemoglobin are decreased, the latter to a greater extent than the former, especially during convalescence. There is a decided leucopenia, the white cells being decreased in number one-third, or even more than one-half. The blood is laden with acid poisons and is, therefore, reduced in alkalinity (Bireger). The amount of toxic extractives in the blood has been shown by Robin to be doubled or trebled in case of fevers. We have already quite extensively discussed the effect of the cold bath on the composition of the blood. Suffice it to say that observations made by Strasser, Breitenstein, Baruch and others prove conclusively that, in typhoid fever, every constituent of the blood is favorably influenced by the cold friction. The red cells in the peripheral circulation are greatly increased, the white cells increased as high as two or threefold, the alkalinity is restored and acid products decreased. Because of these, normal nutritive changes proceed more promptly.

3. The Kidneys. Elimination in febrile conditions is very defective. The quantity of urine is decreased and, while there may be an increase in the solid constituents, it is still quite insufficient to prevent the accumulation of toxic wastes in the blood and tissues. During convalescence, the solids of the urine increase from 10 to 20 per cent, or more, over the amount excreted during the febrile period. The poisonous wastes are more insoluble than those of little or no toxicity and so require a larger quantity of the solvent—water—for their efficient elimination.

The cold bath greatly increases diuresis. The quantity of solvent is increased, thus increasing the toxines eliminated. But this alone, does not account for the great increase in the toxicity of the urine under the bath treatment. While the poisons of the urine in typhoid fever are double the normal amount, Roque and Weil found them increased five times after the cold bath. Bouchard also found the toxic co-efficient of the urine greatly increased by the cold bath. Robin in one case found the urea increased to 20 per cent. On the contrary, antipyretic drugs diminish the excretion of urea and nitrogen. The liver in those cases dying after treatment with antipyrin, is said to be heavier than the liver of those dying after the cold bath treatment. These drugs produce granular and fatty changes in the liver and kidneys.

The respiratory elimination of CO_2 and intake of oxygen are decreased in fevers, the amount of the decrease being in inverse proportion to the severity of the fever. This is due, of course, to the lessened capacity of the body tissues to utilize oxygen. Both oxygen absorption and carbon dioxide elimination are enhanced by the cold bath. Robin found the increase approximating 20 to 30 per cent above the usual amounts in typhoid fever. That all these results are beneficial needs no argument. There is no organ, tissue, or function not favorably influenced by the hydriatic treatment of typhoid fever. Because of the maintenance of the vital resistance and the elimination of toxines during the febrile period, convalescence is much shortened when cold baths have been used.

Contraindications and Treatment of Complications

Pneumonia. The cold bath is contraindicated in pneumonia of the lobar type. The case should be treated as far as possible as simple pneumonia alone would be treated. Fomentations, cold compresses, alternate hot and cold applications, the ice pack to the chest, and such means are applicable where the pneumonia arises as a complication and may be used in much the same manner as is ordinary pneumonia. Special attention must be given to the extremities. They should be kept warm and the circulation active. The cold mitten friction, wet towel rub, sponging, and affusions are serviceable in place of the bath. Hypostatic pneumonia may be treated by alternate hot and cold applications, cold affusions, or ablutions to the back. The warm bath graduated down to 90° F. may be used.

Pleurisy. This condition absolutely contraindicates the use of the cold bath. No cold whatever should be applied to the chest over the inflamed area until the acute stage is passed, that is, for two or three days. However, the cold towel rub and cold mitten friction, sponging, etc., should be kept up as usual, avoiding only the skin surface over the inflamed pleura for the first two or three days. If the cold baths are continued or large cold compresses used to the abdomen, a mild pleurisy may become so fixed as to require months for the eradication of the chronic inflammation.

Nephritis. Contrary to what might be expected, the use of the cold bath is not wholly contraindicated in this condition. Mild cases of nephritis improve under the Brand bath. If the nephritis is severe, the graduated bath may be substituted. Vogl's experience demonstrates that nephritis is less common in those treated by the Brand bath, and also that the mortality is less in those having nephritis. Both the urine and urea increase in quantity and the albumen decreases under the effects of the cold bath. Venous congestion of the kidneys is conducive to nephritis, albuminuria, and the formation of casts. This condition is relieved by the stimulation of the circulation and derivation secured by the cold friction.

Hemorrhage. The cold bath must be discontinued as soon as this condition becomes apparent, principally because of the rest needed. The limbs should be kept warm and some sort of cold application placed over the abdomen. We believe the most satisfactory measure is the Winternitz coil. This does away with the shock occasioned by the renewing of cold compresses, and the temperature can be more accurately gauged and more perfectly controlled than with the ice bag. After the recovery from the hemorrhage, it is best to permanently discard the use of the bath, substituting sponging, affusions, the cold towel rub, etc.

Perforation. Here, as in hemorrhage, the cold bath must be discontinued, the patient being treated by rest and means used to control the shock, so that operation may be done as soon as possible. If peritonitis supervenes, it becomes the chief objective point.

The reduction in mortality from typhoid since the introduction of the cold bath has not been due to reduction in the mortality from hemorrhage and perforation. According to Hare the mortality from these causes before and after the introduction of the Brand bath is practically the same.[3] The mortality from all other causes was much less, dropping from 9.7 to 3.4 per cent and, in spite of no change from the above mentioned conditions, there was a total decrease in mortality of nearly 50 per cent.

Menstruation. The menses frequently cease during severe febrile conditions, but cases in which it has continued have been successfully treated by cold baths; and under this treatment, cases of pregnancy, complicated by typhoid, have been carried to a successful issue.

Tympanites. The cold bath greatly relieves this condition. The continuous use of the ice water coil, interrupted every hour or two by fomentations, gives great relief. The asafœtida or turpentine enema should not be omitted where more energetic means are needed. The plain cold enema or continuous rectal irrigation are also very useful in tympanites.

Mortality and Statistics

Modern methods in the rational treatment of disease have accomplished few more striking changes than those accompanying the hydriatic treatment of typhoid fever. The reduction in mortality compares quite favorably with the lessened fatality in small pox since the introduction of vaccination, and that of diphtheria since the employment of antitoxine. The prophylactic use of antityphoid vaccination has proven an almost unfailing means of preventing large epidemics such as occur in army practice and even in hospitals. It is to be hoped that it will also show itself of material help in treatment in lessening the severity of the attack.

3 Brisbane Hospital, Queensland, 1882—1896.

Under the ordinary expectant plan with administration of medicinal antipyretics, statistics from Germany show, among 11,124 cases, a mortality of 21.7 per cent. In another collection of 27,051 cases, there was a mortality of 17.45 per cent. In still another collection of 80,140 cases, there was a mortality of 19.23 per cent.

In one divison of the German army, during seventeen years among 1970 cases, the mortality was 26.3 per cent. In the English army for six years, ending with 1877, there was a mortality from typhoid of 32 per cent. In recent years, Delafield shows a mortality of 26 per cent from the New York hospitals. And throughout American cities, the mortality from typhoid fever is claimed to be from 25 to 40 per cent. In the typhoid wards of the Johns Hopkins Hospital, during the first ten years, nine of which is since the introduction of hydrotherapy, Osler reports among 829 cases, a mortality of 7.5 per cent. During the first year of this time, the cases were treated by the ordinary expectant plan and, moreover, this series includes all cases admitted, those dying within one or two days and those diagnosed at autopsy. From the Brisbane Hospital, Hare reports a typhoid mortality of 14.8 per cent previous to the introduction of hydrotherapy and 7.5 per cent since its employment.

In 1887 Brand gathered statistics of 19,017 cases, showing under all forms of hydriatic treatment, a reduction in mortality from 21.8 per cent to 7.8 per cent. In another series of cases collected by Brand and enlarged by Baruch, in which the strict cold bath treatment was used, Baruch claims a reduction of mortality to 3.9 per cent.

In the divison of the German army above referred to, the mortality under the strict Brand system was reduced from 26.3 per cent to 4.3 per cent. Baruch further claims that among 1223 cases treated only by apostles of the Brand system, there was a reduction in mortality to 1 per cent (twelve cases) and that "*not one of these twelve deaths occurred in any case that came under treatment before the fifth day.*"

Contrary to what might be expected, the mortality is less in private practice than in hospitals. This is doubtless because the cases come under observation at once and can be treated from the beginning. The same is true of army and navy hospitals where all indispositions are at once investigated by the medical officer.

The statistics gathered by Baruch[4] relative to the mortality from typhoid fever under the varying methods are the most extensive on record. The reduction in mortality seems to depend upon (1) the strict employment of hydrotherapy by the cold bath method where cases come under observation before the fifth day; (2) the discarding of all medicinal antipyretics; (3) judicious employment of various forms of hydrotherapy where cases can not be treated from the beginning; (4) private practice.

MALARIA

Since this disease is of an "infectious" nature, being due to the malarial plasmodium, treatment must be directed toward the destruction of the parasite. This may be accomplished in either of two ways,—first, by the toxic action of quinine; and second, by the phagocytic action of the white blood cell. That quinine does kill the parasite and thereby check the disease, no one can dispute. But that it also fails of effecting a cure in by far the larger number of chronic cases and many of the acute cases, is also indisputable, being witnessed by the experience of all practitioners whose practice brings them in contact with this disease. The last word concerning malaria has yet to be spoken. It would seem that giving quinine in an acute case which has not previously been taking a course of quinine, if so adminstered that there is a maximum dose in the blood just previous to sporulation which produces the chill, stopping there, no more being given until the proper time before the next expected paroxysm, is productive of good results; however, it often fails in the estivo-autumnal type, since it is uncertain just when a paroxysm may be expected, sporulation being irregular so that the above program can not always be carried out successfully. It has also been shown that quinine fails of its best results or fails altogether where it has previously been administered for some time as a prophylactic, or in the treatment of other attacks.

4 Baruch—Principles and Practice of Hydrotherapy, p. 202.

The following experience[5] related by Dr. E. R. Stitt, a United States Navy surgeon, is worthy of careful thought:—

"While in camp along the canal route, we had a few cases of malaria. These were immediately treated with large doses of quinine, and without exception they responded promptly and satisfactorily to such treatment. The only member of the party who insisted on taking quinine prophylactically was Colonel Ludlow, the head of the commission; and strange to say, he was the only one who had malaria on the trip home."

"To those who have thought of quinine prophylaxis as a true preventive, the following instance is instructive:—

"On May 20, 1906, a battalion of marines, numbering 398, was organized at Philadelphia. Seventy-five per cent of the force was made up of recent recruits from the Middle West.

"Leaving Philadelphia May 21, Colon was reached May 28. On June 4 the battalion was disembarked at Colon and stationed for a time at Camp Elliott, which is situated about twenty-five miles from Colon and which was comparatively free from mosquitoes. Later on, three companies were stationed at Camp Reed, five miles from Panama, at which place mosquitoes were numerous and troublesome.

"On July 6, after a service of practically one month on the Isthmus, the marines returned to the ship (U. S. S. Columbia). During the month's encampment, 9 grains of quinine had been served out daily as a prophylactic. In addition, such measures as head-nets for those on night sentinal duty and inspection of mosquito nets about the men sleeping in tents had been in force. There was very little malaria reported from these men while on the Isthmus.

"The ship sailed from Colon on the night of July 7. On the first day out, twenty cases of malaria were admitted to the sick list, the next day fifty-three, and the third day forty-five. In consequence of what appeared to the medical officer to be universal infection among the men, 10 grains daily of quinine were administered to every one as a prophylactic. Notwithstanding this almost curative dosage of quinine, the condition of the men was such when the ship arrived at San Jaun, July 13, that it

5 Journal of American Medical Association, May 23, 1908, p. 1683.

was deemed necessary to get the men out of the tropics, as several cases of a pernicious type and two of blackwater fever had appeared. Accordingly the ship sailed for Boston July 16.

"Notwithstanding the prophylactic use of quinine, under military observation, for those who were not cinchonized, there were 215 acute malarial paroxysms among 298 men during the five days' trip from San Juan to Boston. About 100 men of the original 398 had been transferred to other ships and stations prior to the sailing of the Columbia for Boston. The character of the paroxysms was atypical—there was no frank chill. The men would feel fairly well until shortly before an attack, they would then complain of chilliness and weakness and either lie down or fall down in a heap on deck. Passed Assistant Surgeon Butler, U. S. N., states in a report, that when the men arrived at Boston so many were anemic and weak that they were unfit to return to the tropics. Doctor Butler also noted the fact that these cases did not seem to respond at all satisfactorily to quinine even when given hypodermatically. Before the cases became so numerous, blood examinations were made and the form of malaria was considered to be chiefly tertian. The clinical features, however, would indicate that there was estivo-autumnal infection in many of the cases.

"In considering the experience of these marines who were given prophylactic, I might even say curative, doses of quinine during a period just exceeding a month, and when this was discontinued during the days of July 7, 8, 9, and 10, showed an extensive malarial morbidity, the question naturally presents itself as to the explanation of this. Furthermore, we must note the fact that resumption of quinine prophylaxis at this time in those not cinchonized apparently had little effect in checking the outbreak, and that when quinine was adminstered in curative doses, at times hypodermatically, it did not seem to control infection as is usual. It is common experience that malaria responds readily and promptly to quinine properly administered. I can not but believe that malarial parasites may develop a reistance to quinine.

"Browning, reporting recent work in Ehrlich's laboratory, states that when mice infected with trypanosomes were not given sufficent doses to destroy the flagellates, these protozoa developed a resistance to the therapeutic agent during the time their development was held in abeyance. A most startling discovery was, too, that these trypanosomes retained their chemo-resistance through numberless generations. After passage during a period of fourteen months through 144 mice, these last generations of trypanosomes still retained their immunity to the exciting drug. Browning experimented with atoxyl, parafuchsin, and trypan blue. Experiments with paramecium have also shown that these ciliates may develop marked resistance to agents primarily toxic to them."

While not commonly met with in subtropical countries, it is *possible* for the body to acquire immunity to malaria. This is manifest in numerous dark-skinned races. In regard to the action of quinine in preventing the acquisition of immunity, the following from H. T. Brooks[6] is particularly significant: "*For acquisition of this immunity, however, it is necessary that the natural course of the disease remain uninterrupted by administration of quinine, in order that the natural immunizing processes may completely take place in the blood.* R. Koch has demonstrated that in all localities where the adult natives are, so to speak, immune to malaria, the children invariably are attacked by the disease. They invariably pass through febrile attacks and always have malarial parasites in the blood, often abundantly. The natives know neither quinine nor any similarly acting drug for controlling the malady. They allow it to take its course, and numerous children die of the disease; those who survive, however, are immune for the rest of their lives, that is, in spite of the sting of infected anopheles, they no longer offer a good soil for the malarial plasmodia, and hence the latter are incapable of development in their blood."

The experiments of Bass and Johns[7] in the cultivation of malarial plasmodia *in vitro* have brought out some very interesting and important facts relative to the mechanism of protection in malarial infection. From the report of this work we quote the following:—

6 General and Special Pathology, 1912, p. 411.

7 The Cultivation of Malarial Plasmodia (plasmodium vivax and plasmodium falciparum) in Vitro, Journal of Experimental Medicine, Vol. XVI, No. 4, 1912.

"The parasites have been grown in the presence of red blood cells only. We have not seen any evidence that they can be grown independently of these cells. As already stated, they can not live for even a few minutes free in the serum. Serum inactivated of its complement is less destructive, but the plasmodia can not live in it for any considerable length of time. When cultures are prepared according to the technique described for the cultivation of one generation only, the leucocytes migrate more or less toward the surface and soon become actually concentrated in the layer in which the parasites grow. Leucocytes do not phagocytize parasites as long as they are inside of the red blood cells, but as soon as segmentation takes place and the capsule of the red cells ruptures, liberating merozoites, the latter are promptly engulfed. In fact, it is not uncommon to see a leucocyte that has phagocytized one or more full rosettes. This probably occurs after the parasite has digested the capsule or otherwise made a small opening through it, whereby it is converted into a foreign body which the leucocytes try to remove. Dead parasites in red blood cells are also phagocytized, providing the enveloping cell substance is sufficiently permeable. Parasites phagocytized are soon killed and finally digested. As a result of this phagocytosis, few if any parasites in such a culture escape to develop a second generation." "If more than one generation of plasmodia is to be cultivated, it is necessary to remove the leucocytes when the culture is made in order to avoid destruction of the parasites by them at the time of segmentation."

It is thus amply demonstrated that the phagocytes and the protective substances of the serum are highly destructive to the parasites. For the natural protection of the body against malarial parasites it is, therefore, necessary to increase the number and activity of the phagocytes and stimulate the production of chemical lysins.

It is a well known fact that while quinine kills the plasmodium, it also kills the white blood cell. In fact the two are quite similar bits of protoplasm manifesting quite similar activities. The white blood cells acquire little or no resistance to it. If they are not destroyed, they are for the time-being paralyzed and phagocytosis suppressed. We previously called attention to the fact that 10 grains in the blood of a patient weighing 130 pounds constitutes nearly double a toxic dose for the phagocytes. In these facts lies the explanation of the failure of quinine to cure chronic cases. The parasite becomes accustomed to the poison, or as we might say, acclimated to its unfavorable environment, while the white blood cells succumb to the toxic action. The parasite has then nothing to oppose its action and it multiplies and thrives at the expense of the red blood cells. The latter are broken up and hemoglobinemia and hemoglobinuria result. This breaking up is increased by the action of the quinine itself, and so the case goes on from bad to worse. In fact, it is claimed by many southern practitioners that blackwater fever—the hemoglobinuric form of chronic malaria—is due to quinine and not to the parasite.

In regard to the relation of quinine to hemoglobinuria we again quote from H. T. Brooks:[8] "In certain regions, such as West and East Africa (but not in India), if quinine is taken prophylactically in large doses for a long time—at least half a year—destruction of the red blood cells may occur so rapidly after onset of this severest form of malaria (estivo-antumnal) that the liver is no longer able to transform the large amount of hemoglobin liberated in the blood into bile-coloring matter; therefore, a greater part of it is excreted through the kidneys, producing hemoglobinuria. . . . As a result of the enormous solution of the red blood cells, the renal tubules, on further course of the disease, become completely occluded and no urine can be secreted. Autointoxication of the body, chills, vomiting, and diarrhœa set in and death occurs."

We must, therefore, in *these* cases abandon the use of quinine and search for some means of increasing the number of the leucocytes and enhancing their phagocytic activity. The reaction to cold applications when combined with mechanical means is that which best produces this result. Some enthusiastic hydriatists have endeavored to combat the disease by the use of hot sweating measures applied as soon as there are any indications of the beginning of the chill and continued until

8 General and Special Pathology, 1912, p. 407.

sweating is well established, little attention being given to the frequent and systematic use of cold frictions, affusions, douches, etc. The sweating combats nothing but the effects of the chill; it in no way removes the cause, augments the vital resistance, or restores the blood to that condition in which it is best able to combat infection. On the contrary, if at all prolonged, the resistance is lessened. Quinine, the malarial toxine, and long hot treatments, all lessen the number of leucocytes, driving them into the viscera where they stagnate.[9]

Nearly all who employ hydrotherapy in any regular manner have witnessed the beneficial results that may be obtained in the treatment of *chronic* malaria. The general plan to be followed is that of some systematic regime of tonic measures, carefully graduated and suited to the needs of the individual case. We have seen chronic cases in which 30 grains of quinine administered daily had failed to check the fever, brought to a successful issue by the regular use of the cold mitten friction and alternate hot and cold applications.

The plan followed by Fleury in the treatment of over 100 cases of malaria in the German colonies in Africa is worthy of imitation. One or two hours previous to the expected paroxysm, he administered douches at 55°—60° F. From his experience there, he concludes that in chronic cases of intermittent malarial fever with cachexia, anemia, relapses, etc., cold douches are *always* to be preferred to quinine, also that in acute intermittent fever it may be used *instead* of quinine. These conclusions were confirmed at the military hospital at Brussels by the investigations of a Royal Belgian Commission. Strasser, Fisher, Fodor, and others have reported cases successfully treated by cold applications. H. F. Rand, formerly professor of physiologic therapeutics in the University of Colorado, has successfully treated cases by the use of the cold mitten friction, cold towel rub, and the cold half bath with friction. He begins a number of hours before the chill is due. He reports a case of chronic malaria in which no chill appeared

9 "In the first attack absolute and relative leukopenia is observed which is due to the collection of the white cells in the liver and spleen, to the destruction of the phagocytes, and, in cachexia, to lesions of the blood-making organs."—Edward's Practice of Medicine, 1907, p. 118.

after the beginning of the treatment. At the end of a week the blood was free from plasmodia.

As in other fevers, the rationale of these measures is not difficult of explanation. It has been shown by Maragliano[10] that contraction of the surface vessels in malaria begins two hours before the temperature begins to rise and about three hours before the paroxysm (*Fig. 49.*). The skin vessels continue to

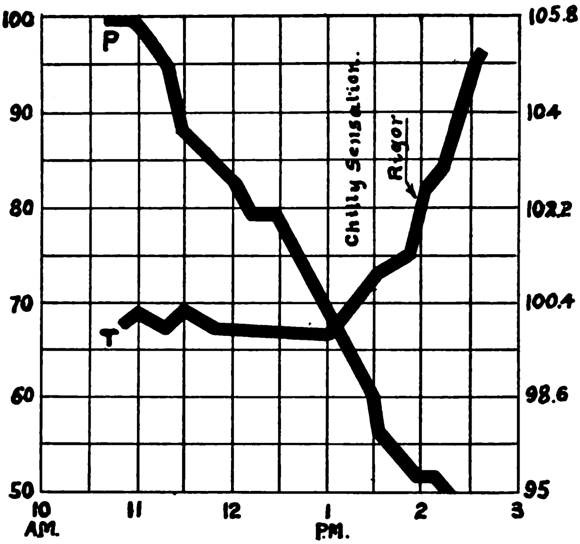


Fig. 49. Chart showing the causative relation of peripheral vasoconstriction to the fever and chill in quotidian malaria. P—state of peripheral blood-vessels as shown by the plethysmograph. T—temperature. (Maragliano.)

contract, and the fever reaches the highest point when the vessels are in a state of maximum constriction. During the sweating stage the vessels dilate, and when maximum dilatation is reached the temperature returns to normal. During the two hours referred to, the constriction of the skin vessels and anemia of the skin becomes well "fixed," so that a severe prolonged chill is provided for. At the same time there is an enormous retention of heat due to the failure in heat elimina-

10 Plethysmograph experiment—quoted from Buxbaum—Lehrbuch der Hydrotherapie, 1903.

tion. The internal congestion is intense. Under these circumstances the cold percussion or friction has a double effect. First, by the production of circulatory reaction the spasm of the peripheral vessels is relieved and the internal congestion gives way because of an equalization of the circulation. The chill is thus aborted. Second, the leucocytes are "mobilized" and phagocytosis encouraged. In malaria the leucocytes forsake the peripheral circulation and accumulate in the viscera, especially the spleen. Experiments with the oncometer show that cold applications cause contraction of this organ. This action, together with the stimulation of the vasomotors of the peripheral vessels, serves to distribute and energize this vast army of phagocytes. Besides the mobilization of the phagocytes, visceral globular stasis of the red cells is prevented. It is believed by Bass and Johns that for malarial parasites to pass from red cell to red cell, these must be in actual contact with each other in order that the parasite escape the destructive action of the serum in which they can not live for even a few minutes. Their conclusion is this: "From our observations of malarial plasmodia growing *in vitro*, we believe that *in vivo* they can pass from cell to cell only when a cell is in direct contact with another cell containing a segmenting parasite, and then only when the opening for the exit of merozoites occurs opposite the cell to be infected."

If this conclusion be true, such reinfection of red cells would be greatly favored by the globular stasis which occurs at the time of the chill. On the other hand, it would be very greatly hindered by an active visceral and peripheral circulation in which condition the majority of the young parasites would for a long time be exposed to the destructive action of the serum and would be readily phagocytized by the leucocytes.

Hot applications, beginning just before the onset of the chill, would serve to dilate the peripheral vessels and so counteract the vasoconstriction for the time-being. But such intense and prolonged heat has no tendency to combat the cause, *i. e.*, it does not produce mobilization of the leucocytes nor cause them to destroy the parasites. On the contrary it has the opposite effect, *viz.*, the causation of an increase in the visceral stasis of leucocytes and red cells and a lessening of phagocytic activity.

Where a patient reacts poorly, a reaction must be "compelled" by the use of local hot applications simultaneously with the cold. This is for the purpose of producing a sensation of warmth, while the essential effect—a brisk activity of the blood-vessels—is secured by the cold application accompanied by friction or percussion.

The following suggestive program will be found useful. It must be varied according to the reactive ability of the patient. Begin the first treatment of the series about six hours before the expected paroxysm and follow it with other treatments about every two hours. These should be continued until the time for the chill is well past.

The first treatment may consist of an enema followed by a hot foot bath and two fomentations to the abdomen of brief duration. As soon as the second fomentation has been placed, begin with a cold mitten friction. This latter should be given with very cold water and vigorous friction. Dry the patient and let him rest for an hour or an hour and a quarter. Next administer quickly alternate hot and cold to the spine, followed by an alternate hot and cold percussion douche to the spine, splenic and hepatic areas, and the legs. If necessary the patient may stand in a tub of hot water during this treatment or, if there is still less reactive ability manifest, give a hot shower while the cold douche is being administered. Let the patient drink freely of water both before and after each treatment. The third treatment may consist of a cold shallow rubbing bath lasting four or five minutes and preceeded, if necessary, by a hot pail pour to the legs and lower spine only. Two attendants should be provided to administer the shallow bath. Succeeding treatments should be carried on along the same line. These may be the cold mitten friction with ice water, the wet sheet rub, the percussion douche, the salt glow with pail pour, etc.

In conclusion we can not do better than quote the principles given by Buxbaum:—[11]

"The best water treatment for malaria consists in the employ-

11 Cohen's System of Physiologic Therapeutics, Vol. IX, p. 136.

ment of a cold application, combined with powerful thermic stimulation. The form of the application is a matter of indifference. The most important requirement, however, is the production of a good reaction. When this fails to take place, success will be wanting. With the powerful stimulating procedure, which may be chosen according to personal preference, a fan douche to the region of the spleen may serviceably be conjoined. The principal objects of the therapeutist's attention are the proper selection of the *time*, and the production of a *good reaction*. The shorter the interval between the procedure and the anticipated chill, the more certain the result. With regard to the procedures to be employed, they consist in cold vigorous shower baths, a cold rub in course sheets in combination with sheet baths; cold sitz baths of ten minutes' duration; cold full baths; plunge baths and other suitable measures. The treatment should be continued until the constitution of the blood, the digestion, and circulation are restored to normal—briefly, until every sign of cachexia has disappeared.

"According to Strasser, the *effect* of hydriatic procedures is to be attributed to the fact that shortly before the attack the infected erythrocytes disintegrate under the influence of the powerful stimulation of cold, so that the plasmodia thus set free are destroyed by the phagocytes." [12]

MEASLES

Measles is an acute, contagious, febrile disease characterized by a blotchy exanthem and accompanied by coryza. It is usually uneventful in its course and not accompanied by any great mortality. However, the patient may be made much more comfortable during the febrile period, and the vital resistance so sustained that there is less tendency to bronchopneumonia. The eruption does not appear until the fourth day, so the treatment must be begun before a positive diagnosis can be made.

12 It is interesting to note that Bass and Johns voice a similar theory for the action of quinine, as shown by the following quotation: "It is suggested that quinine has no destructive effect upon malarial plasmodia, its effect being possibly to render the red blood cell protecting the parasite more permeable to the all sufficient destructive influence of the serum. If this is true, quinine would affect only the parasites in the circulation and not those lodged in capillaries, which would not be reached by it until they segment."

In this disease, as well as in scarlet fever, the first thing to be accomplished is the relieving of the internal congestion occasioned by the infective process. If the case is untreated, the visceral congestion is considerably lessened on the appearance of the eruption. The old idea that measles is much more serious if the eruption "strikes in," or does not appear frankly, is not wholly without foundation. At the time the eruption makes its appearance the skin becomes markedly congested and this serves to, at least partially, relieve the visceral congestion. A treatment which most efficiently relieves the internal congestion is also conducive to the speedy appearance of the rash. In our practice we have seen this best accomplished by means of some hot sweating treatment, either the hot pack or bath, accompanied by the drinking of some hot liquid. The head should be kept cold by compresses or ice bags. In some cases, where there is not much chilliness, sweating is very well accomplished by the use of the wet sheet pack, prolonged to the sweating stage. This draws the blood from the viscera and congests the skin. At the termination of such a treatment, the case, if one of measles, will show the characteristic dull red, blotchy eruption.

Baruch recommends some form of cold treatment for the same purpose and as an antipyretic throughout the febrile period. He prefers the graduated bath, or a warm bath in which the patient sits while cold water is poured over the chest and shoulders. The full expansion of the lungs occasioned by such treatment aids in the prevention of bronchopneumonia. Because of the irritability of the skin, it is not best to employ friction during the cold bath. Cold affusions to the head and back of the neck are useful in relieving stupor, delirium, and other cerebral symptoms. We have found the wet sheet pack, frequently renewed by sprinkling cold water over it, an excellent means of reducing the temperature and, at the same time, it provides against chilliness, since between each renewal of the pack, it warms up and reaction is completed. This may be repeated until the temperature has been reduced to 101° F., or even less. The evaporating stage of the pack should last for a greater length of time than the heating stage, so that the total effect will be that of heat abstraction.

Bronchopneumonia. Capillary bronchitis is the most serious and fatal of the complications arising during the course of measles. In this disease there is a special tendency to congestion of the mucous membranes of the respiratory tract, as evidenced by the coryza which invariably accompanies it. The condition of the lungs may prove to be of a tubercular nature; this is not an infrequent sequel and one accompanied by a high mortality. In the treatment of bronchopneumonia, complicating measles, we employ the same methods used in the treatment of this disease when occurring alone. The child should be placed, at intervals of about three hours, in a bath at 90°—95°. When sufficiently warm, let the child sit upright and cold affusions be applied to the chest, shoulders, and back. The water for the affusion may be at a temperature of from 70°—75°. This vigorous means provokes an unusually deep inspiration, which is followed for a considerable time, by slower respirations of greater depth. It facilitates the expulsion of mucus.

Another treatment that has given excellent success is the cold compress applied to the chest. This should be wrung from very cold water, applied quickly over the entire upper chest, allowed to remain for a very short time, and then renewed. This may be repeated from two to four times, the last compress used being allowed to remain for thirty to sixty minutes. The chest may be slapped in rapid succession with cold wet towels. This, of course, should not be done if the temperature is very high. In the latter case the evaporating wet sheet pack provides for the reduction of the fever and serves to stimulate respiration. Gaseous interchange and oxygenation of the blood are greatly promoted, the circulation is increased, and the heart strengthened.

Among other measures that may be used to good advantage are cold sponging, hot sponging, and the cold towel rub.

SCARLET FEVER

Scarlatina is an acute, contagious fever characterized by a diffuse scarlet erythema and accompanied by sore throat or tonsillitis. It has a higher mortality than measles and is accompanied by more serious complications. In scarlet fever, as in all other febrile diseases, the chief objects to be attained by treatment are the maintaining of the vital resistance, increasing phagocytosis in order to combat the infection, sustaining the heart and circulation, and controlling the nervous manifestations by tonic measures. Before the appearance of the eruption, scarlet fever should be treated in precisely the same manner as measles. Usually by the time the physician is called, the eruption has already begun to make its appearance and here, as in measles, we have found the use of the initial hot bath or pack most effectual in promoting a decided and general eruption. As soon as its appearance, or other symptoms give evidence that the internal congestion has been materially relieved, some form of cold treatment should immediately follow. Because of the soar throat and tonsillitis, it may be necessary to precede the general hot treatment by fomentations to the neck and upper chest. Cold compresses or ice bags should be applied to the head at the same time, and the treatment accompanied by a hot foot bath or leg pack. These partial hot applications in themselves may produce general perspiration, in which case, it is unnecessary to use other hot treatment. A full hot bath may be serviceable in place of the hot pack, and when the patient has become thoroughly warmed, the succeeding cold treatment may be applied by proper graduation of the bath. The temperature must not be reduced too far, since it is impossible to employ friction on account of the rash.

The wet sheet pack, kept at the evaporating stage and frequently renewed, is a very efficient means of reducing the temperature, energizing the nerves and circulation. After the eruption has once appeared there need be no fear of "driving the rash in." However, it is necessary to produce a decided cutaneous reaction with every cold treatment used. The extreme cold bath is contraindicated. Affusions and ablutions, beginning with water at 90° gradually lowering the temperature until water at 70° or 75° is used, are also useful in controlling the temperature and assisting the heart's action.

It is necessary that the patient drink a considerable quantity of water to provide for thorough elimination, because of the tendency to renal congestion and nephritis. This latter condition is the most important complication of scarlet fever.

Nephritis. Should this condition appear during the febrile period, it is not necessary to stop all cold treatments, but the temperature should be somewhat moderated and the time shortened. Short hot applications may be made so as to enhance the reactive ability, and these immediately followed by such measures as cold affusions, cold sponging, wet sheet pack, or the graduated bath. In the case of the graduated bath, the initial heating may be accomplished by beginning the bath at 95°—98°, raising the temperature a few degrees until the patient is well warmed, and then gradually cooling the bath to 80° or 85°. Chilliness should not result from any treatment, as this tends to increase the renal congestion.

If the wet sheet pack is used, the sheet may be wrung from hot water and then maintained at the evaporating stage and renewed by sprinkling cold water over the sheet. During all this time, the drinking of large quantities of water should be encouraged. If the nephritis should make its first appearance after, or at the close of, the febrile period, it is perhaps best to employ the means commonly used in treating nephritis, that is, diaphoretic measures. The hot bath with ice to the head and heart, the hot blanket pack, or partial hot applications, such as the hot foot bath accompanied by fomentations to the spine, chest, or abdomen, are all useful in producing sweating. The hot air bath may be administered in bed according to the plan mentioned under acute nephritis. If the hot blanket pack is used, it may be very conveniently followed by the wet sheet pack, wrung from water at 75° and continued to the sweating stage. Reaction should ensue promptly. The child may be left in this pack an hour or two, or until the sheet is nearly dry.

The cold towel rub and cold mitten friction may be used to promote circulatory reaction, providing desquamation has well begun. It is best not to employ the cold mitten friction, should the nephritis occur before the eruption subsides. Under these treatments, the albumen gradually lessens and casts disappear from the urine. Should there be edema about the feet and ankles, the alternate hot and cold foot or leg bath should be used and followed by centripetal massage. To aid desquamation and prevent spreading of the contagion, the cold mitten friction or salt glow may be used to hasten the removal of the scales. Either treatment should be followed by an oil rub to prevent further rubbing off of the contagion-carrying epithelium.

Endocarditis. Should this complication arise, all cold tub baths should be discontinued, also cold affusions. The patient must be kept at absolute rest, with the ice bag to the heart intermittently. After the eruption has disappeared, there is no measure equal to the cold mitten friction in assisting the circulation and relieving the heart. For further treatment, see endocarditis in rheumatic fever.

LA GRIPPE—INFLUENZA

The clinical condition in influenza is quite different from that of typhoid fever. In this disease, the fever is of the short, high type, with rapid pulse and high blood pressure. These are the manifestations that are found in young adults. With older persons, the disease is quite likely to be accompanied by considerable asthenia, the digestive system and the nervous system bearing the brunt of the infective process. With younger persons the respiratory tract is more likely to be affected.

Since this is a short sthenic fever, the treatment employed will differ considerably from that used in typhoid fever. Aside from cold applications to the head, it is unnecessary to employ long cold treatments for the purpose of reducing the fever and all generalized cold applications are contraindicated. With an individual that has been previously strong and well and is in good flesh, it may be possible to treat the case from the start by vigorous cold applications with friction. This enhances the vital resistance, increases leucocytosis and so combats the infection in a very direct manner.

With cases as they usually present themselves, we have obtained the best results by the use of an initial sweating treatment such, for example, as the hot leg bath accompanied by fomentations to the spine or to the chest and throat, with cold compresses to the head and neck. (*Plate IX.*) At the same time, the patient should drink several glasses of hot lemonade. Chilliness is soon overcome and the patient begins to perspire profusely. As soon as profuse perspiration is well established, the patient may be given a graduated shower beginning at about 110°, gradually increasing the temperature to the limit of toleration. While in the hot spray, the patient should wear a cold compress to the head. As soon as he is again well warmed, the temperature should very gradually be reduced to 90°. This abstracts much of the heat that has been communicated to the body by the sweating treatment. The patient should now be put to bed with hot-water bottles to the feet, and allowed to perspire gently for a number of hours.

Great care must be taken that the patient is not overheated by the sweating treatment, since fainting is quite likely to result unless the cold compresses to the head and neck are frequently renewed. In some cases it is necessary that the patient be in a recumbent position while taking the treatment and, for this reason, the horizontal electric light cabinet is very serviceable in securing free diaphoresis. The use of the upright cabinet at the onset of la grippe is almost certain to result in fainting.

In case this sweating treatment has been carried out in the evening, on the following morning the patient should be treated by preliminary hot applications for the purpose of relieving the aching of the back and limbs. This is best accomplished by the leg pack and large fomentations to the spine. They should not be continued long and should be followed immediately by a vigorous cold mitten friction. From this point on, it is best to treat the case as far as possible with tonic measures, such as the cold mitten friction, cold towel rub, or the hot and cold douche to the spine and legs, finishing with the alternating douche to the feet. The sweating treatment should not be repeated unless it seems quite necessary.

Any plan of treatment may fail of its best results in case the bowel is not thoroughly unloaded at the beginning. This may be best accomplished by thorough enemata. Special complications require attention outside of the general plan of treating

PLATE IX. A sudorific treatment to be given at the onset of influenza.

influenza. Bronchitis and cough, with pain in the chest, should be treated by large fomentations, followed by the heating chest pack. Pharyngitis or tonsillitis should be treated in the same manner, that is, with fomentations, and a cold heating compress applied between treatments. The nervous symptoms are best met by the ice cap, or cold compress to the head. The pain may be very materially relieved by the use of very hot fomentations. In all cases, however, the treatment should be concluded with a vigorous cold mitten friction. It is not designed that the cold frictions shall materially lower the temperature in and of themselves, that is, the fall in temperature does not result immediately after the application, but rather succeeds in a few hours. If the temperature is very high, it may be effectually combated by the use of the ice bag to the heart with ice applications to the head. Both should be continued with but little interruption.

The asthenic type of influenza, except in old people or chronic invalids, is not now as common as during the pandemic of 1889 and the years immediately following. In the event of severe asthenia the treatment is to be carried on along general lines with special reference to those measures which will sustain the heart and circulation. The treatment of respiratory or digestive complications demands special care and is to be carried on along lines laid down elsewhere.

CHAPTER XVIII

INFLAMMATION AND ANTIPHLOGISTIC EFFECTS

BEFORE considering the conditions present in inflammations and their treatment, it will be well to understand the principles involved in the production of certain circulatory effects which are much used in the treatment of inflammations. We shall, therefore, first turn our attention to the methods and principles concerned in the production of depletion and fluxion.

Depletion is the reduction of congestion in a given part or organ.

Derivation is depletion secured by the withdrawing of blood from an organ or part of the body by increasing the amount of blood in some other part. Practically, it is the reduction of *congestion* (and inflammation) by drawing the blood from the part congested into some other part. There is produced a *collateral hyperemia* with *local anemia*.

Fluxion consists in increasing the rapidity of the blood current in a particular part, and consequently, the total amount of blood passing through that part in a given time. It is the production of *arterial hyperemia*.

DEPLETION—DERIVATION

There are three practical methods of securing depletion: first, by the application of heat alone; second, by the application of cold alone; and third, by the application of both heat and cold applied simultaneously. The accompanying outline shows in a condensed form the principal points of each method.

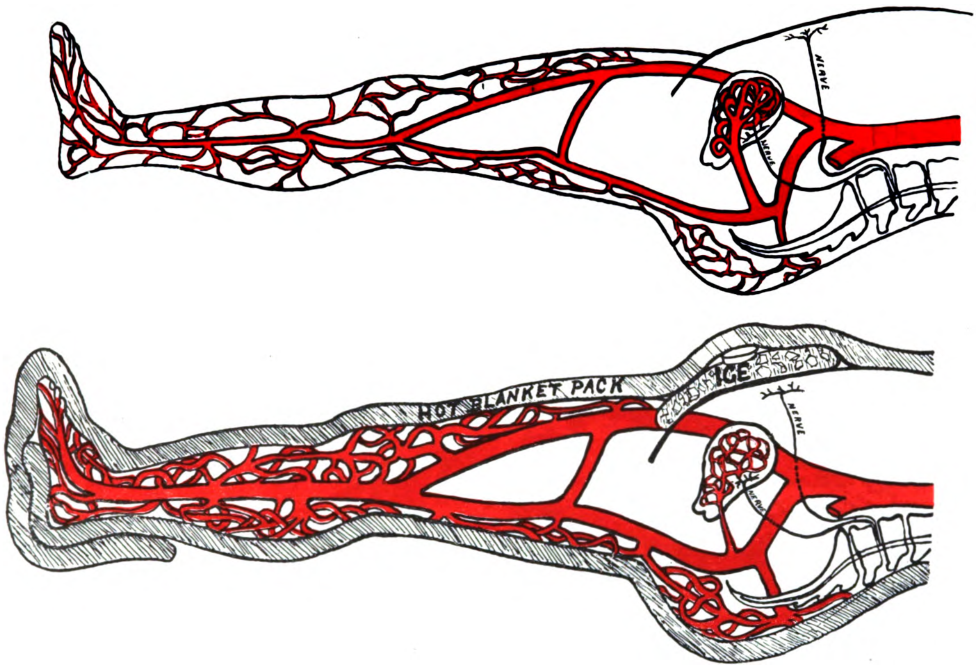


PLATE X. Depletion by simultaneous heat and cold. Upper figure shows a congested uterus. Lower figure shows depletion of the uterus secured by the harmonious action of an ice bag acting reflexly, and a hot hip and leg pack acting hydrostatically (derivation).

Methods of Securing Depletion

Application	Where Placed	Mode of Action	Examples of Use
Heat alone	Collateral—over part or at a distance	Derivation	Pleurisy Renal congestion
Cold alone	Proximal or directly over part	Direct or reflex	Acute rheumatism, infectious arthritis
Heat and cold simultaneously	Cold over part or proximal Heat collateral	Reflex Derivation	Acute appendicitis Acute salpingitis

Simultaneous Heat and Cold. Depletion is most effectually secured by the simultaneous application of both heat and cold in the following manner (*Plate X.*): A large very hot application is made to a distant part; in many cases, it extends up to and includes the congested part. At the same time an ice bag, ice pack, or ice compress is placed directly over the inflamed organ. In this way collateral hyperemia is secured and the local anemia reenforced by the direct or reflex vasoconstricting influence of the ice. The local anemia is made extreme by both a "push" and a "pull" effect on the circulation, the "pull" being secured by the *vis a fronte* of the hot application, and the "push" by the *vis a tergo* of the reflex contraction of the blood-vessels, due to the cold application over the part. The most effective derivation is secured by *direct* contact of the body with hot water. A hot leg bath is more effective than a hot leg pack, and a hot leg pack with the wet blanket applied directly to the skin is more effective than where a dry blanket intervenes. Neither the local hot air bath or the local electric light bath (or either as a general application) are as effective as a hot pack or a local hot bath. The reason for this difference is found in the fact that the blood-vessels dilate to a much greater extent under the action of hot water applied directly to the skin surface. The hot air bath and the electric light bath may produce more profuse perspiration, but the blood-vessels do not dilate to the same degree possible under the action of hot water. However, in the case of a very hot full tub bath and a hot blanket pack, the surface derivation is so extreme in the former case as to cause fainting when it is first entered, with congestion of the brain later on because of the general rise in blood pressure. For this reason, the full tub bath for *extreme* derivation is not a practical application, and in practice we use the hot blanket pack with the continuous application of ice to the head and neck and also to the heart if necessary.

The following are the principal derivative measures indicated in the acute stage of the diseases mentioned:—

1. Appendicitis. Hot hip and leg pack, with ice bag over the appendix.

2. Peritonitis. Hot hip and leg pack, or leg pack only, with ice compress or ice bags to the abdomen.

3. Puerperal Infection and Acute Salpingitis. Full hot blanket pack, or hip and leg pack, with ice to the pelvis.

4. Acute Congestion of the Lungs. Hot leg bath, hip and leg pack, or full blanket pack, with or without cracked ice compress over the lobe affected.

5. Meningitis. Hot leg pack, with ice cravat, ice cap and ice bag to the base of the brain and the upper spine.

6. Mastoiditis. Hot leg bath with ice cravat or ice bag over carotid artery, ice cap, and fomentations to the mastoid.

7. Alveolar Abscess. Same as above, except fomentations to the jaw.

8. Acute Osteomyelitis (of tibia). Fomentations to leg, or leg pack, with ice over the femoral artery.

9. Cerebral Congestion. Hot leg bath with ice cravat, ice cap, or cold compress to the entire face and cranium.

10. Renal Congestion. Fomentations to back; hot trunk pack or full blanket pack, with ice bag over lower third of sternum.

Precautions: In order to maintain collateral hyperemia, the treatment must be concluded with such a vigorous tonic measure as a cold mitten friction applied to the part previously covered by the hot application. The hot application alone produces passive dilatation of the blood-vessels. If the treatment is stopped here, the circulation will soon equalize itself, or even a worse internal congestion may occur. The cold mitten friction, however, produces an active dilatation (alternate dilatation and contraction) of the blood-vessels, thus maintaining for a longer time the derivation secured by the hot.

Depletion by Heat Alone. In some cases sufficient blood can be withdrawn from a part by applying heat over the cutaneous branches coming from the artery supplying the deeper congested part or organ. In this case the larger flow of blood is diverted into the cutaneous (and superficial) branches, leaving less to pass to the deeper branches. Examples of this are found in the treatment of,—

1. PLEURISY. Large fomentations to the chest divert the blood flowing in the intercostal and internal mammary arteries from the pleural branches to the posterior, lateral, and anterior cutaneous branches.

2 RENAL CONGESTION. Large fomentations over the lower dorsal and lumbar spine the entire width of the back. This diverts the blood from the renal arteries to the lower intercostal and lateral lumbar branches of the aorta.

3. SIMPLE SPINAL CONGESTION. Large fomentations to the spine divert the blood from the spinal arteries to the posterior cutaneous arteries supplying the skin and muscles of the back.

4. CONGESTIVE SCIATICA. Large fomentations to back and side of thigh divert the blood from the nerve to the skin.

5. TRIGEMINAL NEURALGIA. Fomentations to side of face divert the blood to the skin. This may be reenforced by the use of an ice bag over the carotid, thus mechanically lessening the total volume of blood going to the head.

Precautions: In pleurisy and neuralgia, cold increases the pain, hence can not be used over the seat of the pain.

Depletion by Cold Alone. In a few conditions a congestion or inflammation may be sufficiently reduced by the use of ice or other cold application applied directly over the part or over the artery supplying the part, without the addition of collateral heat. In acute articular rheumatism and other acute infectious arthritides this method is most effective, in fact in our experience, almost specific. In some cases of brain congestion ice over the carotids and cold applications to the head and face are all that is needed. In the early stage a boil may be aborted by applying an ice bag directly over the seat of the infection.

FLUXION

When hot and cold applications are used to secure *depletion*, they are used *simultaneously* and to *different areas*. If the hot and cold are used *alternately* and to the *same area*, the result is *fluxion*. This may be either by direct effect in the part treated, or by reflex action in a related part. This effect is intensified by friction or percussion.

All alternate hot and cold applications are tonic, both locally and generally. We may here, for the sake of clearness and brevity, confine ourselves to the consideration of measures desired to produce chiefly violent circulatory reaction in a given part or organ.

The following are the principal means used to produce fluxion:—

1. Alternate hot and cold, using fomentations and ice, or fomentations and cold compresses (revulsive compress).
2. Alternate hot and cold douches or sprays, as to spine, legs, liver, etc.
3. Alternate hot and cold packs.
4. Alternate hot and cold, as to head or kidneys and sternum.
5. Revulsive or alternate hot and cold sitz bath.
6. Alternate hot and cold foot or leg bath.
7. Alternate hot and cold immersion, as of hand and arm.
8. Alternate hot and cold vaginal douche, rectal irrigation, etc.

In all the above measures, the condition produced is that of active (arterial) hyperemia. The alternate dilatation and contraction of the blood-vessels is stimulated. This condition is known as *active dilatation*. These alternating changes of vasoconstriction and vasodilatation are more rapid and extreme than the normal. They very markedly increase the number of white blood cells in a given part, and consequently the resulting phagocytosis. It is this which makes it especially valuable, and almost indispensable in some acute congestions and inflammations, such as an acute infection of a hand or a foot, where lymphangitis and lymphadenitis are likely to follow so quickly.

Perhaps the largest field for the use of fluxion (arterial hyperemia) is in chronic congestions, whether a sequel to chronic infections or non-inflammatory. In these cases the congestion is of a passive type, *i. e.*, venous stasis. The treatment is also indicated in local anemias.

Below are given some of the more important indications for the use of fluxion:—

1. Acute infections, as of hand, arm, or foot.
2. Convalescence from all local infections (stage of passive or venous congestion).
3. Chronic congestion of liver.
4. Chronic pelvic congestion, as of uterus or adnexa, whether simple or following infections.
5. Uterine subinvolution.
6. Amenorrhea.
7. Myelitis (chronic stage).
8. Locomotor ataxia and other paralyses of spinal origin (in chronic stage).
9. Alcoholic neuritis (after acute stage).
10. Muscular atrophies.
11. Tubercular arthritis and synovitis.
12. Chronic osteomyelitis.
13. Varicose ulcer.

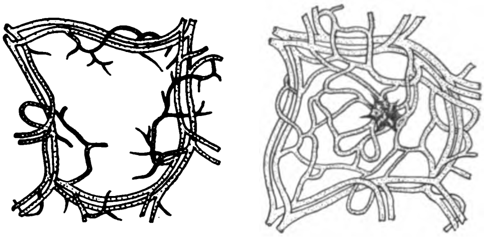
Precautions: In acute infections, massage effects, such as friction or percussion, should be avoided. Dire effects in the quick spread of the bacteria to other parts, will result if these are used.

Revulsion. According to Dorland, this term is synonomous with derivation and depletion. Kellogg evidently uses it to designate the mode of giving a hot and cold application, the chief effect of which is fluxion, for example, a revulsive compress—a treatment consisting of a single prolonged hot application, followed by a single very brief application of cold.

Again it is used to designate derivation secured by collateral fluxion, as in the use of the hot and cold foot or leg bath, or a hot and cold percussion douche to the feet and legs to relieve cerebral congestion. When hot and cold are alternately applied to one part of the body, thus producing fluxion in that part, it will withdraw more or less blood from other related or distant parts. This diverse application of the term has led to no little confusion. While the term can not be fully dispensed with, the student should bear in mind that the effect is that of either derivation or fluxion.

PATHOGENESIS OF INFLAMMATION

"Inflammation consists of the series of changes constituting the local manifestation of the attempt at repair of actual or referred injury to a part, or briefly, it is the local attempt



A B

Fig. 50. A—arterioles and capillaries, normal. B—the same after introduction of an irritant foreign body and the beginning of inflammation.

at repair of actual or referred injury. Inflammation is the reaction of irritated and damaged tissues which still retain vitality."[1].

The pathologic conditions in an inflammatory process may be partially understood by the five cardinal symptoms, *viz.*,—

1. Rubor—redness.
2. Tumor—swelling.
3. Calor—heat.
4. Dolor—pain.
5. Functio læsa—loss of function.

The primary cause of the inflammation, whatever it may be, is responsible for these conditions, which are largely circulatory disturbances. The condition in the *acute stage* is one of (1) arterial hyperemia (*Fig. 50.*) with (2) a serous exudate,

1 Adami—Inflammation, pp. 5, 227.

and (3) an increasing number of leucocytes in the blood stream and tissues; from the latter, they return to the blood stream less rapidly than normal. (4) The inflamed part is bright red. (5) The pain is severe and often throbbing in character because of the increasing tension on the nerves caused by the swelling.[2]

In the *chronic stage*, the condition is one of (1) venous congestion (passive hyperemia). (2) There is a beginning organization of the exudate, and (3) a dearth of leucocytes. (4) The part is of a dark red or bluish color. (5) The pain is less severe, and described as dull and heavy in character. In the intermediate stages, the inflammatory process passes gradually from the first to the last condition. The circulation begins to be slowed, and more and more blood accumulates in the capillaries and veins, less arterial blood being present, so that the total amount of blood in the organ is increased above normal. The severe or throbbing pain gives way to the more constant, but less severe, dull pain. The leucocytes find their way back into the circulation (lymphatic or blood) if no suppuration occurs, and the number in the tissue decreases.

PRINCIPLES OF TREATMENT

In the Acute Stage. (1) Limit the congestion, (2) hasten the absorption of the exudate and prevent further exudation, (3) energize and assist the phagocytes in combating the infection or noxious agent, (4) relieve the pain. While inflammation is a protective process, it must not be supposed that it is always well regulated, or able, unassisted, to cope with the disturbing cause.

The serous exudate of this stage consists of a more concentrate lymph than normal, *i. e.*, a lymph containing more proteins, which doubtless serve for the nutrition of the cells necessary in the regeneration of tissue which follows.[3] It is necessary only to limit this to a proper amount and hasten its return to the blood and lymph vessels when its work is done. This means the restoration of the proper rate of exudation and absorption and is applicable to the leucocytes as well as the fluids.

2 For the details of the process, see Adami—Inflammation, pp. 34—36.
3 Starling—Fluids of the Body, p. 174.

In the Chronic Stage. (1) Stimulate and quicken the circulation by the production of arterial hyperemia, and (2) stimulate the process of phagocytosis, thus (3) promoting resolution and absorption of the exudate and thereby preventing its organization.

In the acute stage of an inflammation, *i. e.*, during the first few hours or first day or two, extreme cold should be used over the part continuously, or with only short intermissions, in order to lessen the congestion, relieve the pain, and, if possible, thereby abort the inflammation. In many cases it is necessary to reenforce the continuous cold by hot applications to collateral areas (derivation) in order to effectually reduce the congestion. The cold energizes the white blood cells, increasing their number and efficiency in the destruction of bacteria, and hastens their return to the blood stream.

After the acute stage has passed, *i. e.*, at the end of a few hours, or on the second day, the cold applications should be replaced by a heating compress; or, if cold compresses were used in the first stage, it is only necessary to leave them on, thus making a heating compress. These cold and heating compresses should be replaced at intervals of one to three hours, using short fomentations when the change is made.

As the inflammation progresses *toward* the chronic stage, more heat and less cold should be used. After the acuteness of the inflammation has entirely subsided, the most vigorous hot and cold applications should be used in order to lessen venous stasis and bring to the organ a greater supply of fresh blood (fluxion), for the time producing an arterial hyperemia. It is possible to use fluxion even immediately following the first few hours of some inflammations, provided they are not in a dangerous area, *i. e.*, where rupture would prove fatal or produce serious complications.

It has been shown that in some cases the maintenance of a high external temperature is conducive to a more rapid and benign course of the inflammation than where cold is used. These are doubtless cases of inadequate reaction as suggested by Adami,[4] better results being due to the increased amount of

4 Inflammation, pp. 199, 218.

blood brought to the part. In the majority of cases still greater benefit results from the use of alternate hot and cold applications, since these produce an arterial hyperemia which has no after-tendency to stasis.

The stage of the inflammation may best be judged by the color. A bright red color is evidence of an acute process, and a dull red, dusky, or bluish color, of a chronic process. Inflammations in certain localities should be treated by hot alone, until after the first stage is passed. This is true of pleurisy.

"For antiphlogistic purposes, it may be safely held that in the early stage of congestion, cold applications are useful so long as the circulation in the affected part is still open, which is indicated by the turgor. But when the parts assume a cyanotic hue, when leucocytes have begun to adhere in large numbers to the vessel wall and emigration has become active, applications of warmth further the latter and hasten suppuration when it is unavoidable. The cold compress diminishes congestion, retards leucocytosis and emigration of white cells, while the warm applications have the contrary effect, each being most useful in the respective stage of inflammation.

"The antiphlogistic effects of cold compresses are readily explained by the results of Genzmer's experiments upon local blood letting. He came to the conclusion that the favorable effect of bleeding upon the inflamed parts beneath was ascribable, not to their becoming more anemic, but to the fact that the blood stream became more rapid, and thus the corpuscles which had adhered to the vessel walls were loosened and driven into the general circulation. The fluxion, therefore, which the application of cold or warm compresses produces, in the parts below them, is the true cause of the changes in the latter when inflamed. Thus may the old theory of derivation be satisfactorily explained.

"This effect of cold applications may be called into action in some local inflammations in which the parts appear cyanotic and it is important to prevent impending suppuration. Here hot compresses or cataplasms are also useful to arouse the surface circulation; as they cool off, they widen the deeper vessels and thus reestablish the circulation which has become stagnant. This being accomplished, cold compresses may succeed the hot, in order to limit leucocytosis and, by fluxion, remove stagnant corpuscles. It is evident that by the exercise of sound judgment, the proper temperature of the compress may be nicely adjusted to each case."[5]

It must not be supposed that circulatory changes are the only effects produced by the treatment outlined above. Proper regulation of the circulation by means of heat and cold also stimulates the cells concerned in the healing process.

From the above, we may draw the following conclusions, as in general, applicable to inflammations. During the acute stage, the treatment should be directed toward the reducing of the congestion, whether by collateral heat alone, or by heat assisted by cold over the part, or by cold alone. The philosophy of the treatment is summed up in the word *depletion*, as understood in its broadest and practical sense, *i. e.*, the reducing of congestion. In the chronic stage, all the pathologic indications are met by the production of *fluxion*. The accompanying outline will serve to make clear these principles:—

Acute Stage

Conditions	Indications for Treatment	Treatment Should Produce
1. Arterial hyperemia	Limit congestion	*Depletion*
2. Increasing serous exudate	Cause absorption of exudate	(Reducing of congestion)
3. Overplus of leucocytes	Energize leucocytes	
4. Bright red color		
5. Pain severe and throbbing	Relieve pain	

Chronic Stage

Conditions	Indications for Treatment	Treatment Should Produce
1. Passive hyperemia	Stimulate circulation	*Fluxion*
2. Organization of exudate	Promote resolution	(Production of arterial hyperemia.)
3. Dearth of leucocytes	Stimulate leucocytosis	
4. Dark red, dusky or bluish color		
5. Pain less severe and dull		

5 Baruch—Principles and Practice of Hydrotherapy, pp. 154, 155.

We have already referred to Bier's hyperemic treatment of inflammation. The form of hyperemia upon which Bier places the greatest emphasis and which he lauds most highly is the passive hyperemia produced by lightly constricting bands, suction cups, etc. These partially obstruct the return flow of venous blood, so producing a stasis in the part.[6] The writer can see no rational basis for this procedure; in fact, to us, it appears decidedly irrational and to in no way meet the needs of a chronic inflammation. In chronic inflammation there is already an extreme venous stasis. To still further slow the blood current, certainly does not tend toward a normal condition.[7] The leucocytes are neither renewed, increased, or energized. The blood, already overcharged with acid products, is in no way restored to its normal degree of alkalinity. On the contrary, the production of active hyperemia meets all these needs as pointed out above.

Meyer recognizes only three methods of producing hyperemia; *viz.*, by elastic bandages, cupping glasses, and hot air.[8] Of these only the hot air produces an active hyperemia, and while it is exceedingly useful in many cases, it does *not* produce the most ideal vascular condition for the relief of chronic inflammations since the blood-vessels are passively dilated with consequent stasis afterward. The active hyperemia continues only during the treatment and for a very short time after the application of the hot air.

While the ice bag over an inflamed part, accompanied by collateral heat for derivative purposes, effectually relieves the pain of an inflammatory process in soft tissue, it will not relieve the pain of a bony inflammation. To decrease the congestion and relieve the pain of an osteomyelitis or mastoiditis

6 If it be argued that the elastic bandage should be so lightly applied as to produce no retardation of the blood flow or any duskiness of the skin, then we may ask how it has produced any change whatsoever, for it certainly could not hasten the circulation. Such a method for the sustaining of a therapeutic hypothesis is closely akin to the homeopathic dogma of increasing potentiality from infinite dilution.

7 There is only one organ in which passive congestion, i. e., the retarding of the blood current can possibly result in an "arterial" hyperemia. This organ is the lung. In the nature of the case any retarding of the outflow of the blood from the lungs only results in increasing the amount of their oxygenated blood. This fact probably accounts for the relative infrequency of pulmonary tuberculosis accompanying valvular heart disease.

8 Meyer and Schmieden—Bier's Hyperemic Treatment, 1909, p. 23.

most effectually, the ice bag must be placed over the trunk of the large artery supplying the inflamed part and not over the part itself, while heat is applied directly to the inflamed part. Ice applied over an inflammation confined in bony walls usually increases the pain, while heat decreases it. Neither will the ice bag or cold compress relieve the pain of an *abscess* even in soft tissue, or only to a slight degree, lasting only while the treatment continues. This very fact is of diagnostic importance. It is presumptive evidence that the inflammation has gone on to suppuration and must be opened. It should then be treated by hot applications to hasten the process and localize the abscess preparatory to drainage.

Not infrequently in the use of physiologic therapy the symptomatic response to a given measure is of material help in diagnosis. This may be either in differential diagnosis, as in the case of the diagnostic bath in typhoid fever or in suggesting the location or stage of a pathologic process as in the cases just cited.

CHAPTER XIX

THE TREATMENT OF INFLAMMATIONS

INFLAMMATIONS OF THE EYE

Iritis, Keratitis, Conjunctivitis, Dachryocystitis, Ophthalmia

BECAUSE of the situation, it is necessary to use more cold than heat in treating these inflammations, since long hot applications to the head produce cerebral congestion. The cold application may be made by means of compresses of four to six thicknesses of gauze wrung out of ice water or kept on a block of ice. The compresses should be applied almost continuously, being renewed as frequently as warmed, which means every two or three minutes. A more convenient and satisfactory method of applying continuous cold, and one which saves much time, is the ice water coil. This is a coil about three inches in diameter (*Fig. 51.*). It is made of very small rubber tubing with a lumen of about 2 mm. Ice water should be kept in the irrigating can and pieces of ice in the receptacle for the outflow so that the irrigating can may be filled from the outflow as soon as empty. It may be necessary to use a hot gauze compress occasionally, often enough to renew the reactive ability and make the cold comfortable and acceptable to the patient. Brief applications of the fomentation may be used over the side of the face to secure derivation, or, with a small piece of ice wrapped in gauze applied over the eye itself, a larger fomentation may be applied so as to cover the eye, forehead, and cheek. In all cases, the hot applications should be of short duration. After the acuteness of the inflammation subsides, small gauze fomentations may be used alternately with the cold compress, the heat being used for a shorter time than the cold. It is usually necessary to renew the compresses about every two minutes. The results are apparent in the relief of the congestion, inflammation, and pain. In ecchymoses about the eye the revulsive compress should be used.

In the inflammations mentioned above, the appropriate antiseptic treatment, the use of silver salts, etc., should be followed

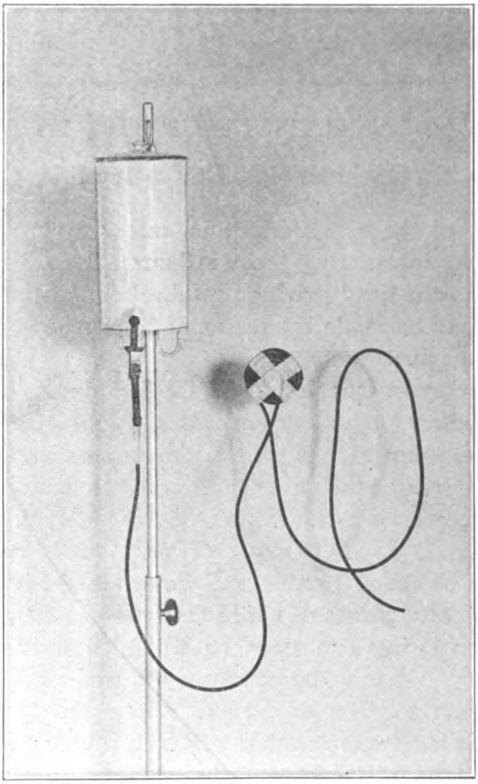


Fig. 51. Apparatus for treating inflammations of the eye.

just as carefully as otherwise, and in iritis dilatation of the pupil should be secured by means of atropine. The ice water coil should also be applied to the eye after operation for tracoma.

Glaucoma, Toxic Amblyopia

Localized disturbances in the eye dependent upon systemic diseases may be greatly benefited by hydrotherapeutic treatment. In glaucoma the following treatment gives relief by reducing the vascular tension. For a period of about thirty minutes give a hot foot bath or hot leg bath together with ice bags over the carotids or apply the ice cravat. Conclude the treatment by a vigorous cold mitten friction to the legs or the alternate hot and cold percussion douche to the feet, keeping the ice over the carotids until its completion. During the period of highest tension full hot baths and other heavy sweating treatments must be discarded.

In toxic amblyopias, such as tobacco blindness and similar affections, sweating treatments combined with tonic measures are indispensable. The bowels should be kept open by enemata, abdominal massage and a laxative diet, especially by the use of fruit. An occasional saline cathartic may be necessary.

ERYSIPELAS

After discussing the antiseptic treatment of erysipelas, Osler says, "Perhaps as good an application as any is cold water, which was highly recommended by Hippocrates." During the first few hours, the ice bag should be used continuously over the topical application. The ice bag is used throughout this disease more than in other inflammations, since new parts are progressively involved and the advancing border is therefore in the acute stage. An occasional fomentation may be necessary to renew the reactive capacity of the tissues. In the case of meningeal involvement, or deep inflammation, strong derivative means should be used, as a hip and leg pack with the ice cap over the affected part. The latter should be continued with but little interruption. Hot applications to the head only tend to increase the deep congestion. In the case of erysipelas migrans, very hot fomentations, or alternately applied extreme hot and cold, give the best results. These should not be used on the head or face, or about the neck. The migratory form usually affects the skin of the trunk or limbs.

OTITIS MEDIA—ACUTE SUPPURATIVE

These cases rarely present themselves early enough to abort the formation of pus unless they come on the first indication of the closure of the Eustachian tube. The pain of catarrhal otitis and aural neuralgias is best relieved by fomentations. After hot treatment, the patient should be unusually careful, since he is rendered more susceptible to colds. If it seems probable that rupture of the drum may be prevented, or while waiting to do paracentesis tympani, the following treatment may be used: Direct the patient to take a hot foot bath, or better, a leg bath, with fomentations over the ear and side of the face, cold compresses being used to the neck and opposite side of the head. In adults the ice cravat, or ice bag to the carotid of the same side may be used. This derivation will reduce the congestion and partially, or entirely, relieve the pain. It may also lessen the liability to rupture of the drum.

Otherwise, the condition should be treated according to plans outlined in any standard text on diseases of the ear. The use of hot air deserves mention as a most efficient means in both acute and chronic suppurative otitis media.

ACUTE MASTOIDITIS

Those cases which tend toward recovery, that is, where the inflammation does not go beyond turgescence and congestion of the lining membrane of the mastoid cells, may be aided to an uneventful recovery by the use of fomentations to the mastoid, dry heat, and derivation. In infants and younger children, the Leiter coil with ice water or the ice bag may be used over the mastoid. At this age mastoid periostitis is very common, which condition is always benefited by the cold coil. In older children and adults we have not been able to use cold over the mastoid because of the pain occasioned by it.

In many cases the pain may be relieved by strong derivative means, as a very hot leg bath and fomentations to the mastoid, with the ice cravat or an ice bag to the carotid of the same side. This should be continued from twenty or thirty minutes to an hour and finished with a vigorous cold mitten friction to the limbs and trunk. We have found this plan very successful in obviating the necessity for large doses of hypnotic drugs in those cases which refuse operation, or while preparations are being made for surgical interference.

ALVEOLAR ABSCESS

This condition should be treated on precisely the same principles as mastoiditis, always bearing in mind that the cure lies in securing drainage as promptly as possible.

SIMPLE PHARYNGITIS

The soreness of the throat is most effectually relieved by large fomentations to the throat, coming well up under the jaw and back to the ears. If there is much fever, a mild sweating treatment will be beneficial at the beginning. This may be accomplished by a hot foot bath with the fomentation to the throat, or an electric light bath. The treatment should be concluded with a cold mitten friction, and a heating compress applied to the throat to be left over night. The next day, use the hot foot bath and revulsive compress to the throat. Each hot treatment should be concluded with some tonic measure, such as the cold mitten friction, cold towel rub, graduated or hot and cold spray. It may be necessary to repeat the hot foot bath and revulsive compress two or three times a day, always leaving the heating compress in place between treatments and over night. This latter measure is more important than any other in the treatment of sore throat. The inhalation of steam and gargling of hot water will aid in relieving the pain. Ordinary antiseptic throat gargles in hot water should also be used.

ACUTE TONSILLITIS

The temperature is usually very high, but of a transient type. It is unnecessary to employ antipyretic measures. In fact, general applications of cold are quite likely to produce chilling. At the beginning of treatment, the patient should be given some sweating measure, such as a hot leg pack, full blanket pack, or hot leg bath with fomentations to the throat and ice compress or ice cap to the top and sides of the head. Because of the rapid pulse and extreme prostration, an ice bag should be applied to the heart. The patient may be taken out with a cold mitten friction, or, if able to stand, a graduated shower. A well covered heating compress should be applied to the neck. After the initial treatment, fomentations or the revulsive compress should be applied to the neck at frequent intervals, always following them by the heating compress. In perhaps the majority of cases and always in severe tonsillitis with high fever, it is better to apply ice bags over the tonsillar area at the sides of the neck. These will also cover the carotid arteries and may be kept on almost continuously. Throughout the disease, very vigorous tonic treatment may be employed. The cold mitten friction, or cold towel rub, wet sheet pack, etc., have been found useful in maintaining the vitality of the patient.

In case of quinsy, the paratonsillar abscess should be lanced at the proper time. Previous to this, fomentations frequently repeated will aid in hastening suppuration, localizing the abscess and making more apparent the pointing. Occasionally in those subject to attacks of quinsy, the early and continuous use of the ice bag may prevent abscess formation.

BOILS AND CARBUNCLES

In the beginning, while the boil is only a pimple, it may be aborted by the prolonged use of ice over it, with a fomentation covering it and a larger area, applied at the same time. The use of extreme hot and cold applications, alternately applied (fluxion), is also an advantage. When it is no longer possible to stop the progress of the boil, fomentations, poultices, heating compresses, etc., may be used to relieve the pain and hasten the localization of the pus. It should then be lanced. The absorption of the indurated residue about the boil may be hastened by hot and cold applications, such as fomentations and ice or the alternate hot and cold pour. Pressure about the boil, or friction to the skin should be avoided, as these measures tend to spreading of the bacteria and the infection of other areas.

ACUTE BLOOD POISONING

Septicemia of Hand, Foot, Etc. These infections are usually occasioned by scratches, cuts, bruises, thorns, etc. While the initial lesion may seem to be trivial, serious results follow very quickly. For this reason, blood poisoning should be treated most vigorously. The object to be accomplished is the increasing of phagocytosis and so increasing the circulation as to rapidly renew the blood flowing through the infected part. When first seen by the physician, the inflammation has usually gone beyond the primary stage. In the case of the hand, the part is very much swollen, blue, and edematous. Extension of the infection is indicated by red lines (lymphangitis) extending upward, and by swelling and tenderness of the regional lymphatics. When this occurs, most prompt and vigorous measures are necessary. The following treatment, if applied reasonably early, has, in the writer's experience, never failed of success:—

Provide two pails, foot tubs, or other receptacles, sufficiently large to immerse the infected part. (*Plate XI.*). One of these should be filled with the hottest water that can be borne, more being added from time to time to the limit of toleration. The other pail should be filled with ice water, containing pieces of ice. The patient is instructed to immerse the part in the hot water for two minutes, then in the cold for fifteen to thirty seconds, after which it is returned to the hot water again for one and one-half or two minutes, then reimmersed in the cold for fifteen to thirty seconds. These changes are kept up for at least half an hour and repeated from two to four or five times a day, according to the seriousness of the infection. If thought best, disinfectants may be added to both the hot and cold water. We have used crystals of potassium permanganate in one and oxalic acid crystals in the other.

It may be necessary to lance the part if there are signs of suppuration. This should be done anyway if the infection has stood some time without treatment, or if extreme swelling and edema exist. In the latter case, multiple openings may be necessary. Massage should be avoided altogether, as it spreads the bacteria along the lymph channels.

Cases treated as outlined above require only a few days for a complete cure, while cases treated by poulticing, antiseptics, incisions, without hydrotherapy, usually run a course of from, ten days to a month, or even longer. Some cases of gangrene are successfully treated by this method. The appearance of the line of demarkation may be hastened by the use of alternate hot and cold applications.

Chronic cases of osteomyelitis, with much riddling of the bone and soft parts, with sinuses, sequestrum formation, etc., are successfully treated along the same lines. The use of von Mosetig's bone-wax followed by the alternate hot and cold pour, applied daily, gives good results.

POISON IVY AND OAK

These inflammations require some active antiseptic treatment. In the earlier stages, continuous cold compresses, or the ice bag may be used with benefit. Later on, vigorous hot and cold compresses, pours, or sprays give the best results. This latter means has proven of inestimable value in long-standing, refractory cases.

PNEUMONIA

Pneumonia is an acute, self-limited infectious disease characterized by a general toxemia and, pathologically, by a definite series of changes in the lungs. The first stage is that of intense pulmonary congestion. In the second stage, there is exudation into the alveoli, so that the affected lobe becomes consolidated, the condition being known as red hepatization. The third stage—gray hepatization—is marked by the changes accompanying resolution. The clinical feature of the crisis marks the transition from the second to the third stage and the beginning of resolution. Clinically, the following symptoms are prominent: pain in the chest, dyspnœa, with rapid respiration, more or less cyanosis, and cough accompanied by the expectoration of "prune-juice" or "rusty" sputum. Pneumonia runs a short course and, if the resistance of the patient is sufficient, antitoxines are produced quite rapidly, so that the progress of the infection is arrested. It should be recognized that pneumonia is a general infection, much like typhoid, and therefore demands systemic treatment.

The greatest danger in pneumonia arises from two causes principally,— (1) deficient aeration of the blood and (2) failure of the circulation. The air hunger is manifest by the rapid respiration, dyspnœa, and cyanosis. In all febrile conditions there is, on the part of the tissues, a lessened capacity for the absorption of oxygen. In pneumonia, beside this, the lung

PLATE XI. Alternate hot and cold immersion for infection of the hand.

area for gaseous interchange is very much limited because of the consolidation. The stasis of the blood in the lungs tends to increase the difficulty. The right heart is particularly embarrassed because of the lung consolidation and the pulmonary stasis. It has difficulty in forcing a sufficient amount of blood through the lungs to provide the tissues with the proper amount of oxygen. There is increased pressure in the right ventricle, as evidenced by the accentuated second pulmonic sound. The absence of this sign is one of the evidences of failure of the right heart and dilatation of the right ventricle.

In those cases due to alcohol, the blood-vessels are in a state of passive dilatation from paresis of the vasomotors. Both the capillary vessels of the lungs and those of the general periphery are in this condition. It is because of this paretic condition of the vessels and the failure of the narcotized cutaneous nerves to appreciate the danger from cold that retrostasis is so likely to occur. Pneumonia is especially fatal in alcoholics. There should be a high leucocytosis. The absence of this is one of the unfavorable signs.

From the foregoing, we may select four indications of prime importance in the treatment of pneumonia. 1. Increase the aeration of the blood. 2. Sustain the heart and circulation. 3. Increase leucocytosis and phagocytosis in order to combat the infection. 4. Decrease toxemia.

Treatment

Pneumonia as such does not exist until the stage of exudation and consolidation. The pulmonary congestion, however intense, does not constitute pneumonia, although if pneumococci are present, it is quite likely to end in consolidation. It is impossible to abort pneumonia after the exudation has occurred, although it is possible, by strong derivative means, to reduce even a very intense pulmonary congestion. The presence of numerous crepitant rales is not, in itself, evidence of consolidation. The rales, together with rapid respiration, pain, and fever, may be present in the stage of congestion before exudation has occurred. If treatment can be begun very early, even though there is no positive assurance that the condition is not more than a congestion, it is best to employ some derivative or sweating treatment in order to reduce as much as possible the pulmonary congestion. The collateral heat may be either a very hot leg bath, a hot hip and leg pack, or full blanket pack. The latter will be best if the patient is very chilly. These measures should be reenforced by the drinking of some hot liquid to produce perspiration and thus aid in reducing the internal congestion. In applying the cold to the chest, it must be borne in mind that the lobes affected are usually the lower lobes and present the greater surface at the sides and back of the chest. Over this area may be used a very large ice cap or ice pack. This should not be placed until the patient is well warmed, since otherwise it may produce chilliness. The collateral heat and local cold should be continued until effectual derivation is secured. If this requires a very long time, the pack must be reenforced by hot water bottles, bricks, etc., and the cold over the affected lobe replaced for a short time by a very hot fomentation to renew the nerve sensibility and promote the vigor of the reflex effect from the cold. It is well to use the ice bag over the heart if the pulse is very rapid. Treatment may be concluded with a cold mitten friction. A very short fomentation may be applied to the chest, followed by a heating compress or a moist chest pack which should be left in place until the next treatment.

The supplying of plenty of *fresh cold air* is of prime importance. It has been stated that, during the late war, cases of pneumonia treated in tents in the most rigorous weather did far better than those treated in hospital buildings. The open air treatment as carried out in some hospitals has greatly reduced the mortality. The laity fear the effects of cold air in this disease, believing that the patient is likely to take cold and so the pneumonia be made worse. Persons with fever are not likely to suffer from an "overdose" of cold air. For the reason stated above, it is very necessary that the lungs be supplied with the greatest possible amount of pure fresh air. Neither should the air be warmed. The depth of respiration is stimulated by the cold. All the cold treatments given in the hydriatic management of pneumonia increase the depth of respiration and so enable the body to make use of the oxygen supplied by the fresh air. This is true of the cold compress, the heating compress, the ice pack and cold rubs and frictions. If it is not possible, because of the season, to obtain very cold air, much might be saved in the mortality by providing means of refrigerating the air supplied to the patient. The air may be supplied through a hood fitted into the opening made by raising the lower sash of any ordinary window (*Fig. 52.*). The other end of the hood should fit down over the head of the

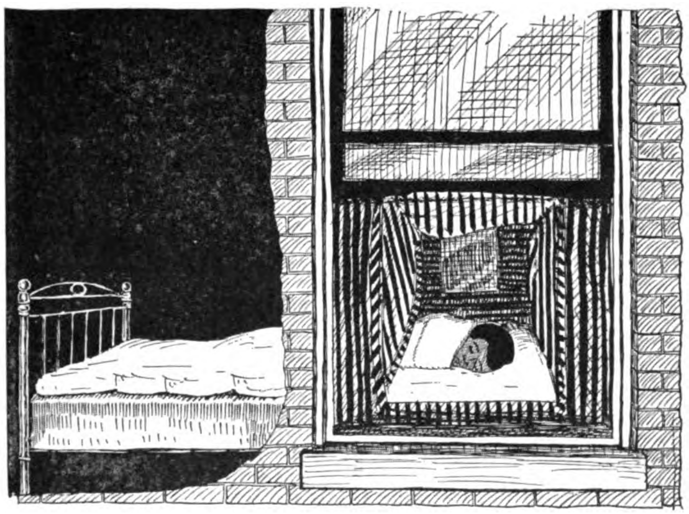


Fig. 52. The window tent for the fresh air treatment of fevers.

patient and can be tucked in about the pillow, coming no lower than just under the chin. This may be arranged with glass windows so as to obviate the necessity of removing the hood for observation of the patient, etc. Those who have lived in the Arctic regions, Labrador and other very cold climates, tell us that pneumonia and tuberculosis are rare diseases there and in some places almost unknown.

Relative to the beneficial effects of fresh air in febrile diseases, the following is related of Dr. Alonzo Clarke:—

It is interesting to read how he managed typhus fever in Bellevue Hospital. There were two hundred fifty cases constantly under his care, and as many more under the care of his colleagues. The mortality was great. Precautions against the draughts of air, for fear of pneumonia, were carefully adopted. Doctor Clarke, not having this dread, ordered that there should be the freest ventilation, with scrupulous cleanliness. Although it was winter, the windows were removed, stoves were placed before the open spaces to raise the temperature of the incoming air, clothing was increased, stimulants were given in moderate quantities, and other medicine mostly dispensed with. Of the two hundred fifty cases not a death occurred in the period of a fortnight. In two weeks they were convalescent. In other wards of the hospital where the management was unchanged, the mortality was undiminished.

Sir William Osler says,[1] "death is most frequently due to the action of the poisons on the vasomotor centers, with progressive lowering of the blood pressure." "An all important indication is *to support the circulation*. Hydrotherapy and keeping the patient out of doors are of great value for this."

The sustaining of the heart and circulation is best accomplished by judicious hydrotherapy. Romberg and Pässler have shown that the toxic albuminoid produced by the pneumococcus paralyzes the vasomotor center in the medulla, and Pässler regards this as the most common cause of death in pneumonia as far as the circulation is concerned. Vasomotor tonics are as essential in pneumonia as in other febrile diseases and the effect of hydrotherapy as a vasomotor stimulant is its most important asset in this disease. Hand in hand with this effect goes stimulation of respiration and of the heart itself. The cold compress to the chest is applicable in all cases. An ordinary linen towel or hand towel may be used for this purpose, two or three thicknesses of cloth usually being sufficient. It should be wrung from ice water and applied to the front and sides of the chest and covered with a flannel cloth. If desired to greatly stimulate respiration and the heart action, it should be frequently renewed. In ordinary cases, it may be left on fifteen, twenty, or thirty minutes at a time. While the patient is sleeping, or when it is desired to give rest, the compress

1 Principles and Practice of Medicine, Eighth Edition.

should be left on an hour or two. It then becomes a heating compress.

The square or roller chest pack is an excellent means of applying the principles of the heating compress. It has the advantage of the heating compress in that a greater area is treated and undue circulation of the air about the wet cloth more perfectly prevented. It should be left in place two or three hours, or may be put on and left over night, unless necessary to give other treatments.

In case of strong, vigorous men, it is possible to use with benefit the ice pack to the chest. The ice pack may be applied by means of several ice bags adjusted to cover the skin surface over the affected lobe, or it may be made by placing cracked ice in a Turkish towel and covering the whole with oiled silk or gossamer cloth so as to prevent wetting the clothing and bedding. These packs may be left in place almost continuously, applying every thirty minutes or every hour one or two short fomentations; and every three or four hours, replacing the pack by the heating compress, allowing the latter to remain thirty minutes or an hour. The ice pack should not be used where the patient is inclined to be chilly, or with thin patients and those of low vitality. Whenever it is used, the limbs should be kept warm by the use of hot water bottles. It is well also to give a hot foot bath or leg pack at intervals of five or six hours. The cold compress wrung from water at 50°—60° and applied to the chest every thirty minutes is better than the ice pack in most cases. It should be covered with flannel so as to become a heating compress before renewal. Such applications changed every hour are highly recommended by Osler.

The cold mitten friction and the cold towel rub are invaluable in aiding the circulation and sustaining the heart. It may be necessary where there is cold clammy perspiration, chilliness, or cyanosis, to precede the cold treatment by short fomentations applied to the limb or part just previous to the cold mitten friction. If the heart is very much embarrassed, it may be greatly relieved and the patient tided over a crisis by the use of short hot applications as just mentioned, and immediately succeeded by the cold mitten friction given until the skin is red and reaction complete. The part should then be very rapidly dried with a rough towel. Dry friction and percussion should follow in order to secure thorough reaction. There are two principles involved in this method,— first, the stimulation of the peripheral circulation so as to relieve the heart of its added burden; and second, because of the tonic dilatation of the surface vessels, there is produced a very decided and lasting derivation, so that the extreme engorgement of the heart and lungs is relieved.

A warm bath at 98° or 100° gradually cooled to 90° is highly recommended by some. The effect of this treatment may be very much increased by allowing the patient to remain just long enough to secure a thorough warming, cold applications to the head and heart being kept in place during this time. The patient then sits up while he receives to the chest, shoulders, and back two to four affusions of water at 90°. This stimulates respiration and increases the efficiency of expectoration. If such tub baths are to be used in pneumonia, it must be only in well selected cases and certainly only in mild cases without high fever or dyspnœa.

Some have very highly recommended the Brand bath in lobar pneumonia. We can see no advantage in this measure over the others mentioned and can readily understand that in many cases it might prove dangerous, as the heart and lungs are unable to withstand the retrostasis occasioned by the initial anemia of the skin, which follows contact with the cold water. In general, it may be said that full tub baths are *not* applicable in pneumonia.

Pain. The pain in pneumonia is due chiefly to the accompanying pleurisy. The inflammation is largely on the side of the visceral layer and so does not contraindicate the use of cold applications. Pain is perhaps best relieved by the use of fomentations. These should be large enough to cover an entire side of the chest and are more efficient when applied from spine to sternum with the patient lying on the opposite side. The chest pack or heating compress should follow the hot treatment.

Cough and Expectoration. All of the treatments recommended above are beneficial in aiding the expulsion of mucus. A severe cough may be relieved by the use of fomentations and the heating compress. Inhalations of steam are also beneficial. The revulsive compress is perhaps the most efficient means in stimulating expectoration. A large fomentation is first applied; as soon as the heat begins to subside, it should be replaced by a towel wrung from ice water. This should be left on until it has become slightly heated, perhaps one to three minutes. The part should be dried and the second fomentation applied. Three or four changes are usually sufficient to accomplish the desired result. A revulsive compress also stimulates the heart and increases the depth of respiration and the consequent aeration of the blood.

The patient should drink large quantities of water by taking it frequently in small amounts. This increases diuresis and the elimination of toxines. Either hot or cold water may be used according to indications. The bowels should be kept open by salines and enemata as needed. A very light diet low in proteid also aids in limiting the toxemia.

Medicinal Treatment

Quinine. So much has recently been written concerning the use of large doses of quinine in the treatment of pneumonia that no discussion of this disease would be complete without reference to its effects.

"It has been suggested that its efficiency in fever is due to an antiseptic action on the blood. This is not the case, since bacteria are very resistant to it and would not be affected by it in the concentration in which it could exist in the blood."[2] It does certainly reduce the temperature as we have previously noted, but this is not of prime importance in pneumonia. Antipyresis is of secondary importance, nor do patients bear great abstraction of heat, as is the case in typhoid fever. The temperature is lowered at the expense of the heart's action and oxygen-carrying capacity of the red blood cells. Both of these, it is necessary to sustain and enhance in pneumonia. Quinine limits leucocytosis and checks phagocytosis. If 20 to 30 grains are given daily, the disease is likely to run an atypical course,

2 Sollmann—Text Book of Pharmacology, p. 350.

there being no frank crisis, which is replaced by very much delayed resolution, the fever declining by lysis.

Moist rales may be heard in the chest long after resolution should be complete. One area will hardly more than clear up before another area is involved, so that by delayed resolution and reinvolvement of another area, the pathology assumes a sort of migratory type. Probably the reason for the failure in the appearance of the crisis is due to the fact that the sthenic condition has been reduced to an asthenia, the system lacking sufficient vitality to produce a normal crisis. Anyone who will take the trouble to "read up" on the effects of quinine will soon be convinced of its harmfulness in pneumonia. The caution sounded by Dr. W. C. Alvarez in a recent letter published in the Journal of the American Medical Association is certainly timely.[3] In a personal communication recieved from Doctor Alvarez, he states that among the many letters he recieved after the publishing of this communication to the journal, one came from a fellow practitioner who was much in favor of the quinine treatment, but had recently had, among a small series, seven bad cases of empyema. On the ordinary expectant plan, it should take two hundred to four hundred cases of pneumonia to furnish seven of empyema. The white blood cells were paralyzed by the quinine and so easily succumbed to the infection. Too much can not be said condemnatory of the quinine treatment of pneumonia.

Strychnine. This drug has been very much vaunted as a specific in meeting cardiac incompetency in pneumonia. Much to the discredit of the profession generally, a plan frequently followed is that of giving 1-60 grain of strychnine every three hours, this being kept up during the greater part of the illness. As some one has said, "continual doping with strychnine to the heart is like kicking a dying horse when he is down." As we have already shown, the results hoped for from strychnine are best attained by proper hydriatic means.

Frank Billings[4] says, "Strychnine and other drugs that are commonly used in failing left heart are absolutely valueless

3 Journal of American Medical Association, June 13, 1908, p. 1996.
4 Ibid, October 30, 1909, p. 1453.

except to stimulate nerve centers: strychnine will not raise the blood pressure 1 mm. I have used it over and over again. . . . Finally, the watchful and vigilant care of patients afflicted with pneumonia without the use of drugs is the ideal treatment."

Relative to the routine use of digitalis in pneumonia F. Forchheimer[5] relates his experience following the use of large doses as advised by Petresco of Bucharest. He says the "mortality was greater than before. All the evil effects that can be produced by digitalis were noted, and after three days of administration of the remedy such cumulative effects were produced as I shall hope never to see again."

Alcohol. When we stop to think of it, it must seem strange to any sane man to suppose that a drug which increases the liability to pneumonia and greatly increases its mortality should ever be recommended as a therapeutic agent in that disease. Yet that such has been done is evidenced by the numerous articles which, a few years ago, appeared in many medical journals, recommending whisky and brandy as a routine treatment of pneumonia. It is supposed that by dilating the peripheral vessels, it aids in decreasing the congestion of the lungs. This might be the case, did not alcohol act upon all the small blood-vessels, those of the lungs included. Neither is alcohol a cardiac stimulant as has more recently been shown by numerous reliable experiments. Experiments by Martin and Stevens, conducted in the Biological Laboratory of the Johns Hopkins University, show that blood containing 1-4 of 1 per cent of alcohol diminished within a single minute the work done by the heart and that in certain animals experimented on, blood containing 1-2 to 1 per cent of alcohol so seriously affected its working powers that it was scarcely able to drive a sufficient amount of blood to supply its own nutrient arteries. Doctor Monroe of Glasgow Royal Infirmary says, "It has yet to be proved that the heart muscle can be stimulated by alcohol."

In a paper by E. Lewis Backman before the Anti-Alcohol Congress at Stockholm, it was shown that when a solution containing from .0025 per cent to .5 per cent was passed through

5 Journal of American Medical Association, October 30, 1909, p. 1450.

the blood-vessels of the isolated heart, in the case of a rabbit, that if the amount were sufficiently large to produce any noticeable effect, there was manifest temporary irregularity and diminution of the strength of the contraction, or a lasting arrythmia, and a considerable reduction in the volume and the number of the pulsations. Alcohol also limits or annihilates phagocytic action.

John H. Musser[6] gives the following summary concerning the treatment of pneumonia: "In the majority of the cases I prefer to rely on fresh air, on judicious local treatment, on hydrotherapeutics, on regulation of the proper amount of food taken, and particularly on care that the patient is not overfed. I watch carefully for the phenomena so well pictured by Doctor Forchheimer, guarding against the possibility of the vasomotor syndrome by proper renal elimination. Attention to proper elimination is of the greatest importance in the management of the cases of pneumonia, looking toward the prevention of cardiac failure; in other words, looking toward the reduction of serious toxic symptoms that arise and have expression more particularly in the phenomena just pointed out. To keep down the amount of food is of the greatest importance in the management of pneumonia patients. Watch carefully the state of the intestinal tract. Tympany is a serious toxic symptom in pneumonia, and its increase with defective elimination is a point that I depend on as suggestive of the occurrence of vasomotor failure. This can be prevented very largely. Colitis occurs with the pneumococcus infection, and this colitis is undoubtedly the cause of the development of tympanites; the colitis plus the toxemia invites an intestinal paresis. Hence to prevent this colitis which gives rise to the tympany, it is well to observe carefully the diet, regulating judiciously the amount and kind of food taken, and washing out the bowels with normal salt solution."

BRONCHOPNEUMONIA

Under two years of age, lobar pneumonia is seldom ever seen. From this up to seven, either type may be found. After

6 Journal of American Medical Association, October 30, 1909, 1453.

that age, lobar pneumonia is the prevailing form. In many ways, the treatment of bronchopneumonia is conducted on the same principles as that for the lobar type. The first two indications, *i. e.*, increase aeration of the blood and sustain the heart and circulation, are the most important. Bronchopneumonia is nothing more nor less than an extension downward of the inflammation of a bronchitis. It is a capillary bronchitis or lobular pneumonia. In order to accomplish the first result—the proper aeration of the blood—it is very necessary to increase the facility and the amount of expectoration, so that the lungs may be free for proper respiration. The child may be placed in a bath at 100° and, while sitting, receive to the chest and shoulders cold affusions at 75°—90°, depending upon the age and vitality. With infants, the wet sheet pack is perhaps the most efficient means. The pack may be wrung from tepid, cool or cold water and spread out on a blanket. The child is then placed on the wet sheet which is wrapped snugly about the body, the blanket being folded over all. The child should remain in the pack to the sweating stage. At first, there is gasping respiration and the child cries. This aids in the expulsion of mucus. As the pack heats up, the respiration becomes deeper, easier and the expectoration much less difficult. Fever may drop one or two degrees and the child pass into a quiet sleep. If this occurs, the child should be kept warm, being left in the pack until it awakes. It may then be taken out with a wet hand rub, or this may be done sooner if the child does not sleep. The moist chest pack and heating compress to the chest are also efficient means of sustaining the heart and increasing the depth of respiration. If there is much cyanosis, especially if accompanied by chilliness, it is best to place the child in a full warm bath; or, if the pack is used, it may be wrung from warm water or hot water. In case of the bath, after the skin has become well warmed, the child may receive an affusion to the chest or to the entire body just as it is taken from the bath. In case of the pack, after the child is well warmed, it may be taken out with a wet hand rub. Infants do not react well to either extreme heat or cold. Fortunately, however, they respond to milder temperatures in as decided a manner as adults do to greater extremes.

PLEURISY

There are several forms of pleurisy. Only the treatment of the dry and serous forms will be considered, since empyema of the pleura is a surgical disease. In the pleurisy usually accompanying pneumonia, the inflammation is largely on the side of the visceral layer. In ordinary pleurisy, however, the inflammation involves chiefly the parietal layer of the pleura. The blood supply of the two layers is quite different. That of the visceral layer is of course from the same blood-vessels as the lung itself, while the parietal layer is supplied by the blood-vessels from the intercostal arteries and with nerves from the anterior divisions of the intercostals. It has been shown that the severe, acute pain in both peritonitis and pleurisy originate in the parietal layer of these membranes. With these facts in mind, it will be seen that the circulation and consequently the congestion of the visceral layer will be most readily influenced reflexly; while with the parietal layer, the circulation and congestion are influenced to a greater extent by hydrostatic means, since the blood-vessels are connected directly with those of the superficial structures.

For these reasons, while cold decreases reflexly the congestion in the lungs, by local retrostasis it increases the congestion of pleurisy. In acute pleurisy, cold applications greatly increase the pain and, if used persistently, may so prolong the inflammation that weeks or months are required for its entire relief.

On the first indications of pleurisy, the patient should be given a hot foot bath for the purpose of warming the feet and providing for thorough reaction to any other treatment that may be given. This also aids sweating which helps to relieve internal congestion. That which is of the most importance is the use of very hot fomentations applied over the affected area. These should be made of thick, heavy flannel, wrung from boiling water and wrapped in one thickness of dry flannel. No cold should be applied between fomentations. From three to five may be necessary in order to completely relieve the pain.

If one side only is affected, these fomentations should be applied *from spine to sternum* and not simply to the chest anteriorly (*Plate XII.*). Given in this manner, the hot application dilates the posterior, lateral and anterior cutaneous branches of the intercostal arteries, thus withdrawing the blood from the congested and inflamed pleura. The fomentations to the chest should be followed by a heating chest pack. The partial pack, so arranged that the moist gauze or linen covers only the affected area, is better than the full pack. In the case of thin persons or those of low vitality, it is best to use the dry chest pack. In case the moist chest pack is used, it may be necessary to apply a hot water bottle over the area outside of the pack in order to warm it more promptly. In case of diaphragmatic pleurisy the fomentations should be applied so as to cover the area of insertion of the diaphragm. The upper edge may reach to the nipples and the lower edge to the navel. They should be large enough to reach to the posterior axillary lines on each side. The heating compress to follow may be applied by means of a moist abdominal bandage covering the same region.

After two or three treatments in which fomentations alone are used, with possibly a cold compress after the last one of each series, the revulsive compress should be used, the cold compress being allowed to remain until thoroughly warm before the second fomentation is applied. Later, alternate hot and cold by means of fomentations and a cake of ice may be used; and when the patient is convalescing, the alternate hot and cold spray douche to the back, front and sides of the chest gives excellent results. Percussion or force should not be used in this treatment since the vibration occasioned by it tends to increase the effusion. Neither should any massage or percussion be given to the chest in concluding a treatment. Even the vibration of a vehicle, such as a street car, may cause the return of a pleurisy which has nearly recovered, and the temperature rise two degrees or more in a single hour.

If this treatment is used from the beginning, that is, fomentations and later the revulsive compress and hot and cold, tapping for excessive effusion will be less frequently necessary. The ice bag to the chest should not be used in any stage of pleurisy. The alternate hot and cold douche to the feet, or the alternate hot and cold foot bath should replace the hot foot bath while the patient is convalescing. This helps to steady the circulation and render exposure to cold much less dangerous.

PERICARDITIS

The conditions in pericarditis, while very similar to those in pleurisy, must be treated upon somewhat different principles, because of differing anatomical relations. While the lung may, to a certain extent, be immobilized or restricted in amplitude of movement, this is impossible in the case of the heart. All that can be hoped in this line is to decrease the frequency of its beat. This is admirably accomplished by the use of the ice bag over the heart and especially by the frequent use of the cold mitten friction. The latter is perhaps the more rational measure since by its stimulation of the peripheral vessels, it relieves the heart of its excessive burden. The circulation of the parietal layer of the pericardium is more or less connected with the surface blood-vessels, so that inflammation may be reduced in the same manner as with pleurisy. Since fomentations over the heart increase its rate and decrease its force through reflex action, it is not possible to apply them as we do in pleurisy. The best results may be obtainad by the use of the ice bag applied directly over the heart, while a very large fomentation is so arranged as to cover it and a much larger area around the heart. The heat produces derivation, while the ice bag slows the heart rate. Three of these fomentations may be given in succession and the treatment followed by the heating compress; or the ice bag may be left on between treatments, being removed frequently enough to preserve the reflex excitability of the nerves. During the course of pericarditis, the cold mitten friction should be used one to three times a day, depending upon the degree of the heart embarrassment.

In the later stages, the revulsive compress to the entire front of the chest should be used to promote absorption. Other treatments that are of advantage are the hot and cold foot bath after the first few days, also hot and cold to the spine and cold towel rub. It is not necessary to do paracentesis unless, by accumulation of fluid, the heart is seriously interfered with.

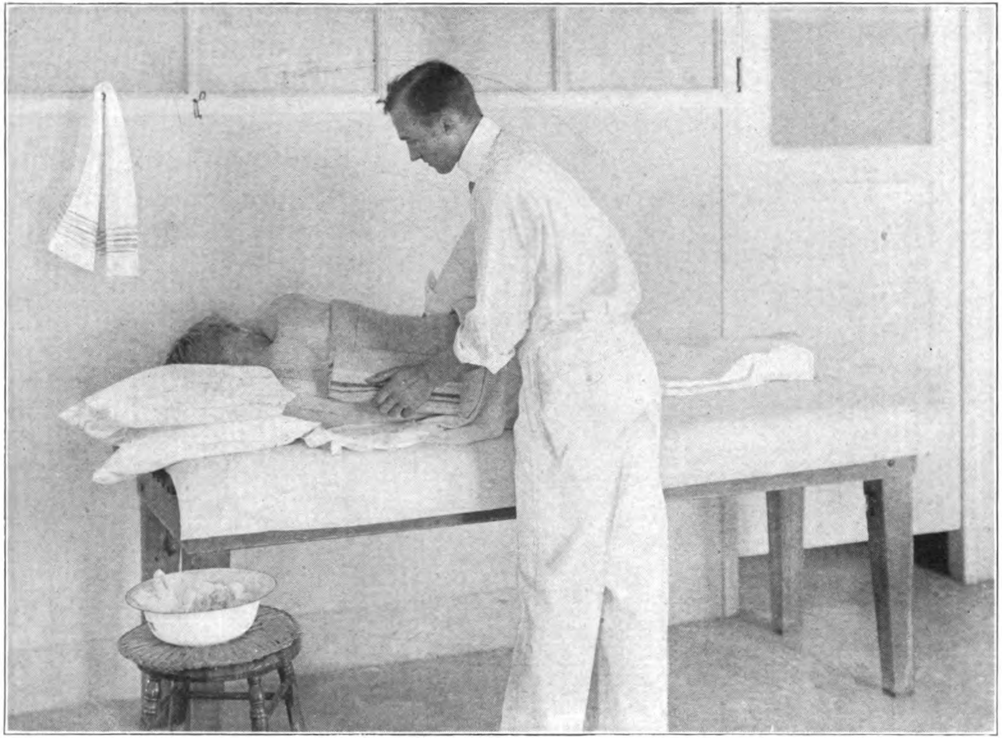


PLATE XII. The proper method of applying fomentations to the chest for pleurisy.

MYOCARDITIS

This is very frequently met with in diphtheria. Since the introduction of antitoxine, it is of course less frequent and less serious. Myocardial degeneration and consequent cardiac asthenia are due to the diphtheria toxine. It may not become apparent until convalescence. That which is of most importance is absolute rest. The ice bag to the precordia should be kept in place a great deal of the time. This slows the heart rate and increases its force without overstraining the cardiac muscle. The cold mitten friction decreases the work required of the heart itself. Both the cold mitten friction and the ice bag decrease the heart rate and increase its force. Digitalis and strychnine are exceedingly dangerous in this condition and should never be used, since by extreme stimulation, they compel the heart to overexert itself. Great depression results from their use.

RHEUMATIC FEVER

Rheumatic fever is an acute, infectious disease, primarily an inflammation of the synovial membranes and periarticular tissues, with a special tendency to involvement of other serous membranes, the endocardium, pericardium, pleura and sometimes the meninges. A more severe infection may be complicated by myocarditis. In ordinary cases, the fever is moderate, 102.5°—103.5°, but it may be very high.

Indications of first importance are (1) reduction and control of the inflammatory process in the joints; (2) prevention and treatment of complications, chiefly endocarditis; (3) relief of the pain. Formerly synovitis was met principally by hot applications, heating compresses, counter-irritation combined with anodyne mixtures for the relief of pain. The local applications which have proven helpful are fomentations, the dry pack or heating pack to the joint, and the local electric light. They should be continued until a decided hyperemia of the skin is produced. After rubbing the part with oil of wintergreen a local heating pack may be applied and allowed to remain until the next treatment. The pain in the joints is greatly relieved by these measures. The internal administration of the natural oil of wintergreen in 20 minim doses every two to four hours also adds to the comfort of the patient and seems to shorten the course of the inflammation. We have never seen any harmful results from its use.

Hot applications frequently fail to produce the best results. Where continuous cold to the joints has been tried, it has been found to give better results than hot applications. The joint should be well covered with a thick flannel cloth, outside of which should be packed cracked ice or snow (*Plate XIII.*) or the joint may be surrounded with ice bags. This pack should be left in place until the part becomes almost numb, care being taken that actual freezing does not occur. At the same time, the warmth of the body should be sustained by hot water bottles, the foot bath, or fomentations to other parts. When the pack has been in place a sufficient length of time to do away with tenderness, it may be removed and the skin rubbed thoroughly with the dry hand or snow until it is red. If the inflammation is severe, the ice pack should then be replaced. The rubbing must be repeated at intervals to promote reaction and prevent freezing. If thought necessary, this opportunity may be taken to mobilize the joint. In the ordinary case the heating compress may be used between the ice packs, the latter being repeated from two to four times a day, each lasting for thirty minutes to one hour. Two or three joints may be treated in this manner at the same time. When these extreme cold applications are used, the inflammation seems to run a much shorter course. Where moderate movement of the patient is not objectionable, the use of alternate extreme hot and cold immersion of the hands and wrists or feet and ankles is one of the best measures for controlling the pain and inflammation in these joints. This is especially applicable when the inflammation has subsided somewhat.

The patients general vitality should be sustained by cold mitten frictions, hot and cold to the spine, and the heart steadied by the use of the ice bag and cold mitten friction. Fomentations to the chest may be used every four or five hours, or oftener if necessary, in order to renew the reflex activity where the ice bag is used for a considerable length of time.

Free water-drinking should be encouraged. An actual sweating treatment is beneficial and may be employed daily or two or three times a week. Both of these measures favor elimination of toxines. If this plan of treatment is thoroughly carried out, endocarditis is less likely to occur.

Endocarditis. Should the valvular endocardium become involved, it is necessary to keep the patient at perfect rest, both during the course of the fever and for a considerable time after. The ice bag to the heart should be used intermittently; that is, being put on for twenty-five or thirty minutes and left off for the same length of time, or even allowing it to remain in place for a longer time, depending upon the results produced. Buxbaum[7] and Laqueur[8] recommend the use of the cold coil to the precordia two or three times daily for a half hour to an hour, or even longer at a time.

Cold mitten frictions should be given from one to three times daily, hot foot baths being used as frequently as necessary. It is needless to say that the heart should be examined daily, the findings being compared with the clinical manifestations. After the fever has subsided, the patient must be carefully guarded from all exposure to cold and damp. He should return to an active condition very gradually, rest in bed being kept up until the pulse rate is nearly normal. The wheel chair may be used from this point, but before further advancement may be made, the pulse rate must again return to normal. The patient may then be allowed to lounge about, being dressed and around the room part of the time. Walking should not be allowed if the pulse rises above ninety. During all this time, such tonic measures as hot and cold to the spine, the cold mitten friction and cold towel rub should be used. After the subsidence of the fever, gentle massage may be permitted. The resistant movements of the Schott method, and the effervescent bath should not be given until well into convalescence; that is, after the fever has been normal for a month or two. From this on, the treatment is essentially that of chronic endocarditis (*q. v.*).

7 Lehrbuch der Hydrotherapie, 1903, p. 234.
8 Die Praxis der Hydrotherapie, 1910, p. 143.

INFECTIOUS ARTHRITIDES

Not only in rheumatic fever but also in a number of other infections, arthritis is a prominent and often very troublesome occurrence. Some of these, especially in the chronic stage respond well to the use of vaccines, but we have obtained more uniform and satisfactory results from the use of scientific hydrotherapy. In these arthritides we include gonorrheal rheumatism, syphilitic arthritis, and the secondary non-suppurative arthritis of scarlet fever, tonsillitis and other infectious fevers. The principles and methods of treatment are very definite. For clinical purposes the cases may be divided into acute and chronic.

The Acute Stage. Each inflamed joint should be packed in ice for thirty minutes to one hour two or three times a day. The more acute the inflammation the greater should be the total duration of the cold. At the close of each of these applications some treatment should be given to promote reaction. This may be by rubbing with snow or by two or three changes of an alternate hot and cold immersion, pour, or spray douche. As the inflammation progresses toward the chronic stage, more heat and less cold should be used.

The Chronic Stage. When an infectious arthritis has existed some weeks or months the treatment should differ radically from that which is given during the first few days or week or two of the inflammation. For chronic arthritis apply to the joint some form of hot application. This may be the fomentation (*Plate XIV.*), the local electric light, or superheated air. After ten to thirty minutes of such applications treat the part by a vigorous alternate hot and cold immersion or alternate spray douche, using from three to six or more changes. The spray douche is better than the immersion. The hot water should be as hot as can be borne and the cold as cold as it can be obtained, which, for the best results, should not be above 60° F. If there is pain in the joint or if it should seem desirable for other reasons, the heating joint compress may be applied after each treatment and kept on until the next treatment.

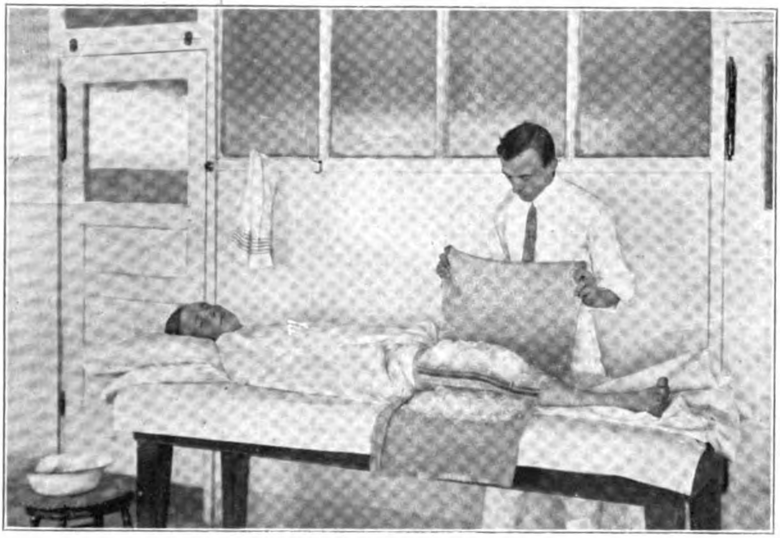


PLATE XIII. The application of the ice pack to the knee in rheumatic fever and acute arthritis.

PLATE XIV. Method of applying fomentations to the knee in chronic arthritis

These methods have given such uniformly satisfactory results that infectious arthritis has, with us, ceased to be a perplexing problem.

MENINGITIS

In acute cerebro-spinal meningitis, there is a purulent exudate covering the convex dorsal surfaces of the brain between the dura mater and the leptomeninges filling the meshes of the arachnoid and extending downward along the cord. The meninges of the brain are intensely congested. The intracranial pressure is increased. Quincke's lumbar puncture should be used for diagnosis and treatment. The most important treatment is the use of *Flexner's serum*, which has given 75 per cent of recoveries in four hundred cases. The most commonly employed hydrotherapeutic applications are the ice cap and spinal ice bag applied continuously, or with but little interruption. The spinal ice bag should be filled with finely pounded ice and placed along the cervical and upper dorsal spine. Another smaller ice bag should be placed cross-wise of the neck at the base of the brain. The ice cap or helmet should cover as large an area as possible of the convex surface and sides of the cranium. These applications, though extensive and extreme, do not usually cause chilling. It will be found helpful to apply heat to the extremities at intervals. The hot foot bath, hot leg pack, or large fomentations to the limbs and abdomen, may be used. They assist the action of the ice bags in reducing cerebral congestion. The ice bags and ice cap may conveniently be replaced by rubber coils through which ice water is flowing.

Rohrer reports a number of cases in which cold affusions to the head and neck were of great service in relieving or mitigating the severity of cerebral symptoms and bringing about a successful termination. He also advises the cold affusion for the relief of cerebral symptoms, whether delirium or coma, accompanying infectious diseases such as pneumonia, acute meningitis and in sunstroke, neoplasms and tubercular meningitis. When made very cold and much prolonged, they are decidedly antipyretic.

In chronic and tubercular meningitis the opisthotonos, and muscular ridigity are best met by the use of the full warm bath given at a temperature of 98°—102° F. These may be continued from ten or fifteen minutes to an hour, according to the needs of the case. The restlessness, delirium and headache are often entirely relieved. The rigidity of the spine and abdominal muscles is favorably influenced. We have seen coma give way to a fairly clear sensorium following the bath. Where the temperature of the patient is above 102°, the ice bag should be kept at the base of the brain and a cold compress to the head during the bath. This is especially necessary in the epidemic form of cerebro-spinal meningitis. In tuberculous meningitis it may not be needed. Aufrecht, Waroschilsky, Wollisch, Netter and others report favorable results from the full warm bath. Rogansky reports among fifty-one cases (not tubercular) in women where the warm bath was used, a mortality of 33 per cent; and among fifty cases where the bath was not used, a mortality of 80 per cent. The warm bath acts as a relaxing and sedative agent. It also aids in depleting the cerebral and spinal circulation and serves as a tonic to the circulatory system. Excitant and stimulating measures should be avoided.

BILIARY INFLAMMATIONS

Cholecystitis, Catarrhal Juandice, Subacute Pancreatitis

Inflammatory states in these ducts and organs are quite likely to be followed by conditions that require operative interference; but if taken early, the milder inflammations subside under proper treatment. In cases of subacute pancreatitis and catarrhal inflammation of the gall bladder and ducts, we have found the following method successful: Once or twice daily there should be given a treatment consisting of a hot foot bath with fomentations to the abdomen and concluded by the cold mitten friction. The hot foot bath and fomentations produce effectual derivation, while the latter application relieves the pain and relaxes the musculature of the ducts and the gall bladder. The cold mitten friction is given for tonic purposes, to increase leucocytosis and combat infection. Fomentations and hot and cold to the spine are used for sedative and tonic purposes. As the patient improves, the revulsive compress to the abdomen may be used, also the graduated shower, hot and cold spray and the alternate douche. Once a week a short electric light bath should be given.

From the beginning of the inflammation, the patient should wear some form of heating compress to the abdomen. This is most conveniently applied by means of the moist abdominal girdle. The ice bag or other continuous cold applications to the abdomen should not be used in these conditions. In case of empyema of the gall bladder, should the patient refuse operation or a brief delay seem advisable, the same plan should be followed. It is inadvisable to use the ice bag in such a condition, since it tends to cause firm contraction of the muscular coat and might occasion rupture of the gall bladder. In fact, it is a principle which should be quite generally followed that inflammations of the hollow viscera are best treated by hot applications. This is also true of the urinary bladder. The spasm of the muscles occasioned by the inflammation is relaxed and the congestion decreased.

Catarrhal jaundice in about 60 per cent of cases is now considered to be due to the induration in the head of the pancreas occasioned by a subacute inflammation. Outside of the dietetic treatment of this condition and the special necessity for free bowel movement, it should be treated on the same general principles as those outlined above.

APPENDICITIS

As we have previously remarked, this is a surgical disease and should be surgically treated in practically all cases. Hydrotherapy produces such marvelous results in the relief of pain and, in many cases, safe conduct to the interval that it might almost seem to be a specific. This temporary relief, however, can not be depended upon for permanent cure. Should it seem advisable to delay operation to the interval or, in case the patient refuses operation, hydrotherapy offers the best chances for immediate recovery.

The patient should be given a hot hip and leg pack with an ice bag inserted under the edge of the blanket just over the appendix. By means of the combined effect of the hot, in drawing the blood from the inflamed part, and the ice bag, in causing contraction of the vessels reflexly, the most effectual derivation is secured. The pain is almost instantly relieved in those cases in which the inflammation has not produced rupture of the appendix. After twenty or thirty minutes in the pack, it should be removed and a vigorous cold mitten friction be given to all parts included by it, except the abdomen. This serves to fix the blood in the skin and so make derivation more permanent. Following this treatment, the heating compress may be applied to the lower abdomen or the ice bag may be applied over the appendix almost continuously. The hip and leg pack with ice bag should be repeated as often as necessary to relieve the pain and make the patient comfortable. It is perhaps needless to say that the treatment should be preceded by a thorough enema. Cathartics should be avoided. A very large fomentation with an ice bag under the center over the appendix may be substituted for the pack. After the temperature has become normal and the acute tenderness has subsided, the patient should be given general tonic treatments, always avoiding extreme measures to the abdomen or about the appendix, since excitation of peristalsis may cause return of the inflammation or rupture of the appendix. In chronic appendicitis the fomentation to the abdomen is best calculated to relieve the pain and tenderness. Where possible, these cases should be operated in the interval.

PELVIC INFLAMMATIONS

Acute Endometritis from Puerperal Sepsis, Salpingitis, Ovaritis, Pelvic Cellulitis and Peritonitis

It is necessary to differentiate between these conditions, although hydriatic treatment is carried out along much the same line in all. In the case of retained secundines following labor or abortion, it is imperative to perform currettage as early as possible. In the case of simple salpingitis, operation should not be done at all. Should the inflammation go on to the formation of a pyosalpinx, operation should be delayed until the temperature is normal and the acute inflammation has subsided. In pelvic cellulitis operation is unnecessary and dangerous. Should abscess formation occur, either in the cellular tissue or in the peritoneal cavity, drainage should be provided.

With these different conditions in mind and the possible outcome of each, the inflammation should be treated in the same manner as that outlined for appendicitis. The patient may be given the hot leg pack or hip and leg pack, with the ice bag applied to the groin, suprapubic region or other part nearest the inflamed organ. This should be continued twenty to thirty minutes and concluded with the cold mitten friction. The heating compress may be applied or, if it seems wise, in some cases the ice bag may be left in place. In other cases, fomentations to the lower abdomen may be given every two hours. The hip and leg pack with the ice bag, followed by the cold mitten friction, should be repeated two or three times daily according to the necessities of the case. It is well, in nearly all of these inflammations, to precede the pack by very hot vaginal irrigation. As the acuteness of the inflammation subsides, the revulsive compress and other alternate hot and cold applications may be used. Perhaps the most effectual means of treating chronic pelvic inflammations is found in the sitz bath. When it is considered safe to allow the patient to begin to walk, the hot sitz or revulsive sitz may be used. The temperature of the bath should be gradually lowered until the patient is taking a hot sitz followed by a brief application of cold or very cold water. The hot half bath is an effectual means of applying the principles of the sitz bath. In some cases, it is to be preferred. The body is less cramped and both the limbs and hips are entirely immersed in the water. At the conclusion, the patient should receive a cold pail pour to the hips. It is not necessary to use the extreme or prolonged cold sitz in the conditions mentioned above. In place of this, the patient should be given alternate hot and cold percussion douches to the sacrum, feet, and legs. Other tonic measures should form part of the course of treatment. The cold rubbing sitz is beneficial in delayed resolution. Hot vaginal irrigation or alternate hot and cold irrigation should be used until resolution is complete.

PHLEBITIS

During the early stages of phlebitis, the cold compress or ice bag should be used over the affected vein. At the same time, the limb must be elevated and kept warm. All massage movements are strictly contra-indicated in this condition. After the first day or so, fomentations should be used frequently, the ice bag or cold compress being left in place between fomentations. While the patient is recovering, that is, after the temperature becomes normal and all signs of acute inflammation have subsided, the revulsive compress may be used. The edema should be treated by elevation and such alternate hot and cold measures as the revulsive compress, hot and cold foot or leg bath and the alternate pour. When there is no longer danger from embolism, massage may be used, avoiding, however, the vein itself. Later on, when there remains only the stasis and edema, the most vigorous hot and cold measures such as the alternate douche, are beneficial.

MUCOUS COLITIS

The first object to be accomplished in the treatment of mucous colitis is the removal of the mucous cast covering the mucous membrane. The thorough removal of this coating will be accompanied by more or less pain, since it leaves a raw, unprotected surface. That which most effectually removes the coating is some form of treatment which will produce a vigorous exosmosis. This may be accomplished by the hypertonic saline enema, or the honey enema. In preparing the saline enema, about double the amount of salt should be added as in preparing a physiologic salt solution, or to each pint of saline solution there may be added a quarter of a teaspoonful of Epsom salts. This tends to draw water from the tissues because of the concentration of the solution. Before using the salt solution, the bowel should be thoroughly cleansed, if necessary, by both low and high enemata; after which the salt solution is introduced by means of the high bowel catheter, or by the ordinary enema given in the knee-chest position. A pint or even a quart of the solution may be used at one time. It should be retained as long as possible, twenty to thirty minutes is sufficient. Owing to the cathartic action it can not be retained long. It usually brings away with it considerable of the tenacious mucus, often in cast form. The pain and tenderness occasioned by the enema may be relieved by fomentations to the abdomen, and the weakness induced by such drastic measures somewhat relieved by the cold mitten friction.

The enema should be repeated about three times a week and continued until there is little or no mucus brought away with the passage of the salt solution.

The molasses or molasses and soap suds enema may be substituted for the concentrate salt solution. If given, it is necessary to warm it slightly so that it may pass readily through the colon tube. From three to six weeks of such treatment may be necessary in order to thoroughly rid the bowel of the mucus coating. After this, the enemata should be entirely discontinued, the patient being given general tonic treatment, including fomentations to the abdomen. The following plan will be found helpful: In the morning a treatment consisting of a hot foot bath, fomentations to the abdomen, and a cold mitten friction. The revulsive compress to the abdomen may also be used. In the afternoon hot and cold to the spine, followed by a cold towel rub or general massage, avoiding the abdomen. The patient rapidly regains the weight and strength lost during the first part of the treatment and after a few weeks there is usually no more mucus discharged from the bowel. It of course goes without saying that the underlying neurasthenic condition and derangements of digestion should receive their share of attention by rest, proper diet, etc.

CYSTITIS

In the acute stage only hot treatment is permissible. This may be given by means of a hot hip pack, fomentations to the lower abdomen and pelvis, or the hot sitz or revulsive sitz. Neither the ice bag nor cold compress should be used. Both of these measures cause contraction of the bladder muscles and so increase the pain arising from the inflamed mucous membrane. The hot applications tend to relax the musculature and draw blood from the organ to the surface. The patient should drink freely of water in order to dilute the urine, thus lessening its irritating qualities. Regulation of the diet is fully as important as these measures.

In the chronic stage more cold treatment may be used, such as the revulsive sitz, graduated sitz, hot and cold perineal spray, hot and cold rectal irrigation, and the alternate spray douche to the pelvis. These alternate applications may, at first, occasion some vesical spasm, but if persisted in, help to relieve the stagnant circulation. The hot saline enema and continuous hot rectal irrigation also produce good results. Bladder irrigation with hot physiologic salt solution or some mild antiseptic as boric acid or potassium permanganate should be done once daily, rarely oftener. In long standing chronic cases alternate hot and cold rectal irrigation gives excellent results. This plan of treatment is especially beneficial in those cases in which the capacity of the organ is very much reduced and the walls have become greatly thickened and indurated.

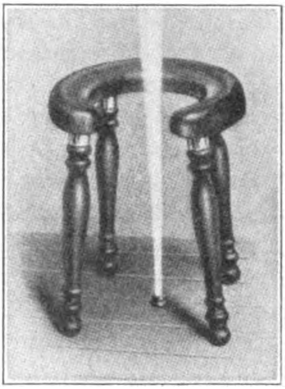


Fig. 53. The perineal douche.

SPECIFIC URETHRITIS, VAGINITIS, OR PROSTATITIS

In the acute stage, in addition to the local medication, the ice bag should be used almost continuously. The Leiter coil is an excellent means of continuous cooling. Some form of internal cooler may be used. The hollow prostatic cooler which is applied to the prostate through the rectum is useful in decreasing acute inflammations of that organ. Desnos recommends very hot (120° F.) rectal irrigation in the acute stages, forbidding it in the chronic stage. We would reverse this rule, using cold rectal irrigation in the acute stage and vigorous hot and cold in the chronic stage. As these conditions progress toward the chronic stage, short hot applications should be used, alternating with the cold, and after the acute inflammation has subsided, the most vigorous hot and cold measures are necessary. That which is the most serviceable is the alternate hot and cold perineal spray. (*Fig. 53.*) Chronic cases which have resisted all sorts of medication very readily respond to this measure. It greatly increases the circulation and stimulates local leucocytosis, both of which are necessary in order to combat the infection which frequently becomes cryptic in this stage and so is beyond the reach of topical medication. The graduated sitz or even the cold sitz may also be used. This should be begun at a temperature of 98°—105°, and after one or two minutes, the temperature gradually lowered to 85°, or after several applications, to as low as 75°. The bath should last from four to six or eight minutes, and be followed by the alternate hot and cold perineal spray. In chronic prostatitis alternate hot and cold rectal irrigation produces astonishingly good results.

CHAPTER XX

STIMULANTS AND TONICS

THERE is a decided difference in the physiologic effects of a stimulant and a tonic. The idea that stimulants are necessary for tonic purposes has lead to great confusion in the proper understanding of these terms. While tonics have a wide range of applicability, the necessity for stimulants is much more limited. We quote the following from Sir William Broadbent as giving the best idea of the effects produced by stimulants: "A falsehood which dies hard is the idea that stimulants of whatever kind actually give strength and are necessary for the maintenance of health and vigor. Such is not the case and the well-worn comparison that they are the whip and spur, and not the corn and grass, is strictly accurate. Anything accomplished under the influence of stimulants is done at the expense of blood and tissue and, if frequently repeated, at the expense of the constitution."

On the other hand, a tonic tends to restore the body to such a condition that it is better able to perform its usual functions. It not only "stimulates" and hastens the normal expenditure of energy, but it also increases the vital capacity of the body for work. This it does by its action in augmenting the processes of anabolism. It will be seen from this that the whip can not be a tonic, since it in no way tends to restore an organ to its normal condition, nor does it so shape circumstances that the tissues of the organ are built up. For this reason strychnine should be considered a stimulant, and a stimulant only. All tonic measures are physiologic in their nature, while stimulants may or may not be natural means. Medicinal stimulants produce an unnatural condition which in no way tends to restore to the normal. On the contrary, while physiologic stimulants may excite an unusual expenditure of energy, greater in this direction than in the building up of the vitality, yet they do not have the bad after effects constantly observed following the use of such stimulants as strychnine.

In the consideration of physiologic means, we may properly divide measures which enhance vital activity into two classes, —those which are largely or wholly excitant and stimulating, and those which are chiefly tonic in their effects.

HYDRIATIC MEASURES CHIEFLY TONIC

Tonic effects are derived principally from cold applications. The reaction to vigorous cold measures has been shown to increase muscular capacity, quicken the circulation, enhance nerve activity, etc. In this sense, tonic effects may be considered to be a secondary result or reaction from the primary stimulation. Tonic effects may also be had from alternate hot and cold applications, never from hot alone, except they be very short or where the heat of the body is much below par.

That the wide-spread effects of tonic applications may be fully realized by the reader, we give below a tabulated list of such effects. These have been discussed in detail in the first part of this work.

Cold applications produce the following tonic effects:—

1. Quicken the circulation of the blood and lymph.
2. Strengthen the heart beat.
3. Raise blood pressure.
4. Increase glandular activity.
5. Enhance nerve activity.
6. Augment assimilation.
7. Increase depth of respiration.
8. Increase amount of oxygen absorbed and carbon dioxide eliminated.
9. Leucomaines are more perfectly oxidized.
10. Increase oxidation and metabolism in general.
11. Stimulate heat production.
12. Equalize the distribution of red and white blood cells, in-

creasing their number in the peripheral circulation and thereby preventing globular stasis.

13. Increase alkalinity of the blood.
14. Augment the production of agglutinin and other antibodies.
15. Stimulate phagocytosis.
16. Increase muscular capacity.
17. Decrease fatigue.

Tonic measures, to a greater or less extent, are indicated in all forms of disease. In some conditions the tonic results derived from measures, whose principal effects are other than tonic, are sufficient to secure recovery; but in nearly all diseases some special tonic treatment is needed, and in not a few, this alone is sufficient. In the majority of cases, it is necessary to begin with the mildest of tonic measures, increasing the vigorousness of the treatment as the patient develops the ability to react.

The following are the principal tonic measures in the order of their severity. Taken one after another, they may be said to constitute a *therapeutic ladder*.

1. WET HAND RUB. A few very anemic patients do not possess sufficient vitality to react at first to the cold mitten friction. These patients should be given a wet hand rub beginning with one or two parts only, and increasing the extent of the area treated as the patient's reactive powers increase. At first, tepid or cold water may tax the reactive powers. If so, the patient must be rubbed vigorously during and following the application. The temperature of the water should be decreased daily 2° or 3° F., until cold water or ice water is used. Usually, before this point is reached, the cold mitten friction may be employed.

2. COLD MITTEN FRICTION. Begin with cold water, dipping the mitten once for each part, and rubbing it vigorously until it is well warmed. It should then be dried and rubbed with the dry hand. With each succeeding treatment the temperature may be lowered and, in a day or two, the number of times the mitten is dipped for each part may be increased to

two and later to three or four. When the patient is able to react to ice water used in this manner, other more vigorous means may be tried.

3. Cold Towel Rub. This is graduated in the same manner as the cold mitten friction. Since the cold water is applied to a greater surface at one time, it requires somewhat greater vitality to react to this measure.

4. Pail Pour. After the warm bath or some other hot treatment, the patient may receive to the shoulders, chest and back, two or three pails of water differing in temperature from 5°—15° F. The first used should contain water from 100°—105°, the second from 80°—90°, and the third from 65°—80°. As the patient shows ability to react to these measures, the temperature of the water may be decreased, or additional pails used.

5. Salt Glow. This may be made a mild or extreme measure according as fine or coarse salt is used, and much or little friction given. Since it is not accompanied by cold water, it does not severely tax the reactive powers. A pail pour or shower may be used to remove the salt and so combine it with other tonic measures.

6. Cold Douche. This should be preceded by a warm or hot shower, or it may be given as a hot and cold douche consisting of three or four changes. The reaction is enhanced by the use of percussion. At first only a limited portion of the body should be treated in this manner, such as the feet and legs, later the spine and chest also.

7. Wet Sheet Rub. The patient should stand in a tub of hot water. At first the sheet should be wrung nearly dry from cold water. This is wrapped about the patient in the manner directed under technique. The rubbing should be *over* the sheet until the skin is warm and then the patient quickly dried by means of sheets and towels. Later, colder water should be used and the sheet wrung less thoroughly.

8. Dripping Sheet Rub. When the patient has acquired the ability to react to the wet sheet rub, the treatment may be increased in vigor by pouring over the shoulders while

the patient is still wrapped in the sheet and after he has been warmed by rubbing, from one to three pails of cold water, at first using one containing cool water, and later two or three pails of colder water. After each pour, the rubbing should be renewed and continued until the patient is warm.

9. SHALLOW BATH. A full length tub should be partly filled with cold water. The patient then enters the tub, sitting upright while both patient and attendant rub the limbs and hips. The patient now reclines in the tub while he is again rubbed with cold water, it being dashed up over the body during the course of the rubbing. The water should hardly more than half cover the body. The temperature of the shallow bath may be gradually decreased.

10. COLD PLUNGE. This measure may be considered the last round of the ladder. By active swimming movements, the patient should promptly react to a plunge in cold water at 80° —85° F., and later to much lower temperatures. The plunge bath should not be continued long. At first one or two minutes only are sufficient. Later, five, ten, or even fifteen minutes may profitably be spent in swimming.[1]

We have already mentioned that there are a large number of conditions in which tonic measures are indicated. In some, however, it is necessary to provide a special course of tonic treatment. The following is a partial list of such conditions. A few of these will be considered somewhat at length.

Indications for Special Tonic Treatment.

1. Anemia.
2. Neurasthenia.
3. Melancholia and hypochondria.
4. Hysteria.
5. Dyspepsia.
6. Insomnia.
7. Chronic inebriety.
8. Chronic articular rheumatism.
9. Pulmonary tuberculosis.
10. Valvular heart disease and obesity with fatty heart.

[1] For more complete details of these treatments see technique.

11. Diabetes.
12. Cerebral congestion due to sunstroke.
13. Multiple neuritis (chronic stage).
14. Locomotor ataxia.
15. Hemiplegia.

In the three last conditions the treatment should partake more of the nature of a true stimulant, as extreme measures are necessary to provoke activity in atrophied nerve structures.

ANEMIA

Under this heading we include the various forms of secondary anemia. Primary, idiopathic, or pernicious anemia should be treated along much the same lines. As far as possible, all known causes should be removed. Irrespective of the many ultimate causes of anemia, this state is due to deficient activity of the blood-making organs or increased rapidity in the destruction of the red cells. There is one factor that is an almost constant accompaniment of anemia. This factor is defective digestion and malassimilation. Because of bad food, gastro-intestinal infections and putrefactions, the body may be unable to digest and appropriate from the food the elements needed to sustain the system. It is not only the blood that is deficient, but the entire system is impoverished. Therefore, one of the chief objects to be attained is improvement in digestion and assimilation. Without this, all other treatment, no matter how good in itself, will be an almost total failure. The body may be given a more than sufficient supply of iron without the slightest effect, unless the digestion and assimilation are improved by appropriate treatment.

Artificial preparations of iron nearly always derange the digestion and so lessen the absorption of all nutriment, iron included. Preparations of iron, from Blaud's pill to the bad blood and marrow of slaughter-house animals, are all alike unnecessary in the treatment of anemia. The amount of organic iron contained in ordinary foods is abundantly sufficient to supply the hematogenic organs with the necessary amount for the formation of the normal per cent of hemoglobin. Prof. G. von Bunge[2] tells us that the yolk of eggs contains a stable

2 Physiological and Pathological Chemistry, Second English Edition, p. 375.

organic compound of iron with neuclein and that this compound is doubtless an immediate precursor of hemoglobin. So efficient is this in the formation of hemoglobin that he proposes to call it the "blood former" (hematogen). The fresh green vegetables, fruits, grains, and nuts contain considerable amounts of organic iron. Asparagus and spinach contain from 20 to nearly 40 milligrams of organic iron to 100 grams of dry substance.[3] Ten milligrams or 1-6 grain of iron, the daily amount required by an adult, would be contained in four ounces of the yolk of egg. Moreover, this iron is in a form to be most easily digested and most fully absorbed.

It is thus amply demonstrated that inorganic or artificial preparations of iron are not only entirely unnecessary, but also in many cases, positively injurious, since they derange the digestion. On the other hand, the best food, containing sufficient organic iron, will not suffice to cure anemia if intestinal putrefaction continues; and, through lack of proper tone and circulation, the body is unable to appropriate the food it receives. In addition, then, to the necessity for a simple, natural diet and special attention directed toward improving the digestion, there are two other objects to be attained. First, the blood-making organs must be stimulated; second, the circulation must be improved. That all these results can be accomplished by tonic hydrotherapy has been demonstrated, as shown in the chapters on the circulation.

That tonic hydrotherapy, combined with a simple natural diet, and outdoor life, fresh air and sunshine is far more efficient than iron, strychnine, arsenic, the hypophosphites, quinine and the like, is the daily experience of those who systematically employ physiologic means. It has yet to be proven that arsenic has any effect on the blood but to impoverish it. That it lessens both the per cent of red cells and of hemoglobin, when regularly administered, has been amply proven. In searching for experimental data concerning any positive benefit that may be derived from the administration of arsenic, one is struck with the paucity of evidence along this line. We are asked to rely upon very vague assumptions,

3 Bunge—Physiological and Pathological Chemistry, Second English Edition, p. 376.

mostly empirical in nature. We have frequently treated cases of profound anemia in which the whole picture was that of chronic arsenic poisoning rather than simple anemia, the arsenic having been administered to cure the anemia.

In the hydriatic management of anemia, it is necessary to provide a carefully graded system of tonic treatment. In the extreme forms of anemia, the beginning must be at the bottom round of the ladder of tonic measures. Each application of cold should be preceded by a short hot application, such as fomentations to the spine or abdomen, the hot foot bath, or local electric light bath. No long hot treatments should be used since the vitality is so much reduced as to illy bear the depression occasioned by sweating. However, all forms of local applications of heat are indicated in anemia. Following one or more short moderately hot applications, the patient should be given a wet hand rub, cold mitten friction or cold towel rub, according to his ability to react. This should be repeated about twice daily, or a light massage may be given once a day. Later on, as the circulation improves, the patient may be treated by the cold towel rub, hot and cold to the spine, and still later, alternate hot and cold douches and sprays. Advancement in the tonics should be made slowly. It may take several weeks for the patient to acquire sufficient vitality to react to a general shower bath. The salt glow may be used before the more vigorous cold applications can be borne. Following this, may be used the general affusion or pail pour, at first of warm or tepid water, later of cool and cold water. After some weeks a short full electric light bath may be given, followed by a vigorous hot and cold spray. When this point has been reached, advance may be made more rapidly, using the wet sheet rub, dripping sheet rub, cold shallow bath, and the cold plunge.

Massage is especially indicated in anemia before the patient is able to take much exercise. The manipulation should be what is termed "general massage;" *i. e.*, it should combine all of the procedures usually given in Swedish massage. Of special importance are the movements of deep kneading. After a single massage lasting forty-five to sixty minutes, the red cells frequently show a gain of 25 to 50 per cent and may even be doubled in number. These gains are of course not permanent but they last longer and longer as the treatments are repeated. The hemoglobin per cent rises more slowly than the red cells.

Full sun baths are especially beneficial. The scientific basis for the use of the sun bath in anemia and chlorosis has been well demonstrated experimentally.[4] Exposure to sunlight increases the oxygen-carrying capacity of the red blood cells. It stimulates hematogenesis, increasing both the number of red cells and the hemoglobin per cent. It is a fundamental protoplasmic stimulant. It hastens cell division and cell growth. It is a most effective stimulant to the peripheral circulation. Pure, fresh air supplies the needed oxygen that makes possible the best results from the sunlight. "Zuntz and his school have shown that the effects of mountain air are apparent, not only in their influence on red corpuscles, but also on the nitrogenous metabolism of the body as a whole, so that there is in most individuals a positive nitrogen balance, an actual reproduction of the conditions found in the growing organism."[5]

An Anglo-American expedition to Pike's Peak in the summer of 1911 confirmed the claims of European observers in the Alps relative to the effect of high altitudes upon the blood. They found a large increase in red cells, hemoglobin, and white cells.[6] The red cells increased 30 to 40 per cent and the hemoglobin kept pace with it. On descent it required about four weeks for the excess of hemoglobin to disappear. These observers claim that the lungs develop a capacity to secrete oxygen from the alveolar air into the blood.

The effects of sunlight and out-door life among natural surroundings are apparent not alone in the physical changes they induce, but also in the psychic improvement of the patient. When proper attention is given to all of the items mentioned, also to digestion (see dyspepsia) the maximum good may be obtained.

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4 Cleaves—Light Energy, pp. 271, 322.

5 Starling—Fluids of the Body, p. 142.

6 Douglass, Hendane, Henderson and Schneider: The Physiologic Effects of Low Atmospheric Pressures, as Observed on Pike's Peak, Colorado; Proc. Roy. Soc. London (B), LXXXV, 65.

NEURASTHENIA

The management of neurasthenia by systematic hydrotherapy has been so universally successful that it is now regarded by neurologists as indispensable in the treatment of this condition. Moreover, the necessity for change of environment and efficient training of the patient in proper habits of diet, rest, exercise, etc., demand that for a time, at least, this be carried on in an institution fully equipped with the necessary appliances and manned with physicians and attendants trained in hydriatic technique.

The manifestations of nerve exhaustion are exceedingly protean. For this reason, individualization is perhaps more imperative in this than in any other disorder. It is necessary to carefully observe the effects of each treatment. While the statements of the patient in regard to these effects are not a sufficient guide, they should not be wholly disregarded. It may be necessary to make several changes before the most suitable measures have been settled upon. A mere training in technique is not all that is necessary for the physician to acquire. He should be thoroughly conversant with the scientific basis of physiologic effects, by close observation adapting these to the needs of the patient as experience shall direct.

The psychic element plays such a large part that, in case the patient takes a violent dislike to some procedure, not absolutely essential, it is best to substitute another of similar effect. We commonly encounter the idea that frequent baths are weakening. It is no small task to disabuse the mind of this. This and other imagined dangers are very real to the mind of the patient. Often, they may be overcome by utilizing some other notion as a placebo. We have, however, found straight-forward education the best all-around plan. This requires a great deal of time on the part of the physician, but the efforts are often well repaid in the long run.

The neurasthenic state is almost invariably associated with faulty digestion. The digestive derangement may be a large cause, a contributing factor or a result of the nerve exhaustion.

Where defective digestion is a prominent feature, special measures should be directed toward restoration of the normal function. The treatment of dyspepsia is considered in another place.

The overworking of any organ or function leads to exhaustion. The chief cause of nerve exhaustion lies in overactivity of the brain and nerves, accompanying deficient physical activity. Neurasthenia may, however, occur in an individual who is engaged in an occupation requiring constant bodily activity. Worry, grief, disappointment—financial or social—these all have their place in the causation of nerve exhaustion. A comprehensive view of the disease and its causes reveals the necessity for two classes of physiologic effects, viz., tonic and sedative: sedative, to assist in securing rest, the most essential element in building up lost nerve force; tonic, to restore normal nerve activity and hasten the building up process. No hard and fast lines may, however, be drawn between procedures directed to these ends. Tonic measures are, of course, in the long run conducive to normal rest, but they may also be immediately sedative in their effects. This peculiar paradox, that tonic measures produce sedation and sedative measures are tonic, exists only in the realm of physiologic therapy. One would not pick upon the bromides to restore the normal nerve tone or upon strychnine to produce rest or sleep. The special treatment of insomnia and the irritative neurasthenic state will be considered more at length under sedative effects (q. v.).

In beginning the treatment of a neurasthenic patient, it is well, at first, to test the reactive powers by mild measures which will produce no shock. Since first impressions are often very lasting, the initial treatment may consist of such forms of the bath as are not greatly different from those used at home. This serves to make the patient acquainted with the attendant and the attendant with some of the pecularities of the patient. The full warm tub bath and tub shampoo, finished with a warm and then a cool pail pour serves this purpose for a large number of patients. Since nearly all neurasthenics complain of cold feet and more or less abdominal distress, we frequently use the hot foot bath with fomentations to the abdomen. This may be made the second treatment and concluded with a wet hand rub or cold mitten friction. With this, or following closely, we utilize hot and cold to the spine, the revulsive compress, the pail pour, salt glow, and graduated spray. Later, after considerable reactive capacity has been developed, the cold towel rub and wet sheet rub may be used. The alternate spray, alternate douche, and shallow bath are quite vigorous means and should not be ventured upon in the agitative form of neurasthenia, or not until milder tonics have been used for some time.

The wet sheet pack, although an excellent tonic, as well as sedative means, is often objected to by the neurasthenic. He complains that it makes him nervous, he feels restrained, etc. The sitz bath at the various temperatures at which it may be used, is capable of most excellent results. For this purpose the tub must be deep enough so that the water will cover the greater part of the abdomen. Provided there are no local conditions requiring treatment, the sitz tub may first be filled with water at 98° which is gradually raised to 102° or 103° and then lowered to 90° or 85° just before the close, or it may be concluded with a cold pail pour to the hips (revulsive sitz). The second bath may be begun at 98° or 95° and, without raising the temperature of the water, gradually lowered to 85° or 80°. On each succeeding day, it is begun at a slightly lower temperature and finished with colder water, until it is essentially a prolonged cold sitz. The bath acts by reducing the blood supply to the abdomen and pelvis, decongesting the abdominal and pelvic sympathetics and restoring their tone. It aids in the relief of general splanchnoptosis.

About once a week the patient should be given a short electric light bath followed by a spray, or shampoo and spray. The electric light bath should be three or four minutes in length, sufficient to thoroughly warm the skin and produce beginning perspiration.

The old idea that the melancholic state is due to liver derangement (black bile) is not wholly without foundation. Wrong habits of diet, together with constipation, are large factors in the production of the depressed type of neurasthenia. Both of these crowd the liver with toxins and products of imperfect digestion. An overworked liver in time becomes a sluggish, torpid liver, incapable of performing its functions as a toxin destroyer and emunctory. In addition to general treatment and treatment directed toward the relief of indigestion and constipation, we have found alternate hot and cold applications to the hepatic area of special advantage. The revulsive compress, alternate hot and cold, and especially the alternate hot and cold percussion douche to the liver should be used frequently.

For cerebral congestion nothing is superior to the alternate hot and cold foot bath or the alternate percussion douche to the feet. The latter may be preceded by a short hot leg pack or hot leg bath with cold compresses to the head and neck.

The work cure for neurasthenia has been successful in the hands of a few physicians who have formulated a definite plan for such treatment. That which has been reported is largely in the line of indoor work. Much more successful is the use of gardening, floriculture and horticulture to employ the time and occupy the thoughts of the neurasthenic patient. These occupations take him out into the fresh air and sunshine, and to the extent he can be interested in "helping things grow," just to that extent the success of the plan is assured.

It has also been shown by Pansini[7] that the actinic rays of sunlight or artificial light increase muscular capacity, while red light has the opposite effect. Red light, of course, consists largely of thermic frequencies and hence its effect is essentially that of heat. Blue light (actinic ray) increases both the amplitude and number of contractions as shown by ergograms.

In a control test the muscles were able to lift 1.736 kilograms; before recovering from the fatigue of this test, they lifted 1.455 kilograms; and after the exposure to the light of a blue lamp, the total of the curve showed 1.848 kilograms, indicating not only the recovery from fatigue but a gain of .112 kilograms over the capacity of the unfatigued muscles.

The general program and the distribution of the treatments during the day are of importance.

It will be found that the best results are obtained by one tonic treatment a day. A short sedative treatment may be given in

7 Cleaves—Light Energy, pp. 301—303.

the afternoon or at night. If more than this is used, the afternoon treatment may consist of massage or electricity in some form. Too continuous a round of treatment limits the time for rest and out-of-door life and recreation, which are all important in neurasthenia. It is a mistake to allow the patient to insist upon local applications three or four times a day for local distresses, such as "backache" or "indigestion." They only serve to more firmly fix the patient's attention upon some minor ailment, and confirm his introspective tendencies.

The measures and plan outlined above, when given under careful supervision and combined with regulation of diet, exercise, rest, etc., will, if proper psychic control be not neglected, invariably result in the recovery of the neurasthenic patient.

SPLANCHNIC NEURASTHENIA

In many neurasthenic patients the distressing symptoms center about the abdomen. There is a feeling of weight and exhaustion accompanied by mental depression. The exacerbations of this state have not inaptly been styled "the blues," as the exciting causes are worry, disappointment, and such like nervous disturbances, which give rise to a temporary melancholia. The predisposing factors entering into this condition are constipation, auto-intoxication, dyspepsia, general nerve exhaustion, insufficient physical exercise, etc.

The immediate physical basis of splanchnic neurasthenia lies in an engorgement of the splanchnic blood-vessels, particularly of the veins. These vessels are capable of great distension when the vasomotors are rendered paretic through intestinal auto-intoxication, worry, grief, etc. A very rational plan of treatment, as far as this condition is concerned, is advised by Abrams.[8] This consists of various means intended to increase the abdominal tension and stimulate the splanchnic vasomotors for the purpose of relieving the visceral stasis of blood, and by means of a quickened splanchnic blood current, especially in the liver, directly increasing the hepatic destruction of poisons and hastening their elimination.

Abrams especially favors the use of the sinusoidal current for

8 The Blues; also Spondylotherapy.

this purpose. Applied by means of a stationary spinal electrode and a labile abdominal sponge, the treatment is certainly most effective. The abdominal muscles are powerfully stimulated by the slow sinusoidal current, thus increasing intra-abdominal pressure, but the greatest effect is upon the splanchnic vasomotors reflexly.

These patients experience much relief by assuming the horizontal position. The movement of "inspiratory lifting," as carried out in abdominal massage, also affords instant relief. The use of abdominal supporters, and the application of broad bands of adhesive plaster to the abdomen, in splanchnoptosis and splanchnic neurasthenia give relief as long as they are in place. Both these means, however, ultimately result in weakening the abdominal muscles, and so, unless accompanied by other treatment, defeat their own purpose. Where it is at all possible to strengthen the abdominal muscles, it is better to adopt some system of exercises especially calculated to develop them.

Of hydriatic means, the following combination is especially efficacious in splanchnic neurasthenia for the purpose of decreasing the splanchnic congestion. A hot foot bath with the cold Winternitz coil to the abdomen and cold compresses to the head and neck, continued for from twelve to twenty minutes, is the first part. A cold sitz of four to six minutes duration follows, and the treatment is concluded by a wet sheet rub. This is especially adapted to warm weather. During the winter months it may be necessary to apply more heat. With less vigorous patients, the first combination of hot foot bath with cold coil to the abdomen and cold compresses to the head may be continued thirty minutes or longer, and concluded with a cold mitten friction. These cold applications to the abdomen and pelvis produce decided and prolonged contraction of the visceral blood-vessels. The fan douche to the hepatic region and abdomen also accomplishes much the same results.

HYSTERIA

While some cases require a greater proportion of sedative treatment, nearly all require more or less of tonic treatment.

The chief result to be obtained by tonic treatment is the restoration of tone to the neurons, so that, by training, self-control becomes possible. The methods outlined for neurasthenia are all applicable in hysteria.

DYSPEPSIA

The special treatment necessary in this condition will be considered later, but local measures unaccompanied by general tonic treatment are often insufficient to accomplish full return to health. The measures recommended for anemia and those necessary in neurasthenia are all applicable in altered states of the digestion.

PULMONARY TUBERCULOSIS

The recovery from pulmonary tuberculosis is essentially a matter of vital resistance. Hence, efficient treatment resolves itself into means for the promotion of this vital resistance and the improvement of nutrition. These means are fresh air, sunshine, and diet, together with other measures which have tonic effects. Although early tuberculosis has proven one of the most curable diseases by these hygienic methods, yet no hard and fast lines can be laid down for their employment in individual cases. The exercise of enlightened and scientific common sense is especially necessary in dealing with this disease. Not all patients can eat the same thing. While milk and eggs may form a sort of dietetic center for the improvement of nutrition, yet these must be intelligently used; nor should other articles, such as cereals and fruits, be neglected. The latter are especially useful in maintaining the alkalinity of the blood and improving urinary elimination. The nutrition may be pushed by a milk diet in some cases with most excellent results, while other patients do not bear this method well. Like all exclusive methods, if used, it should be for a limited time only and for the accomplishment of certain results, return then being made to a more general diet, by which only *all* the needs of nutrition can be permanently met. The tuberculous patient requires as careful dietetic treatment as that given to the patient with a gastric or intestinal disorder only.

In regard to fresh air, it must be insisted that nothing less than twenty-four hours of outdoor air will accomplish the best results. This means that proper sleeping arrangements should be provided, so that fog and dampness will not interfere in climates where these are prevalent. Of course, if possible, a change should be made to a dry climate. Whether this should be a warm or a cold dry climate, a moderately high or a low altitude, will depend upon the stage of the disease and upon the needs of the individual case. An altitude of 4000 to 6000 feet is beneficial to those who are not nervous, and when healing in the lung has progressed sufficiently to be assisted by the lung gymnastics of deep breathing.

The patient with a rise of temperature above 100° should observe complete rest. With the temperature between 99° and 100°, complete rest is not necessary; the patient may be up and about, but rest is still the rule. The full sun bath—direct exposure of the entire skin surface to the sunlight—is the most beneficial form of light therapy. The Kime or other reflector for the concentration of actinic rays upon the chest is a very useful means of promoting healing. The sun bath improves the nutrition, increases cell division and growth, stimulates hematogenesis, and increases oxidation. It stimulates capillary circulation, so as to do away with the symptoms of poor circulation—cold hands and feet. It improves the psychic condition of the patient, a result which is not to be lightly esteemed.

In regard to hydriatic tonics, we must caution the physician against anything but those of a very mild nature. Fomentations to the various portions of the body, together with the cold mitten friction, is all that we have found beneficial. General tonic baths, sprays, and douches had best be omitted entirely. Of course these may be used in building up the resistance of one who has recovered, but they are *not* to be used in the *treatment* of the disease. Fomentations to the chest are useful in the treatment of pleurisy and the relief of pain, drawing, and other abnormal sensations. The cold mitten friction is also one of the best means of checking night sweats. Its action is directly upon the vasomotor and secretory nerves. But back of this, by its tonic effect, it helps to do away with the asthenia, which is the ultimate cause of the excessive sweating.

Altogether the general hygienic management of tuberculosis by fresh air, sunshine, and ample feeding, is of greater importance than hydrotherapy, which occupies a minor but helpful place in its treatment.

INSOMNIA

Treatment of this condition will be considered under sedative effects. A large number of cases occurring in business or professional men may be treated almost wholly by tonic measures, since normal fatigue is lacking because of insufficient exercise. Tonic treatment is directed toward the production of moderate fatigue, so that sleep may be induced as a natural consequence. The tonic measures listed at the first of this chapter are nearly all applicable in this condition, and should be accompanied by active exercise in the open air.

CHRONIC INEBRIETY

In chronic alcoholic poisoning the tissues are in a state of lessened activity. Alcohol circulating in the system for months or years tends to harden the tissues, causing an over-production of fibrous connective tissue and lessening the activity of parenchymatous cells. In order to overcome this partial pickling process, it is necessary to use the most extreme measures, such as extreme hot and cold, to wake up the deadened tissues, especially the brain and nervous system. Immediately following a spree, measures should be directed toward the rapid elimination of the alcohol imbibed. If the patient is still under the influence of the liquor, he may be held under the cold shower to stimulate the nerves and hasten the circulation. After the immediate danger is passed, he should be given full hot tub baths or the electric light bath, accompanied by the drinking of large quantities of water. These measures hasten the elimination of the alcohol. Any hot treatment should be followed by the hot and cold spray or shower. The hot and cold douche is an excellent means of stimulating activity. In those cases that have been very much reduced by long years of dissipation, it may be necessary to employ milder measures, such as the neutral bath, the wet sheet pack, fomentations, and the cold mitten friction.

CHRONIC ARTICULAR RHEUMATISM

It is the usual custom in gouty rheumatism to employ extreme sudorific measures. Such treatment, unaccompanied by tonic measures, is applicable only in obese rheumatics, and in those cases only for a limited time. While any form of cold treatment may temporarily increase the stiffness and soreness, it is quite essential that these patients should be given tonic treatment. The cold mitten friction is probably the best measure, since it quickly produces a reaction and can be given to all parts of the body, avoiding the joints. Tonic measures are necessary, not only to assist the heat in increasing the oxidation and elimination of toxines and the surplus of nitrogenous material, which, by long crowding with proteid foods of high purin content, has become well fixed; but also to increase the building up process and the general body weight.

DIABETES

Diabetes is a condition in which the system is unable to warehouse and consume the carbohydrate of an ordinary diet. The disease may be classified under two heads: First, an alimentary form in which withdrawal of carbohydrate from the diet for a time produces a cure, *i. e.*, the body is thereafter able to utilize a moderate amount of sugar. This is looked upon as a functional disease, although, as remarked below, it may be due to partial destruction of the ductless glands of the pancreas. Second, a permanent or organic diabetes in which excretion of sugar continues after the withdrawal of all carbohydrate. It has been pretty well proven that destruction of the islands of Langerhans is the causative lesion in the majority of cases. These ductless bodies are believed to secrete a glycolytic or oxidizing ferment (oxidase), which has the ability to break up and oxidize the sugar molecules. This occurs in the general system, but principally in the muscles. If about one-tenth of the pancreas remains intact after partial extirpation, diabetes results only on ingestion of carbohydrate. According to Thoinot and Delamere, Langerhans insufficiency is found in about 80 per cent of cases. Defect in the glycogenic function of the liver may also cause permanent diabetes.

The usual treatment of diabetes is directed toward securing but one end; *viz.*, decreasing the excretion of grape sugar by lessening the ingestion of carbohydrates, substituting proteid (chiefly meat), as recommended by von Noorden. Chittenden[9] has recently shown that the ingestion of proteid, above a certain minimal requirement, which he sets at about 35 to 60 grams, results in a very few hours in the excretion of practically all the surplus nitrogen in the form of urea, the residue being simple carbohydrate not distinguishable from the carbohydrate taken as such. Such a process can hardly be said in any way to conserve the body powers. The great amount of useless labor demanded of the liver by such a diet must result in overworking that organ. All this occurs, to say nothing of the detrimental effects of flooding the system with purins from the large quantities of meat which the von Noorden diet necessitates. While temporary exclusion of carbohydrate from the diet with a gradual return to a moderate ingestion of starches and sugars is quite essential and an effective plan for the dietetic management of diabetes, this alone does not meet the needs of the condition. The real cause of the disease lies in altered carbohydrate metabolism. The sugar passing through unoxidized causes a loss of energy that should accrue from this source. In other words, the carbohydrate fuel falls through the grate before being burned, because of lack of proper regulation of the fire. Lessening the amount of fuel, while a most important factor in treatment, only partially remedies the defect.

The rational management must, therefore, aim at increasing the oxidation of grape sugar, and thereby preventing its elimination in an unoxidized state with the consequent energy loss. There are no known medicinal agents or even any mode of dietetic management which will accomplish this result. Experiment has revealed the fact that nothing so greatly promotes oxidative changes as exercise in the fresh air and tonic hydrotherapy. The effects of these agents on carbonaceous metabol-

9 Nutrition of Man, p. 131.

ism we have already considered. Because of the languor, lessened vitality, and great susceptibility to fatigue which is an almost constant accompaniment of diabetes, it is often difficult not to say unwise, in many cases to pursuade the patient to exercise. When there is much loss of vitality the exercise must be of a passive nature, *i. e.*, secured by massage. Massage stimulates the glycolytic powers of the muscles, improves the circulation, and aids nutritive changes. More important than this, however, are the effects derived from applications of cold water accompanied by friction or percussion. Cold frictions, cold douches, and mild alternating hot and cold applications effectually stimulate metabolism. Those hydriatic measures which are accompanied by strong mechanical stimuli have double the effect of cold applications without friction or percussion. Cold douches have been shown to increase oxidation more than 100 per cent. These means also improve the nutrition of the skin, and so aid in preventing many of the annoying cutaneous complications.

Graham Lusk reports a series of experiments on the influence of cold baths on the glycogen content of man in which he shows that extreme cold treatment so greatly enhances oxidation as to quickly change the aspect of combustion from support by carbohydrates to support by fat. These experiments were done with normal individuals. From this report[10] we quote the following:—

"During the shivering which followed the second cold bath the metabolism, as measured by the heat production, was 63 per cent higher than during the subsequent resting period, but the respiratory quotient of 0.75 remained unchanged during both periods. It is evident from this experiment that *the influence of two successive cold baths, which cause shivering during a period when the intestine is free from carbohydrate, is sufficient to change the metabolism from one maintained at the expense of carbohydrate (R. Q.=0.99) to one maintained essentially by the combustion of fat (R. Q.=0.75). Hence the organism of man may be quickly rid of glycogen by shivering.*

10 The Influence of Cold Baths on the Glycogen Content of Man, American Journal of Physiology, Vol. XXVII, No. V, p. 427.

"The greatest increase in heat production, which was brought about by the cold baths, was 181 per cent above the normal. The urine remained free from albumen and from sugar."

In connection with the oxidation of sugar, it is interesting to note the results obtained by two French observers[11] from the inhalation of ozone in patients suffering from glycosuria:—

"Labbe and Perochon have their patients with glycosuria inhale ozone for from fifteen to thirty minutes a day, and have found that in some way it promotes the utilization of sugar, so that sugar disappears more or less completely from the urine. Eight typical cases are described to show the benefit thus realized. In one case, for example, a man of 57 had had diabetes for six years, and 50 gm. of sugar were found in the liter of urine. He inhaled ozone for fifteen minutes a day for two months, by the end of which time the sugar had vanished from his urine. Two weeks later the sugar appeared anew in the urine and ran up to 8 gm., but subsided to traces on resumption of the ozone treatment. Another patient was a woman of 66 with diabetes for many years. She had 150 or 200 gm. of sugar to the liter of urine, and this became materially reduced under the ozone treatment and her severe pruritus became very much improved."[12]

In the practical application of hydrotherapy the treatment must be carefully graduated and mild tonics used at first, because of the lowered vitality of almost all diabetics. Local hot applications followed by the wet hand rub or cold mitten friction may be used to begin with, also the neutral faradic tub, graduated shower, and cool affusions. After becoming accustomed to these treatments the patient may, if in good flesh, be given a wet sheet rub, dripping sheet rub, cold shallow bath, and alternate douches. In some cases the cold plunge may even be ventured upon. As rapidly as able, the patient should be encouraged to take moderate exercise in the open air; the effect is greater if the air is cold. These measures improve the appetite and stimulate digestion and assimilation. The feeling

11 Labbe and Perochon—Ozone in the Treatment of Glycosuria, Presse Medicale, March 19, XXI, No. 23.

12 Abstract in Journal of American Medical Association, April 26, 1913.

of languor and debility gives way to a greater inclination to exercise, and so hydrotherapy indirectly makes possible the use of the other great aid in oxidation—bodily activity.

With thin diabetics, the prognosis is less favorable. They can take only the milder tonic treatments. Neither do they bear well any great reduction in the diet. But even with such unfavorable conditions, astonishingly good results may be obtained by carefully graded hydrotherapy combined with light massage. Much time should be spent in the open air and sunshine, careful attention being paid to general hygiene and especially to good skin activity.

CEREBRAL CONGESTION

Due to the Effects of Sunstroke or Heatstroke

Patients who have once suffered from sunstroke must select a cold climate in which to live. Even moderate heat for any length of time produces harmful results. It would seem that in this condition the vasomotor centers have been so interfered with that there is a loss of vascular control. This may, in some cases, be so extreme that even a short hot treatment limited to a small area may induce general vaso-dilatation with a special tendency toward cerebral congestion. The condition is best treated by cold applications accompanied by friction. *No hot applications at all should be used.* During all treatment, the head should be kept cool by cold compresses and the ice bag, or the ice cravat to the neck. The cold mitten friction, cold towel rub, wet sheet rub, cool or cold showers and sprays may all be used according as the conditions indicate. If the brain seems unduly congested a great deal of the time, derivation is best secured by the cold percussion douche to the feet.

Much the same line of treatment is to be pursued in chronic nitroglycerine poisoning, which occasionally occurs in miners. This may be very troublesome. It is accompanied by severe headaches, in some cases assuming a migraine type. In treating these patients, the cerebral circulation should be steadied by bathing the head in cold water before other treatment is begun, which latter should consist of cold showers, cold percussion douches, and the cold plunge. If milder measures must be used, the cold mitten friction with ice water gives excellent results. However, these patients bear much more extreme cold treatment than any other class, and seem to have no difficulty in reacting.

VALVULAR HEART DISEASE

Etiology and Pathology

Organic heart disease refers to such diseases of the heart as are due to gross structural changes. The term is applied almost exclusively to chronic valvular disease. In the larger number of cases this is the result of some acute inflammatory condition on or about the valves. These valve inflammations may arise as complications of rheumatic fever, tonsillitis, scarlet fever, sepsis, gonorrhœa, pneumonia, pleurisy, or pulmonary tuberculosis. Predispositions are found in prolonged and heavy muscular exercise, auto-intoxication, gout, alcoholism, syphilis, Bright's disease, and arterio-sclerosis. The result is a valve orifice either too large or too small. Scar tissue following the inflammation may cause the valve segments to adhere to each other and so, by partially obstructing the orifice, cause stenosis; the valve leaflets may be partially destroyed or their attachments weakened so that the orifice is too large, or the heart dilated so that the segments are incompetent to close the opening.

In the first case, that is, stenosis, too little blood passes through the orifice and extra force is required to overcome the obstruction. In the latter case, part of the blood returns through the enlarged opening or past the incompetent valves, so that regurgitation takes place at every heart beat. Because of the former condition, the first change in the heart muscle is that of hypertrophy. In the second condition, the first change is that of dilatation of one or more cardiac chambers. If compensated, both conditions result in great hypertrophy and thickening of the muscular wall. The maximum force of the heart will be greater than normal, but the work required of it is also greater, so that in this condition, its reserve force above what it ordinarily uses is less than the normal reserve. Here the heart is said to be in a state of *compensation*, since the muscle is so much hypertrophied as to still be able to perform its work under ordinary circumstances. Sometimes there is little or no such reserve, *i. e.*, the heart may have barely enough force for its work when the body is at rest. In this

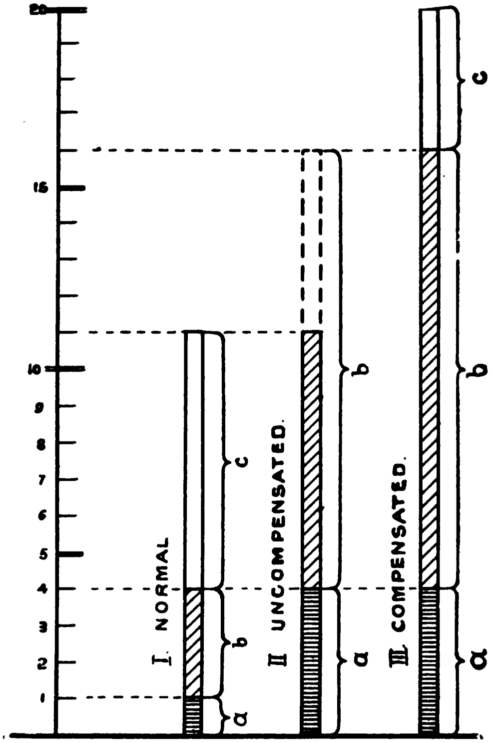

Fig. 54. Diagram showing dynamic conditions in valvular heart disease: A—force required at rest under conditions indicated, B—additional force demanded by moderate muscular work, C—reserve cardiac force above that needed for moderate work.

condition, the heart is said to be in a state of ***broken compensation***. This state, that is, where the maximum force is in constant use, is revealed by such symptoms as edema, cyanosis, dyspnœa, heart pang or distress, rapid pulse, palpitation, sleep start, enlarged liver, etc.

Moderate muscular work demands four times the energy used at rest, and the total reserve power of the heart muscle is from eleven to thirteen times the normal output during rest.[13] This proportion is shown in *Fig. 54 I.* In the case of valvular lesions so bad as to require three or four times the usual expenditure of energy, it will be seen that only during complete physical rest will the heart be able to accomplish its work (*Fig. 54 II.*). Moderate muscular exercise will demand more energy than it possesses, and so will be accompanied by signs of broken compensation. In order that compensation may be restored, the muscular wall must nearly double its thickness to possess even a little reserve force, as shown in *Fig. 54 III.*

Treatment

It will be readily seen that the above conditions set forth two indications for treatment: First, so shaping conditions that the heart may be given opportunity to increase its muscular tissue and thereby its reserve force; second, as much as possible, relieve the heart of part of its work, not only temporarily in order to bring about the condition just mentioned, but also to constantly assist the overtaxed organ. These indications are met in the following procedures:—

1. **Rest—Physical and Mental.** This is first and foremost in importance. It is necessary that absolute physical rest be observed in the state of broken compensation. Exercise should not be permitted until the heart has acquired at least some reserve force. According to the gravity of the case, physical rest may be secured by absolute quiet in bed, by rest in a wheel chair with an attendant, or by restricted exercise. While at rest the body tissues demand less oxygen, and consequently less rapid circulation. It is quite as essential to eliminate all nerve strain, such as worry, apprehension, business or social cares, etc. Through the avenue of the sympathetic system, these irritate and overstimulate the intrinsic nerves of the heart muscle.

2. **The Ice Bag to the Heart.** This is one of the most efficient means we possess in its ability to produce direct tonic effects upon the heart muscle. Prolonged, continued cold lessens the rate and increases the length of the period of rest

13 Hutchison Applied Physiology, p. 116.

(diastole). It also shortens the systole and increases its force. The ice bag should be well wrapped to modify the intensity, so that the application may be prolonged. In some cases, the cold compress is to be preferred. While the ice bag tends to increase the force of the systole, it can hardly be said to come under the head of pure stimulants, since by its repeated use, the effects of over-stimulation are never seen. It always exercises a beneficial effect in aiding hypertrophy of the heart muscle, since by its shortening the systole and increasing the length of the diastole, the actual period of rest is increased. It may, therefore, be said to be a true physiologic measure.

3. Measures which Stimulate the Peripheral Heart, performing part of the work of the circulation, increasing its activity, and so aiding the central heart. In the chapter on the *peripheral heart*, we have discussed at length the physiology of the blood-vessels, their normal action, and the rationale of the measures used to increase this activity.

We need here only briefly summarize the facts already pointed out. Independently of the heart, the blood-vessels exert a pumping or propulsive action upon the blood stream.

Lauder Brunton [14] makes the following observation relative to this activity: "When working under Professor Ludwig in 1869, he directed my attention to the contractile power of the small arteries apart from any nerve center, and while watching their movements I have sometimes seen a regular peristaltic action take place, by which the blood was driven forward in the arteriole just as fæcal matter would be driven forward in the intestine."

"Franke discusses the various theories prevailing in regard to the functional importance of the peripheral blood-vessels. His conclusions reaffirm, he asserts, that the peripheral vessels have an independent pressure and suction action similar to that of the heart. This assumption is sustained by their anatomic structure, physiologic experiments, direct observation of the blood-vessels in living animals, and in certain pathologic conditions in man. At the points where there is the greatest resistance to the circulation, Nature has placed a system of

14 Therapeutics of the Circulation, p. 5.

especially powerful blood-vessels like a second peripheral heart, as in the portal and intestinal vessels. Compensation may fail from disturbances in the peripheral vessels as well as in the heart itself, and the peripheral system may compensate the heart at need; the vessels in the abdomen especially are the last resort of all means to maintain the balance of the circulation. These views, he considers, explain the beneficial effects of gymnastics, massage, and baths.'' [15]

In disease, as long as there remains any vasomotor control at all, the activity of the blood-vessels may be stimulated by applications to the skin surface. The condition of the blood-vessels to be sought in the treatment of valvular heart disease is that known as active dilatation, not only of the arterioles, but also of the other blood-vessels. It consists of an alternate contraction and relaxation occurring at regular intervals. It is, in short, a pumping action. It is often astonishing to note the amount of assistance rendered the circulation in this way, as shown by prompt decrease in the pulse rate following, or even during, some of the procedures listed below. These may be given separately, combined in one treatment or at different times during a course of treatment, as indicated by conditions in the individual case.

(*a*) *Massage.* Friction is perhaps the mildest of measures by which the peripheral circulation may be stimulated. It stimulates the arterioles and, by proper movements, the venous circulation is hastened. All the other procedures of massage are also vasomotor excitants.

The procedure of deep kneading accomplishes more than the other movements of massage. It acts upon the circulation in almost the same manner as exercise. The alternate compression and release of the muscles forces on their contained blood, so that the rate of flow is greatly accelerated. Lauder Brunton records [16] graphically the results of some interesting experiments showing the increase in the rate of venous outflow from muscles during and after massage. In some instances the rapidity was increased two or three times the normal rate.

15 Abstract in Journal of American Medical Association of article by M. Franke in Wiener klinische Wochenschrift, March 10, 1910, XXIII, No. 10, p. 347.

16 Therapeutics of the Circulation, p. 135.

Mechanical vibration is quite similar in its effect to manual massage. Vibration, when properly given, is an excellent means of assisting the peripheral circulation, especially that of the feet and limbs. Vibration may also be given to the back and other parts, as indicated.

(*b*) *Hydriatic Vasomotor Tonics.* The cold mitten friction has the greatest range of adaptability in organic heart disease. It can be used in all stages from the inception of the acute endocarditis through all the varying conditions of established or broken compensation. This is largely due to the readiness with which it may be made a mild, medium, or powerful vasomotor tonic and stimulant. This can be accomplished by varying the temperature of the water used and altering the amount and vigorousness of the friction given. We have never observed, even after the most vigorous cold mitten friction, or its long use over a period of months, any overstimulation such as does sometimes occur with the effervescent bath. The cold mitten friction and ice bag can be used in the acute stage of endocardial inflammation, while it might be dangerous to use the Nauheim bath in this stage. There are many other hydriatic measures similar in effect to the cold mitten friction. Each has its advantages and special indications, as well as limitations. The following is a list of the more important and commonly used hydriatic measures in the treatment of organic heart disease: The salt glow; hot and cold to the spine; hot and cold douche to the spine, legs, and feet; the alternate hot and cold foot or leg bath. Brief fomentations followed by a brisk but brief cold mitten friction may be given to any part of the body as a means of stimulating the peripheral circulation.

(*c*) *Nauheim or Effervescent Bath.* The essential feature here is the chemical irritation of the skin produced by the carbon dioxide and salines with which the water is charged. Natural carbonated waters can be secured in only a few localities, but the carbonic acid gas may be produced artificially in any one of several ways. It powerfully stimulates the vasomotors, having, however, a cumulative action on the vasodilators [17] so that the heart is left without a resistance governor.

17 Hare—Practical Therapeutics.

For this reason it is necessary to discontinue the treatment at intervals in order to obviate palpitation and other disturbing symptoms. The cutaneous irritation also reflexly stimulates the heart (Hare). This may be another factor in the production of palpitation by over-stimulation. The cooler the water the less likely its occurrence.

When the patient first begins to take the Nauheim bath, it should not be continued longer than about eight minutes at a temperature of 95° F. Five minutes may be better in some cases. An ice bag or cold coil should be placed over the heart. The bath may be repeated two or three times a week for from two to four weeks. It is usually best to give a course of about twelve treatments, when two or three weeks should be omitted. In each succeeding treatment the temperature of the water may be slightly lowered until the bath is taken in water even as low as 80°. The duration of the bath may be increased up to twelve, or under exceptional circumstances, fifteen minutes. The longer the duration of each bath and the more frequent its repetition, the greater is the liability to over-stimulation. This is evidenced by palpitation, tachycardia, cyanosis, and dyspnœa.

When carefully given, the Nauheim bath is one of the most useful of vasomotor stimulants and tonics; certainly it is the most powerful. In a single treatment administered to a patient with a dilated heart, the area of cardiac dullness may be reduced in diameter by as much as three-quarters of an inch or even a little over an inch. These results are not occasional, but are the general rule. The ice bag is very useful in maintaining this effect. A very large cardiac liver may be reduced to normal by a course of such treatment combined with other physiologic vasomotor tonics. These results are graphically shown in the accompanying physical chart (*Fig. 55.*).

(*d*) *Resistant Gymnastics.* This system is known as the Schott treatment. As carried out by the Schott Brothers, it is combined with the Nauheim bath. It consists of a series or system of graduated exercises. At first the patient is assisted by the attendant; later, with apparatus or alone. First one group of muscles is exercised and then another, until the principal muscle groups of the body have been gone over. For example, while the attendant resists, the patient gradually contracts the biceps, flexing the forearm. When the forearm has been flexed, the patient contracts the extensors while the attendant resists the movement. This is gone through with a number of times for each group of muscles. With each succeeding treatment the number of movements and the strength

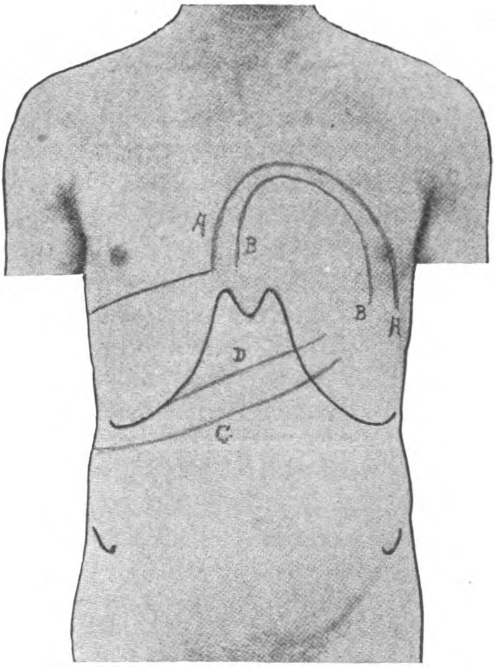

Fig. 55. A—border of cardiac dullness in a case of dilated heart. B—same after a single Nauheim bath. C—lower edge of congested (cardiac) liver. D—same after a course of tonic hydrotherapy.

of the resistance is increased.[18] The gradual contraction and relaxation of first one and then another group of muscles hastens the peripheral circulation and tends to induce the state of active dilatation of the blood-vessels. This treatment should not be applied in acute endocarditis, but is applicable in the chronic stage where compensation is not seriously broken.

18 For details see McKenzie—Exercise in Education and Medicine, p. 328.

(*e*) *Oertel Method.* General exercises, such as walking, use of the arms, etc., follow as a natural consequence of the method just described. As a system, the Oertel method consists in graduated climbing exercises, up hills of various grades and finally even mountain climbing. At first, the patient walks for short distances each day; and later, longer distances and up steeper grades. This is, of course, applicable only where a fair degree of compensation has already been established; never when the compensation is broken or in the slightest impaired. Where systematically followed for months or years, it has resulted in much good and will secure for the patient the maximum cardiac reserve.

These measures combined with careful diet regulation, fresh air, and sunshine will give results which often appear like a complete cure, but of course, do not remove the defect in the heart. At the beginning of the incompetency, the progress may be stayed for years. The promptness with which these measures act and their efficiency has to be seen to obtain a real appreciation of their value. For example, the ice bag to the heart, accompanied by a cold mitten friction, may reduce the pulse from 115 or 120 per minute to 100 or less within fifteen or twenty minutes. In case of a dilated heart, the cardiac dullness may decrease more than an inch in diameter and the apex retract half an inch or more toward its normal position following a single treatment. In case the valve is relatively insufficient, the murmur occasioned by this insufficiency may entirely disappear, whereas before treatment, it may have been considered to constitute a real organic lesion. The minor murmurs of the valves secondarily affected often disappear following a treatment of fifteen minutes with the ice bag to the heart and the cold mitten friction, or ten minutes in a Nauheim bath.

Contraindications. Extreme stimulants and excitants are contraindicated in organic heart disease, unless it may be in emergency. For this reason, the percussion douche to the chest, wet sheet rub, the cold plunge, and such measures should not be used. The use of electricity in any form may produce shock. The electric light bath is usually contraindicated or, if used at all, it must be in those patients which have acquired a good degree of compensation, and then only for a short time. All other extreme sudorific measures are contraindicated.

General Program

We have already outlined under the head of endocarditis the treatment for the stage of acute inflammation. As soon as the endocardial inflammation subsides, the patient may be given daily or three times a week a light general massage, avoiding the chest. The ice bag should be applied to the heart four or five different times during the day, being kept in place from twenty to thirty minutes each time. Once daily the patient should have a treatment consisting of a combination of some of the following measures: Hot foot bath, fomentations to the abdomen, hot and cold to the spine, cold mitten friction, and cold towel rub. This tonic treatment is best given during the forenoon. The massage may be reserved for the afternoon or evening. If there is much restlessness or insomnia, it may be best to give a hot and cold foot bath just before retiring. During this time the patient should be kept in bed; but when the pulse has become normal, he may change to the wheel chair, and later, be allowed about the room, walking a few steps or for short distances only. The pulse should become normal before any regular walking exercises are taken. The patient may now be given a salt glow, alternate douche to the feet and legs, graduated shower, etc. The Nauheim bath may be given after the temperature has been normal for a month or two. This should be followed by the Schott treatment, which at first should last only a few minutes and consist of mild exercises. Later this may be prolonged and increased in severity.

In case the patient comes under observation during the chronic stage, with compensation broken, the treatment may be begun at this point or perhaps with milder measures. The resistant movements should not, however, be used during the stage of broken compensation. Care must be taken that the patient is not treated too frequently. This may often seem necessary, but it will be found better to allow the patient sufficient time for rest. Three treatments a day are usually ample and only one of these should consist of the more vigorous stimulating measures. The evening treatment should be mild in character, sedative, and conducive to sleep. The afternoon treatment may be the hot and cold foot bath followed by massage. This at first should be mild and not last more than fifteen or twenty minutes.

Complications

Edema. The edema of the feet and legs accompanying cardiac disease will improve as compensation is restored, so that all of the measures recommended during the stage of broken compensation will aid in the reducing of the dropsy. The local measure which we have found most useful is the alternate hot and cold leg bath. The water should come sufficiently high to more than cover the edematous part. The limbs should be immersed in hot water for one and a half to two minutes and then in the cold for ten to fifteen seconds. It is best to make the hot water as hot as can be borne, gradually adding more hot water as the toleration increases. The cold water may, at first, be used at a temperature of 50°—70° F. Later, chunks of ice should be put into the receptacle for the cold water. From five to ten changes may be made at one treatment. The limbs should be dried from the cold water, and the drying followed by massage consisting principally of centripetal movements. The limbs should be kept elevated until the edema has nearly all subsided.

In the minor grades of edema, that is, where there is swelling only about the ankles, vibration may be applied to the feet by means of the vibrating foot machine. The hot and cold leg bath, together with massage, should be repeated daily.

Congestion of Liver. The liver may remain congested for some time after the heart condition has materially improved. Because of the nature of the hepatic tissue, the organ tends to remain enlarged. The passive congestion does not readily respond to treatment. In spite of these facts, an enormously enlarged liver may be caused to return to nearly normal size by a month or two of vigorous treatment. The patient should be given large fomentations over the liver. It will be found helpful to place an ice bag under the center of the fomentation.

The ice, having a greater reflex effect, tends to contract the blood-vessels of the liver, while the hot application shows its effect chiefly in derivation. Alternating with this treatment, the revulsive compress or hot and cold to the liver should be used. The alternate douche to the hepatic region is one of the best measures that can be used. While acting somewhat indirectly by a derivative process, the hot and cold leg bath will be found to be as efficient as the local treatment.

Acute Edema of the Lungs. This condition may come on because of chilling and nervous shock. The heart becomes engorged and the chambers dilated at the same time. The patient should be immediately wrapped in a large blanket, the feet and legs being placed in hot water and an ice bag held against the precordia. It is usually necessary for the patient to sit up. The ice bag may be removed every three or four minutes, the skin being warmed by brisk rubbing. Another attendant should apply to the spine a large fomentation, so as to cover its entire length and breadth. When the skin is well reddened, a brief but very cold and brisk cold mitten friction should follow. Another fomentation should be applied to the spine, or the part may be dried well and covered with the blanket. Each arm and leg should be treated in a similar manner, that is, the skin well warmed and reddened by a fomentation and immediately followed by a cold mitten friction. Each part should be thoroughly dried with a rough towel, and the drying followed by friction with the bare hand until the part is again warm and red. The object to be obtained in this treatment is the drawing of the blood from the heart and lungs to the skin and skeletal muscles. However, this can not be effectually done by hot alone, but must be accomplished by what may be termed "collateral fluxion," that is, the blood-vessels of the surface must be stimulated to unusual activity, so that the blood will be held in the periphery. This not only acts powerfully, but leaves no bad after effects such as are frequently noticed when these complications are treated by digitalis, nitroglycerine, and strychnine. Neither are these latter stimulants able to accomplish the desired result in extreme cases. In a few hours the moist rales in the chest, which can at first be heard at some distance, will have entirely disappeared. The finer crepitant rales which remain in the bases of the lower lobes should clear up in from one to three days.

Palpitation and Arrhythmia. These conditions are largely due to digestive disturbances, especially that form of indigestion accompanied by gas formation. The treatment should, therefore, be directed toward the relieving of constipation and decreasing of amylaceous dyspepsia. It may be necessary to avoid even moderate quantities of starchy foods unless most thoroughly dextrinized. Tachycardia is best controlled by the ice bag, cold mitten friction, rest, etc. Nervous disturbances, nerve fatigue, etc., are also responsible for temporary arrhythmia.

OBESITY WITH FATTY HEART

It is not safe to employ extreme sweating measures in obesity accompanied by fatty degeneration of the heart muscle. Consequently, the treatment of these cases at the hot springs is a dangerous procedure. They must be treated in much the same manner as valvular heart disease. The patient should be kept at rest with an ice bag over the heart for a considerable portion of the time. Beside this, the patient should be given cold mitten frictions, cold towel rubs, hot and cold to the spine, general massage; and later, the alternate douche to the spine and legs, hot and cold foot bath, wet sheet rub, etc. Treatment should be very carefully graduated so that the heart is not subjected to over-stimulation before it has sufficiently increased its strength.

EXCITANT AND STIMULATING EFFECTS

In many emergencies it is necessary to employ extreme stimulating measures. These aim at the sustaining of vital activity in order to tide the system over a crisis, or until such time as the natural vitality of the patient comes to his assistance. Such measures are especially directed toward the heart, blood-vessels, and respiration. In collapse, surgical shock, drowning, and asphyxia, these measures are indicated. As we have noted many times, the greatest amount of assistance to the heart can be given by vigorous stimulation of the peripheral blood-vessels. In addition to such measures, certain applications may be used which have a direct reflex effect upon the heart itself. The most efficient reflex stimulation comes through the accelerator nerves. Short very hot fomentations may be applied to the front of the chest, covering well the heart area. This should be continued from thirty seconds to a minute, and immediately followed by the rubbing of a cake of ice over the heart. The extreme change in temperature produces powerful stimulation. The part should be immediately dried, after which a second fomentation, very hot and continued for half a minute or more may be used, again followed by the ice rub. After three or four such applications, it is well to rub vigorously with the bare hand the skin of the precordia. These procedures may be given at the same time as artificial respiration.

A very efficient stimulating measure is the slapping of the chest with a cold wet towel. If this is done during the movements of artificial respiration, it should be given while the inspiratory movement is made. In the asphyxia of the new-born infant, thermic applications are indispensable. If slapping of the chest and buttocks does not produce respiration, it is well to employ the alternate hot and cold immersion. Two large dishpans will be found handy containers for the hot water and the cold water. The hot water must not be hot enough to produce a burn or even erythema. It must be of such a temperature as may be well borne on the back of the hand or the cheek. The cold water should produce decided excitation, but ice water should not be used. The child should be held in the hot water for ten or fifteen seconds, and then merely dipped in the cold water. It should then be returned to the hot for about the same length of time and again dipped in the cold. Another plan which has proven equally effective is rubbing the chest with a smooth cake of ice while the infant lies in the hot water. These procedures are usually the most effective stimulants that can be used. All other means of resuscitating the new-born have their place and applicability. The physician should not too readily become discouraged in working with an asphyxiated infant. It may require half or three-quarters of an hour to so stimulate the heart and respiration that the child will continue to breathe without artificial means.

Uterine Stimulants

Uterine excitation may be necessary in order to produce two different classes of effects, viz., contraction of the uterine muscle and production or increase of menstrual flow.

Oxytocic Effects. In cases of inertia uteri, much may be accomplished without the use of forceps. That which has given us the best results, producing the most powerful contractions, has been the use of the ice bag or cold compress to the lower abdomen, applied intermittently, especially just at the beginning of the pain, or short intermittent applications of cold to the breasts. Alternate hot and cold applications may also be made to the lower abdomen. Both areas are in direct reflex connection with the uterus and produce powerful uterine contractions. These measures are less disagreeable to the patient than manual stimulation through the abdominal wall, and, on account of the tenderness often produced by this method, are to be preferred when they produce the desired result.

Emmenagogic Effects. Wherever amenorrhœa is due to pelvic anemia, it is necessary to supplement the general tonic treatment by special stimulating treatments directed toward the pelvic organs. This may be accomplished by the cold percussion douche to the lumbar and sacral regions, or the cold douche to the lumbar spine and feet. Hot vaginal irrigation is applicable in all cases. In some cases, alternate hot and cold vaginal irrigation may be used. The revulsive sitz is applicable in cases of extreme pelvic anemia. It may be followed by the cold lumbar and sacral douche. This douche should be accompanied by considerable percussion and given for only a short time.

Vesical Stimulants

Nearly all sudden thermic applications to the feet, legs, or trunk produce contractions of the dedrusor muscle. This is especially true of the cold percussion douche to the feet, or the alternate hot and cold douche to the feet. The same result may be accomplished by the sudden application of the ice compress to the lower abdomen or upper inner surfaces of the thighs.

Intestinal Stimulants

Intestinal excitation is indicated chiefly in constipation. There are a large number of measures which are useful in relaxed conditions of the intestinal musculature. The patient should be put upon some regular program. This may conveniently embody several of the measures which are efficient in stimulating peristalsis. Among these measures are the hot enema, cold enema, or alternate hot and cold rectal irrigation. The graduated enema is an excellent means of accustoming the patient to the cold enema. It is especially useful in treating patients who have acquired the enema habit. Of external applications there may be employed fomentations to the abdomen, the revulsive compress, hot and cold spray douche to the abdomen. These same measures may be applied to the spine from the middle of the dorsal region to the sacral region. The alternate hot and cold percussion douche to the feet and legs also tends to stimulate peristalsis. In atonic constipation the cold rubbing sitz is an excellent measure. It should last from two to four minutes and be followed by the alternate douche to the spine and abdomen. These measures should be carefully selected and utilized according to the severity of the case, special attention being given to the cause. The above treatments, except the hot enema and fomentations to the abdomen, are not applicable in spastic constipation such as that accompanying lead poisoning. In this case it is best to use fomentations to the abdomen, the hot sitz, together with large warm enemata for thorough cleansing of the colon and relief of the pain. Oil enemata may be given at night to be retained over night or for several hours.

A number of other measures not hydriatic in nature may be conveniently combined with hydrotherapeutic treatment. Among these are the following: Abdominal massage, spinal nerve stimulation, special exercises to strengthen the abdominal muscles, vibration to the abdomen, faradic electricity to the abdomen and spine, also sinusoidal electricity and the Morton wave from the static machine. Some of these forms of electrical stimulation may be applied by means of a rectal electrode and an abdominal sponge. All exercises which strengthen the abdominal muscles should be utilized, such as walking, rowing, horseback riding, bicycling, etc.

Contraindications to Excitant and Stimulating Measures.

1. Old age.
2. Infancy.
3. Arterio-sclerosis.
4. Acute mania.
5. Tuberculosis (pulmonary).
6. Emaciation.
7. Thin diabetic patients.
8. Bright's disease.
9. Exhaustion from any cause.
10. Hemorrhage.
11. Severe coughing.
12. Asthma.
13. Emphysema.
14. Organic heart trouble.
15. Chorea.
16. Extreme neurasthenia.

CHAPTER XXI

SEDATIVE EFFECTS

MEASURES which reduce or check the over-activity of an organ or function are said to have a sedative effect. Since there are many organs and functions, one might so elaborately classify sedative effects as to prove confusing, and so lose the distinctive principles governing hydriatic sedatives. Any application must of necessity affect more than one structure, as we have learned concerning tonic measures; but we have also learned that every application has its predominating effect. For the sake of clearness we shall, therefore, here discuss only nerve sedatives—those measures which relieve irritation, nervousness, spasm and convulsions, and are conducive to rest, relaxation, or sleep. The *principal* sedative measures may be classified as follows:—

I. GENERAL SEDATIVES.
   1. Pure sedatives.
   2. Tonic sedatives.

II. LOCAL SEDATIVES.
   1. For the relief of pain (analgesics).
   2. For the relief of paræsthesia.

The first (I) employs mild hypnotic, calmative, and antispasmodic means, and mild tonics almost entirely. The second (II) must, of necessity, employ extreme means, since pain and abnormal sensations can not be relieved by mild applications.

GENERAL SEDATIVES

1. Pure Sedatives: Temperatures at or not far removed from neutral.

(a) Neutral or warm bath 94°—98° F.
(b) Neutral wet sheet pack.
(c) Continuous flowing bath.
(d) Oxygen bath.
(e) Warm or hot shower, spray, douche, or affusion.
(f) Neutral pour to spine.
(g) Sponging—cool, tepid, or warm.
(h) Heating compress, as moist abdominal girdle, spinal compress, throat compress, moist chest pack, etc.
(i) Fomentations moderately hot, especially to spine and abdomen.

In addition to the above, the following sedatives are especially directed toward decreasing the congestion of nerve centers.

(a) Hot foot bath with cold to the head.
(b) Cold sitz bath.
(c) Cold water coil to abdomen or head.
(d) Alternate hot and cold percussion douche to feet.

It will be noticed that all of these measures, unless it be the neutral bath, secure sedation by combining the purely sedative effects with that of derivation. For example, the hot foot bath with cold to the head produces sleep and relieves nervousness and headache by reducing cerebral congestion.

The wet sheet pack at 65°—70° F., given alone or followed by a graduated shower at 95°—90° F., is effective because of the relief of cerebral hyperemia which it produces, combined with pure sedation. Relative to the effects of the cold wet pack, Baruch[1] says:—

"The experiments of Max Schüller and the observations of Mary Putnam Jacobi have so clearly demonstrated the calming influence of the wet pack upon the cerebral circulation that we have an exact basis upon which this treatment may be applied in many cases of neurasthenia, especially those troublesome cases in which insomnia is a pronounced manifestation.

"This procedure is one of the most effective means of quieting the entire nervous system, whether the irritable condition be due to an essential increase of reflex excitability or to a cere-

1. Principles and Practice of Hydrotherapy, p. 440.

bral hyperemia. The pronounced sinking of the brain substance, the positive diminution of the respiration and heart beat, the weakening of the reflex excitability and of activity of the cerebral ganglia observed in trephined rabbits during the wet pack, combined with the positive diminution of the vessels of the pia mater, represent the fundamental conditions for physical calm and sleep. These are probably also present in man during the wet pack. Sleep is accompanied by a decided diminution of blood in the cerebral vessels; indeed, the latter has been accepted as an essential condition for the production of sleep. This may explain why the wet pack, properly applied, is a useful procedure in the insomnia of neurasthenics."

The cold sitz, cold coil to the abdomen, etc., produce sedation by reducing congestion of the sympathetic ganglia of the abdomen and pelvis. Fomentations to the spine withdraw blood from the spinal cord, and the heat is in itself relaxing and depressant. Heating compresses are mild derivatives and combine with this derivation a neutral temperature. All antipyretic measures are in the nature of the case antispasmodic and hypnotic, since they lessen toxemia and so relieve the nervous system. Cold sponging is sedative in both actual fever and feverishness. Hot sponging is usually most effective in conditions purely nervous. In acute mania the wet sheet pack is a most excellent means, and serves a double purpose in restraining the patient while applying the neutral temperature.

Indications for the Use of Pure Sedatives.

1. Insomnia.
2. Agitative neurasthenia.
3. Hysteria.
4. Mania.
5. Chorea and choreiform diseases.
6. Paralysis agitans.
7. Spastic spinal paralyses.
8. Epilepsy.
9. Locomotor ataxia (first stage).
10. Nervousness due to congestive headache.
11. Clonic and tetanic spasms from various causes.

Precautions. The personal factor or idiosyncrasy has much to do with the selection of a sedative treatment. If a patient has taken a dislike to a certain measure, it is likely to produce agitation rather than sedation. Sedative effects are likely to be transient, and so the treatment must be frequently repeated. With neurasthenic patients a treatment which may have given good results in a certain case may be robbed of its effect by some unusual occurrence which may seem trivial in itself, such as slight alteration in the manner in which it is given, or the changing of an attendant.

2. Tonic Sedatives. Insomnia and nervousness may be due to a lack of normal fatigue such as follows active work, especially out of doors. This is particularly true of those in sedentary occupations, such as professional, business, and office men. These persons may be of fairly good physique and health otherwise. It also occurs in enforced idleness, as after fractures, operations, etc., and in the case of chronic invalids. The rational treatment consists in the production of fatigue. Where possible, of course, exercise in the open air is the most efficient means of producing fatigue. Mild tonics are usually all that can be well borne. A few cases may be given even the most vigorous treatment. The following are the means most used as tonic sedatives:—

(a) Hot and cold to the spine.
(b) Wet hand rub.
(c) Cold mitten friction.
(d) Hot and cold spray, shower, or douche.
(e) Neutral faradic tub.
(f) Massage.
(g) Rapid faradic current.

The *indications* have been outlined above. Some of the *principal* conditions requiring tonic measures in order to produce sedation are,—

1. Insomnia.
2. Neurasthenia.
3. Splanchnic neurasthenia.
4. Chronic rheumatism.
5. Paralyses (flaccid).

LOCAL SEDATIVES

1. Analgesics (relief of pain). For the purpose of relieving pain, extreme hot or cold applications are absolutely essential. Just which shall be used depends upon the particular cause and condition in each case. Some aim at the cause and others at the immediate relief of the pain, where the cause can not be removed in a short time.

For the relief of pain, hot applications are usually employed. We say that heat has a specific pain-relieving effect. This is true; but it must be remembered that the relief of the pain is due to the production of definite circulatory changes which remove the cause of pain. In inflammatory states the cause of

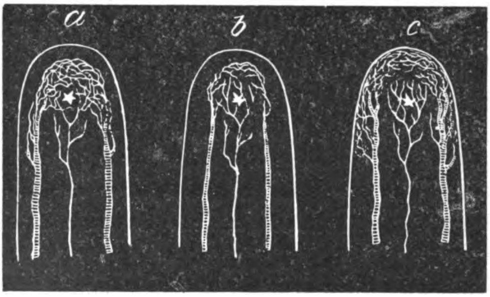

Fig. 56. Diagram to show the effects of heat and cold in lessening the pain of inflammation. (Brunton.)

pain is to be found in pressure upon nerve filaments occasioned by the congestion and heightened vascular tension. By derivation, heat reduces the congestion or it relaxes the tension, and thus the cause of pain is removed. When properly applied, cold may accomplish the same results. These principles are well illustrated in a diagram devised by Lauder Brunton.[2]

"The diagram (*Fig. 56.*) is supposed to represent the end of the finger. The small star indicates the point of irritation, *e. g.*, a prick by a thorn. The line in the center of each finger is intended to represent the nerve going to the injured part; and at the side of each figure is an artery and vein connected by a capillary network. In *a* the capillary network around the

2 Therapeutics of the Circulation, p. 174.

seat of irritation is seen to be much congested; the nerve filaments are thus pressed upon, and pain is occasioned. *B* represents the condition of the finger after the application of cold to the arm or hand. In consequence of the contraction of the afferent arteries, the finger becomes anemic; no pressure is exerted on the nervous filaments, and pain is alleviated. *C* represents the finger after it has been encased in a warm poultice; the capillary network at the surface of the finger is dilated, and the blood is thus drawn away from the seat of irritation, and the pain therefore relieved."

For the relief of pain the following treatments are useful:—

(a) Very hot fomentations.

(b) Hot immersion, foot bath, sitz, etc.

(c) Hot pack, local or full blanket pack.

(d) Hot enema.

(e) Extreme cold, as ice bag, ice compress to painful part or over artery supplying the part, use of ice water or cracked ice by mouth.

(f) Cold immersion, as of a hand or foot, sitz bath, etc.

(g) Derivation.

(h) Fluxion by alternate extreme hot and cold applications.

The *indications* for the use of pain-relieving measures are numerous.

1. Pain of deep-seated inflammation.
2. Pain of superficial inflammation.
3. Gastric ulcer.
4. Rectal ulcer.
5. Hemorrhoids.
6. Toxic neuralgia.
7. Inflammatory neuralgia.
8. Tenesmus—rectal or vesical.
9. Dysmenorrhea.
10. Colic—renal, biliary, intestinal.
11. Burns.
12. Sprains, bruises, etc.
13. Fractures.

2. Relief of Paresthesias (abnormal sensations, such as burning, smarting, itching, crawling sensations).

(a) Ice bag.
(b) Immersion in cold water or ice water.
(c) Very hot sponging.
(d) Stupes.
(e) Weak chemical irritants, as neutral saline bath, bicarbonate of soda bath, saline sponging, alcohol rub, witch-hazel rub, menthol compress.
(f) Short sweating bath followed by tub shampoo and cool bath.

Indications:—

1. Pruritis from various causes.
2. Hives and heat rashes.
3. Formication.
4. Numbness and tingling.
5. Burning and smarting.

INSOMNIA

Baruch not inaptly styles the insomnia of neurasthenia an *opprobrium medicorum*. If one were to form an opinion from the bad effects of medicinal treatment and the frequency with which such treatment is used, the condition is indeed a discredit to scientific medical practice. The insomnia accompanying neurasthenia is due to a peculiar association of nerve exhaustion with hyperirritability. Doubtless nerve poisons from auto-intoxication play a large part in the causation. It would seem that congestion of the cerebral and spinal centers is also a cause of nerve irritability and sleeplessness. It is present in the majority of cases.

Because of the lack of nerve tone, general tonic treatment, as outlined for neurasthenia, is quite as essential as sedative measures which aim principally at the insomnia. In many patients, lack of normal fatigue is the chief, if not the sole cause. In such cases a mild or even a vigorous tonic treatment given about an hour before bedtime will produce the best results. With some persons brisk exercise to the point of moderate fatigue, taken just before retiring, will accomplish the same results.

We have principally to consider the insomnia due to increased reflex excitability and unusual irritability of the nerve centers. The condition may be perpetuated long after removal of the first cause has been effected. This is especially true of those patients who "can't go to sleep" because of constant worrying about their inability to sleep. These persons are the bane of the neurologist's life. They are exceedingly introspective and often almost hysterical. In order to decrease reflex excitability it is necessary to remove as far as possible all external stimuli and at the same time decongest the spinal and cerebral centers.

For these purposes the ideal means is found in the neutral bath or pack. The body is enveloped in a non-irritating medium, the skin is slightly warmed and both the skin and the skeletal muscles relaxed. The temperature of the neutral bath should be not less than 94° F. and it is often better to use water a little warmer, say 96° or 97° F., since the warmth secures a full relaxation. The bath should be given in a quiet, fairly warm room and last for fifteen or twenty minutes to a half hour or longer. The disturbing effect of drafts may be avoided by stretching a sheet across the top of the tub. It is well to lower the temperature of the water two or three degrees just at the close of the bath. A patient should never be put into a neutral bath with cold feet. All parts of the body should be warm beforehand. The neutral bath or warm bath has an effect similar to the neutral pack in causing the sinking of the brain substance. The rationale of the wet sheet pack has already been explained. With many patients it is the most efficient means that can be used. By means of woolen blankets the covering of the pack can, by an observant nurse, be so regulated as to be kept constantly at the neutral stage. The feet should be more warmly covered than the upper part of the body. An exceedingly restless patient who has had but little sleep for weeks may sleep for hours or all night in a neutral pack.

For cases of agitative neurasthenia with insomnia we have recently found the oxygen bath more efficient than any other means. The temperature of the water should be 97° or 98° F. since the oxygen gas produces a slight anemia of the skin. For the same reason it is well to precede the bath by a hot foot bath or fomentations to the spine. The bath itself lasts twenty minutes. No pour or shower or any other stimulating measure should be used after it. The bath should be taken in the late afternoon or early evening, never later than 7:30 P. M. It may be used daily, but it seems to give as good or better results administered three times a week only. The method and other effects are described under technique (*q. v.*).

The salutary effects of a drugless sleep are felt all the next day. There is not the usual after-tendency to drowsiness. The patient feels like himself. Quite the contrary condition follows the rest obtained by trional, the bromides and other hypnotics. The patient is likely to be drowsy during the succeeding forenoon. For this reason medicinal soporifics often defeat their own end. The patient must be kept awake during the daytime so that natural fatigue may result and thus the system demand rest and sleep.

There are many other measures which will be found useful. The milder types of insomnia respond very quickly to a set of three fomentations to the spine given just at bedtime. If thought best, this may be followed by a light rub either to the spine alone or to the body generally. The tepid spinal affusion has an effect similar to the spinal fomentation. It should be applied to the lower dorsal and lumbar spine. Some cases of insomnia seem to be due solely to cerebral hyperemia. This is common in brain workers. In these cases the feet are almost invariably cold. If the unbalance is extreme, a very hot foot or leg bath with cold to the head should be given for about ten or fifteen minutes. This should be followed by an alternate hot and cold percussion douche to the feet. Sometimes the latter will accomplish the results as well when given alone as following the hot foot bath. The vigorous fluxion produced in the feet by the combination of percussion with thermic stimuli results in more permanent cerebral derivation than a hot foot bath alone.

The moist abdominal girdle is an excellent adjunct to a sedative treatment. As shown by the experiments of Schüller, it lessens the filling of the cerebral vessels. It may be used after any of the treatments recommended above. It should be worn all night. If properly applied, it will be dry or nearly dry by morning. If, because it does not promptly "warm up," chilliness results, it must be removed. With some patients it produces "fidgets" and for this reason must be discontinued.

Of tonic sedatives designed to aid in producing normal fatigue, the following may be used in insomnia: Hot and cold to the spine, the cold mitten friction, the alternate spray or a short electric light bath followed by a spray. The neutral faradic tub followed by a short massage gives good results. Either one may be used alone. The mild exercise occasioned by dry faradism or the faradic tub is often sufficient to induce sleep. In the management of most cases of neurasthenic insomnia, it is best to give a tonic treatment in the forenoon, reserving sedative treatment and massage for the afternoon or evening. Following the plans outlined above, or similar methods, carefully adapting the treatment to the needs of the particular case under observation, can not fail to produce cure provided the patient fully commits himself to the judgment of the physician and remains long enough to secure permanent results.

CHOREA

The common or Sydenham's chorea is the form especially considered here. This is the type which is associated with rheumatic fever and endocarditis, occurring from five to twenty-five years of age and most frequent between the ages of five and fifteen. It may also occur during pregnancy. The cause is not definitely known. The chorea movements are sharp, decisive, and irregular. Huntington's chorea is also benefited by the methods outlined below.

The condition demands a period of absolute rest in bed with freedom from all excitement. Chorea can best be treated in an institution away from friends and relatives. All possible sources of auto-intoxication, such as bad diet and constipation should receive special attention. The hydriatic management, while very simple, is of great importance. During the period when perfect rest is demanded, pure sedatives should be used. Of these the neutral bath is most efficient. It should be given once or twice a day and prolonged from twenty minutes to an hour. The bath should feel warm, having a temperature of 96° or 97° F. On the alternate days the oxygen bath may be substituted with good results. The wet sheet pack may also be used, being kept at the neutral stage. It should last about the same length of time as the bath, or the patient may be allowed to sleep in it and be removed later with a wet hand rub. After some improvement has been secured, in a week or ten days, other sedative means which combine with them mild tonic effects may be used. These should at first be very mild, such as a wet hand rub, tepid sponging, and the neutral spinal affusion or pour. The heating abdominal compress or moist abdominal bandage may give good results. Fomentations to the spine, followed by the cold heating compress for fifteen to twenty minutes is an excellent sedative. During the entire course of treatment, the neutral baths or packs should be continued. When convalescence is well established the cold mitten friction, cold towel rub, graduated and alternate sprays may be used, also light massage. All of these measures serve to remedy the anemia; even the neutral bath is helpful in this direction. The beneficial effects of outdoor life in the country, sunshine and fresh air can not be over-estimated.

In case chorea is complicated by endocarditis, the same system of treatment should be followed as outlined for the endocarditis of rheumatism. The only alteration necessary is the substitution of sedative treatment once or more daily for some of the tonic treatment, such as the cold mitten friction used in rheumatic endocarditis.

PARALYSIS AGITANS

While this is considered an incurable affection, the patient may be much benefited and the progress of the disease stayed for quite long periods of time by general hygienic management combined with sedative and mild tonic hydrotherapy. The measures recommended above for chorea are all helpful in shaking palsy. Dana[3] especially recommends the lukewarm (neutral) bath and mild massage. Oppenheim[4] has seen

3 Text Book of Nervous Diseases.
4 Diseases of the Nervous System.

improvement following the use of the faradic bath. Vibrating chairs or vibrating machines adjusted to give a fine rapid movement may show good results. Outdoor life in the woods and country are especially beneficial.

SPASTIC SPINAL PARALYSES

There are a number of lesions of the cord which ultimately result in degeneration of the upper motor neuron, chiefly in the lateral column. The inhibitory control from the cerebral cortex being cut off, a condition of spastic paralysis results, *i. e.*, a loss of control associated with rigidity and spasticity of the muscles. Such a condition occurs after various forms of myelitis, especially a transverse myelitis, also in amyotrophic lateral sclerosis. If there is an acute onset as by trauma or inflammation, as frequently occurs in myelitis, the patient must be put to rest, either absolute or partial, according to the nature and needs of the case. In some cases gentle spinal extension should be used for some weeks and perfect quiet observed. In other cases, the patient may be allowed to move about the bed. During this time spinal fomentations may be applied twice daily, followed by the heating spinal compress. The warmth of the limbs should be maintained by the hot foot bath or hot water bottles. It is necessary that the patient be given tonic treatment to keep up the nutrition and invigorate the circulation. These must, however, be quite mild, such as the wet hand rub and moderately cold mitten frictions. Later, light massage to the limbs may be used.

As soon as the necessity for absolute rest is past, in the chronic stage when spasticity becomes marked, nothing has proven so helpful as the prolonged neutral or warm bath. In those cases in which cure is possible this measure is almost a specific. The patient should be made very comfortable in the tub by using a sheet hammock, rubber pillows, etc. The temperature of the water should be from 95°—97° F. It must feel slightly warm to the patient. At first the bath may be twenty minutes to an hour in length, gradually increasing the time up to three or four hours of continuous immersion daily. Even six hours in the neutral bath may prove beneficial.

Where the necessary facilities can be had, the continuous flowing bath is a most grateful substitute. The gentle motion of the water appears to add much to the effect. The salutary effects are manifest in a lessened degree of rigidity, the limbs become more supple and can be separated to a greater extent. In order to obtain any permanent benefit, the patient must submit to treatment for many months.

In the subacute stage, positive galvanism to the spine may be useful. During this time mild alternating hot and cold applications may be used to the part of the spine affected. Later in the disease, prolonged neutral baths give better results.

LOCOMOTOR ATAXIA

In the treatment of tabes dorsalis, we are concerned chiefly with the first two stages, the initial or pre-ataxic and the ataxic. In the paralytic or third stage, there is little that can be done except to make the patient comfortable and treat symptoms as they arise.

In the pre-ataxic stage the patient must be put to rest. This may be accomplished by restricting or prohibiting exercise. It is usually best to proscribe exercise altogether for a time. The wheel chair may be used or, if thought best, the patient may be put to bed for two or three months. Simple, regular habits are imperative. During the period of rest, the patient may be treated by fomentations to the spine, cold mitten frictions and the warm bath. Dana recommends that this latter be given for ten to twenty minutes daily and followed by a single cold pour to the spine and rubbing. The object of treatment during this stage is to keep up the patient's general nutrition and afford rest, both mental and physical, so as to relieve the tax on the spinal nerves.

If the progress of the disease can be stayed, the treatment outlined for the ataxic stage may be ventured upon, beginning mildly. The Fraenkel exercises may now be begun. These should at first consist of the more simple movements and the effort restricted to a few minutes. Later on, as coordination improves, they may be more prolonged and made up of more complicated exercises.

Vigorous spinal tonics should be used during the ataxic stage unless the patient is becoming rapidly worse. Alternate hot and cold to the spine by means of the fomentation and ice may be used daily, or this may alternate with the Charcot (cold percussion) douche to the spine, or hot and cold douche to the spine. These applications should be persisted in for months. The long static spark to the lower spine and legs may be used at the same time, say thrice weekly. Galvanic currents are also beneficial. It must be remembered that not all cases are susceptible of any marked improvement. The plans outlined above have proven very satisfactory in the hands of many neurologists. Nearly all agree that mercurial treatment is harmful unless symytoms of active syphilis still exist. Even in this case bad results have frequently been reported, and some observers believe that antisyphilitic medication may be the direct cause of tabes.

For the arthritic complications (Charcot's joint) alternate hot and cold applications for the purpose of maintaining the local nutrition and improving the circulation will be found helpful. These may be given by means of the revulsive compress, alternate pours, or alternate hot and cold immersions. Surgical treatment has proven useful in skilled hands in remedying the deformities and restoring the usefulness of the affected joint. For painful joints, very hot fomentations may be given, followed by the heating compress.

The treatment of the various crises is unsatisfactory. They may at times be relieved by local hot applications. All forms of treatment, including hypnotics, may fail. The same may be said of the lightening pains. Building up the general vitality of the patient will tend to remedy these distressing conditions.

PARENCHYMATOUS GOITER

The pathology[5] and morbid physiology of parenchymatous or exophthalmic goiter must be fully understood if medical treatment is to be conducted to produce the best possible results. Exophthalmic goiter is now considered to be due to hypertrophy

5 See articles on goiter among Collected Papers by the Staff of St. Mary's Hospital, 1905—1909.

and hyperactivity of the thyroid gland. The disease is better described as hyperthyroidism. The thyroid is one of the ductless glands producing an internal secretion. The exact chemical nature of this secretion is not known. It is believed to be closely associated with some iodine compound. It is one of that class of substances known as chemical messengers or harmones. It exercises a special influence over certain functions. In infancy the absence of the gland is marked by the condition known as cretinism, in which both the mind and the body remain in an undeveloped state. In adult life atrophy or removal of the gland produces the condition known as myxedema, or cachexia strumipriva. In these conditions mental activity is below par, cerebration is exceedingly slow and all bodily movements are deliberate and physical activity much depressed. The opposite condition, known as hyperthyroidism, caused either by hypertrophy of the glandular tissue or by giving large doses of thyroid extract, produces a train of symptoms just the opposite of the above. The patient is nervous, restless, irritable, and may be subject to insomnia. There is a fine tremor of the fingers when the hand is held away from any support with the digits spread. During the early part of the disease, mental activity is excessive, ideation is rapid, and all the brain functions are increased in acuity. If intoxication becomes intense, the pulse may be very rapid, running from 100 or 120 to 160 or more per minute; the skin is usually warm and moist, being covered with perspiration the most of the time. The blood-vessels are dilated. Catabolic changes are increased and hastened as shown by the fever and increase in the excretion of nitrogen. There is a feeling of languor, and asthenia may become very marked. In the gland itself, the colloid material is deficient in amount, there is an increase in the number of secreting cells, even to the filling of the alveoli with cells; the blood-vessels of the gland are dilated and may be increased in number. Later, the parenchymatous cells degenerate (cytolysis) liberating a large amount of thyroid secretion; the most aggravated symptoms may be present while this is going on. The stethoscope applied over the gland frequently detects a systolic bruit. Owing to this increased vascularity and the hypertrophy of the parenchymatous tissue, the thyroid is enlarged. Later in the disease the eyes become prominent, the lids are closed with difficulty, and the eyes feel dry. It is supposed that the exophthalmia is due to dilatation of the blood-vessels in the orbit.

It will be seen that these conditions set forth the necessity for treatment directed toward decreasing and depressing the activity of the thyroid gland. In the spontaneous cure of this condition, the colloid material increases in amount, producing pressure upon the parenchymatous cells, thus causing their atrophy. The increase of the fibrous stroma of the gland has the same effect. In these facts lies the rationale of the beneficial action of the X-ray. It has a specific effect in destroying or causing atrophy of highly differentiated tissue, while it favors the production of connective tissue. X-ray exposures should not be given so frequently as to cause unduly rapid disintegration of the secreting cells, in which case thyroid intoxication may ensue. The vascularity of the gland must also be decreased.

Albert Kocker makes the following statements:[6] "By reducing the hypertrophic thyroid tissue or reducing its blood supply, we reduce the possibility of too extensive reaction to the primary cause and also enable the gland to adapt itself to counteract new outbreaks of primary causes which a nervous subject can easily show.

"The fact that increased vascularization is indispensable for the development of the disease also proves that what reduces vascularization prevents its development."

At the same time it is necessary to slow the heart rate and restore the blood-vessels to their normal tone. While all cases will not respond to the same treatment, or even to different measures arranged in different ways, yet in general, the treatment should consist of the means making up the following program: An ice cap should be placed over the goiter almost continuously or for thirty minutes to an hour from two to five times a day. These cold applications reflexly contract the blood-

6 Surgical Treatment of Exophthalmic Goiter—Journal of American Medical Association, October 12, 1907, pp. 1242—1243.

vessels of the gland, thus decreasing its vascularity and the amount of blood in the gland. They also tend to inhibit or depress the glandular activity, decreasing the formation of the internal secretion. At the same time, an ice bag should be applied to the precordia in much the same manner and for the same length of time as the ice bag to the goiter. It may be found convenient to alternate these applications, keeping the ice bag over the goiter for thirty minutes, then applying it to the heart for the same length of time, then reapplying it to the goiter; these alternations being continued more or less during the entire day. The vaso-dilatation and warm moist skin require some treatment which will restore the vessels to their normal tone and check the over-activity of the sweat glands. This is best accomplished by the cold mitten friction. It should be given from one to three times daily. Many of the principles governing the treatment of organic heart disease are involved in the treatment of parenchymatous goiter. The cold friction, by restoring the peripheral vessels to their normal tone, assists the heart action and so reduces the rate.

The vascular conditions present in exophthalmic goiter and the therapeutic indications to be derived therefrom are very ably discussed by James Mackenzie[7] from whom we quote the following:—

"The essential features arising from the circulation in many cases of exophthalmic goiter, it seems to me, are the abnormal and persistent dilatation of the arterioles, and a heart acting with a force relatively great to the resistance opposed. These are indicated by the rapid and forcible pulse-wave felt by the finger, and the visible pulsation of the superficial arteries and the carotid. The corresponding sphygmographic features are a high upstroke and a rapid fall, so that the dicrotic notch is near the base line. The rate of the pulse may be greatly increased, up to 140 to 160 per minute. The same factors—the unusually forcible injection of the blood into the arteries of low blood pressure—are present in aortic regurgitation. Though the beating of the carotid is due to similar causes in the two cases, the low arterial pressure at the end of the diastole is

7 Diseases of the Heart, Second Edition, p. 133.

different. In exophthalmic goiter the dilatation of the arterioles and capillaries is the sole cause, whereas in aortic regurgitation there is in addition the backward flow into the ventricle through the incompetent valves. The condition of the circulation in exophthalmic goiter is also comparable to that in some forms of sthenic fever, where the heart beats forcibly and the arteries are relaxed.

"Another evidence of the relaxation of the arterioles is to be found in the subjective sensation of warmth felt by some sufferers from exophthalmic goiter. They rarely complain of cold in winter, however lightly clad they are, and this is not infrequently the cause of matrimonial disputes, for while the ailing wife feels warm in bed during winter with few blankets, the healthy husband feels the cold keenly. This feeling of warmth has supplied me with the indications for the only treatment of this class of case that I have found both grateful and beneficial to the patient, namely, the periodic stimulation of the vasomotor nerves by cold baths."

The patient should be kept at absolute rest until the pulse has returned to nearly normal. Freedom from mental excitement and worry are fully as necessary as physical rest. In fact, overtaxation of the mental powers, nervous excitement, etc., are often contributing factors in the causation of the disease and may constitute the immediate cause. In some cases it may seem best to employ some of the sedative measures, such as fomentations to the spine and the neutral bath. Usually both of these treatments are contraindicated. If the feet remain cold much of the time, the alternate hot and cold foot bath or alternate hot and cold douche to the feet should be used.

We have yet to see a case which has not been brought to a successful issue when these measures have been applied early, and have seen complete restoration in cases that have come under treatment later in the disease when the pulse reached 160, while the patient was exceedingly nervous and unable to sleep, and there was very marked exophthalmia together with a large goiter. Those cases which come on after thirty respond much more readily to treatment than when the disease occurs in younger adults or under twenty years of age. But it is also true there is a natural tendency to recovery among young adults, nineteen out of twenty recovering without much treatment but rest. Hyperthyroidism beginning in persons from eighteen to twenty years of age is likely to run a course of three or four years and end in a spontaneous cure. Operative interference will be much less frequently necessary when these measures—rest, hydrotherapy, etc.—are given a thorough trial by those experienced in their use.

METHODS FOR THE RELIEF OF PAIN

Deep-Seated Inflammations

Those treatments which have already been outlined for the relief of congestion and inflammation in internal organs are also most effective in relieving the pain occasioned by the inflammation. In the majority of cases, derivation by collateral heat, together with cold directly over the part, is used to relieve the congestion and pain. In others, hot applications alone are used. This is true of pleurisy, in which cold applications increase the pain. In many cases the pain is relieved best by very hot applications applied directly over the seat of pain. It has already been mentioned that cold may be used over an inflammatory process in soft tissue, while in bony parts it is necessary to use hot applications directly over the seat of the pain. In the case of osteomyelitis and usually in mastoiditis, cold applications or the ice bag applied over the inflamed part increases the pain. When an inflammation has gone on to the formation of an abscess, cold applications, especially the ice bag, have very little influence on the pain as far as relieving it is concerned, and may make it worse. Fomentations over an abscess may relieve the pain for a time, but this does not last as long as the relief afforded previous to the formation of the abscess.

In order to decrease the throbbing pain of an inflammatory process or collection of pus in the bone, it is best to apply the ice bag over the large artery supplying the inflamed part. The relief of the pain in this case is brought about chiefly by reducing the congestion. If, at the same time, a very hot fomentation is applied over the part, the effect is intensified by the specific pain-relieving action of the heat.

Superficial Inflammation

In the early stage of a superficial inflammation, a prolonged cold application is usually very effective in relieving the pain. This should be accomplished by immersion in cold water or ice water or by the use of the ice bag. Later on, it will be found that very hot applications more effectively relieve the pain. Either very hot fomentations or hot immersion may be used. Sometimes the neutral or warm pour is very grateful, there seeming to be an added effect from the affusion that is not obtained by quiet immersion. The production of fluxion by alternate extreme hot and cold immersion is productive of good results where there is not much throbbing pain.

Gastric or Duodenal Ulcer

It is often the case that the pain is worse during the time that there is little, if any, hemorrhage from the ulcerated surface. In case hemorrhage of any moment occurs, it is necessary to use some cold applications, such as cracked ice by mouth or the ice bag over the stomach. Otherwise, the pain is best relieved by very hot fomentations applied to the epigastrium, or the full hot trunk pack. These applications my be followed by either the moist abdominal girdle or by the heating wet sheet trunk pack. The effect of these applications is to relax the musculature of the stomach and so, by decreasing peristalsis, relieve the pain incident to muscular contractions.

Rectal Ulcer

The same principles apply here as above. The pain is most effectively relieved by applications which relax the bowel, thus decreasing the movement and consequent irritation of the ulcerated surface. This may be accomplished by the hot enema or fomentations. Usually the hot sitz bath is much more effective.

Hemorrhoids

Two different plans may be followed in relieving the pain occasioned by rectal varicose veins. Very hot applications are effective in relieving the pain, but these have no tendency to decrease the size of the hemorrhoids. On the contrary, they may increase the dilatation of the veins, stasis of blood and consequent pain. Of the hot applications which may be used, the very hot sitz bath is most effective. In case facilities for this are not at hand, fomentations may be used.

For permanent results, we prefer cold applications, such as the prolonged cold sitz bath, ice bag to the perineum, also the hot and cold perineal spray. To be effective, these treatments should be repeated once or twice daily for several weeks. The temperature of the cold sitz bath may be decreased gradually as the patient is able to bear it.

Neuralgia

The classification of neuralgias into two types has aided in the treatment of this condition. Simple neuralgias, not due to pressure from tumors, exostoses, etc., we have classified as either toxic or inflammatory. By the term toxic, we designate such neuralgias as are due to rheumatic (uric acid) diathesis, or some form of auto-intoxication. The essential element in the causation of this form of neuralgia is the circulation of toxins in the body, or the accumulation of toxins about nerve centers or nerve trunks.

By the term inflammatory neuralgia, we understand such conditions as are due to actual inflammation, usually such inflammations as pass through the regular stages of an inflammatory process, from acute to chronic.[8] It may often be difficult, impossible, and in some cases, unnecessary to make these distinctions. It will be readily understood that some of the changes occurring in an ordinary inflammation are produced by the accumulation of toxins about nerve trunks. Local edema of tissues occurs in both cases.

1. Toxic Neuralgia. Where there is a local accumulation of toxins about a nerve trunk, it appears that hot applications most effectually relieve the pain while cold increases the pain. Nitrogenous extractives and other nitrogenous toxins are soluble with difficulty. They are more readily dissolved in hot water. Since prolonged hot applications raise the local tem-

8 The term inflammatory neuralgia is not intended as a synonym for neuritis, such as alcoholic neuritis, which latter results in nerve degeneration and gives the R. D. on electric test.

perature of the part treated, it might be supposed that the toxins are rendered more diffusible, and hence may be gotten rid of more rapidly. The chilling of the tissues would result in a greater precipitation of these sparingly soluble substances and so tend to increase the pain. It must, of course, be remembered that heat has a specific pain-relieving action which is possibly greater in importance than any action it may have upon the local accumulation of toxins. The pain of toxic neuralgia may be relieved by very hot fomentations or the local electric light bath. For a prolonged application, the hot water bottle is very serviceable. Any of these applications may be followed by the heating compress. This should be wrung from tepid or cool water; rarely, if ever, from ice water. The mode and duration of the hot application should be varied according to the character and location of the pain.

In treating sciatica, the hot fan douche is a very effective means. Very hot affusions may be used. Sometimes the hot percussion douche is more effectual. It must always be borne in mind that the cure of the case requires the entire removal of the cause. For this reason, a regime embodying the prolonged use of tonic hydrotherapy, general eliminative treatment, and proper diet, is necessary for the permanent relief of neuralgias. We have found the use of positive galvanism of very great benefit in neuralgia, especially in facial neuralgia of severe chronic type.

2. Inflammatory Neuralgia. A very different plan should be followed where the pain in nerve trunks is due to real inflammation. Prolonged cold applications, even to almost freezing the part, give better results than hot applications. For this purpose, it is sometimes recommended to use the ethyl chloride spray. Cold may also be applied by means of the ice bag, ice pack or ice compress. These should not be too thickly covered and should be left in place a sufficient length of time to materially lower the temperature of the part treated. Sometimes derivation by direct cold and collateral heat is very effective. Cold affusions may also be used. The pain of an inflammatory sciatica is often benefited by the alternate hot and cold douche applied up and down the thigh over the sciatic nerve.

In all cases of neuralgia, it is best to make repeated search for the cause. While the majority of cases of facial and other neuralgias are not due to conditions which can be remedied by operation, yet this is sometimes the case. In this connection, it might be mentioned that operation for facial neuralgia is, in the majority of cases, not only a failure, but an actual detriment to the patient. The relief of the pain is merely temporary and, because of shock, nerve exhaustion, etc., repeated operations render the patient much more susceptible to pain.

Myalgia—Lumbago

Lumbago is the most common myalgia, and is that treated of here. It follows colds and exposure to cold and dampness. The actual cause and the morbid condition are not well understood. The treatment differs considerably from other sedative measures, in that the best results are obtained by the most vigorous stimulation. We have obtained almost invariably unfailing results from the use of large very hot fomentations to the lumbar spine followed by the alternate hot and cold percussion douche to same region and heavy massage or vibration to the large lumbar muscles. About once a day the negative static spray or short static spark may be used; also slow sinusoidal or static surging to produce vigorous muscular contractions. In acute cases these treatments bring prompt relief; and in chronic cases, in a few days or a week or two.

Tenesmus,—Rectal or Vesical

Pain in hollow muscular organs is chiefly due to the contractions of the muscular tissue. This activity of the muscular wall increases the irritation arising in the mucous membrane. To relieve tenesmus of the bladder or rectum, we have found the hot sitz bath the most effectual. The heat should be prolonged a sufficient length of time to fully relieve the pain. Only a brief dash of cold water should be given at the close. In some cases it should be omitted entirely. Large fomentations or the hot hip pack may be used. In rectal tenesmus, a small hot enema or the starch enema affords relief. The enema should be given before fomentations or the hot sitz is applied. Cold applications stimulate muscular contraction, and hence increase the pain.

Dysmenorrhea

The condition here is somewhat similar to a tenesmus. It is most frequent in sharp anteflexions of the uterus, or may be occasioned by chilling. In order to afford immediate relief, it is necessary to relax the musculature of the organ. Cold causes contractions of the uterine muscle and so prevents the outflow of blood, while hot applications relax the muscle. Often simple fomentations are sufficient to afford relief. It may, however, be necessary to use the short hot sitz bath. No cold treatment should follow it. The application of the unwrapped ice bag to the sacrum may be used, accompanying some hot application to the feet and legs. It may be necessary to continue this twenty or thirty minutes. Hot applications in front may be used at the same time. The ice bag when applied anteriorally has the opposite effect, that is, it causes contraction rather than relaxation. Probably the explanation of the action of the ice bag to the sacrum in relaxing the uterus, as has been pointed out, lies in the fact that the posterior area is in less perfect reflex relation with the uterus; and for this reason, the reflex is easily paralyzed, the effect then being opposite to that which we usually expect from the ice bag. The use of the ice bag, however, is not as satisfactory as hot applications alone.

In addition to these measures, the hot enema and very hot vaginal irrigation may be administered prior to the use of the fomentation or hot sitz. In the case of suppressed menses with pain, when due to colds or exposure to dampness, it is well to use a hot foot bath; or better, hot leg bath, together with some local hot applications. This reduces the extreme pelvic congestion, renders the outflow easier, and so relieves pain.

Colic,—Renal, Biliary, Intestinal

The pain of renal, biliary, and intestinal colic is largely due to spasmodic contraction of the non-striped muscle of these parts. The irritation of the mucous membrane by the calculus stimulates the muscle to contract. To relieve pain from calculus or the pain of intestinal colic, it is necessary to use large hot applications in order to secure perfect relaxation.

1. Renal and Biliary Colic. It is usually considered that morphine is absolutely essential in these conditions. By the use of the full hot blanket pack or hot trunk pack, morphine may often be entirely dispensed with. If the pack does not fully relieve the pain, a much smaller dose of morphine than would otherwise be required, will be sufficient. The blanket should be wrung from boiling water, quickly spread out on the bed over a dry blanket and as quickly as possible wrapped about the patient. A thin dry blanket may be used next the patient if it seems advisable. It is not necessary to include the arms in the pack. A hot-water bottle over the abdomen and spine bags along each side of the trunk will help to maintain the heat of the pack. In cases where the pain is not so severe, large fomentations may be sufficient. The full hot tub bath gives good results in some cases. Wherever a hot application is much prolonged, cold compresses should be applied to the head and neck. No cold applications whatever should follow the hot pack. Even a very brief application of cold may bring on the pain.

2. Intestinal Colic. In regard to the causation of colicky pain in hollow viscera and particularly the intestine and the region to which it is referred, Mackenzie relates an interesting experience with a patient on whom he performed an intestinal resection without anesthesia. He says, "It turned out as I had expected, and I was able to break down numerous old and recent peritoneal adhesions, to detach them from the liver and bowel, to resect a piece of bowel and mesentery, and to stitch these structures without the patient experiencing the slightest sensation. But I found that he occasionally groaned with pain when I was not touching him, and watching to see the cause I found that the upper part of the resected bowel, which was laid on one side in a warm aseptic cloth, occasionally passed into peristalsis, contracting from a wide tube to a thick fleshy rod; when this happened the patient groaned with pain. I asked him where he felt the pain, and he passed his hand invariably over the umbilical region. I started the peristalsis several times by slightly pinching the bowel, and each time the patient felt the pain. Here before my eyes was the cause of the pain, and the seat of origin of the pain was at least twelve inches away from the part in which the pain was felt.

"From this experience the following deductions can be made: First, that the stimuli that produce pain and other sensations in the external body-wall are not adequate to produce these sensations when applied to the viscera; second, that violent contractions of non-striped muscular fibres can produce pain, but the region in which the pain is felt is different from that in which the contracting muscle lies."[9]

The effect of hot applications in these cases is due to the reflex relaxation of the intestinal musculature, and hence the relief of the pain.

When intestinal colic is due to poisoning or simple diarrhea, it is well to begin the treatment by thorough cleansing of the intestinal canal. It may be necessary to use a cathartic in order to completely remove the irritating toxic material. Castor oil is very satisfactory, especially in children, because of its constipating after effect. In all cases, hot enemata should be given until the lower bowel is thoroughly cleansed. If necessary, this may be followed by the starch or starch and laudanum enema. Following this, the most effective measure for the relief of the pain is the abdominal fomentation. These should be repeated until the pain has been entirely relieved. The hot-water bottle may be used between treatments. Fomentations to the abdomen may be given every two to four hours or as frequently as necessary.

Burns

In the case of burns covering a somewhat limited area, the dressings usually applied are sufficient to relieve the pain. Cold immersion relieves the pain during the time the part is in the cold water. It has, however, been our experience that the pain is worse after removal from the water. On the contrary, while hot immersion is not very grateful during its continuance, its after effect is better than that of cold immersion. A neutral or

9 Mackenzie—Diseases of the Heart, pp. 34, 35.

warm pour to the burned part is very effective in relieving the pain. In extensive burns, it is often necessary to use a full immersion bath of either neutral or cool water. In the absence of facilities for this, a prolonged wet sheet pack, renewed by frequent sprinkling with cold water, may be used. With the exception of extensive burns or where the pain is unbearable, we do not greatly favor the use of hydrotherapy for the relief of the pain. The use of picric acid in saturated aqueous solution, followed by drying and dusting the part with stearate of zinc, has given such good results in the relief of pain, rapid dermatization, and healing that we use it as a routine treatment.

Sprains and Bruises

Hot applications, including fomentations and hot immersion, are common household remedies for the relief of pain occasioned by sprains and bruises. These applications do effectually relieve the pain and relax the muscles. In many cases, much better results may be obtained by the prolonged cold immersion. This reduces the congestion and helps to prevent excessive exudation of serum into the soft tissues about the sprained part. Along this line, we may draw a practical lesson from the method instinctively pursued by wild animals. They usually seek a stream or body of cold water and stand in it for hours at a time. Whatever method is used at first, after a day or two, it will be found advantageous to utilize alternate hot and cold applications, such as the hot and cold spray, pour, or immersion. These stimulate the circulation, thus hastening the absorption of the edema.

Fractures

There are two objects to be attained by hydriatic applications in fractures. These are the relief of the pain and the relaxation of the muscles. The limb should be enveloped in a large fomentation or immersed in very hot water. Care should be taken that a burn or blister does not result. These methods are in too common use to need extensive discussion. It will always be found easier to set a bone if the muscles have been thoroughly relaxed by the preliminary use of hot applications. The same principles apply to the reduction of hernia by taxis.

Headache

The subject of headache is such a large one that we can not enter into it here with any degree of completeness. A few principles of therapeutics will, however, be helpful in obtaining an understanding of the scientific application of physiologic therapy in the relief of this condition. In order to give these principles with the least possible repetition, we have adopted the classification of J. W. Shiels:—[10]

I. Functional headaches.
  1. Toxemic headaches (acute, chronic).
  2. Neuropathic.
  3. Reflex.

II. Organic headaches.

III. Circulatory headaches.
  1. Anemic.
  2. Hyperemic (active).
  3. Hyperemic (passive).

The above is very much abreviated. As given by Shiels, each division embraces from five to twelve or more individual items—the designations of morbid conditions, diseases, or pathologic states.

Functional Headaches. *The acute toxemic headaches* of acute infections, acute nephritis, uremia, diabetic acidemia, and acute drug poisonings, are best relieved by direct and vigorous treatment of the causative diseases. Ice bags to the carotids and to the base and vertex of the brain will help in relieving the accompanying congestion.

The *chronic toxemic headaches* of gout, rheumatism, constipation, torpid liver, and other diseases affecting metabolism, are also to be treated by treating the causative disease. But in these conditions it requires patient, persistent effort over weeks or months of time in order to produce satisfactory results. Out-of-door life, sunshine, and tonic and eliminative hydrotherapy will do much to remove the toxins by stimulating their oxidation. In addition to this, the measures recommended for neuropathic headaches will prove helpful in relieving or miti-

10 Shiels—California State Journal of Medicine, November, 1909, p. 401.

gating the distress until more permanent results can be secured by the removal of the cause. In some of these diseases the headache is made worse by an accompanying anemia or hyperemia, in which case the measures recommended below for these circulatory conditions should also be used.

Neuropathic headaches are relieved with ease or difficulty according as they are of short or long standing, *i. e.*, as to whether or not they have become habits, appearing periodically. The neurasthenic headache usually responds to tonic hydrotherapy and out-of-door life. It is the form of headache which is most benefited by nerve pressure and nerve stimulation, spinal and head massage. It is in these neuropathic headaches that the osteopath acquires a justly obtained reputation for skill. However, any thoroughly trained masseur who has acquired a fair knowledge of anatomy can accomplish the same results without the recital of osteopathic dogmas with which the osteopath accompanies his treatment and by which he ties his patient to himself and his creed, greatly to the patient's detriment in case of other or more serious maladies.

Positive galvanism to the base of the brain or forehead, the positive static head breeze, or mild faradism to the head, are useful in certain cases of neuropathic headache.

Migraine, in our experience, is both toxemic (metabolic), hyperemic, and in many cases reflex (from the liver, stomach, or pelvis). It is most discouraging and unsatisfactory to treat as far as immediate relief is concerned. We have attained success only by a painstaking, diligent, and often prolonged search for the cause. If it is the expression of visceral gout, a rigidly purin-free diet with eliminative and tonic hydrotherapy, fresh air, and sunshine, continued for months or years, will ultimately result in a satisfactory cure. If reflex, the diseased organ or function must be sought out and treated. In all cases out-of-door work is one of the most beneficial means of treatment.

Organic Headaches. The headache of acute or chronic meningitis is to be treated in the same way as any headache due to acute congestion. The results are less satisfactory because of the high intracranial pressure. This factor may be partially or wholly eliminated by spinal puncture, except in cases where the foramen of Magendie is closed. The headache of brain tumor yields but slightly to anything except a powerful hypnotic or analgesic drug. In all cases where syphilis may be a possible cause, potassium iodide should be used. In headache due to gumma of the brain, its results are satisfactory and usually prompt.

Circulatory Headaches. *Anemic.* This is present in severe anemias from many different causes, sometimes in convalescence, and in blood dyscrasias. It may also be caused by vascular spasm. The most satisfactory treatment is alternate hot and cold applications to the head given as described under technique. This measure occasions a more active circulation in the cerebral vessels by stimulation of the vessels themselves through their vasomotor nerves. It should be repeated daily or on alternate days as required. Alternate hot and cold to the spine and the cold mitten friction will both aid in stimulating the circulation.

Hyperemic. In active hyperemia the pain is often throbbing in character and the face is flushed, so that the diagnosis is not difficult. The treatment consists in depletion. This may be secured in many different ways applied as necessary according to other conditions present. The hot foot bath with ice bags to the carotids and back of the neck is a routine measure and usually results in relief. When due to excessive brain work, the alternate foot or leg bath or the alternate hot and cold percussion douche to the feet and legs is more beneficial. It produces depletion by collateral fluxion. In some cases the use of simultaneous hot and cold to the head is best designed to relieve the hyperemia, especially where there is also a toxemic factor present.

Passive Congestion. This is a very troublesome form of headache, found chiefly in cases of cold in the head (coryza). Since passive hyperemia is best treated by fluxion, the headache present with this condition also yields best to the application of alternate hot and cold to the head, the same as recommended for anemia of the brain. This stimulates the circulation and so remedies the passive congestion. Since the brain is very susceptible to hyperemia, the treatment should be accompanied by the hot foot bath or hot leg pack and finished by a cold mitten friction or the alternate hot and cold percussion douche to the feet, in order to prevent active congestion and to secure permanent derivation.

In connection with the subject of headache, we can not refrain from uttering a caution against the use of analgesics. It is true that patients desire and often demand something for immediate relief. The relief received, the patient makes no reform, or in many cases no attempt at reform, and obscure causes are not searched out. The headache powder is repeated on the next occurrence of the headache, and in a very short time the habit is formed. It is then a much more difficult matter to afford temporary relief without the drug, and a still more difficult matter to effect a permanent cure.

The patient had better have suffered a little temporary discomfort and pain, and have yielded to the physician's advice in starting a search for the cause and instituting a method of treatment for its removal and the correction of the morbid habit. Practically all headaches other than organic, and even some of these, may be entirely remedied by persistent and painstaking endeavor.

CHAPTER XXII

EXPECTORANT EFFECTS

THERE is a definite series of changes accompanying the course of such conditions as colds, acute bronchitis, and simple croup. In all congestions and inflammations of the mucous membrane of the respiratory tract, the first change is that of intense congestion accompanied by swelling and turgescence of the membrane which is dry and much irritated. In this condition the cold is said to be "tight" because of the extreme irritation and the fact that the dry mucous membrane renders gaseous interchange difficult. Very soon there begins to appear a secretion of a thick tenacious mucus, accompanied by leucocytes. Later, the character of the secretion becomes altered. It is more fluid, contains frothy mucus and is more purulent in nature. When this change occurs, the cold is said to have "loosened." From this time on, expectoration becomes easier. During the first stage of the turgescence of the mucous membrane, there is no expectoration. Later, there is a very small amount of thick mucus which is expectorated with difficulty; and after the cold has thoroughly loosened, the quantity is very much increased, while the sputum is quite fluid.

In the application of measures designed to relieve these conditions, that which appears most rational is the hastening of this series of changes and relieving such symptoms as pain and cough. During the first stage, that is, the stage of congestion, and the second stage when there begins to be a secretion of thick mucus, it is necessary to decrease the congestion and increase the fluidity of the secretion. This is best accomplished by moist heat, such as the inhalation of steam, fomentations to the chest and throat, hot water drinking, the heating chest pack or some general sudorific measure. The moist heat dilates the blood-vessels and stimulates the activity of the mucous glands, so that they produce a more fluid secretion. These measures should be continued with but little change until the symptoms are considerably ameliorated. Then after the first day it is best to employ alternate hot and cold applications, the revulsive compress, cold mitten friction, etc., in order to promote resolution, absorb the exudate, and prevent further excessive secretion. This is best accomplished by stimulating the circulation, so equalizing it that congestion of the pulmonary mucous membrane and the mucous membrane of the nose and throat is decreased. These measures also stimulate the depth of respiration and increase gaseous interchange. All sudorific measures ease difficult respiration and increase the fluidity of expectoration. The following are the most useful measures in the treatment of inflammations of the respiratory tract:—

1. Russian or vapor bath.
2. Inhalation of steam, plain or medicated.
3. Fomentations to chest and throat, or the hot trunk pack.
4. Heating chest pack and heating throat compress.
5. Hot water drinking.

Several of these may be combined: for example, fomentations to the chest and throat may be accompanied by hot water drinking, inhalation of steam, and the hot foot bath. Expectorant effects are indicated in the following conditions:—

1. Colds.
2. Acute bronchitis.
3. Chronic bronchitis.
4. Asthma.
5. Croup.
6. Bronchiectasis.
7. Pulmonary tuberculosis.

Precautions. All of the applications recommended for expectorant effects are of a more or less diaphoretic nature, and consequently the patient is predisposed to colds and there is greater liability to a return of the symptoms. For these reasons, it is best to employ such measures as the alcohol or witch-hazel rub at the conclusion of the sweating measure, or some mild cold application, such as the wet hand rub or cold mitten friction. The chest should be protected by a dry chest pack. The clothing should be sufficient to provide warmth, and the patient should be cautious about exposure to drafts and dampness.

ACUTE CORYZA, PULMONARY CONGESTION, ACUTE BRONCHITIS

In these conditions, it is necessary to accomplish the following results: First, relieve congestion and pain; second, ease the cough and aid the expectoration, first by increasing its fluidity, and later, the facility of expectoration.

Some general sweating measure is indicated during the first stage of a cold. The treatment already mentioned in the introduction is indicated at this time. Fomentations to the chest and throat should be repeated at intervals of three to five hours followed by the heating compress to the throat or chest, according to the location of the congestion. Fomentations also relieve the excessive cough and pain accompanying the cough. The drinking of hot water aids diaphoresis and helps to increase the fluidity of the secretion by increasing the amount of water in the blood. From the beginning of the cold, the patient should, after every hot treatment, be given a cold mitten friction or cold towel rub; and later, such treatment as hot and cold to the spine, revulsive compress to the chest, hot and cold foot bath, in order to equalize the circulation and promote return to the normal tone. In acute coryza (cold in the head) alternate hot and cold to the head may be used from the start, and repeated several times. A hot foot bath should be given at the same time.

CROUP

In diphtheritic croup, we are less frequently called upon to treat extreme conditions than before the introduction of antitoxine. However, in this disease and also in simple and spasmodic croup, expectorant effects are indicated. In the latter conditions the child should be given some sweating treatment, such as a hot foot bath accompanied by hot moist applications to the chest and neck. This should be continued until the harsh, brassy cough gives way to free and easier expectoration. When this occurs the dyspnœa and cyanosis will be relieved. The inhalation of medicated steam is a great aid in the treatment. Special inhalers may be provided (*Figs. 57 and 58.*), or an ordinary tea-kettle or basin may be utilized for the production of steam which may be conveyed to the patient by means of an inhaling funnel or mask. The drinking of some hot liquid will increase the sweating and hasten the loosening of the secretions.

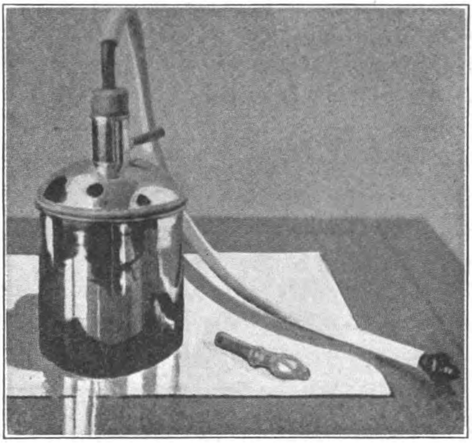

Fig. 57. Inhaler for medicated steam. (Kellogg.)

The heating compress or the moist chest pack should be applied after the fomentations and left in place from thirty minutes to two or three hours. The child usually falls into an easy sleep following such treatment. In some cases it may be necessary to dispense with the moist inside part of the chest pack, using only the dry pack.

ASTHMA

The treatment of the asthmatic paroxysm by means of hydrotherapy is a disappointment, and this in spite of the fact that by a more or less prolonged course of hydriatic, dietetic, and climatic treatment, very severe cases of asthma of long standing are almost completely cured. Permanent and very decided results are obtained in cases that submit to treatment for a sufficient length of time. Hydriatic applications, however, may be made to assist in relieving the patient during the paroxysm. Two objects are to be attained,—the lessening of the dyspnœa and facilitating expectoration. These may be accomplished by some mild sweating treatment, fomentations to the chest, or the inhaling of medicated steam. As soon as the patient breaks out into a gentle perspiration, the dyspnœa begins to lessen.

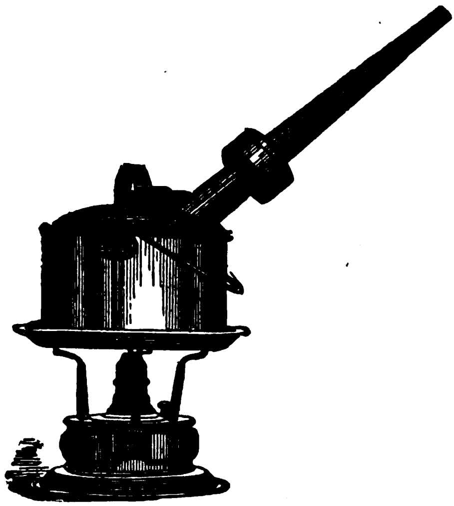

Fig. 58. An improved croup kettle. (Dieffenbach.)

CHRONIC BRONCHITIS

This condition is treated in much the same manner as any chronic inflammation. The results to be obtained are: First, relief of the cough; and second, lessening of the amount of expectoration and facilitating its expulsion. The patient should be given a definite program of treatment, such, for example, as the following: Hot foot bath, together with fomentations to the chest and the cold mitten friction; also fomentations or revulsive compress to the abdomen, revulsive compress to the chest, hot and cold to the spine, cold towel rub, salt glow. It is usually best to have the patient wear some form of a dry chest pack. All of these measures stimulate the circulation, reducing the venous stasis in the lungs, and promote resolution. The fact that the circulation in the lungs is more rapid tends to decrease the amount of the secretion. The patient's general vital resistance is raised by such a course of treatment.

The digestion requires special attention. "Stomach cough" is not a bad name for many cases of chronic bronchitis, since the indigestion, auto-intoxication, and sluggish condition of the liver are very largely accountable for the excessive secretions. If the patient may be induced to give up all complicated dishes, desserts, meats, rich and highly seasoned foods, and limit himself to a very simple diet, the condition will yield to treatment much more readily. The same is true of bronchial asthma. So astonishing are the results obtained in both these diseases by rigid dietetic regulation, accompanied by general tonic treatment, that, although requiring a long time to produce, they seem almost miraculous.

CHAPTER XXIII

DIAPHORETIC AND DIURETIC EFFECTS

IT will be noticed that nearly all of the diseases in which diaphoretic and diuretic effects are especially indicated and where they must be used repeatedly, are intimately associated with, or due to, defective metabolism. The treatments that promote diaphoresis and diuresis all powerfully affect metabolism. Internal tissue changes are of course the antecedents of, and are manifest by, changes in excretion. It is these tissue changes and the consequent elimination of carbon dioxide and nitrogenous wastes that are of so much importance. For this reason we have devoted one chapter to a consideration of the methods and principles of diaphoretic and diuretic treatment and followed it by another devoted to the special application of these principles in systemic diseases and diseases of metabolism.

DIAPHORETIC EFFECTS

There are a large variety of measures which induce general perspiration. Any hot application, even if local, may induce perspiration over the entire body. The measures to be selected as most efficient in treating a disease depend upon the causes of and conditions in that disease.

The following is a list of the principal diaphoretic measures:—

1. Electric light bath (general or local).
2. Sun bath.
3. Turkish bath.
4. Superheated air bath (250°—400° F.).
5. Russian bath or vapor bath.
6. Full hot bath.
7. Hot blanket pack.

8. Dry pack.
9. Electro-thermal pack.
10. Heating wet sheet pack.
11. Hot spray or douche.
12. Hot leg or foot bath.
13. Hot sitz bath.
14. Fomentations to the spine.
15. Hot water drinking.
16. Hot enema.

Each measure has its own range of applicability and special adaptability to the needs of the individual case. The more local and milder measures have a wide range of usefulness. The more extreme and general heating treatments have certain contraindications which must not be disregarded. Tonic cold applications should usually follow sweating treatment. The main effects of diaphoretic applications are as follows:—

1. Increase perspiration (water chiefly).
2. Increase catabolic changes (spoliative or reducing).
3. Increase elimination of toxins through the skin and through the kidneys indirectly by relieving these organs when overworked or congested, thus making more efficient the work which is done. In health, diaphoretic measures do not increase the amount of urine and may considerably decrease it, but in all conditions where there is lessened functional activity of the kidneys, diaphoretic measures tend to produce diuresis and hasten the elimination of toxins through that channel.
4. Increase the activity of the sebaceous glands and skin in general, thus improving its nutrition.
5. Relieve internal congestion.
6. Decrease dropsical effusions.
7. Prepare the patient for cold treatment by promoting ability to react.

There are a large number of conditions in which diaphoretic measures are indicated. In a few diseases the most vigorous sweating treatments may be used with great benefit. Below is given a list of diseases and morbid conditions which require special diaphoretic treatment. Very vigorous means may be used in all but the first three.

Indications for diaphoresis:—

1. Icterus.
2. Systemic poisoning (toxemia).
3. Internal congestions.
4. Secondary syphilis.
5. Obesity.
6. Acute rheumatic fever.
7. Gouty rheumatism.
8. Gout (podagra).
9. Bright's disease, acute and chronic.
10. Uremia.
11. Eclampsia.

Contraindications to *extreme* sudorific measures.

1. Asthma.
2. Organic heart disease.
3. Emaciated rheumatics and diabetics.
4. Sunstroke and heatstroke.
5. Pulmonary tuberculosis.
6. Asthenic fevers.
7. Icterus.
8. Emaciation and exhaustion.
9. Old age.

DIURETIC EFFECTS

We have previously shown the close connection existing between the functions of the kidneys and skin in diseases of either of these organs. Above is given a list of the various sudorific measures. All of these treatments are beneficial in conditions of defective kidney activity. It has long been known that nephritis and diseases of metabolism, closely associated with the functions of the kidney, are benefited by free diaphoresis. In these diseases all brisk sudorific measures indirectly increase urinary secretion. This is probably due to the fact that renal congestion is lessened, the stagnation relieved, so that while there is less blood in the kidneys at any one time, the rapidity of the renal circulation is increased. The secretion of urine is therefore more efficient and the quantity of the watery and solid constituents is increased. The increase in urinary solids is due not alone to stimulation of the renal epithelium by a quickened circulation, but also to heightened metabolic changes occurring in the tissues themselves. The stimulation of the general circulation and especially of the hepatic circulation and of the liver cells, produced by sweating treatment or accompanying the reaction to cold treatment, has been shown to increase the toxicolytic powers of the liver. Toxemia is thus lessened in a very direct manner. The blood being less toxic, irritation of the renal cells is decreased and the work done by the kidney is more efficient.

The following are the principal diuretic measures which are useful in kidney insufficiency and allied conditions:—

1. Full blanket pack.
2. Electric light bath.
3. Russian and other vapor baths.
4. Hot air baths.
5. Full warm tub bath.
6. Water drinking (especially with above).
7. Cold (or hot and cold) douche to lower sternum and lumbar spine (entire width of back).
8. Cold heating trunk pack or the rubbing wet sheet pack.
9. Fomentations to lumbar spine.
10. Intermittent or continuous proctoclysis with warm physiologic salt solution.

Indications:—

1. Bright's disease, acute or chronic.
2. Uremia, eclampsia, and other toxemias.
3. Acute suppression of the urine.
4. Ether and post-operative nephritis.
5. Ptomaine poisoning.
6. Poisoning by lead, turpentine, alcohol, etc.

CHAPTER XXIV

SYSTEMIC AND METABOLIC DISEASES

OBESITY

IN considering the effects of thermic applications upon tissue changes in respect to both nitrogenous and carbonaceous metabolism, it was shown that all forms of cold treatment increase catabolic changes, also that excessive heat or long continued heat has the same effect. The two extremes, however, do not have the same effect upon anabolism, heat having little or no tendency to increase the building-up processes through increased absorption and assimilation of food. Tonic cold applications often increase anabolism more than catabolism. It is for this reason that cold applications signally fail in securing any great reduction in weight. The patient may lose a few pounds.

Of course, the general vitality of the patient and all nutritive processes are enhanced by alternating hot and cold applications. This is doubtless the more rational way to treat obesity, since it is more necessary to improve the general condition of the patient than to reduce the weight; but if the reduction of the weight is the objective point, it is necessary to resort to extreme sudorific measures, unaccompanied by cold applications. For this reason it is not possible to greatly reduce the weight of persons suffering from fatty heart, accompanying the general obesity. Spoliative and reducing measures aim at increasing catabolism without a corresponding increase in anabolism. All extreme sudorific measures available should be used in this condition. Those which will be found most helpful are the Russian bath, Turkish bath, electric light bath, full blanket pack, electro-thermal pack, and sweating wet sheet pack. The full hot bath and the mud baths commonly used at hot springs may be used. These do not, however, have any advantage over the first three measures mentioned.

The patient should have one prolonged sweating treatment daily. It is often necessary to finish with a very short cold spray. This should not be greatly prolonged for the reasons above mentioned. The patient should take as much vigorous exercise as possible. Heavy massage may also be used. It is needless to say that the following of such a program will result in weakening the patient, as well as in reducing the weight. These measures will all fail unless the diet is reduced, especially as regards the total number of calories. As soon as the patient returns to his usual habits of inactivity and over-feeding, there will be a prompt gain in weight which will replace all that has been lost. Extreme sweating treatments do, however, materially reduce the weight and, by guarding the diet and encouraging exercise, the loss in weight may be quite permanent.

ICTERUS

It is usually impossible to employ prolonged or extreme diaphoretic treatment in this condition, but free perspiration should be encouraged, since by increasing the elimination of bile through the sweat, it relieves the nervous irritability and aids in relieving pruritus. Local hot applications are illy borne because of the extreme sensitiveness of the skin. The electric light bath is a very efficient means, since its heat is evenly distributed. The drinking of much water is an essential for both free diaphoresis and diuresis.

SYSTEMIC POISONING

In many conditions in which toxic substances circulate in the blood and lymph, free diaphoresis materially hastens their elimination. Such substances may be produced by auto-intoxication from intestinal sources, or faulty metabolism. General poisoning may result from the ingestion of ptomaines, lead, mercury, alcohol, etc. In some cases, vigorous diaphoresis is necessary; in others, only mild diaphoresis with copious water drinking should be used. Because of the weakness and debility resulting from the poison, extreme sweating measures can not be used. A short electric light bath is often all that is necessary. Renal elimination should be hastened by free water drinking.

INTERNAL CONGESTIONS

The use of sudorific measures in relieving congestion of the viscera has been considered elsewhere, especially in connection with inflammations and diseases of the kidneys. It is not possible for an extreme congestion to exist in the internal organs while the skin is red and congested, as occurs in a sweating treatment. But in order to more permanently relieve the internal congestion, it is necessary that the blood be retained in the skin. This is not accomplished by the hot alone, but can be by the reaction hyperemia resulting from a cold friction. The principle of these effects has been considered in connection with the subjects of derivation and fluxion. The relief of visceral congestions by general sudorific measures is indicated in acute nephritis, eclampsia, uremia, pulmonary congestion, acute pleurisy, and the early stages of many infectious diseases such as influenza, measles, scarlet fever, etc.

GOUT AND GOUTY RHEUMATISM

General Consideration

The literature on the purin diathesis is most voluminous and much of it unreliable; there are, however, some important facts regarding purin metabolism that have been sufficiently well proven to allow of their being used as a foundation for the basic principles involved in the treatment of these conditions. We can not here attempt anything like a complete consideration of this question, but merely point out those facts which seem to us to be of importance in determining the treatment. There seem to be three causes for the accumulation of basic purins and uric acid in the system. These are: First, excessive ingestion of purin-containing foods over long periods of time; second, defective and deficient xanthin oxidation and uricolysis; and third, decreased elimination of purins because of kidney insufficiency.

To provide a diet free from purin is not difficult, and so the removal of this first cause is a comparatively easy matter. To remedy the second is, however, a more difficult matter. It has been shown how applications of both heat and cold accomplish a quite thorough xanthin oxidation, *i. e.*, a change of the basic purins to uric acid. This change of basic purins to uric acid is a distinct advantage, as uric acid is less irritating to the renal epithelium than the bases. "Mammals form uric acid only from the purins and have the power of destroying some of the uric acid formed. This uricolytic power is relatively weak in man."[1]

Nucleoproteids are converted into free purins and these, in turn, are changed into uric acid by the loss of nitrogen and the addition of oxygen. "Wiechowski has particularly studied the enzyme concerned in the destruction of uric acid by the tissues, and the fate of free uric acid in the body. This uricolytic enzyme, which has been appropriately called uricase by Batteli and Stern, is an oxidizing enzyme, acting best in experimental digestions when a lively current of air is running through the digestion mixture, and which seems not to be present in the blood plasma and tissue fluids, but only in the cells. It acts rapidly and with striking effect, for active organ extracts are sometimes able to destroy quite considerable quantities of uric acid in a few hours; for example, one gram of powdered tissue, dry weight, can often destroy totally 0.1 gram of uric acid in four hours. Unlike the enzymes of autolytic disintegration of tissues, uricase is not inhibited by the presence of an excess of serum. Another interesting feature is that this enzyme acts reversibly, or at least tissue extracts which destroy uric acid with a current of air running through, *soon build up the uric acid again when the air is shut off*."[2]

The above facts show the benefit to be derived from hydrotherapy in stimulating the circulation, increasing the oxygen-carrying capacity of the red cells, and increasing oxidation in the body tissues. Out-of-door life in the fresh air and sleeping

1 H. G. Wells—Trans. Chicago Pathological Society, May 1, 1909.

2 Editorial in Journal of American Medical Association, October 9, 1909, p. 1191; see also The Oxidases, Bulletin No. 59, p. 103, of Hygienic Laboratory, Public Health and Marine Hospital Service of the United States.

out of doors furnishes the abundant supply of oxygen so necessary to uricolysis.

In addition to the effects of hydrotherapy, certain articles of diet play an important part in the prevention of uricacidemia. This is notably so of fruit. "Weis, in 1898, asserted that after eating fruit the uric acid of the urine is decreased and the hippuric acid increased."[3] "Wohler found uric acid, but no hippuric acid, in the urine of sucking calves, so long as they consumed nothing but milk. But as soon as they passed on to vegetable food, the uric acid disappeared and hippuric acid was substituted. It thus appears that the benzoic acid arising from *vegetable diet* siezes upon the glycocol and prevents the synthesis of uric acid.

"It is useless merely to give benzoate of sodium, as I have proved by many experiments. But here again it should not be forgotten that it is not in our power to make the benzoic acid reach the proper point at the proper moment when the glycocol, before its union with the cyanic acid could reach it. As already mentioned, the benzoic acid in vegetable food is not generally contained as such, but is formed in the body by the decomposition and oxidation of more complex combinations. It is quite possible that these latter are taken up by the cells in which glycocol occurs, while the benzoic acid already formed is rejected."[4]

The use of medicinal substances in the treatment of gout, outside of those found in man's natural diet is a disappointment. This is true of benzoic acid, the salicylates and also of lithium. This latter neither affects the solubility of uric acid in the tissues nor in the slightest increases its elimination by the kidneys.

Even if lithium exerted an influence on the solubility of uric acid, the amounts present in commercial lithia waters would be too minute to accomplish anything. Relative to this fact, Dr. Henry Leffmann says,—[5]

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3 Lewellys F. Barker—Truth and Poetry Concerning Uric Acid, p. 32.

4 Bunge—Physiological and Pathological Chemistry, Second English Edition, pp. 303, 304.

5 Proceedings of the Philadelphia County Medical Society, December 8, 1909, reported in Journal of American Medical Association of February 19, 1910.

"On the result of an analysis of about two score of the so-called mineral waters, the Bureau of Chemistry of the Department of Agriculture has recently issued a circular of inquiry, the essential features of which I give herewith. It has been found that nearly all 'lithia waters' either contain only spectroscopic traces of lithium (unweighable quantities in from 2 to 4 liters), or contain less than one part per million (approximately 0.05 grain per gallon) of lithium."

Along the same line we quote[6] the following from Bunge:—

"If it be desired to prevent the formation of uric acid sediments, or to dissolve concretions that are already formed, by the administration of alkalies, it is more sensible to advise the use of fruits and potatoes than to order alkaline mineral waters, the continued use of which may produce disturbances which we are unable to estimate. Because the combination of uric acid and lithia is more soluble in water than its combination with soda or potash, it has been thought necessary to treat the uric acid diathesis with a few decigrammes of carbonate of lithia, or even with mineral waters containing one centigram of lithia to the liter. This naive idea simply implies ignorance of Berthollet's law. We know that in solutions of bases and acids, every acid is distributed to all the bases in proportion to their quantity. It follows that only the very smallest portion of uric acid will combine with the lithia, the largest proportion combining with the preponderating quantity of soda, which we introduce as chloride of sodium. The largest proportion of lithia will reappear in the urine, united with the chlorine of the chloride, with sulphuric and phosphoric acid. There will be no increase in the solubility of uric acid."

Treatment

Purin diathesis, true gout, and allied conditions, such as the myalgias, lumbago, the visceral forms of gout, etc., are usually treated by extreme diaphoretic measures. It must be confessed, however, that the majority of rheumatics are not able to stand such treatment. Only those who are obese or of more than average weight can stand extreme sweating measures. It is

6 Physiological and Pathological Chemistry, Second English Edition, p. 322.

for these reasons that many a rheumatic patient leaves a course of baths at the hot springs in worse condition than when he began. Many and many are the patients that year after year visit the various spas of this country and Europe, deriving each time only a temporary benefit. For this, there are two reasons: All are given the same routine of hot baths, regardless of the individual conditions and needs. Obese or emaciated, they are all treated alike. Second, there is a failure to eliminate from the diet all purin-containing foods and reduce to a minimum the proteid intake. Chittenden has shown that a daily ration containing 35 to 60 grams of proteid is not only compatible with perfect health, but also conducive to gain in muscular capacity, increasing the endurance to prolonged muscular effort and lessening fatigue. In gout and gouty rheumatism the proteid should be reduced to the least amount compatible with the actual need of the body for nitrogen. As pointed out by Garrod, every particle of food not absolutely needed for the nourishment of the body merely nourishes the disease. One can not hope to cure disease unless the cause is removed. In the purin diathesis, the two chief causes are over-feeding and under exercise. The over-feeding is in the line of heavily proteid foods and foods containing purin. These must be eliminated from the diet, if great benefit is to be derived from treatment.

For practical purposes, we must divide gouty rheumatism into two classes, *viz.*, obese rheumatics and emaciated, anemic rheumatics. In the first class, sweating treatment may be used with benefit when properly combined with tonic measures. In the second class, extreme sweating treatment is not permissible.

Rheumatism with Obesity. Those patients who are well nourished may be given a thorough sweating treatment daily. Any of the sudorific measures recommended in obesity are serviceable. The Turkish bath, Russian bath, electric light bath, full superheated dry air bath, hot blanket pack, sweating wet sheet pack, or electro-thermal pack, are all applicable. Their effects may be greatly enhanced by free water drinking. The mineral waters possess no advantage over any pure water. The beneficial results are derived from the free perspiration and diuresis it induces. It thus affords ample solvent for the increased nitrogen excretion. F. Umber[7] claims that alkaline water has the opposite effect; also that the blood of gouty patients is able to dissolve larger proportions of free uric acid than it ever contains. He declares that none of the alkalies or mineral waters have any specific influence on the purin metabolism in gout and that the propaganda for the "lithium content," etc., of springs should be abandoned.

Tonic measures should not be neglected. The strength should be maintained and the circulation stimulated. All hot baths should be followed by some form of cold treatment. These may at first have to be mild, but obese patients stand cold treatment well. The alternate hot and cold percussion douche is an excellent means. It serves as a massage, stimulates the vasomotors, and restores the tone lost because of the hot bath. It should be applied especially to the spine and legs and should consist of from three to five complete changes from hot to cold. The patient should be dried from the cold and may either rest or take exercise after it, according to the conditions of the particular case under observation. Individualization is the life of therapy no less with rheumatism than with other diseases. Light or heavy massage may be given. The massage douche is highly recommended by some. It possibly possesses some advantage over the percussion douche. The Turkish shampoo is an excellent means of combining massage with vigorous sudorific measures. Other tonic applications may be used, such as cold affusions and general sprays and showers. Later in the disease, the wet sheet rub may be used to advantage.

Rheumatism with Emaciation. This condition is doubtless in some cases the direct result of "hot springs" treatment. Hot treatment must be used with much caution. The vigorous sweating treatments are never to be employed if the patient is under weight. Local hot applications are permissible and a mild sweating treatment once a week may in some cases be ventured upon. Hot applications to the swollen joints, as fomentations, local hot air baths, superheated air (*Plates XV and*

7 Therapie der Gegenwart, February, L, No. 2., pp. 73—120.

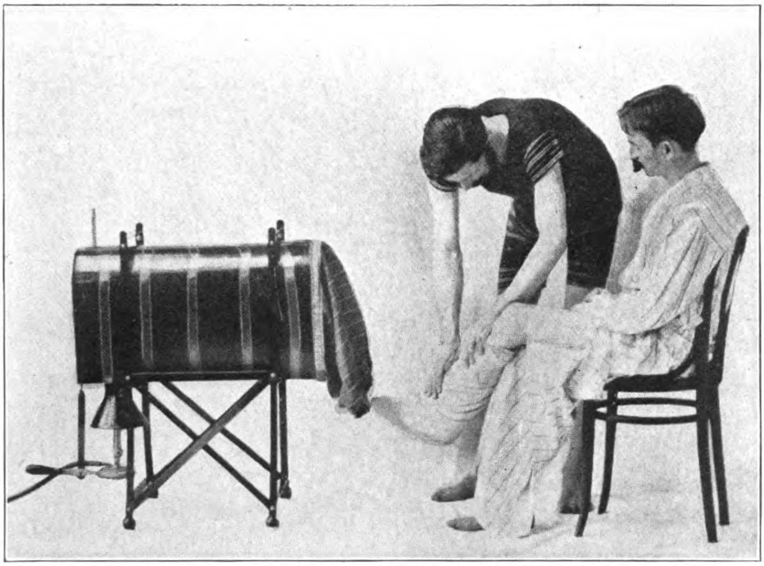

PLATE XV. Superheated dry air bath. Foot bandaged in Turkish toweling ready to be introduced.

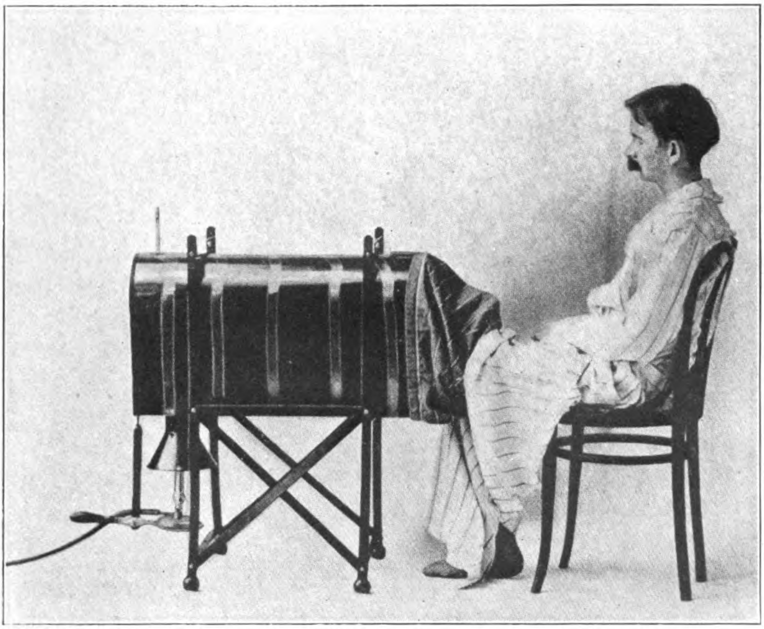

PLATE XVI. Superheated dry air bath. Treating foot.

XVI.), or local electric light bath should be followed by a tonic friction. At first this may be a wet hand rub with tepid water, then with cold water and later, the cold mitten friction. These frictions should be applied to the muscular portions of the body, the swollen joints being avoided. The joints should be enveloped in heating compresses or packs wrung from cold water. These should be thoroughly covered with several layers of flannel or absorbent cotton, if necessary, in order to exclude the air. The effect may be increased by counter-irritants or anodynes. After a time the alternate soft spray douche may be applied to the joints and the body generally. When convalescence is well established, the patient should be given daily some general tonic treatment with only short preliminary hot applications.

In true gout, *i. e.*, where the disease is localized in the metatarso-phalangeal joint of the great toe, the tonic measures outlined for gouty rheumatism must be used in the interval. Only hot applications can be made to the foot during the paroxysm.

At first the patient suffering from rheumatism will complain some of increased stiffness and possibly pain in the joints after even a mild cold friction. This should not deter the physician from following the plan outlined nor cause discouragement on the part of the patient. If much complaint is made, the alcohol rub may for a time be substituted.

Faradization of the joints by the rapid faradic current helps to relieve the pain and the annoying paresthesias that keep the patient awake. Gentle massage of the muscles and rubbing to the spine are helps in treating the insomnia. The myalgias such as lumbago may be treated as recommended elsewhere. In lumbago, however, the most vigorous hot and cold percussion douche to the back should be used, followed by heavy massage or firm deep vibration to the large muscles of the back. These relieve the pain as milder measures will not.

In some cases of rheumatism, notably where the patient is bed-ridden or must be closely confined to the wheel chair, it is best to follow a somewhat different plan than that outlined above. In these cases, only mildly hot local applications, such as the fomentation, radiant heat, and the hot foot bath should be used. The usual regime of cold treatment should be omitted and its place taken by carefully applied but thorough massage. This massage should include special attention to nerve stimulation, spinal and abdominal movements. The use of faradic and sinusoidal electricity for the same purpose is an addition of distinct advantage.

In all cases of chronic rheumatism, special attention must be given to the alimentary tract and to the digestion. Modern investigations into the contributing causes of chronic articular rheumatism are turning more and more to alimentary stasis, intestinal infections, and auto-intoxications for an explanation of the pathogenesis of metabolic forms of chronic articular rheumatism. In some of these cases the purin diathesis doubtless has nothing to do with the disease or at most plays only a minor part. The routine use of gastric lavage and copious enemata for a limited time may be productive of excellent results. These treatments must be thorough to be effective. Purin accumulation through defective xanthin oxidation and very limited uricolysis are a part of this auto-intoxication, and are surely to be traced to an overworked and functionally deranged liver as one source of their occurrence.

BRIGHT'S DISEASE

Diaphoretic measures are valuable in both acute nephritis and in the various clinical and pathological varieties of chronic nephritis. It is hardly necessary for our purpose to discuss the structural alterations occurring in the kidneys in Bright's disease. Only in acute nephritis is there hope of any marked restoration of the normal structure. However, the functional perversions may to a great extent be corrected. The alteration of function which is the chief, if not the sole cause of the various clinical manifestations of nephritis, is the renal impermeability and insufficiency in the elimination of nitrogenous wastes and salines. There is also an abnormal permeability to albumen and, in some cases, to water, notably so in the interstitial variety of chronic nephritis.

In interstitial nephritis and the kidney of arterio-sclerosis, the high blood pressure is a prominent symptom and is due, at least to a great extent, to nitrogenous toxins. "Experiments on patients with chronic nephritis have shown that rich protein diet increases tension and disturbs the general condition of the patient for the worse. Müller describes an individual in whom a change from milk and carbohydrate diet to rich meat diet caused pressure to rise from 140 to 190. Rich meat diet causes, in nephritics, headache, one of the earliest and most constant symptoms of uremia, and one which has a definite relation to hypertension."[8]

Treatment must, therefore, be directed toward the attaining of two objects: First, decreasing the amount of toxic substances and salines the kidneys are required to excrete; second, increasing renal sufficiency, so shaping conditions that increased elimination may occur without increased strain and irritation of the kidneys. In order to meet the first indication, it is necessary to bring about several changes. The ingestion of purins (exogenous) must be stopped. The consumption of proteids must be limited as far as the needs of the system will allow. By general hygiene, exercise, etc., one may decrease the formation of intestinal toxins and promote complete oxidation of nitrogenous wastes. These results may be attained by regulation of the diet and attention to digestion. For a time it is well also to limit the use of salt to what naturally occurs in the food.

The experiments of Strasser prove conclusively that the second object, *viz.*, increasing the elimination of nitrogen, salines, and water, is best accomplished by the systematic use of hydrotherapy; and that what has been vainly hoped from diuretic drugs is produced by bathing. His experiments were largely with the full warm bath at 95°—100° F. In all cases there was a decided increase in the quantity of urine and chlorides excreted, which frequently continued several days after the cessation of treatment. In no case was there a storage of nitrogen or salines on the bath days. This was true alike of cases having edema and where there was no decrease in the

8 J. H. Musser—Causes of Hypertension in Nephritis—Journal of American Medical Association, November 27, 1909, p. 1791.

chlorides or nitrogen in the diet. The full warm bath frequently increased the elimination of sodium chloride two or three times the usual amount. In one case, increase in the nitrogen and sodium chloride of the urine occurred without increase in the total amount of urine and continued for three days after the treatment.

Relative to the relation of the two crystalloids—glucose and sodium chloride—to dropsy and diuresis, some interesting facts have been pointed out by Starling. While the presence of unusual amounts of glucose in the circulating fluid induces diuresis at the expense of tissue fluids, the ingestion of much salt does, under certain circumstances, tend to increase tissue fluids and limit diuresis, producing a "water-logged" condition.

"If a solution of 30 grains of glucose in about 30 cubic centimeters of water be injected into the jugular vein, the first effect is a great increase in the volume of the circulating blood, brought about by the osmotic attraction of water into the vessels at the expense, first, of the tissue spaces, but ultimately of the tissue cells. The consequence of the hydremic plethora thereby induced is increased circulation through the kidneys and increased output of urine containing large quantities of sugar. . . . Under ordinary circumstances, the concentration of the tissues thus induced would produce intense thirst and an increased intake of water, so that the urinary flow would be maintained at a high level until the whole excess of the glucose had been excreted."[9]

"The ingestion of an excessive quantity of salt provokes thirst rather than diuresis. If this excessive ingestion were continued or became chronic, there would be a tendency for the amount of this salt in the body to continually increase, the salt being associated with sufficient water to maintain the molecular concentration of the body fluids at their normal height. It is not surprising, therefore, that excessive quantities of salt have been found to exert a deleterious influence in cases of dropsy, or that marked benefits as regards the reduction of dropsy have been attaided by the limitation of salt in the diet."[10]

9 Starling—Fluids of the Body, p. 153.
10 Ibid., p. 154.

Edema is lessened by warm or sweating baths and sometimes very promptly. The dropsy responds even more promptly to alternate hot and cold applications to the edematous parts. The rationale of these hydriatic effects in lessening edema is a very interesting study. We have already dwelt quite at length upon the vascular changes produced by alternating thermic applications. Starling has recently correlated present knowledge regarding the causation of dropsy. In the summary he brings out a number of practical points. "Ranvier has shown that if, after ligature of the inferior vena cava, the sciatic nerve be divided on one side so as to produce dilatation of the arterioles on that side, the limb in which the nerve has been divided will become edematous."[11] There must be other factors beside venous obstruction if edema is to result. Starling concludes that the determining cause, other than stasis, lies in an increased permeability of the vessel wall. This is due in disease to lack of the proper nutrition and oxygen supply to the cells of the vessel wall. "Cohnheim showed that, after long continued anemia of the rabbit's ear, the vessels became so permeable that restoration of the normal circulation was followed by pronounced edema of all the tissues."[12]

The same results were obtained by Barlow. This anemia resulted in asphyxia and starvation of the cells. A long continued venous stasis must affect the vessel walls in much the same way, since it also decreases the oxygen and nutritive supply. In chronic nephritis there is usually a marked anemia with hydremic blood and this appears before the edema. From experiments by Bolton, one may conclude that edema results solely because of this series of changes occasioned by the stagnation of blood in dilated veins and that plethora or increased capillary tension are neither of them necessary for the production of edema. These facts have led Starling to the belief that alterations in the endothelium of the capillary wall must be regarded as the essential factor in the production of edema. The retention of nitrogenous wastes in nephritis must be an added cause of injury to the vessels. With these facts in mind, the

11 Starling—Fluids of the Body, p. 159.

12 Ibid., p. 162.

rationale of hydriatic treatment is quite evident. The restoration of tone to the vessels, both blood and lymph, hastens the circulation, thus relieving the stasis and consequently improving the nutrition of the vessel walls. The nutritive processes and activity of the endothelial cells are directly stimulated by hydriatic applications. In short, the entire series of morbid changes from the decreased permeability of the kidneys to the venous stasis and increased permeability of the vessel walls, is met by the one agent—warm water. There is no evidence that free water drinking is harmful in edema where the amount of urine is less than normal. On the contrary, it has been shown that plethora is not a contributing factor in edema. The diuresis it induces greatly lessens nitrogenous retention and thus, by decreasing the toxemia, aids recovery.

Acute Nephritis. Beginning as it does as an acute imflammation and passing through the various stages of the inflammatory process, acute Bright's disease should be treated along the lines laid down for inflammations. The peculiar course of the disease is governed by the anatomic and physiologic relations of the kidneys, organs of necessarily constant activity, and activity of such a character that it must militate against their recovery. The kidney is congested, swollen, edematous, and tense at the onset of the first symptoms; later, venous stasis is the predominating physical change. To relieve these conditions, sweating measures have abundantly proven their superiority. These congest the skin and relieve the kidney congestion. The patient should perspire freely for an hour or more, at least once a day. The skin should be warm and moist all of the time. Free diaphoresis may be accomplished in several ways. It is often best to resort to some of the milder measures, such as the hot foot bath with fomentations to the abdomen or spine, or the hot trunk pack. If the symptoms are urgent, the full hot pack may be used. The head should be kept cool, and if the pulse is over 100, an ice bag placed over the heart. During the sweat, copious water drinking should be encouraged. This favors diaphoresis, and as soon as the renal congestion lessens, it aids in diuresis. The patient may be sponged off with tepid water and then placed between warm blankets to continue perspiring gently for an hour or longer. A brisk cold mitten friction so given that the part treated is immediately dried, rubbed with the dry hand until warm, and then covered with the warm dry blanket, will prove a valuable adjunct to the sweating measure. It improves the general vitality and helps restore the cardio-vascular mechanism to normal tone. Frequent repetition of the warm saline enema is unrivaled in the prevention and treatment of the uremia of acute nephritis. General cold applications, *i. e.*, cold applied to a large surface at one time, such as the cold towel rub or wet sheet, are contraindicated. The cold mitten friction given as described above counteracts the depressing tendency of the sweating measures which must be repeated daily. The alcohol rub may be used, but it lacks the tonic effect obtained from the cold. The hot air bath, so prepared that it can be given in bed, is an excellent means of producing perspiration (*Plate XVII.*). Croftan[13] objects to the use of dry heat in cases unaccompanied by edema, claiming that it increases the concentration of the blood. He favors the use of the full warm bath in acute nephritis. This should be at a temperature of 98°—104° F., continued for ten or fifteen minutes. Others recommend a temperature not over 100° F. in subacute nephritis, and the prolonging of the bath from thirty to sixty minutes. During this time, the head and face should be bathed in cold water or cold compresses applied to the head and neck. The tub should be covered with a sheet in order to limit the cooling of the surface, and when the patient is removed, the room temperature must be 85° or more to guard against chilling. The patient should be immediately placed between dry blankets, or in a sheet and well covered by warm dry blankets and allowed to remain in this heating pack for a time. The electro-thermal pack is a very convenient substitute for the dry pack.

During the first few days of acute nephritis, in case it seems necessary to use the hot trunk pack or full hot blanket pack, an ice bag may be applied over the lower third of the sternum. It tends to cause reflex vaso-constriction in the kidney. With these intensely hot applications, an ice bag over the heart is

13 Clinical Therapeutics.

usually necessary and, if a large ice cap is used, it will cover the sternal kidney area as well. Other forms of hot bath, such as the Russian and electric light, may be best left for subacute or chronic nephritis after the acute symptoms have largely subsided.

Chronic Nephritis. In chronic nephritis, whether a sequel of the acute or coming on insidiously and complicated by cardiac and vascular changes, it is possible to utilize a greater variety of measures and more vigorous tonics can be borne. A southern climate is of advantage largely because free perspiration is secured without effort and there is less tendency to chilling. We have utilized with success all hot baths, such as the Russian, Turkish, electric light, and superheated air. These may be given two or three times a week. About once a week or once in two weeks, it is desirable to follow a vigorous sweating treatment by the Turkish shampoo. All these extreme sudorific treatments should be concluded by some form of the hot and cold shower, douche, or spray. The douche is the best means since it combines percussion effects with the thermic stimulus and so lessens the tendency to chilling. The alternate application of fomentations and an ice bag to the lower sternum and kidney region produces mild fluxion in the kidney. The alternate hot and cold percussion douche to the lower sternum and the lower dorsal and lumbar regions is more vigorous and a very efficient means of stimulating renal activity.

Nearly all hydriatists recommend very highly the full warm bath as the most serviceable measure in subacute nephritis. While we do not doubt its great utility, yet we have seen better results by employing, in about two out of every three treatments, more vigorous means and means employing more tonic effects. These are obtained to only a slight extent by the warm bath. Where there are marked changes in the heart and vessels, we have found tonic hydrotherapy a necessity. Of tonic measures, one may use hot and cold to the spine, the revulsive compress to the kidney region or abdomen, the cold mitten friction, the ice bag to the heart, and the alternating douche. The Nauheim bath is highly recommended both for the relief of dropsy and the treatment of cardio-vascular disturbances.

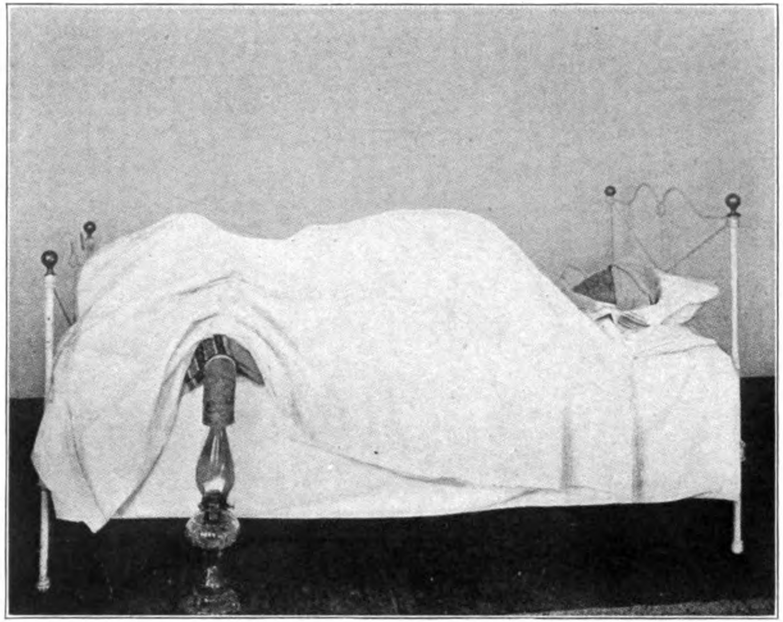

PLATE XVII. Hot air bath in bed. (Kellogg.)

That it is a powerful means can not be doubted. It must, however, be used with caution, remembering that it may result in overstimulation. For the edema of the feet and legs, alternate hot and cold immersion is as valuable as for the same condition in cardiac incompetency. Its beneficial action may be assisted by massage.

Cathartics and Medicinal Diaphoretics. About the only diaphoretic drug recommended as a routine is pilocarpin. This must, however, be mentioned only to be condemned. It is dangerous where the heart may be involved in the general vascular changes and its use is entirely superfluous, since we have such efficient hydriatic means of accomplishing the same results. Saline cathartics or elaterium as a means of reducing ascites or anasarca may at times be necessary. Their repeated use is not to be encouraged, since they induce great weakness and derange the digestion. Diuretin should not be used in any form of nephritis since it irritates the renal epithelium. It is necessary that special attention be paid to gastric digestion. The measures recommended for the various forms of atonic indigestion should be used as indicated. Attention should also be given the gastrectasia which so frequently accompanies a chronic parenchymatous nephritis. It is a cause of faulty nutrition and is closely connected with morbid proteid metabolism. The free use of mineral waters may greatly increase the dilatation. Fluids must be taken in small amounts, preferably as plain cold water. In interstitial nephritis, mineral waters or even the free use of ordinary water is unnecessary, since diuresis is the rule. In this form, whether simple or forming part of a general arteriosclerosis, extreme measures, either hot or cold, are usually contraindicated since the increase of blood pressure which both produce may determine an apoplexy. However, in some cases of chronic nephritis accompanying obesity the most vigorous sweating measures followed by vigorous hot and cold sprays and douches are taken with benefit and marked reduction in blood pressure. Mild diaphoresis is beneficial and this may be secured by short hot baths or the prolonged warm bath at a temperature of 98° or 99°. This tends to equalize the blood pressure and helps to relieve the nerve tension which is a part of the clinical picture in many of these cases.

It has recently been shown that the endogenous uric acid in the blood in interstitial nephritis varies according to the functional activity of the kidneys.[14] These observations were made on a purin-free diet. This retention of uric acid is very favorably influenced by exercise and hydrotherapy. Umber noticed that on a purin-free diet the elimination of uric acid decreased after exercise, owing to its participation in the increased oxidation incident to muscular exertion. That like results may be obtained by hydrotherapy has been shown by the researches of Strasser.

UREMIA AND ECLAMPSIA

These pathologic states, while not identical, have many points in common. In uremia, there is, in the majority of cases, a retention of toxic urinary products because of the kidney insufficiency. While all observers are not agreed as to the constant occurrence of kidney insufficiency in eclampsia, yet nearly all agree that its manifestations are accompanied by a severe poisoning from some autotoxic source. Croftan says there is much chemical and clinical evidence to show that in uremia the general metabolism and, in particular, the manifold functions of the liver, are perverted. The kidney may not be primarily involved and possibly in some few cases not at all. In the majority of cases, however, there are demonstrable lesions in the kidney as well as functional inadequacy during life. A great variety of conditions have been reported, among which are infarcts, acute and chronic congestion, edema, greatly increased tension, and actual nephritis. In a case of eclampsia reported by Wiemer[15] the tension was so marked that the kidney substance bulged out on incision in the course of Edebohl's operation. Braak and Mijnlieff[16] report a case in which the right kidney was much enlarged and so painful that the patient, in coma, reacted when it was palpated. They report thirteen other cases

14 In gout the endogenous uric acid in the blood is more constant and never exceeds a certain maximum amount (about 0.003 per cent). A demonstrable amount of uric acid is always present in the blood in gout, even when the food has been free from purins for weeks or months, while blood from normal individuals on a purin-free diet contains no uric acid.—Journal of American Medical Association, April 3, 1909, p. 1110.

15 Monatschrift für Geburtsh und Gynakologie, March, 1908.

16 Centralblatt für Gynakologie, October 19, 1908.

of eclampsia accompanied by increased tension in the kidney. All were treated by decapsulation and, with one exception, recovered. Franck reports ten cases with no bulging or increased intracapsular tension.

Hepatic changes are almost universally present. In fact, functional and structural alterations of the kidneys and liver are very frequently associated. Their functions are consecutive, *i. e.*, the liver is the chief agent in the preparation of wastes for excretion and the kidneys receive these for purposes of excretion. This naturally leads to the view, which is also supported by clinical analyses, that in many cases the decrease of urea in the urine is due not to failure in its elimination, but to failure in its formation from the various precursors, including the ammonia compounds; uremia then, being due to these toxic antecedents, rather than to poisons retained with the urea, and of the amount of which the decreased urea excretion is a gauge. "Somewhere in the organism there is a deficient changing of ammonia and amino-acids into urea. This has been called 'deficient desamidation' by Ewing, who asserts that the process is no more than an oxidation. This work is in a great measure performed by the liver, and therefore we are not surprised to find the liver most severely involved." [17]

In this connection it is interesting to note the relation of one of the chief causes of uremia and eclampsia, *viz.*, a diet rich in meat, to the size of the liver. Dr. Chalmers Watson [18] calls attention to the difference in the size of the liver in meat-fed rats and in bread-and-milk-fed rats. From an examination of the livers in the two cases, it was shown that the average liver weight of the meat-fed rats was 6 grams, while the average liver weight of the bread-and-milk-fed rats was 4 grams. The meat diet had caused an increase of 50 per cent in the size of the liver.

Moreover it has been shown that a severe acidemia may cause the convulsions and coma characteristic of uremia and eclampsia. Were this the case, sweating treatment, if much pro-

17 Davis and Foulkrod—The Etiology of Eclampsia—Journal of American Medical Association, January 7, 1911, pp. 11, 12.
18 London Lancet, October 12, 1907.

longed, would only deepen the difficulty since, if unaccompanied by cold, it increases the acidosis.

For practical purposes, we may divide the treatment into two parts: First, the treatment of chronic uremia, the conditions that predispose to the acute attack, and the pre-eclamptic state; second, the treatment of the acute attack of uremia or eclampsia, the convulsive seizures and coma. It should be borne in mind that in eclampsia a neurotic temperment predisposes to the attack and that there is the added factor of pregnancy which may, in spite of vigorous treatment, demand hasty emptying of the uterus.

"Chronic" Uremia and the Pre-eclamptic State. The principles involved in the treatment of faulty nitrogenous metabolism have been discussed in the consideration of gout and Bright's disease. Those persons living upon a highly nitrogenous diet, containing purins, are predisposed to the uremic state. Women who partake heavily of tea and coffee are predisposed to eclampsia. The reason for this is that the caffein greatly increases the amount of basic purins which must therefore be raked over by the liver and thrown out by the kidneys.

Alfred Schittenhelm[19] has shown by experiments upon dogs the extent to which caffein increases basic purins and uric acid. We give below a table of averages which shows these items. The dog was kept on a purin-free diet previous to the tests. The pre-period lasted three days. For three days following this, three daily doses each of 0.3 grams of caffein were administered. Next intervened a period of two days with purin-free diet, and following this the same daily amount of theobromin (as previously of caffein) was given for two days.

	PRE-PERIOD	CAFFEIN PERIOD	INTER-PERIOD	THEOBROMIN PERIOD	AFTER-PERIOD
Uric acid in gm. N.	0.006	0.008	0.006	0.007	0.006
Purin bases in gm. N.	0.005	0.026	0.009	0.013	0.008

Chronic congestion of the liver as pointed out above and hepatic cirrhosis are also factors in the causation of uremia. The vicious cycle and disordered liver accompanying periodic

19 Zur Frage der harnsaurevermehrenden Wirkung von Kaffee und Tee und ihrer Bedeutung in der Gichttherapie—Therapeutische Monatshefte, March, 1910, p. 115.

sick headaches are additional causes. These conditions demand the exclusion of purins—meat, tea, and coffee—from the diet, and the limitation of proteins. The diet should consist largely of carbohydrates, milk, fresh vegetables, and fruits. Hydriatic treatment should be directed toward the oxidation and elimination of nitrogenous wastes. As a means to this end, special attention should be given to the liver activity, the circulation, and renal activity. Extreme diaphoresis is not necessary, but gentle, free perspiration should be encouraged. To this end, short electric light baths may be used once or twice a week. More or less perspiration accompanies the use of local hot applications, such as the hot foot bath with fomentations to the abdomen and spine, warm showers and douches. A regular course of tonic treatment should accompany these measures. Of these, may be used hot and cold to the spine, revulsive compress, cold frictions, alternate showers, sprays, and douches. The neutral or warm tub bath is an excellent means of quieting nervous symptoms and equalizing blood pressure. The patient should drink water freely and frequently. Fomentations and the revulsive compress to the liver, also the alternate douche to the hepatic region, are efficient chologogues and stimulate all the other hepatic functions. In case pregnancy is complicated by a pre-existing nephritis, the patient should be under constant observation and treatment. The measures recommended for chronic Bright's disease may be employed.

Acute Uremia and Eclampsia. So successful have diaphoretic measures proven in these conditions that they are almost specific. The repeated use of prolonged sweating treatments is not advisable unless there is a favorable response from the first or second application. The measure which has given best results is the full hot blanket pack accompanied by the ingestion of an abundance of water. It may be necessary to use saline solution by hypodermoclysis or enteroclysis. This can not result in damage from increase of blood pressure if the patient is perspiring freely. Many cases have been reported in which the giving of saline solution resulted in prompt diuresis. It dilutes the blood, decreases the toxemia and favors elimination by the skin and kidneys. It may be necessary to somewhat prolong the hot pack. Whenever it is used, the cerebral circulation should be guarded by the cold compress, ice bag, or cold affusions to the head. An ice bag should also be used over the heart. The patient may be removed from the pack by a wet hand rub or other cold friction and put between blankets to continue perspiring gently. Croftan, Edwards, and others favor the use of the full hot bath as recommended by Liebermeister. The bath begins at 98° or thereabouts and is generally run up 5° or 6°, the head being kept cool by cold affusions.

The rationale of these sweating treatments lies not alone in the elimination of toxins by the skin. In fact, we believe this is only a part, and perhaps often a small part of the real effect. Soon after free diaphoresis has been established, urinary secretion begins to increase and may, in acute suppression, appear very promptly. This is doubtless due to the relief of the kidney congestion and the reduction of renal edema and increased tension in those cases in which these occur. Relieving renal stasis always results in freer excretion of urine. The case of eclampsia with great enlargement of the kidney mentioned above as reported by Braak and Mijnlieff, having refused operation, recovered under the use of wet packs with hot-water bottles and medicinal measures. The coma subsided and the kidney gradually returned to normal size. O. M. Hayward reports a case[20] of eclampsia in which two hot packs failed to relieve the coma. With the patient deeply comatose, pulse 160 and very weak, axillary temperature 105.2° F., and respiration irregular and gasping, she was wrapped in a sheet, placed on a table, and a cold rubbing pour administered. In five minutes there was some improvement and the cold pour and rubbing were continued. In thirty minutes the patient was returned to bed with a temperature of 100° F., pulse 100, and respiration nearly normal. The failure in the hot pack was doubtless due to the fact that it was unaccompanied by a cold friction. This might have been administered by the cold mitten or, as was done later, by the cold pour and rubbing wet sheet pack.

The use of a large ice cap to the heart and over the lower third of the sternum is desirable and usually necessary.

20 Modern Medicine, March, 1908, p. 60.

CHAPTER XXV

PEPTOGENIC EFFECTS

THIS term—"peptogenic effects"—is here used to designate a variety of effects upon the digestive organs and digestive activity in the sense of increasing the efficiency of these organs and functions. The measures directed toward improving the digestion also increase the activity of the liver. All tonic treatments increase the muscular and glandular activity of the stomach and intestines, also the glandular activity of the liver and pancreas. They aid digestion and sharpen the appetite. In addition to general tonic treatments, it is necessary to direct special attention to the digestive organs themselves. The following are some of these special treatments which are useful in promoting digestion and absorption:—

1. Winternitz pack (hot and heating trunk pack).
2. Hot trunk pack.
3. Fomentations to the abdomen.
4. Revulsive compress to the abdomen.
5. Hot and cold to the spine.
6. Hot and cold douche to the abdomen, liver, and spine.
7. The umschlag (moist abdominal girdle).
8. Hot-water bottle or Winternitz coil over the stomach after a meal.
9. Ice bag over the stomach, or cold water drinking, before a meal.

These treatments properly selected to meet the needs of the individual case are indicated in,—

1. All forms of atonic indigestion.
   (a) Hypochlorhydria.
   (b) Anacidia.

(c) Gastrectasia.
(d) Gastroptosis.
(e) Lowered gastric motility.
(f) General splanchnoptosis.
(g) Biliousness.
(h) Periodic sick headaches (in interval).
(i) Amylaceous dyspepsia.

2. Chronic congestion of liver.
3. Anemia of liver.

ATONIC DYSPEPSIA

This term is not used in its ordinary restricted sense as applying alone to painful digestion. We use it here to designate a great variety of digestive disorders associated with deficient gastric secretion, and lessened motility with more or less distress or discomfort after meals. These various conditions may be grouped in this manner for convenience in considering their hydriatic management, for this must be carried on along much the same lines in all. The aim is to produce a general increase of tone in both the glands and musculature of the digestive organs. We hardly need mention that special attention must be paid to the matter of diet, exercise, rest, favorable environment, etc. These are all of prime importance.

In the more severe grades of defective digestion, something like the following program should be carried out:—

Half an hour before the meal, the patient should be instructed to take half a glass of cold water or even ice water. Bits of ice or a small amount of fruit ice may be taken twenty minutes to half an hour before the meal. Instead of cold internally, an ice bag may be placed over the stomach beginning half or three quarters of an hour before the meal and continued for ten or fifteen minutes. The skin over the stomach should warm up before the meal is taken. This will require about fifteen minutes after the ice bag has been removed. The philosophy of these measures lies in the fact that the cold application produces a reaction which comes on at the time the meal is taken, so that the glandular activity is increased during the period of digestion.

The experimental basis of this old and very successful means of promoting gastric secretion has been worked out by Doctor Kasanski in the laboratory of Prof. I. P. Pavlov.[1] By the application of cold, the activity of the gastric glands is arrested while the cold continues. After the removal of the cold, the work of the glands rises above the normal and continues at a higher point for a longer time. In the following table will be noted the result of intense cold applied during the first hour of the digestive period. The reaction comes on during the second hour.

HOUR	NORMAL SECRETION	SECRETION AS AFFECTED BY COLD
1st	11.6 c. c.	6.2 c. c.
2nd	8.4 "	11.6 "
3rd	3.5 "	10.8 "
4th	1.9 "	5.6 "
5th	1.3 "	3.6 "

In cases of extreme anemia a small amount of a hot soup or hot beverage should be used just previous to the meal, as there is not sufficient vitality to react to the cold drink. Following the meal, the patient should use a hot-water bottle over the stomach. This should be continued for twenty minutes to an hour, or even longer. In more severe cases, the Winternitz pack (*Plate XVIII.*) will be found very efficient. It should be applied immediately after the meal, or the pack may be applied first and the meal eaten while the patient is in the pack. It should be continued for from thirty minutes to as long as two or three hours, and be concluded with a cold mitten friction. In applying the pack the hot-water bottle may be used in place of the Winternitz coil (*Plate XIX.*). Since a constant temperature can not be maintained by the hot-water bottle, the treatment is not so effectual. Fomentations of moderate heat may be applied to the abdomen over the stomach and liver, immediately following a meal. Two or three hours after the meal, the patient may be given a treatment consisting of a hot foot bath with a revulsive compress to the abdomen, or hot and cold to the spine, together with the cold mitten friction or cold towel

1 Work of the Digestive Glands, Second English Edition, pp. 239, 240.

rub. Other applications which may be used are the hot and cold douche to the abdomen and liver, also to the spine. At night it is well to apply the moist abdominal girdle. It should be dry by morning. The protected girdle is not used in this condition.

In addition to these hydriatic measures, the patient should be given general massage with special abdominal massage, vibration to the abdomen, faradic or sinusoidal electricity to abdomen and spine, or the Morton wave to the abdomen and spine. Since these various measures are not applicable to all cases of atonic dyspepsia, they should be selected according to the needs of the individual case. All of them, with the exception of fomentations to the abdomen and the hot trunk pack, are contraindicated in hyperchlorhydria and gastric or duodenal ulcer with much hemorrhage.

Patients with dyspepsia soon become accustomed to cold applications and may be given most vigorous tonics. After a week or so of treatment a general cold affusion or pail pour may be used daily. The cold wet sheet rub may also be used after tolerance for douches and pail pours has been acquired. The cold morning plunge is not excelled as a general tonic and exerts a beneficial action on digestion. It sharpens the appetite, thus aiding in the production of "psychic juice" which Pavlov assures us is five times as efficient in gastric digestion as the chemically excited secretion.

Pavlov has further shown that another of the circumstances favorable to the activity of the gastric glands is an abundant supply of water in the organism. He says,[2] "One of these favoring circumstances we discovered in the introduction of large quantities of water into the system. We based this upon earlier facts, showing that the quantity of juice was strikingly dependent upon the amount of water in the organism." This makes clear the necessity for free water drinking between meals in order to provide fluid for the formation of the requisite amount of gastric juice.

In cases of motor insufficiency associated with marked dilatation, cold drinks can not be used before the meal, since there

2 Work of the Digestive Glands, Second English Edition, p. 245.

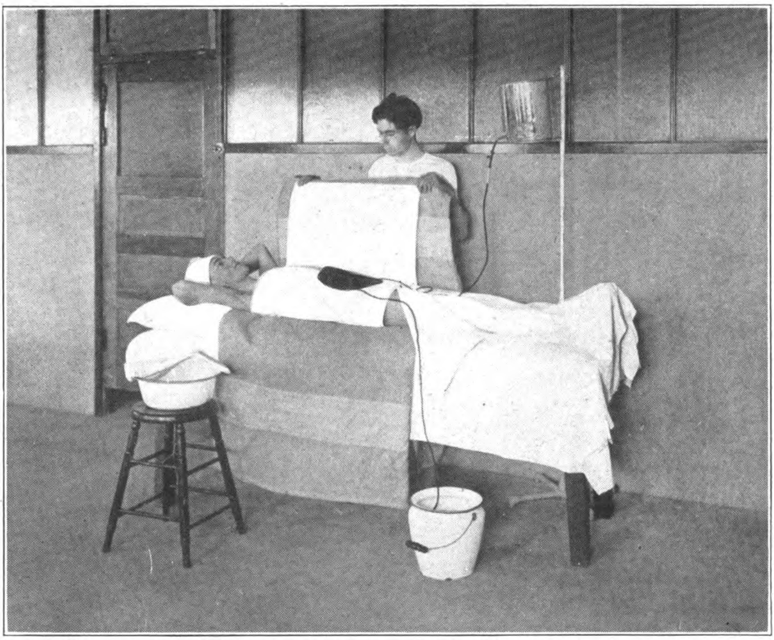

PLATE XVIII. Winternitz pack (hot and heating trunk pack).

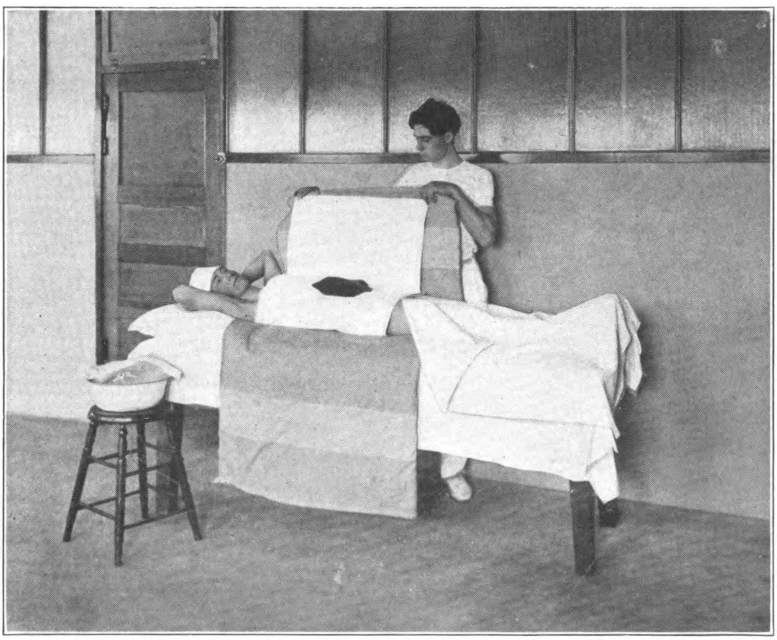

PLATE XIX. Winternitz pack (with hot-water bottle).

is not sufficient power to empty the stomach in so short a time and the circulatory reaction is much delayed. Before the meal, the patient may be placed on a table or slab and a cold affusion administered to the abdomen. This should be intermittent, as it will be, if, by means of a large dipper, water is dipped from a pail and poured over the abdomen. The temperature of the water at first should be about 75° F. and gradually reduced to 45° or 50° F. One full pail of water will usually suffice for a single treatment.

Douching the mucous membrane—lavage of the stomach—with cold water may be found helpful. This measure, combined with intragastric electricity, is a most efficient means. After swallowing a glass of cold water the gastric electrode is introduced and, by means of either an abdominal sponge or plate placed to the mid-dorsal spine, the slow sinusoidal or slow faradic current is given for five to eight minutes. One may frequently hear succussion sounds or the gurgling of water through the pylorus, caused by vigorous contractions of the gastric muscles. These treatments may be given daily or on alternate days. In one case, a month of such treatment with other tonic measures resulted in a retraction of the greater curvature toward its normal position of one and one-half inches on the left and one inch upward in the median line. On applying for treatment, the greater curvature lay three inches below and four and one-half inches to the left of the umbilicus.

In connection with the use of gastric lavage, a caution should be uttered relative to the frequent use of large quantities of warm or hot water introduced into a dilated stomach. The relaxing effect is very marked and in the course of months or years, the stomach becomes extremely dilated and entirely loses its elasticity and contractility. A few years ago the author was present at the post mortem examination of a man who had, at frequent intervals for a number of years, resorted to warm gastric lavage to relieve the gastric retention and fermentation occasioned by an extreme pyloric stenosis. The stomach was found to be enormous, reaching from the greatest height of the fundus at the level of the fourth intercostal space on the left to the level of the anterior superior spines of the ilia, two and one-half inches from the right iliac spine. It would easily hold one and one-half or two gallons. The pylorus, for a distance of two inches, admitted with great difficulty a small size lead pencil. The condition, of course, should have been treated surgically by some form of pylorectomy.

The caution here is not against systematic washing of the stomach to free it from decomposing remnants of food, but against the use of *hot* water for this purpose. If it seems advisable to resort to gastric lavage frequently and warm water is used first, it should be followed by a "dash" of cold.

In those cases of gastric dilatation and lessened motility not associated with pyloric obstruction, hydriatic means produce excellent results. In addition to the measures recommended above, the alternate hot and cold douche to the epigastrium may be used; at first, with little or no force, later, with moderate percussion. The percussion douche to the mid-dorsal spine, also to the legs and feet, serves as a vigorous tonic. Gastrectasia, associated with a general splanchnoptosis, irritable, tender sympathetics, and a feeling of weight and dragging in the abdomen may be benefited by the cold sitz-bath begun as a graduated measure. The continuous cold coil to the abdomen acts in the same way. The cold sitz may be prolonged to five or six minutes and the cold coil left in place twenty to thirty minutes.[3]

HYPERCHLORHYDRIA

Nearly all cases of indigestion pass through the stage of hyperacidity at the beginning of the departure from normal. In only a few, however, is this condition so marked as to require special treatment. The patient is of a nervous temperment, and eats rapidly, swallowing his food with very imperfect mastication. The free hydrochloric acid may be double or even treble the normal amount. The course to be followed is just the opposite to that outlined for hypochlorhydria. The patient may drink hot water or use a hot application over the stomach preceding the meal, after which an ice bag should be used for twenty to thirty minutes, or even longer. The hot

3 See also the treatment recommended for splanchnic neurasthenia.

water drinking or the hot application to the epigastrium produces an atonic reaction. In this connection it should be noted that among the experiments performed by Professor Pavlov, on one occasion the work of the large stomach was arrested for several days by the application of *very* hot water. Thus it will be seen that by applications of heat of a suitable temperature an overactive state of the gastric glands may be depressed and their activity be brought back toward normal.

It is needless to say that dietetic regulation is the most important factor in the treatment of this condition. Oils, whether free or emulsified, have a specific inhibitory action upon the secretion of hydrochloric acid. The patient should discard the use of meats entirely. Other heavily proteid foods should be interdicted. Salt and condiments should be proscribed. The hyperacidity may be lessened by the use of the protected or sweating moist abdominal girdle. Tonic treatments should be replaced by sedative measures such as the neutral bath, neutral pack, or heating pack. These may be given one or two hours before a meal or at night.

CHAPTER XXVI

HEMOSTATIC EFFECTS

CAPILLARY hemorrhage and hemorrhage from smaller blood-vessels does not usually require surgical treatment. Hemorrhage into the hollow organs tends to check itself, provided the circumstances are at all favorable, so that in many cases absolute rest, accompanied by the use of the ice bag, may produce all that is desired. Thermic applications may be made directly to the part or so as to influence the blood-vessels reflexly. Cold may also be used over the trunk of the artery supplying a part. If heat is used to check the hemorrhage, the application must be very hot and be made *directly* to the bleeding part. The *reflex* effect of even very hot water produces only a transient narrowing of the vessels, while in a short time, the vessels become dilated and the hemorrhage increases. Cold applications may be used either to the part itself or to the reflex area. In fact, it is quite a general rule that cold is more efficient through reflex action, while hot is efficient only when applied directly to the bleeding vessels. In nearly every case where ice is used, it is well to employ some hot application for derivative purposes. The hot should not, however, produce sweating since this tends to dilate the blood-vessels and increase the hemorrhage.

Epistaxis

Thermic applications are often very effectual in treating capillary hemorrhage from the nose. Very cold water or very hot water may be drawn into the nose. An application of ice may be made over the nose itself. Of the more remote reflex areas, use may be made of that at the back of the neck and the hands by having the patient hold a chunk of ice at the back of the neck. The hands or feet may be placed in ice water or very cold water for a short time. These applications should not produce chilliness.

Pulmonary Hemorrhage

The patient should be kept at absolute rest. Warmth of the body and limbs should be maintained, hot-water bottles being placed to the feet, or, after the hemorrhage has somewhat subsided, the patient may be given a hot foot pack. That which is of most importance is the applying of an ice bag to the front of the chest. This should be left in place continuously until all danger of hemorrhage is passed. It should be a large ice bag or ice cap. This not being available, the ice compress may be used. For some unknown reason, possibly through reflex action, the taking of salt on the back of the tongue is a very efficient means of quickly checking the hemorrhage.

Gastric Hemorrhage

Gastric hemorrhage most frequently occurs in cases of ulcer. The patient should be kept at absolute rest with an ice bag over the stomach. He may be given cracked ice to swallow. It may be necessary to apply a large fomentation over the lower abdomen or to other parts for derivative effects. The cold compress is not as efficient as the ice bag, having a greater tendency to produce a hydrostatic effect, while the ice bag acts chiefly through reflex action.

Uterine Hemorrhage

We may, for convenience, divide hemorrhages from the uterus into two classes: First, prolonged and profuse menses; and second, hemorrhages following labor or abortion. The means used to check the hemorrhage in these two conditions is usually quite different, since one is acute and would soon produce exsanguination; the other lasting for a number of days may be treated by less vigorous means. In case of profuse menses due to subinvolution, uterine vegetations, small fibroids, etc., the patient may be given a cold sitz bath. This should be prolonged and accompanied by a very hot foot bath. In some cases, the shallow cold foot bath (water two or three inches deep), without other means, serves to check the hemorrhage. This is through reflex action. In case it is necessary to keep the patient in bed, an ice bag should be placed over the pubes and another ice bag between the upper surfaces of the thighs. At the same time the patient should be given a hot foot bath or leg pack. These means will often prove so effectual that packing or astringent douches are unnecessary.

Post-partum hemorrhage, if occurring immediately after the delivery of the child and of such an amount as to prove alarming, should be immediately treated by manual stimulation of the uterus through the abdominal wall, or failing in this, by a very hot intra-uterine douche. If the hemorrhage is slight or not so alarming as to require the intra-uterine douche, the patient may be given a very hot vaginal douche with or without alum. An ice bag may be used over the pubes and replaced after the douche, or it may be kept in place without interruption. Any of these means which may be at hand should be applied at once, ergot hypodermatically, being given as soon as possible, providing the placenta has been passed.

Apoplexy

The early treatment of cerebral hemorrhage should consist of an ice bag, ice cap, or large ice helmet applied to the head, also ice bags or compresses placed at the back of the neck and over the carotids. The limbs should be kept warm by hot-water bottles, etc. These applications may be left in place until there is reason to believe the hemorrhage has been checked. Usually the hemorrhage does not continue for any great length of time, but in some cases almost the entire cerebrum may become infiltrated with blood and the ventricles filled. Cold applications, if used promptly, may check such excessive hemorrhage as these. Perfect rest is an absolute essential to the success of any form of treatment.

CHAPTER XXVII

HYDROTHERAPY IN SURGERY

UNDER various heads we have already considered the hydrotherapeutic treatment of many surgical diseases. The treatment of inflammatory diseases, many of which require surgical intervention, has been discussed under its proper head. In considering the effects of pure stimulants and under treatment designed to relieve pain, still other surgical conditions have been discussed. There remains then to be considered only the general relation of hydrotherapy to operative treatment and the care of the patient. For convenience the subject of hydrotherapy in surgery may be divided into three sections, *viz.*, preparatory treatment, immediate care, and after-treatment.

PREPARATORY TREATMENT

The physical condition of the patient at the time of operation has a great deal to do with his behavior upon the operating table and with the comfort and rapidity of his subsequent convalescence. Of course in conditions demanding immediate attention there is no time for preliminary treatment, but in a very large number of surgical diseases it is neither necessary nor advisable to hurry the patient to the operating table. This is true alike of many inflammatory and many non-inflammatory conditions.

In considering the realm of physiologic therapy we have already mentioned the advisability of delay in the operative treatment of certain inflammations, especially of pelvic inflammations. Even definite inflammatory states largely limited to the Fallopian tube or the ovary are usually accompanied by more or less cellulitis. Sometimes an inflammation whose most marked effects are in the cellular tissue involves other parts so as to necessitate removal of such parts or mechanical means for their release from plastic exudates or adhesions. In such cases the induration and residual thickening may be cleared up and quite a degree of the normal mobility restored as has been discussed under the treatment of the chronic stage of inflammations. These results may be so thoroughly accomplished that the remaining conditions will necessitate very much less operative work and work which can be easily and rapidly performed with a minimum of trauma and consequent shock. The resulting shortening of the period of anesthesia is also a distinct advantage.

The stability of the circulatory system is still another factor of great importance in surgery. In those who have had chronic inflammatory or suppurative lesions and in neurasthenics and other chronic invalids the circulation is unbalanced and the vasomotors fail to properly control the ebb and flow of circulatory changes. The anesthetic and the operative procedure both tend to further unbalance the circulation. By interference with the vasomotors the liability to undue cooling of the surface and to consequent internal congestion are much increased. Slight chilling during or following operation may produce marked retrostasis of blood to the interior, and thus result in deepening an already existing inflammation.

The preparation of the patient by a preliminary two or three weeks' course of vascular hydriatic tonics will guard against these dangers. In this length of time the vitality of the patient may be materially raised. Such a course of treatment will also result in ridding the system of the accumulation of half oxidized leucomaines which have piled up during the preceding invalidism. Sweating treatments at intervals of two or three days may also be necessary to still further enhance elimination and incidentally to promote the nutrition and healthy activity of the skin.

The stimulation of kidney activity and the consequent increase in urinary leucomaines is another factor in the general clearing-out process. Because of the more perfect oxidation and more complete elimination of waste products, the alkalinity of the blood is increased. Desirable conditions preparatory to operation are also produced by a low proteid diet and the free use of fruits. Free water drinking should be insisted upon whenever the elimination is defective. All of these changes help to remove toxemia—the principal cause of nerve irritation —and hence aid in rest or in nerve tone and the stability of nerve action. The increased activity of the circulation and the restoration of the normal reaction of the blood and body fluids are large factors in the proper healing of wounds. The physiologic leucocytosis and consequently heightened phagocytic powers of the white blood cells which result from hydriatic tonics help to prevent post-operative infections, whether of the wound, of the respiratory tract, or other part subject to unusual conditions or strain during operation.

IMMEDIATE CARE

The treatment of the patient during and immediately following operation resolves itself almost entirely into the use of means for the prevention and treatment of surgical shock and collapse. The keeping of all the vital functions in as nearly a normal condition as possible, consistent with the attainment of surgical anesthesia, will tend to prevent the occurrence of shock. The use of ether by the open drop method, discarding, unless specially indicated, all mixing of anesthetics or the hypodermic use of hypnotics and analgesics, has done much to lessen the occurrence of shock. Of course where the occurrence of psychic shock is an important factor, the preliminary use of hyoscine and morphine is of decided advantage. Let the ether be given slowly at the start; it should never be "pushed." To quite an extent this will obviate the occurrence of retching and vomiting. Where the alimentary tract is not the objective point of the operation, the giving of a glass of cold water by mouth, immediately before beginning the administration of ether, will be found very helpful in diminishing the tendency to vomiting. It also adds that much water to the body fluids to aid in the subsequent elimination of the ether.

The skill of the operator in proceeding rapidly yet with a minimum of trauma and hemorrhage is one of the chief factors in preventing surgical shock. In this connection[1] W. J. Mayo has said, "We hear a great deal about shock but we don't see it. We sometimes see collapse from loss of blood."

The patient should not be weakened by repeated catharsis. Limit the preparatory use of cathartics to what is really indicated, and on the morning of the operation finish the cleaning out by means of a thorough enema of tepid or warm water. The patient should reach the operating table with warm feet and hands, and during the operation the extremities should be kept warm by the use of blanket coverings and, if necessary, hot-water bottles applied outside the blanket. The use of a hot foot bath, concluded by a dash of cold water, given just before entering the operating room, may do much to prevent or limit splanchnic engorgement.

Surgical Shock

Until the researches of Geo. W. Crile placed the subject of the causation of surgical shock upon a definite experimental basis, the ideas held by practicing surgeons were most various and conflicting, and these ideas underwent frequent change. If one might judge of these ideas by the therapy employed at that time (and it is to be regretted the therapy still used by a very large number of surgeons), one would unquestionably say that some derangement of the heart itself or its nerve supply has been looked upon as the cause of surgical shock. That the heart is not primarily at fault in shock has been proven beyond question.

Crile makes a sharp distinction between shock and collapse. Although there are many contributing causes, he considers that the primary and principal alteration of function in surgical shock is a derangement of the vasomotor mechanism. Collapse is due to loss of body fluid, *i. e.*, to hemorrhage. It may also be due to direct damage to the heart muscle, the respiratory organs, or the nerves of either. While both conditions may be present in a given case at the same time, yet they are essentially distinct entities. These are the views generally accepted by surgeons today.

1 Remarks made at clinic in St. Mary's Hospital, August 4, 1910.

The prevention of shock is fully as important as its treatment, and to accomplish either result, it is necessary to understand the causes of the disordered function. We may, therefore, with profit discuss briefly the causes contributing to the production of surgical shock. Crile[2] enumerates these under approximately six heads. They are:—

1. Duration of operation.
2. Trauma.
3. Temperature.
4. Physical condition of subject.
5. Anesthesia.
6. Hemorrhage.

To this list Yandell Henderson[3] has recently added another factor, *viz.*, acapnia. The term is used to designate a state in which there is a deficiency of carbon dioxide in the blood. In connection with these seven contributing causes we should also discuss the vasomotor and the cardiac changes present in shock.

1. Duration of Operation. The duration of an operation always bears a direct relation to the occurrence of shock. "In all the experiments in which pure shock was produced, it was found that a considerable time was required, usually half an hour or more."[4] With ether as the anesthetic, it was found that dogs would survive its continuous administration for a period of time averaging ten hours.

2. Trauma. As has been mentioned, trauma is one of the chief external causes of shock; in fact, the term, "traumatic shock" is frequently used interchangeably with surgical shock. Trauma of nerve centers, nerve trunks, or areas richly supplied with nerves, is especially liable to produce shock. Shock is also especially likely to occur on exposure of the brain, pleura, and peritoneum. "Exposure of the capacious splanchnic area is attended by a rapid dilatation of the splanchnic vessels, leading to intense congestion, detracting thereby a dangerous amount of blood from the somatic circulation, and inducing a rapidly declining blood pressure."

2 An Experimental Research into Surgical Shock, 1899, pp. 135—144.
3 American Journal of Physiology, Vol. XVII.
4 Crile—Blood Pressure in Surgery, 1903, p. 298.

3. Temperature. "Contact with air is a very great irritant to local tissues, owing to the lowering of local temperature and to the drying." Animals operated in a cold room seem to succumb more readily than under ordinary warmth. The depressing effects of cold were plainly seen when cold water was brought in contact with the intestines or when an intra-venous injection of cold saline solution was given. The effects of warm towels applied to the exposed intestines or of warm saline solution in the abdomen immediately improved the respiration and checked declining blood pressure. The same effect of cold and warm salines was noticed on the brain and exposed nerve fibers.

4. Physical Condition. Individuals in impaired health, poorly nourished, with sluggish circulation, too young or too old, are always bad subjects for operation. We have elsewhere mentioned various physical conditions which contribute to the occurrence of shock.

5. Anesthesia. Over-anesthesia, rapid anesthesia at the start, or awkward or irregular giving of an anesthetic, contribute to the production of shock. Chloroform requires much greater care in its administration than ether. Chloroform is more toxic than ether. Chloroform may cause sudden cardiac arrest; and if this occurs, it is usually before surgical anesthesia is attained. In this respect clinical experience coincides with experiment. For these reasons, in America, the majority of surgeons prefer ether, using it almost exclusively.

6. Hemorrhage. Loss of blood always predisposes to the occurrence of shock. Hemorrhage from veins is productive of more immediate harm than hemorrhage from arteries. "Hemorrhage from large venous trunks caused the most profound effect upon the blood pressure, because the quantity of blood supplied to the heart was immediately diminished, while, if the hemorrhage was arterial, the income of blood was not so suddenly diminished. The output of the heart does not depend at all upon the height of the arterial pressure, but is in direct proportion to the venous pressure."

7. Acapnia. Henderson holds that carbon dioxide is a harmone or chemical regulator of respiration and that the phenomena of vasomotor failure in shock are due to diminution of this gas in the blood and body tissues. This, he claims, is brought about by the excessive respiration (and consequent over-ventilation of the blood) caused by excitement, fear, pain, or forced breathing. Anesthetics tend to prevent shock because they diminish the excessive respiration due to pain. The habit of covering the face and ether mask with extra layers of gauze, thus causing the patient to rebreathe some of his own carbon dioxide, is pointed out in support of this theory; it being believed that this practice helps to maintain more perfect narcosis and raise the blood content of carbon dioxide. Henderson states that "skillful anesthesia consists in maintaining the threshold of the respiratory center for carbon dioxide at a nearly normal level, and in avoiding the development of either acapnia or hypercapnia." The theory seems to have many points in its favor; it needs further confirmation.

Vasomotor Changes. The experimental data upon which the vasomotor theory of traumatic shock rests is altogether too lengthy to be given here, even in abstract. It has, however, been shown that in surgical shock the changes in blood pressure are entirely independent of the working power of the heart itself. In an animal reduced to a state of shock, the heart continues to beat with its usual force as long as it is supplied with the normal amount of blood, *i. e.*, as long as it is furnished with something upon which to expend its force.

In shock the vasomotors are at first over-excited and reveal symptoms of irregular, disordered action. Vasomotor curves of blood pressure (Traube-Hering curves) become rhythmic over a large area and are exaggerated. Later, after some exhaustion has set in, vasomotor effects are more difficult to produce. Rhythmic variations finally cease and changes in vascular calibre end in maximal vaso-dilatation. In animal experiments, after removal of the stellate ganglia, stimulation produced neither a rise nor a fall. In drawing conclusions from these phenomena, Crile says, "These several results, so many times obtained, are taken as an evidence of a vaso-constrictor mechanism or action and a vaso-dilator mechanism or action, or, in other words, a pressor and a depressor action; and that the former is exhausted more readily than the latter."

"In a number of vasomotor phenomena observed, it was apparent that there are regional vasomotor actions quite independent of each other."

"There is no portion of the circulatory apparatus so delicate, whose equilibrium is so easily disturbed, and whose connection with all parts of the body is so minute as the vasomotor. *A priori*, it would be the most readily disturbed as well as the most readily exhausted and to such conclusions do our observations lead us. The more richly supplied with vasomotor nerves was a given area, the more rapidly was the vasomotor mechanism exhausted when such area was subjected to injury. This principle was abundantly illustrated in the experiments upon the splanchnic area."

"The experiments of Mall show that the splanchnic nerves are vein-nerves and control this large and spacious vascular area. Every experiment in this area gave evidence of the dilatation of the vessels controlled by these nerves, and the decline of the pressure occurred *pari passu* with this dilatation."

Cardiac Changes. It is perfectly evident, as remarked by Crile, that "The heart is the base of support of the blood pressure, and any interference with its action at once causes marked changes in the pressure." The heart action is thus directly influenced by venous pressure in the vena cava. Henderson places special emphasis upon this latter factor in discussing what he has called the "veno-pressor" mechanism. The recognition of this factor in cardiac action is, however, not new. It was early pointed out by Crile in his researches into the causes of altered heart action (and lowered blood pressure) in shock. He says, "The output of the heart is in direct ratio to the pressure of the vena cava, and not at all to the height of the aortic blood pressure. The venous pressure, then, determines the heart's output and the venous pressure is, in a good measure, dependent upon the force and frequency of the heart-beats, together with the necessary vascular tone, which is under the control of the vasomotor nerves."

Through vasomotor exhaustion the blood accumulates in the dilated veins, especially those of the splanchnic area which are so capacious. There has, therefore, occurred "a hemorrhage into the veins." This is due both to exhaustion of the vaso-motors of the veins with consequent vaso-dilatation and to the failure of the arterioles to continue their pumping action. This latter is likewise a result of vasomotor failure. The results of vein engorgement may be temporarily overcome by pressure upon the abdomen or by the use of the pneumatic suit devised by Crile.

In regard to the relation of intra-abdominal tension to the veno-pressor mechanism, the observations recorded by Leonard Hill[5] are instructive. "When a large hutch rabbit is held for a few minutes in the vertical position with its limbs stretched out and head uppermost, it may become unconscious and die from cerebral anemia. The blood collects in the large flaccid abdomen, the animal not being able to return it to the heart by changing its posture. It struggles to maintain a circulation—cerebral anemia excites convulsions which squeeze the blood from the limbs, etc., into the heart—but the difficulty in face of the circulation is too great and the animal dies. A wild rabbit with taut abdomen is not affected in this way, neither is a cat or dog, but a goat is with its capacious belly. The wild rabbit can, however, be brought into like state by a dose of chloral, and so can a dog by chloroform poisoning or by bleeding. The emotional fainting of a man is due to the inhibition of the nervous system—a neutralization of all other afferent stimuli by one all-powerful one—the consequent sudden relaxation of muscular tone, collapse of the body and non-return of venous blood to the heart. The horizontal posture or compression of the abdomen immediately restores from syncope the rabbit or the man."

Pumping Action of the Blood-vessels. The control or maintenance of a definite vascular *calibre* is not the only work of the vasomotors; vascular *activity* is also controlled by the vasomotor centers. Arterial vascular activity helps to fill the veins and venous vascular activity helps to maintain blood pressure in the vena cava. While laying great stress upon vascular *calibre* in its effects upon the work of the heart, nearly all observers entirely ignore vascular *activity*. To illustrate the three factors

5 Further Advances in Physiology, p. 173.

in the circulation, Henderson[6] employs a diagram in which the arteries are represented by rigid tubes and changes in their calibre as equivalent to the widening or narrowing of nozzle outlets. While this may illustrate one factor in the work of the vasomotors, it entirely overlooks arterial activity, the result of which it is impossible to conceive of as illustrated by mere changes in resistance, brought about by the widening or narrowing of the nozzles.

In conclusion it must, therefore, be admitted that failure of the vasomotor mechanism is the chief immediate cause of surgical shock. Neither the views of Porter and Quinby, Seelig and Lyon, or Yandell Henderson have greatly altered this conception of the pathologic physiology of shock.

The Treatment of Shock

There is no better place than the operating room in which to demonstrate the prompt tangible results obtained by the use of hydrotherapeutic stimulation. In operations upon the head, in prolonged or extensive abdominal operations, breast amputations, etc., and in other cases where shock is likely to appear and prove dangerous, the success attained by the use of hydrotherapy has, in our hands, been uniformly gratifying. This has also been the experience of many others working in the association of medical institutions with which the writer is connected.

The plan which we have followed is very similar to that outlined in Chapter XX for the relief of acute edema of the lungs and circulatory crisis in valvular heart disease. There are certain additional features to be taken into account, so that it will be repeated here in full. The principles involved in the hydrotherapeutic treatment of surgical shock are neither complicated nor difficult to understand. Their intelligent effective application, however, requires a knowledge of the causation and morbid physiology of shock, a thorough acquaintance with the methods used and an experience in their use, in order to know how to adapt the means to the case in hand and bring results where these results are difficult to obtain.

6 American Journal of Physiology, Vol. XXVII, No. I, p. 159.

The vasomotor failure in surgical shock can be and is met ideally by only one method of procedure, *viz.*, the application of cold water combined with friction. If hemorrhage has occurred, the loss of fluid must be met by the introduction of more fluid. Warm saline solution may be given by hypodermoclysis or by proctoclysis according to the urgency of the case. It is usually well to give the hypodermoclysis while the patient is on the operating table and follow it with saline solution by either intermittant protoclysis or by continuous proctoclysis after the method of Murphy, begun as soon as the patient reaches his room.

When shock appears during the operation, the patient should be treated on the operating table. The effectual treatment of shock requires the attention of two persons. The head of the table should be lowered to counteract cerebral anemia. On the appearance of the symptoms of shock, immediately place the patient's feet in hot water, care being taken that the water is not nearly hot enough to produce a burn; or better, quickly apply well wrapped fomentations so as to cover both feet and legs to the knees. As soon as the parts have been well warmed and reddened, remove the hot applications and quickly administer to the same parts a cold mitten friction. The water used should be ice water and the friction most vigorously given. The mitts should be dipped two or even three times, another attendant holding the limb while it is being treated. The skin is now dried and rubbed with a coarse Turkish towel and immediately covered with a warm dry blanket. The thighs should be treated in the same manner, also the arms. While this is being done and beginning at the same time as the first treatment to the limbs, intense and quickly alternating hot and cold applications should be made to the anterior surface of the chest and especally over the precordia. This may be done by removing the ice bag from the precordia, which should have been placed there when the pulse first became unduly rapid, and after rubbing the skin briskly, applying a very hot but well covered fomentation. This should not be left in contact with the skin longer than fifteen or thirty seconds. Next rub the chest with a flat smooth piece of ice, using quick to-and-fro movements and wiping away the water with a Turkish towel. After this another fomentation is applied, again followed by the ice. These alternations should be repeated three or four times, after which the well covered ice bag should again be placed over the heart.

Wherever there is any hope at all of vasomotor response, these measures result in prompt rise of blood pressure and as prompt cardiac response to the increased venopressure. Where an abdominal operation is being done, it is, perhaps, needless to say that warm gauze napkins should be applied and, if feasible, some pressure exerted upon the splanchnic area in order to more quickly send the blood on to the heart. Rather than leave fluid in the abdomen, we prefer to give warm saline solution per rectum even while the patient is still on the operating table.

Unless the shock is very severe it will not be necessary to repeat the vasomotor stimulation short of thirty or forty minutes. If the condition of the patient permits and repetition of the vigorous measures outlined above is not really needed, it will be better from now on to employ milder tonics after giving some efficient derivative treatment.

The principle of this plan of treating shock lies in the effect of brief applications of heat to the skin surface and especially to the limbs, in order to warm the skin and aid in reducing internal congestion. The quickly following cold friction produces vigorous stimulation of the vasomotors, so that the blood pressure rises immediately. The vascular condition is not at all comparable with that produced by the injection of adrenalin. It is not a stationary vaso-constriction that results from a cold friction, but a vascular activity—a rapidly alternating dilatation and contraction of the blood-vessels. This is a true pumping action which is in reality only a heightening of the normal activity of the blood-vessels.

The effect of different temperatures upon the blood pressure has already been discussed in Chapter IX, where the laws deduced by Müller are recorded. Müller's studies into the effects of baths on blood pressure were carried out by means of a Riva-Rocci instrument and were very carefully done with apparently every precaution taken. Those who desire to study further these experiments will find a complete consideration of the question given in his paper.[7]

In meeting Henderson's acapnia, what could be more ideal than raising the carbon dioxide content of the blood and tissues by stimulating its production from the tissues themselves through increased oxidation? That this can be efficiently done by thermic and mechanical stimuli and results very promptly from the application of such means, has already been shown in Chapter XII. The circulatory stimulation and the stimulation of respiration by the same means serve to maintain the proper per cent and proportion of oxygen and carbon dioxide in the blood.

In concluding the consideration of the treatment of surgical shock, other than a practical experience in the satisfactory results attained, we could offer no better apology for the presentation of so simple a plan for its treatment than to summarize the experimental work and conclusions therefrom, reached by recognized authorities, showing the failure of older and more pretentious methods. Those who wish the facts at first hand will find the results of the most exhaustive and conclusive studies along this line given by Doctor Crile in his monumental work, "Blood Pressure in Surgery,"[8] which appeared in 1903.

Alcohol. "The immediate effect of intravenous administration only was observed. The first effect usually noticed was a decline in the blood pressure. In the majority of such instances a compensatory rise followed; in a number of instances no change in the blood pressure was noted; in but few was there a rise. The average length of the stroke of the manometer (height of pulsewave) was increased. There was no evidence that the heart beat more forcibly. In animals reduced to varying degrees of surgical shock, the usual effect of an average dose of alcohol was the production of a further depression; in smaller doses but little effect was noted, while in larger doses a more marked decline often occurred. In few instances the administration of a considerable dose in deep shock was followed

7 Über den Einfluss von Badern und Douchen auf den Blutdrück beim Menschen—Deut. Arch. für klin. Med., 1902, Volumn LXXIV, p. 316.

8 Quotations immediately following, unless otherwise credited, are from this work, pp. 261—300.

by almost immediate death. In a number of experiments the decline in the blood pressure was as prompt and as marked as in the administration of the amyl nitrite and nitroglycerine. In no instance, in the normal animal, did death immediately follow the largest dose of alcohol; the more profound the shock, the more marked was the depressing effect of alcohol. In a number of experiments alcohol was given prior to procedures intended to produce shock. It is not certain that it rendered the animal more susceptible. It is quite certain that the susceptibility was not diminished."

Nitroglycerine and Amyl Nitrite. "The immediate effect of nitroglycerine and amyl nitrite upon the pulse was an increase in its volume and a decrease in frequency. The immediate effect upon the respiration varied. At times there was a slight increase, more frequently a slowing of respiration. The immediate effect upon the blood pressure in almost every instance was a fall. The decline was usually rapid. There were but few exceptions, and in these there was usually no effect. A rise was rarely observed. In the latter it was but temporary and was usually followed by a fall. The descent in the blood pressure was gradual and rather rapid; the ascent, more gradual."

"In the experiments in which the animal was in deep shock, and the blood pressure was gradually falling, there was no evidence to show any decrease in the rapidity of the decline. On the contrary, as nearly as could be estimated, nitroglycerine distinctly increased the rapidity of the decline. The effect of nitrite of amyl was in every respect similar to that of nitroglycerine. In many instances the heart beat irregularly after the injection. On the whole, nitroglycerine and amyl nitrite increased shock."

Digitalis. The administration of digitalis in the normal animal produces a rise of blood pressure which is well sustained. The drug is very likely to cause over-stimulation resulting in sudden cardiac failure. In varying degrees of shock, digitalis produces a less marked rise of blood pressure than in the normal animal. "The respiration when at all affected was either impaired or arrested. Death in the digitalis experiments, even in those in which the dosage was only therapeutic, was usually more sudden than in the controls. Although the data does not permit positive statements, it seemed on the average, that cases of shock treated by digitalis did not live as long as the controls. It may certainly be stated that they did not live longer than the controls."

Strychnine. "In the majority of instances, in the normal animal, when sufficient amount of strychnine was given to cause an increased excitability of the spinal cord, as indicated by heightened reflexes and an increased muscular tone, a rise in blood pressure was noted. In smaller doses, occasionally, a slight immediate fall, a slight immediate rise, or later, irregularities were noted; but on making forty-eight careful measurements of the effects, it was found that no noteworthy changes occurred."

"In forty-eight experiments it was found that strychnine in therapeutic doses does not cause a rise in blood pressure."[9]

"The stage of increased excitability above mentioned represented the border-land between the dosage without effect upon the blood pressure and that of maximum effect. When more was given after this stage had been reached, convulsions appeared, and the blood pressure rose abruptly and high, sometimes even more than doubling the normal. The curve during the convulsions was exceedingly irregular, and continued for some time above the normal, exhibiting a secondary rise if later convulsions occurred."

In speaking of strychnine experiments in which both vagi and accelerantes were severed and curare given, Doctor Crile says, "On repeating the dose, a period was soon reached in which no further effect was noted. After each dose, when the effect had worn off, the blood pressure fell to a lower level than it was before the injection was given, until finally it reached the level, usually between 20 and 30 mm., which was not altered by an additional dosage."

"In a series of experiments in which strychnine was given in various degrees of shock in such dosage as to cause a stimulation, the effect was proportional to the degree of shock, *i. e.*,

9 Crile—Detroit Medical Journal, May, 1903, p. 38.

when but little shock was present, a marked effect from strychnine was obtained; and when most profound, there was no effect. In the intervening degrees the effects were proportional; but after giving the strychnine the animals, not yet in complete shock, always passed into a deeper degree of shock. In any degree of shock, after the administration of a therapeutic dose of strychnine, the animals passed into deeper shock. Later in the research it was found that the most convenient and certain method of producing shock for experimental purposes, is by the administration of physiologic doses of strychnine. The treatment of shock then by therapeutic doses of strychnine is inert and physiologic doses dangerous.

"It then follows that treatment of shock by vasomotor stimulants in the form of drugs is on precisely the same basis as treatment by burning the animal or crushing his paws, or by subjecting it to injury or operation, it would seem to be as reasonable to treat strychnine shock by administering traumatism as traumatism by strychnine." [10] [11]

The more recent researches of Wallace and Pamment [12] on the effects of strychnine upon blood pressure fully agree with those of Crile. They induced low blood pressure by chloral, the nitrites, hemorrhage, diphtheria toxin, chloroform, and by shock. In no case, except chloral poisoning, did the use of therapeutic doses of strychnine produce a rise in blood pressure.

"Surgical shock is an exhaustion of the vasomotor center. Neither the heart muscle, nor the cardio-inhibitory center, nor the cardio-accelerator center, nor the respiratory center, are other than secondarily involved. Collapse is due to a suspension of the function of the cardiac or of the vasomotor mechanism. In *shock* therapeutic doses of strychnine are inert, physiologic doses dangerous or fatal. If not fatal, increased exhaustion follows. There is no practical distinction to be made between external stimulation of this center as in injuries and operation, and internal stimulation by vasomotor stimulants, as by strychnine. Each in sufficient amount produces shock;

10 Detroit Medical Journal, May, 1903, pp. 38, 39.

11 Doctor Crile shows sections of brain tissue revealing degeneration of the Purkinje cells from continuous use of strychnine.

12 Report before American Society for the Advancement of Clinical Investigation, May 13, 1912. Abstract in Journal of American Medical Association, July 20, 1912, p. 219.

and each, with equal logic, might be used to treat the shock produced by the other. Stimulants of the vasomotor center are contraindicated. Cardiac stimulants have but a slight range of possible usefulness, and may be injurious. . . . Adrenalin acts upon the heart and blood-vessels. It raises the blood pressure in the normal animal, in every degree of shock, when the medulla is cocainized, and in the decapitated animal. It is rapidly oxidized by the solid tissues and the blood. Its effects are fleeting; it should be given continuously."[13] The effect of a single dose of adrenalin lasts from two to four minutes. "The longest time that the action of the extract on the blood pressure was prolonged was found to be four minutes. . . . With the continuous flow of the extract into the vein, however, the pressure was kept up as long as the flow was continued, and for the usual time after it had been discontinued."

AFTER-TREATMENT

Post-anesthetic Infections. The question of how best to prevent and treat post-anesthetic pneumonia, wound infections, and other infections following operations is an ever-present one, and to the surgeon the cause of no little anxiety during the first three or four days of the after-care of the patient.

Modern aseptic technic together with caution in regard to unnecessary traumatism in operating and in regard to injury of the tissues by strong antiseptics or the prolonged application of antiseptics, also the proper use of serum drainage, has reduced wound infection very largely to a matter of the resistance of the patient's tissues.

We have already shown how the tissue resistance may be increased by preparatory treatment. There is, however, one cause of lowering of the vital resistance which, in the nature of the case, can not be eliminated. This factor in lowering resistance is nothing else than the anesthetic itself. It results in limiting or checking for the time-being, both phagocytosis and leucocytic activity.

After anesthesia, the power of the blood to destroy pathogenic bacteria is markedly reduced. "In fact, the members of the

13 Detroit Medical Journal, May 1903, p. 45.

entire group of alcohol, ether, and chloroform reduce the power of the blood to combat bacteria; the state of a man after a long anesthesia is comparable to that of an alcoholic with bronchitis who has been sleeping off an overdose of alcohol in a door-way or a freight car.

"So important a subject is this post-operative pneumonia that much interest attaches to the recent studies of Graham on anesthesia and the bactericidal powers of the blood. According to these experiments, it is not the power which serum itself has of destroying bacteria through bacteriolysis which is reduced by anesthetics, but the destruction of bacteria by phagocytosis is greatly reduced. Now it so happens that the organisms which we have to fear in surgery, the pneumococcus and the pus cocci, are destroyed chiefly through phagocytosis and not by bacteriolysis, which gives added importance to this depressing effect on the bactericidal powers of the blood. Apparently ether, the anesthetic which Graham has studied, reduces both the efficiency of the opsonins and the power of the leucocytes to take up the sensitized bacteria; these effects can be seen both in the blood of the patients or animals after anesthesia, and in drawn normal blood treated with ether in the test tube. The action of the ether is not permanent, the opsonic power being restored promptly on removal of the ether." [14]

Dr. C. Achard has recently called attention to these facts and their importance in the causation of certain post-operative accidents in a paper [15] read before the Academie de Medecine.

The use of morphine as an anesthetic aid, even where definitely indicated, must of necessity be an added source of danger from infections. L. Reynolds [16] has emphasized this fact and called attention to the disadvantage in using morphine.

"From experiments performed by him, Reynolds concludes that morphine exerts a marked influence on the leucocytes. Not only does it check diapedesis, but phagocytosis is diminished in a marked degree. The growth of bacteria, on the other hand, is not appreciably affected. What bearing has this

14 Editorial in Journal of American Medical Association, February 18, 1911, also March 26, 1910, pp. 1043—1045.

15 April, 1910.

16 London Lancet, February 26, 1910.

on the practice of medicine in surgery? It is probable that in most surgical operations a certain number of pathogenic organisms gain entrance to the wound, however carefully asepsis be observed. The further history of the case turns on this point. Will the phagocytes be able to destroy these bacteria before the latter have multiplied sufficiently to gain the upper hand? If morphine temporarily paralyzes the activity of the phagocytes, if this drug be given, time is lost during which the bacteria multiply. When the narcosis passes off, the phagocytes may be unable to destroy the bacteria on account of their number and the paralyzing effect of the toxins produced by them; in fact by giving the morphine the chances of sepsis have been increased." [17]

In 1903 Snel [18] reported the results of experiments with guinea pigs relative to the effects of ether, chloral, and alcohol on immunity. These drugs temporarily suspend immunity, the longer the period of anesthesia the shorter being the process of infection. In 1904 Rubin [19] reported the same results from alcohol, ether, and chloroform. These agents depress leucocytosis and phagocytosis and even where a high leucocyte count was present before death, the marked diminution of the phagocytic power of the leucocytes accounted for the fatal result.

It thus appears plain that the use of mixed anesthesia is not to be encouraged unless very definitely indicated. The use of morphine may be necessary in operations for hyperthyroidism and in a few other conditions, but unless there are good reasons for its administration in other conditions, it should not be given.

In the treatment and prevention of post-anesthetic infections, there are three things to be accomplished. These are: First, the rapid elimination of the ether; second, the raising of the phagocytic activity; and third, the reduction of local congestions.

Rapid elimination of ether is best accomplished by the giving of much water immediately following the operation. The rou-

17 Abstract of article by Reynolds in Journal of American Medical Association.
18 Berliner klinische Wochenschrift, 1903, No. 10, pp. 212—214.
19 Journal of Infectious Diseases, 1904, May 30, pp. 425—444.

tine use of gastric lavage before the patient recovers from the anesthetic is one of the best means for getting rid of the ether, preventing vomiting, and the occasional occurrence of acute gastric dilatation. The use of the saline enema is specially helpful. In giving continuous proctoclysis, after the volume of the circulating fluid has reached normal, the added fluid is eliminated by the kidneys as fast as it is absorbed.

This same measure also helps in decreasing the danger from post-operative nephritis. As soon as the patient is out from under the anesthetic, copious water drinking should be insisted upon. It will not be likely to cause vomiting, and if it should seem to have this effect, gastric lavage may be resorted to and continued until the stomach has been washed clean. Sips of very hot water or swallowing bits of ice will then relieve the trouble, and in a little while the free use of water may be continued.

An active circulation will also aid in the elimination of the ether; and this, together with the stimulation of leucocytic activity, may be accomplished by the use of the cold mitten friction with the ice bag to the heart. Both these measures increase the depth of respiration and the volume of tidal air so that more thorough ventilation occurs.

Considerable importance attaches to the prevention of internal congestions and visceral stasis of blood, especially in the lungs and about the site of operation. As a means to this end, we have adopted as almost a matter of routine the use of the hot foot bath, the hot leg pack, or electro-thermal pack to the legs as soon as convenient, immediately following the operation. If the hot leg pack is used, a dry blanket should be placed next to the skin. A well covered ice bag is placed over the heart at the same time. The treatment is continued until the limbs are well reddened and should be concluded by a cold mitten friction to the same skin surface. This procedure will usually last about thirty minutes. It will probably not be necessary in ordinary cases to repeat it for several hours or until the next day.

Transient albuminuria does not usually require any special treatment. If albumen and casts appear in the urine, derivative treatment is indicated and free perspiration should be encouraged. Sweating should never continue long at a time.

If pneumonia occurs, use derivative measures and apply the cold coil or cold compress to the chest. These should be occasionally interrupted by the application of a fomentation or the revulsive compress used. The ice bag to the heart and the cold mitten friction are also of great service in treating post-operative pneumonia. For further details see article on pneumonia in Chapter XIX.

After gall-bladder, appendix, tubal, and some other abdominal operations, a right sided, diaphragmatic and consequently much hidden pleurisy may appear. It is usually not severe and will respond to the usual treatment.

CHAPTER XXVIII

INSANITY AND DRUG ADDICTIONS

JESSIE H. SIMPSON, M. D.

THE INSANE

THE treatment of the insane is still in the involutional period to a more marked degree than any other line of therapy, and the introduction of hydrotherapeutic measures has done much to alleviate this unfortunate class, tending as it does to eliminate the use of hypnotic drugs and mechanical restraint.

In dealing with the insane two very different lines of symptoms are encountered, so that for the purpose of this chapter we will divide them into excited and depressed cases regardless of mental diagnosis.

Many of these cases when first coming under treatment show marked symptoms of autotoxemia, which suggest colonic flushings, and measures calculated to stimulate skin elimination with free drinking of water, and indeed all hydrotherapeutic measures should be preceded by thorough cleansing of the intestinal tract.

The *excited cases*, whether manic-depressive, paretics, seniles, dementia præcox, or other, presenting the symptoms of sleeplessness, hyperactivity, logorrhea perhaps destructive, profane, violent, and resistive, require sedative treatment, which must be adapted to the condition of the individual patient. Here two methods have proven very helpful,—the continuous flowing bath and the wet pack.

The continuous flowing bath (*Plate XX.*) requires a special tub six feet long, which is supplied with a large overflow vent near the top and a large outflow, so that the tub can be emptied and cleaned quickly. The inflow may consist of one large opening at the head, or of several small openings around the sides, in either case connected directly with a mixing chamber which is supplied with a thermometer. A continuous supply of hot water must be assured. The water is regulated to the desired temperature in the mixing chamber before it is turned into the tub. When the tub is full and overflowing the quantity is reduced to a gentle stream. The patient rests upon a canvas cot which fits inside the tub, or upon a hammock which swings from its margin, is protected by a convas cover and provided with a rubber air pillow. An ice turban should be placed upon his head and he should be given cold water plentifully to drink.

An attendant must watch the insane patient constantly while in the bath to see that no harm comes to him. It is well to keep a bath thermometer in the tub and consult it frequently, not relying wholly upon the thermometer in connection with the mixing chamber. The usual temperature of these baths is 98° F.

Very excited and violent patients are difficult to handle and should be placed in a dry sheet or blanket pack, securely pinned about them and then placed in the tub. The continuous bath may be administered for hours or days. In the latter case the patient must be removed once or twice in the twenty-four hours, the bowels given proper attention, and the skin annointed with olive oil or other unguent to prevent too great maceration.

Wet sheet or blanket packs (*Plate XXI.*) have many advantages in as much as they can be administered in either institutional or private practice and to maniacal patients. They may be used cold, neutral, or hot. Authorities differ as to which gives the most sedative effect. However, good results can be obtained at any temperature.

Dr. Rabekah B. Wright, whose experience in this work has been extensive, recommends cold packs, "the colder the better (40°—65°) in maniacal cases." Packs should be administered in a warm room and ice applied to the head, and it is well to pin the pack so that the patient may not become exposed. They may be continued from one hour to several hours. If the patient becomes quiet and sleeps, he may remain in the pack all night, or he may be removed at any time when the restraint becomes tiresome. If, however, he does not become quiet in an hour, he should be removed from the pack and sponged and dried, as under these conditions the pack may become heating and send his temperature up to an alarming degree. Debilitated patients, or those suffering from arterio-sclerosis, should not receive this treatment, the continuous bath being preferable.

Depressed cases require tonic treatments. Of these the salt glow holds a leading place; hot and cold to the spine followed by the needle spray and fan douche; fomentations to the liver, if that organ is inactive, followed by the spray and douche; the electric light or hot air bath followed by the spray and douche are all useful, together with liberal feeding and good hygiene.

DRUG HABITUES

Morphine, Cocaine, Etc. Whether immediate or gradual withdrawal of the drug is practiced or whatever method of cure is used, hydrotherapy is a useful adjunct. During the early abstenance symptoms, when the patient is suffering from nausea, diarrhea, shifting pains, and great restlessness and sleeplessness, the continuous bath administered for one-half hour to two or three hours at a time relieves the symptoms and frequently induces sleep. Sometimes a wet pack will bring sleep, fomentations will relieve the pains when they are more localized, and an ice cap at the pit of the stomach will frequently relieve the nausea.

After these early symptoms have been relieved, elimination can be stimulated and the patient toned up generally by the use of electric light or hot air baths followed by the spray and douche.

Alcohol. In delirium tremens the continuous bath is indicated together with other measures. If this is not available, hot packs may be used. For the later effects of alcohol, elimination, and tonic treatments are needed, the electric light and hot air baths holding a leading place, each to be followed by the spray and douche.

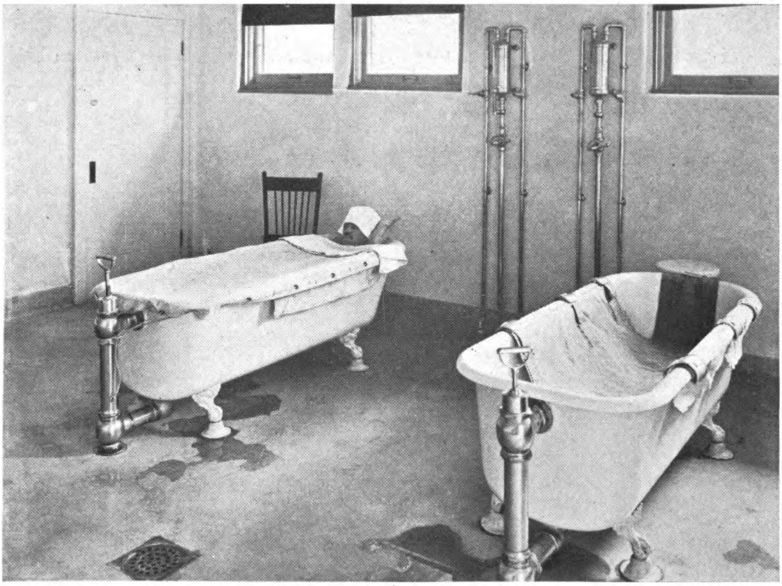

PLATE XX. The continuous flowing bath as installed at the Southern California State Hospital.

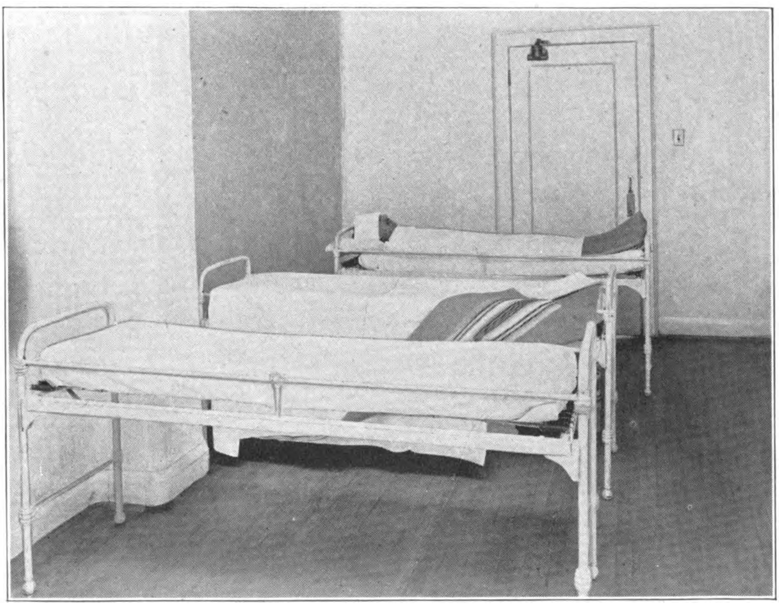

PLATE XXI. The wet sheet pack and pack tables at the Southern California State Hospital.

PART III

TECHNIQUE OF HYDROTHERAPY

CLASSIFICATION OF PROCEDURES

BECAUSE of similarity in technique and for convenience of description, we have classified the procedures of hydrotherapy under the following thirteen heads:—

1. Local Applications of Heat. These include localized applications of heat to such areas as the abdomen, spine, chest, or a joint. Examples: The fomentation, hot-water bottle, radiant heat.

2. Local Applications of Cold. These are circumscribed applications of cold to such areas as those mentioned above. Examples: Ice bag, cold water coil.

3. Heating Compresses. A heating compress is a local application of moist heat made by applying next to the skin a cloth wrung from cold water, and so covered with flannel or an impervious covering as to cause an accumulation of body heat. Examples: Moist chest pack, moist abdominal girdle, heating compress to throat.

4. Poultices. A poultice is an application of moist heat made by means of a semisolid mixture of various substances, and applied to the body while hot. Examples: Flaxseed, clay and glycerine, charcoal.

5. Tonic Frictions. A tonic friction is an application of cold water so combined with friction as to produce stimulating or tonic effects. Examples: Cold mitten friction, wet sheet rub.

6. Sponging. Sponging or ablution consists in the application of a liquid by means of a sponge, a cloth, or the bare hand, in which the chief effect is derived from the liquid applied. Examples: Cold water sponging, alcohol rub, soap wash.

7. Rubs and Frictions. These are procedures in which the chief effect is derived from friction with the bare hands. Examples: Centripetal friction, oil rub.

8. Baths. Under this heading are included various local and general procedures in which the body is immersed in water, light, heated air, or vapor. Examples: Tub bath, foot bath, electric light or Russian baths.

9. Shampoos. The term shampoo applies to local or general cleansing measures by means of soap and water. (It is sometimes applied to massage). Examples: Swedish shampoo, Turkish shampoo.

10. Packs. A pack is a procedure in which a considerable portion of the body is enveloped in wet sheets or blankets for therapeutic purposes. Examples: Hot blanket pack, hot hip and leg pack, wet sheet pack.

11. Sprays and Douches. A spray or douche consists in the projection of one or more streams of water against the body. Examples: Shower bath, needle spray, pail pour, hot and cold douche.

12. Enemata. An enema is an injection of fluid into the lower bowel. Examples: Warm enema, rectal irrigation, coloclyster, oil enema, starch enema.

13. Vaginal Douches. The vaginal douche consists in the flushing or irrigating of the vaginal cavity with a fluid. Examples: Hot vaginal irrigation, disinfectant douches, styptic douche.

GLOSSARY OF TERMS

The terms listed below are used to designate the various physiologic or therapeutic effects of water and in the description of methods. Some of these have applied meanings slightly different from that ordinarily given.

1. Tonic. A tonic effect is one in which vital activities are increased so as to restore the body to a normal tone or condition. The nutrition, circulation, and other body functions are promoted.

2. Pure Stimulant. A stimulant arouses the body to unusual activities. It may be compared to a whip and is used chiefly in emergencies. Like a tonic it increases vital activities, but to a much greater degree. Between a pure stimulant and a tonic there are various gradations which might be designated as mild stimulant, extreme tonic, etc.

3. Sedative. A sedative or calmative agent is one which lessens vital activity and is conducive to relaxation and rest.

4. Antispasmodic. The relaxing of spasm or relieving of convulsions.

5. Depressant. A depressant effect is one in which heightened or normal body activities are decreased to a marked degree. Such an effect is desirable only where a function is greatly overactive.

6. Anodyne. An anodyne effect refers to the relief of pain.

7. Spoliative. A spoliative treatment is one which increases the oxidation and breaking down (catabolism) of tissue; tending to reduce weight.

8. Diaphoretic. The production of sweating. An agent that produces sweating is said to have a diaphoretic or sudorific effect.

9. Diuresis. Increased excretion of urine.

10. Eliminative. An eliminative effect consists in promoting and hastening excretion from the kidneys (diuresis), skin (diaphoresis), and lungs.

11. Depletion. Depletion is the lessening of the amount of blood in a given part,—practically it is the reduction of congestion.

12. Derivative. Derivation is the drawing of blood or lymph from one part of the body by increasing the amount in another part. The term depletion is also applied to this process, but refers particularly to the result produced.

13. Fluxion. Fluxion consists in greatly increasing the rapidity of the blood current in a particular part. It is the production of active or arterial hyperemia.

14. Revulsive. A term used to designate a treatment consisting of a single prolonged application of heat followed by a single very brief application of cold. This meaning is not strictly adhered to as the term is also used where three applications of such proportionate duration are made.

15. Alternate. The expression "alternate hot and cold" is used in this text to describe treatments in which the duration of the cold application is from one-fourth to one-half that of the heat (in a few cases equal with it) and in which three or more changes from heat to cold are made.

16. Antipyretic. The lowering of the body temperature in fever.

17. Refrigerant. Relieving of thirst and restoring the alkalinity of the blood by such means as free water drinking and the use of fruit juices.

LOCAL APPLICATIONS OF HEAT

Fomentations—Fo.

A fomentation is a local application of moist heat by means of cloths wrung from hot water.

(*a*) *Articles Necessary.* In well equipped treatment rooms the fomentation tank should be so arranged that the water from which the fomentations are to be wrung can be heated by live steam passed into the water through a coil. When properly arranged the escape of steam from this coil into the water will be noiseless and cause the water to boil more vigorously than over a fire. The outlet of the tank should be controlled by a valve, never by a plug. A wringer with extra long rollers should be clamped to the side or end of the tank and a table placed immediately beyond the wringer on which the fomentations may be wrapped (*Plate XXIII.*). The fomentations will be hotter if heated directly by live steam. Special steam boxes (*Plates XXIV and XXV.*) may be provided for this purpose or live steam passed into fomentation cloths packed in a pail. If treatment is given at the patient's residence a boiler or pail of hot water may be used. In an institution it is rarely necessary to carry a pail of hot water to the patient's room, as the fomentations will be hotter if prepared in the treatment rooms and packed in a pail in the manner described below. The nurse should also be provided with a set of six fomentation cloths, two Turkish towels for drying the patient, one large cotton sheet for covering the patient, a bowl of cold water or ice water, and one or two hand towels. An oil cloth and extra sheets and towels will be necessary to protect the bedding. If the treatment is to be given in a patient's room, provide a grass mat on which the pail of fomentations or hot water may be placed. If the pail is placed on a carpet, a newspaper may be all that is required. When the pail is set on a chair with a newspaper under it the heat causes the paper to stick to the varnish.

(*b*) *The Patient.* All clothing should be removed. If the clothing is not removed, then bare a larger area than the part to be treated and thoroughly protect the clothing by thick Turkish towels. See that the feet are warm and kept so during treatment. If they are cold, a hot foot bath should be given, or hot-water bottles applied. The hot foot bath is much more effective than any other means of warming the feet.

In giving fomentations to a bed patient great care should be exercised to avoid steaming the bedding, as a patient may easily take cold because of bed linen left damp after treatment. Protect the bedding underneath the patient by oil cloth, sheets, and towels as necessary. After applying a fomentation, cover it with a dry fomentation cloth or a newspaper in order to protect the bedding over the patient.

(*c*) *The Fomentation.* Prepare a set of four or six fomentation cloths, thirty to thirty-six inches square. Four of these may be cut from a single blanket. The material should be half wool. Three cloths are necessary for one fomentation where they are to be very hot—one for the dry covering and two to be wrung from boiling water for the inside wet part. Where less heat is required one inside cloth may be sufficient. Two such fomentation sets are necessary if the best results are obtained.

Spread out on the table the cloth for the dry covering. Fold together in three thicknesses so as to make a long narrow piece, the cloth or cloths to be used inside; and holding the strip by one end, immerse in the boiling water. When thoroughly saturated with the boiling water, pass it quickly through the wringer and after further folding or readjusting to the proper shape and size for the part to be treated, fold it quickly inside the dry fomentation cloth. It is now ready for use. By again doubling together the surface of the fomentation to be applied to the patient, it can be carried with less loss of heat. The fomentation should be large enough to cover a much larger area than the part affected.

Where it is necessary to wring the fomentation by hand, partially twist the long folded piece while it is held doubled together with one hand holding each end. Both ends are now grasped in one hand and the fomentation dipped into the boiling water. When it is ready to wring, twist tightly, handling the fomentation cloth by the dry ends. Next pull the ends apart. The water is thus squeezed out. (*Plate XXII.*) The twisting and pulling may be repeated as necessary for thorough wringing of the cloth. By releasing one end while holding up the cloth by the other, it may be quickly untwisted and at once wrapped in the dry covering.

Where it is necessary to give the treatment in the patient's room, a set of three fomentations may be packed in a *papier mache* pail in such a way as to preserve their heat for a half hour or even longer. First, line the pail with large, dry fomentation cloths. Prepare each fomentation as usual and pack in tightly or better still, wring by hand the inside cloths, leaving them twisted as tightly as possible and pack closely in the lined bucket. A hot-water bottle may be placed in the bottom of the pail if thought necessary and another over the wet cloths. The necessary number of dry fomentation cloths may be packed into the top of the pail and the fomentations made up in the room as needed.

(*d*) *Procedure.* The fomentation should lie closely in contact with the skin, and be renewed in three or four minutes; or in case of pain, as soon as it becomes comfortable. If unbearably hot, rub the part with the hand under the fomentation or remove the moisture by firm rubbing once or twice with a Turkish towel wrapped about the hand. The fomentations may be applied over a towel in order to temper the heat. Always be careful to protect from chilling the area being treated, by keeping it covered with the fomentation cloth or a towel.

PLATE XXII. Wringing a fomentation by hand.

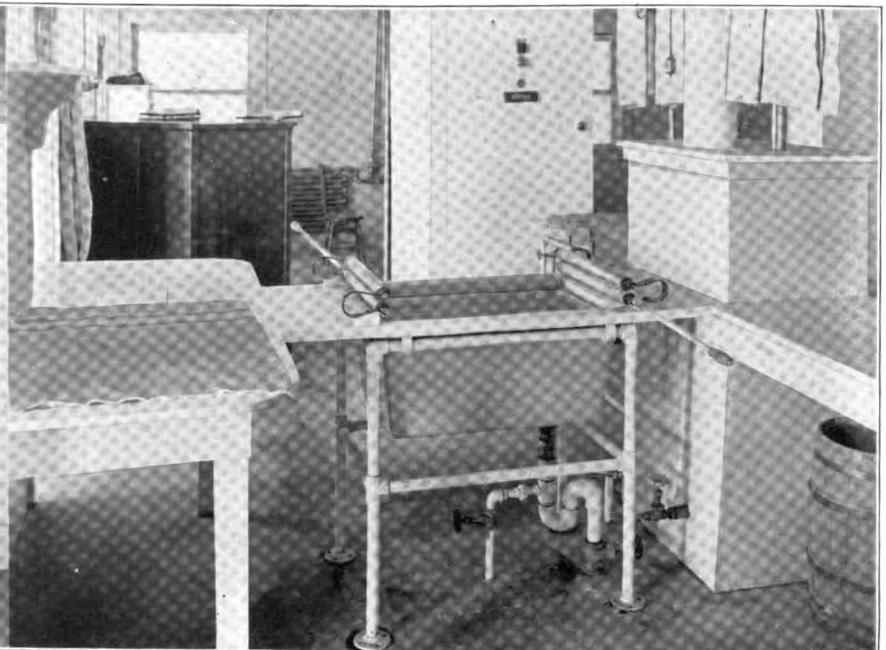

PLATE XXIII. A fomentation tank with wringers and tables for folding.

To renew the fomentation, prepare another similar one and apply immediately after removing the moisture occasioned by the first. Never apply another fomentation until this is done, as the water on the skin makes it more difficult to endure the heat of the newly prepared fomentation. The second fomentation should be ready to apply before the first is removed. The removal of the inside cloth from the outer for purposes of renewal does not give the best results, although careful attention to details may still make the treatment very effective.

Unless otherwise indicated or ordered, three successive applications are made. In all cases, however, they should be continued until the desired effect is obtained. After the last one, the part should be immediately cooled by a wet hand rub, cold compress, or rub with the cold wet towel. Dry thoroughly and cover at once to prevent chilling. In some cases of pain, the part should be dried without the cold application. All changes should be made quickly, and the part treated should never be left uncovered.

(*e*) *Precautions*. In cases of unconsciousness, paralyzed sensation, diabetes, dropsy, under anesthesia, or after operations, great care must be taken to avoid burning. The degree of each application should be tested by the back of the hand or the face before being applied to the patient. In giving fomentations to the face or other sensitive part, gauze should be placed next to the skin.

In case of general perspiration, a general cold friction, wet hand rub, wet towel rub, or alcohol rub, should be given.

Sensitive surfaces, especially bony prominences such as the ilia, costal arches, clavicles or scapula, may need to be protected by extra coverings of flannel or Turkish towel.

Where the patient is liable to cerebral congestion, and always in case of fever, apply cold compresses to the head and also to the neck if needed. The same should be done where two or more applications of heat are made at the same time or general perspiration induced. In case of heart disease, usually in fever, and with rapid pulse from any cause, an ice bag should be placed over the heart.

In order to relieve pain, the fomentation must be very hot, as hot as can be borne, and renewed as soon as it becomes comfortable. In some cases of pain the cold application at the close should be omitted, the part being dried and immediately covered with flannel or other dry covering.

For sanitary reasons it is desirable that each patient furnish his own fomentation cloths. However, persons with communicable diseases should not be admitted to a general treatment room.

(*f*) *Effects.* The fomentation is used to relieve pain, produce derivation, as a preparation for cold treatment, and for stimulating or sedative effects, according to the temperature and mode of application. Its first effect is that of a vital stimulant; unless followed by a cold application, the reaction is atonic. A brief application is stimulating; prolonged applications sedative or depressing. For sedative effects the heat should be moderate and the application more prolonged before renewal. These points should be observed in applying fomentations to the spine for insomnia.

Hot Gauze Compress—H. Comp.

This is used when it is desired to apply moist heat to such sensitive parts as the eye, a wound or infected part where the cloth must be disinfected or discarded after being used.

Several thicknesses of gauze, cheesecloth or ordinary cotton cloth of appropriate size and shape, are wrung from boiling water and applied in the same way as a fomentation. Because the compress is usually small and unprotected, it cools quickly, and for this reason must be more frequently renewed, nor does cotton hold heat as long as wool. From ten to fifteen minutes will usually suffice to obtain the desired result. The treatment should be concluded in a manner similar to the fomentation.

Stupes

A stupe consists in the application of a medicament by means of a fomentation. When gauze compresses are used, the disinfectant or medicament may be put into the hot water from which the compress is wrung. In case of a large fomentation with flannel cloths, the medicament may be applied by compresses

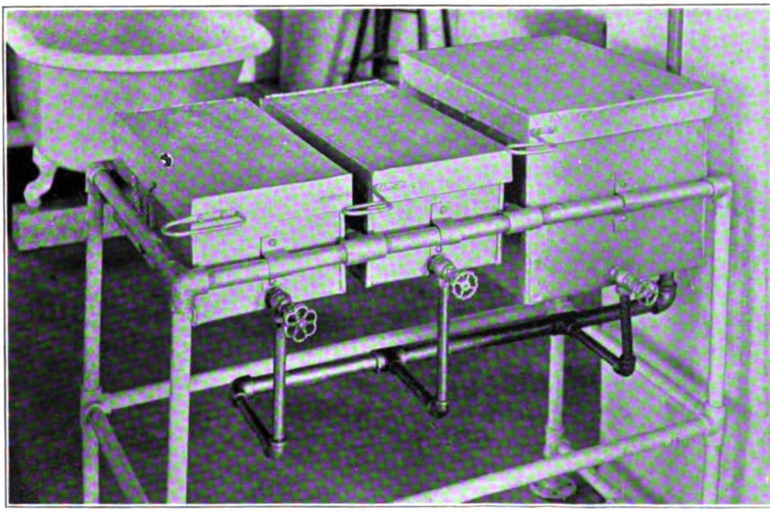

PLATE XXIV. Steam boxes for heating fomentations and packs—closed.

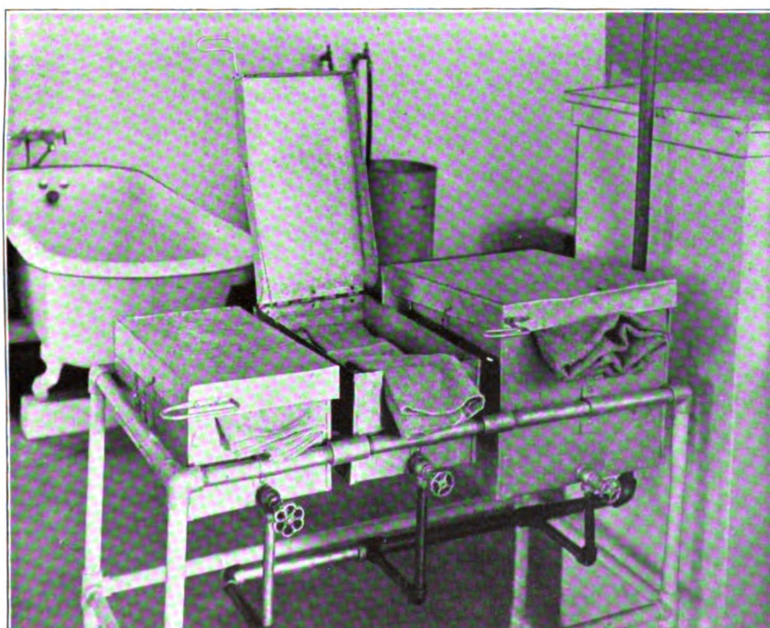

PLATE XXV. Steam boxes for heating fomentations and packs—open and in use.

placed under the fomentation. Turpentine, mustard, menthol, etc., may be used in this way. However, the desired hyperemia and depletion can usually be obtained in a more cleanly manner by a plain fomentation, and without the danger of a blister.

To prepare a mustard fomentation, make a thin paste of mustard and spread on a piece of gauze or muslin of the desired shape and size, apply this to the surface to be treated and cover with the fomentation. To prepare a turpentine stupe, sprinkle on the wet gauze half a teaspoonful of oil of turpentine, apply and cover with a fomentation. If the stupe is to be left on some time, it will be better to wring the gauze from a dilute solution of turpentine (10 to 20 per cent).

Revulsive Compress—Rev. Comp.

This is given in the same manner as the fomentation, with the addition of a cold compress after each application of heat. A hand towel is wrung from cold water or ice water, according to the ability of the patient to react. This is spread out over the surface immediately on the removal of the fomentation, allowed to remain a few seconds, and then turned over and allowed to remain about thirty seconds. The skin is now dried and the next fomentation applied. Three changes of hot and three of cold are usually employed.

The revulsive compress is a mild stimulant and tonic measure, it also produces mild fluxion in the part treated.

Alternate Hot and Cold to Spine—H. & C. Sp.

Fomentations are given in the same manner as for the revulsive compress. After each a smooth piece of ice is quickly rubbed back and forth over the part, making from three to five or more to-and-fro movements. The part is then dried and another fomentation applied. In making these hot and cold applications, the next fomentation should be ready before the ice is applied.

Alternate hot and cold applications may be made to other parts in the same manner.

Alternate hot and cold to the spine is a vigorous stimulant and tonic measure and is useful in a great variety of conditions.

Alternate Hot and Cold to Head—H. & C. Hd.

(*a*) *Articles Necessary.* Two compresses of three to five thicknesses of gauze or cheesecloth about twelve inches square, two ice bags filled with finely chopped ice and covered with cheesecloth, a spine bag partly filled with hot water and covered with a fomentation cloth or towel, a bowl of ice water and a pail of boiling water.

(*b*) *Procedure.* Place the spine bag crosswise of the cervical spine, bringing it well up under back of head and neck. Lightly wring cheesecloth from ice water and apply to face, covering top of head and ears. Press down firmly over forehead and temporal arteries; renew every minute.

After three minutes replace spine bag by two cloth-covered ice bags, and the cold compress to face by another wrung quite dry from hot water; the latter should be renewed every minute. In another three minutes replace the first applications of spine bag to the back of the neck and cold compress to the face. Continue these alternations for three complete sets of hot and cold. Cool all the parts by wiping off with a cold compress and dry thoroughly, especially the hair.

(*c*) *Effect.* These alternating hot and cold applications stimulate the cerebral circulation and the treatment is, therefore, indicated in headache due to anemia of the brain, also in passive congestion and in a cold in the head. Any *alternating* hot and cold application produces *fluxion*.

Simultaneous Hot and Cold to Head—Simul. H. & C. Hd.

Place an ice bag to the base of the brain and another ice bag, or better, ice cap, to the vertex after moistening the hair so that the cold will penetrate. Also place ice bags or ice compresses over the carotids. Now apply a fomentation to the face, covering the ears and forehead. Gauze or cheesecloth should be used under the fomentation when applied to the face. The nose should not be covered by the fomentation as it is uncomfortable when so done, and it is better for the patient to breathe cooler air.

This treatment is very effective in reducing cerebral congestion and relieving congestive headache. It is well to conclude the treatment by an alternate hot and cold percussion douche to the feet, cold cervical and cephalic compresses being kept on while giving the douche.

Simultaneous applications of heat and cold so given that the cold application is placed over a reflex area of, or the large artery supplying, the deep part, produce *depletion*.

Hot-Water Bottles

These should be partly filled with hot water (never boiling water) and wrapped in cloth, preferably flannel or a Turkish towel. Great care should be taken in applying them to patients with paralysis and during and after operations that burns do not result. The safety of the hot-water bottle may be tested by holding it against the cheek. When not in use, the bottle should be hung bottom end up with the stopper out. It should never be left doubled sharply upon itself as it is likely to crack at the fold. The hot-water bottle is made in two- and three-quart sizes. The spinal hot-water bottle is useful in giving hot packs, also for the local application of heat to the spine or legs. The metal hot-water bottle is very durable. It is serviceable as a bed warmer and for the feet. It must be well covered and great care exercised in its use that burns are not produced by leaving some part of the metal exposed. These bottles are shown in *Plate XXVI*.

Fomentations and hot packs may be reenforced or prolonged by the use of hot-water bottles, or the bag may be wrapped in a moist cloth covered over by a dry one, to give the effects of a mild fomentation.

Winternitz Coil

This consists of a coil of rubber tubing about ten or eleven inches in diameter, through which a stream of hot water is caused to flow. (*Fig. 60.*) A dry blanket is placed on the treatment table, and over this is placed a doubled sheet, wrung from cold water or ice water, so that it may be wrapped about the trunk. The patient lies down on the wet sheet and one end is wrapped tightly about the chest and abdomen. The coil is now placed on the abdomen over the wet sheet, and the other end of the sheet wrapped around the trunk over the coil. The dry blanket is folded over and about the patient. A small stream of hot water at 135° flows slowly through the coil from the center outwards. The treatment is continued from thirty to forty minutes, or even three hours in cases of very slow and defective digestion. It is concluded by a cold mitten friction. A hot-water bottle may be used in place of the coil. (See hot and heating trunk pack.)

The coil may be used for cold water in the same manner as the Leiter coil. In fact the cold coil is much more frequently used and for a greater number of purposes than the hot coil.

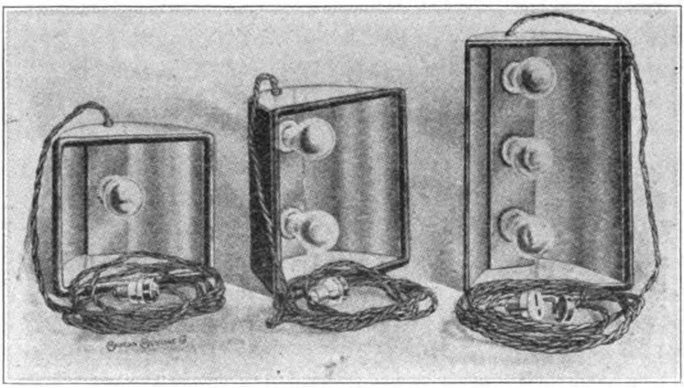

Fig. 59. Three sizes of radiant heat.

Radiant Heat—Rad. Heat.

The radiant heat is a local application of heat by means of electric lights arranged in a reflecting metal case. (*Fig. 59.*) From one to twelve or more such lights may be arranged in a single case, and the case so constructed as to fit to any part of the body. An instrument with one light is perhaps the most useful. An oblong case containing three lights is a convenient means of applying heat to the spine. A case in the shape of a half cylinder and containing six or more lights may be made for the feet and legs.

In applying the radiant heat, the body should be protected from the edge of the case by towels or fomentation cloths. The

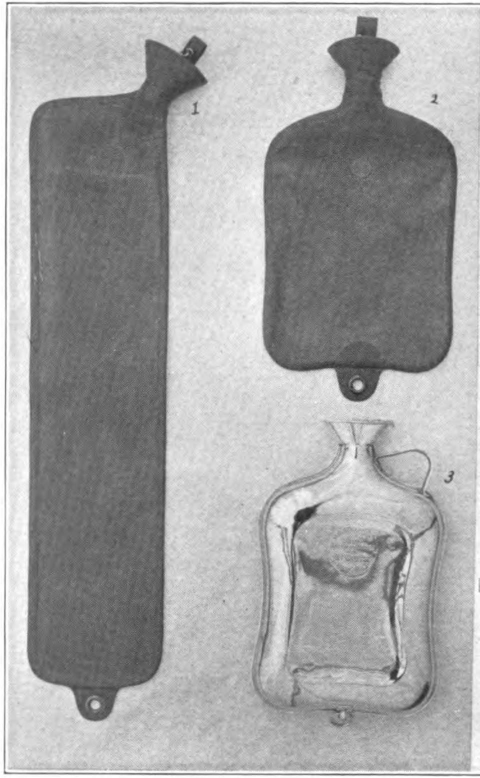

PLATE XXVI. Hot-water bottles.

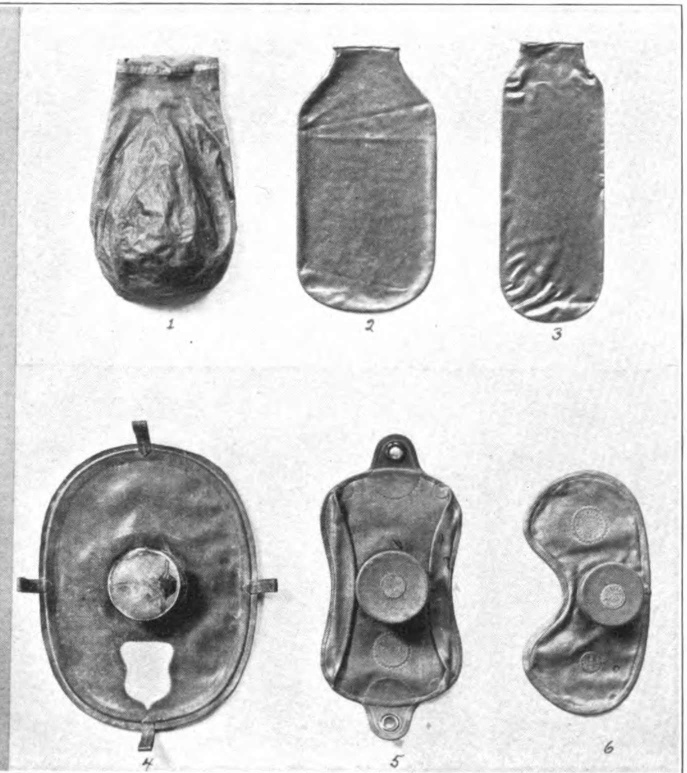

PLATE XXVII. Ice bags.

amount of heat may be regulated by the number of lights or the distance from the skin. Leave in place for ten to twenty minutes, or until the desired results are obtained. Cover the part well after drying perspiration, or use a cold wet towel. The local electric light is a convenient means of applying heat to the feet, knees, and other joints. It may be used over bandages and surgical dressings where it is not desirable to remove them.

LOCAL APPLICATIONS OF COLD

Cold Compress—C. Comp.

A cold compress is a local application of cold by means of a cloth wrung from cold water. Hand towels, ordinary cotton cloths, or better still, cheesecloth may be used. These should be folded to the desired size, and wrung from cold water or ice water. The wringing should be just sufficient to prevent dripping. They will be colder if taken immediately from a block of ice. As a continuous cold application, the compress must be very frequently renewed, always before it is warmed to any great extent. The thicker the compress, the less frequently will it require renewal. A set of two compresses should be used and renewed at intervals of from one to five minutes depending on the thickness of the compress and the result to be obtained. Cold compresses may be applied to the head, neck, over the heart or lungs, to the abdomen, spine, etc. When applied to the head they should be pressed firmly down on the surface being treated, especially over the forehead and the temporal arteries. The pillow should be protected by rubber cloth covered by a towel. When applied to the abdomen in typhoid fever, the bedding and patient's garments should be protected by Turkish towels. Unless very thick and always when left longer than three to five minutes, the nature of the application changes and it becomes a heating compress.

When applied over a large artery it decreases the amount of blood in the part beyond the application. Such an application is called a *proximal compress*. Examples of this are found in such applications as a cold compress to the neck, over the femoral artery, at the bend of the elbow, etc. Ice bags are also used for the same purpose.

Ice Pack—Ice Pk.

An ice pack is used where a large continuous and very cold application is desired. Spread cracked ice over a thick Turkish towel, folding one end and the edges over this so as to retain the ice. Apply next to the skin or over a single layer of flannel. This may be used over the heart, also over a consolidated lung area in pneumonia. In the latter case it should never be applied until after the hot packs used in this disease have warmed the body sufficiently to prevent chilling. It should occasionly be interrupted by applying a fomentation. This helps to preserve the desired reflex effect.

Snow may be used in place of the pounded ice. In applying an ice pack to a joint, first wrap the part in flannel so as to prevent actual freezing, then pack the snow or pounded ice closely against the flannel forming a layer about one inch thick, retaining it in place by a larger flannel cloth wrapped about all and pinned together (*Plate XIII.*). Several gum rubber ice bags filled with snow or pounded ice are better for pack purposes, as there is no danger of wetting the bed linen.

Ice packs should be interrupted often enough to prevent freezing, and the part either rubbed with snow or a fomentation applied to renew the local reaction.

Ice Cravat

The ice cravat or collar is made in the same way as the ice pack, the towel being filled with ice and folded so as to be about three inches wide and encircle the neck. If the towel is wrung from ice water, it must be more frequently renewed than when cracked ice is used.

An ice cravat may also be made by using two narrow spinal ice bags (*Plate XXVII, fig. 3.*). These should be filled with pounded ice and wrapped in linen or cotton cloth.

The effect is that of a proximal application. The carotid arteries and their distal branches are contracted, also the vertebral arteries. Thus the blood supply to the brain and head generally is very much lessened. The ice collar is frequently used in fever, in congestive headache, in acute epidemic meningitis, etc. It should also be used in sunstroke and whenever prolonged sweating treatments are given, as in eclampsia and uremia.

Ice Bag and Ice Cap—Ice Bg.

Ice bags are made in various shapes and sizes (*Plate XXVII.*). The best ice bags are made of pure gum rubber and are usually elliptical in shape. They may be obtained in almost any size desired. The spinal ice bag is about three inches wide by seven to nine or ten long.

Ice caps are usually round or elliptical and provided with a screw cap; some are also made with loops or eyelets for holding them in place. Cloth-covered ice bags offer no advantage; they usually leak after being used a few times, and are also unsanitary. Japanese paper ice bags, because of their cheapness, may be thrown away after being used in infectious cases. The ice bag or cap should be filled with finely cracked or pounded ice, never with large chunks. In closing the ice bag the neck should be doubled down, then folded several times across this and tied with tape about one-fourth inch wide. Thread or fine twine should not be used as it cuts the rubber. When applying the bag, wrap it in a towel or one thickness of flannel. The skin should not be severely chilled. The bag should be removed often enough to prevent this, the part rubbed briskly with the hand until warmed or a fomentation applied for a short time.

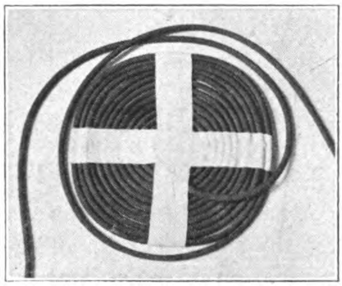

Fig. 60. Winternitz coil.

Cold Water Coil—C. Coil.

The rubber coil (Winternitz coil) is the most convenient means of applying a local application of cold. Matted coils ten or eleven inches in diameter may be purchased or a coil may be made of ordinary rubber tubing and held together by adhesive tapes (*Fig. 60.*). The inflow should enter at the center of the coil. The rate of flow may be very conveniently controlled by tying a knot in the outflow tube just above where it dips into the receiving pail. This knot may be loose or tight as desired for rapid or slow flowing of the cold water through the coil. The reservoir should be about two feet above the level of the coil and may be a large can with an outlet at the bottom, or an ordinary pail may be used and the outflow secured by siphonage.

The coil should always be applied over a cold compress and covered with a dry flannel cloth or fomentation cloth. In applying it to the head, the coil may be made in the shape of a cap (*Plate VIII.*) and held in place by light bandages or folded towels. Always wet the hair before placing the coil.

The Leiter coil is not used as much as the rubber coil. It is a small flat coil of flexible metal tubing through which a stream of cold water or ice water passes. It may be moulded to fit any part, and is often used over the mastoid.

HEATING COMPRESSES

A heating compress is a cold compress so covered that warming up soon occurs. The effect is, therefore, that of a mild application of moist heat.

A heating pack or compress consists of an application of heat to the body by means of three or four thicknesses of gauze or one of linen or cotton cloth wrung from cold water and so perfectly covered with dry flannel or mackintosh and flannel as to prevent the circulation of air and cause an accumulation of body heat. In case warming does not occur promptly, it should be aided by hot-water bottles or the radiant heat. It is usually left in place for several hours between other treatments, or over night. If left on over night it should be dry by morning unless an impervious covering such as a mackintosh or oiled silk is used. On removal of the compress the part should be rubbed with cold water.

According to the extent and location of the surface involved, the nature and thickness of the coverings, the temperature and amount of water left in the wet cloth, and the duration of the application, it may have the following effects, *viz.*, tonic, sedative, derivative, or sweating.

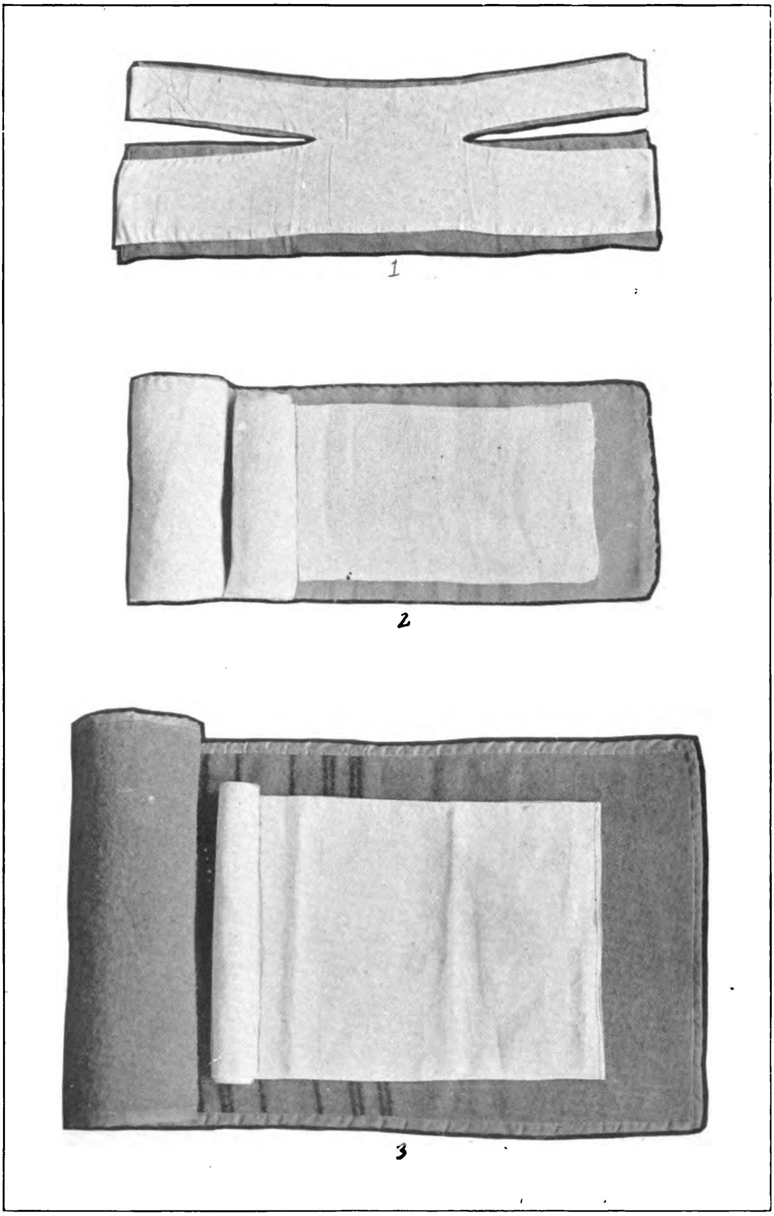

PLATE XXVIII. 1. The square chest pack. 2. The roller chest pack. 3. The moist abdominal bandage.

If the pack dries out before being removed, it will have a mild derivative and a mild sedative or tonic effect according to the part to which it is applied and the condition in which it is used. If the coverings prevent drying, the result will be that of a stronger derivative because of the local sweating. It also causes relaxation of the muscles and vaso-dilatation of the vessels in immediate or reflex relation with the surface treated.

Moist Chest Pack—Ch. Pk.

Any kind of a jacket which combines the above requisites for a heating compress with ease and neatness of application and accuracy of fit, will answer the purpose of a chest pack. The roller, square, and fitted chest packs are examples of these.

1. Roller Chest Pack. The inside piece consists of two to four thicknesses of gauze eight to ten inches wide and about six or eight feet in length. One thickness of thin linen may be used. The outside piece of flannel is a little wider than the gauze and somewhat longer (*Plate XXVIII, middle figure.*). The gauze or linen is loosely rolled in bandage form and wrung nearly dry from cold water. While standing in front of the patient, the end is applied under one arm, more handily the right, then carried diagonally across the front of the chest and over the left shoulder, then obliquely across the back, under the right arm and directly across the front of the chest, under the left arm, across the back and over the right shoulder and fastened under the transverse front piece. The bandage must be snugly applied at all places but not so tight as to restrict the movements of the chest. The flannel is now applied in the same order, care being taken that the wet piece is well covered and then securely fastened with safety pins. The pack should be comfortable and feel warm in a very short time. (*Plates XXIX and XXX.*)

2. Square Chest Pack. Both parts of the pack are of an oblong form (*Plate XXVIII, upper figure.*), wide enough to reach from the top of the shoulder to the lower ribs, and long enough to give a double thickness in front. The ends of the bandage are slit into two strips one-third and two-thirds respectively of the total width, and each one-third of the length.

The outer flannel part should be about two inches wider and of the same length and slit in the same fashion. The flannel part should be spread out on the treatment table and the linen over it after being wrung from cold water. The patient now lies back on this. The narrow strips are brought up over the shoulder and across the chest. (*Plates XXXI and XXXII.*) The top of the wider strips should fit under the axilla and be brought across the chest. The flannel should now be applied in the same manner and at all loose places be drawn tight or folded in and the whole fastened with safety pins.

3. Fitted Chest Pack. From flannel cut a front and a back piece in much the same shape as for a vest making the necessary curved cuts about the arms and neck. The front piece should be the larger so as to come back under the arms and lap over the back piece; also on each side of the neck, a strip four inches wide should be made long enough to overlap the back piece.

An inside piece of the same shape should be cut from gauze or thin linen. This inside piece should be about one and one-half inches narrower at all edges so that when covered by the flannel it will not be exposed at any place, but be covered at least one inch beyond its edge.

After applying see that it fits snugly and is well pinned with safety pins so as to prevent the entrance of air at any place along the edges.

Various other forms may be improvised to meet the needs of the home not provided with the more perfect requisites. To retain the moisture and so give greater sweating effects the cloth may be covered with mackintosh, gossamer cloth, or oiled silk of the same size and shape. When so covered it is spoken of as a protected chest pack.

4. Partial Chest Pack. It is often desirable to apply the moist cloth to only a portion of the chest. The gauze or linen may be cut to any desired shape and size and applied to the proper area under the square or roller flannel pack. The chest being covered principally by dry flannel, this form approaches in effect the dry pack.

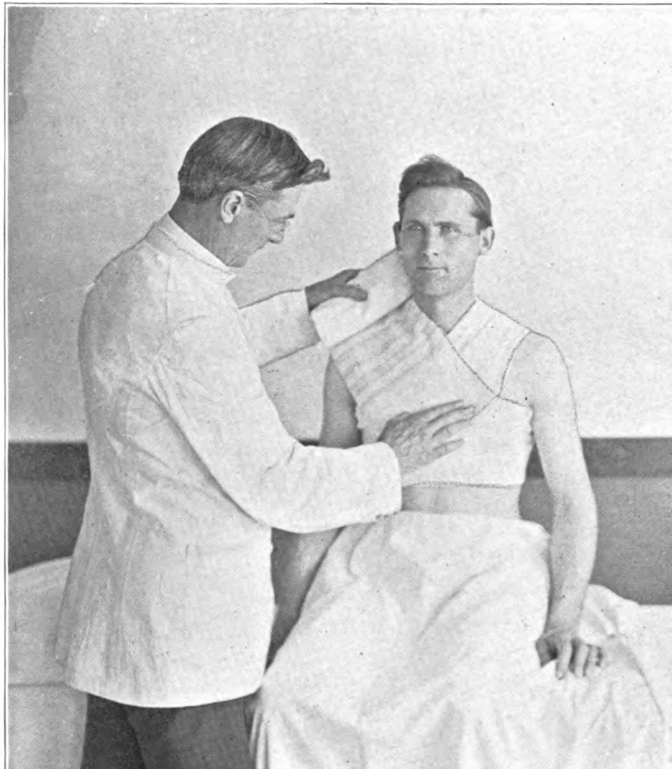

PLATE XXIX. The roller chest pack—applying.

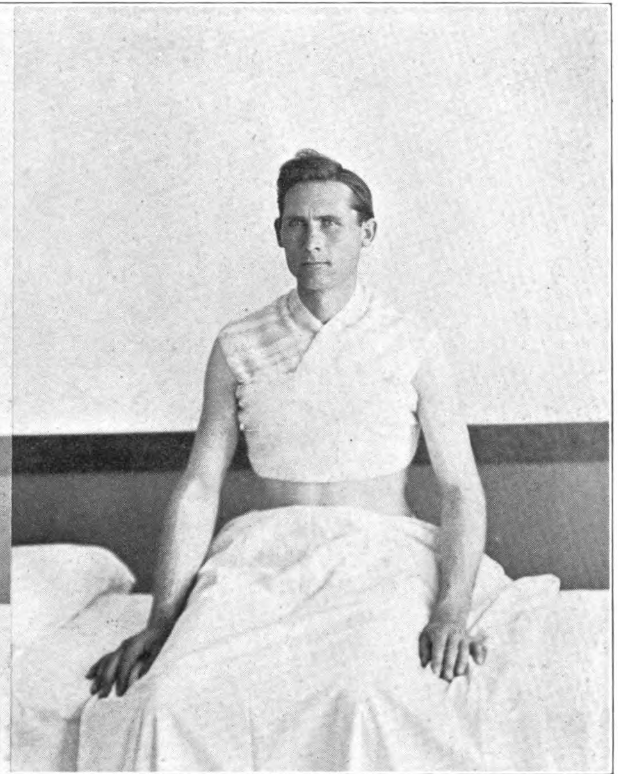

PLATE XXX. The roller chest pack—finished.

Dry Chest Pack—Dry Ch. Pk.

With the dry chest pack only the flannel is used of either the roller, square, or fitted style. It should usually be applied over a thin undergarment. The dry chest pack is desirable in thin persons, the aged, and those having insufficient body heat to warm up the wet pack. It is often difficult, not to say impossible, in the case of a thin person, to pin the wet pack so tightly as to prevent the air from circulating under the edges of the pack and yet loose enough to be comfortable and not restrict the breathing. In many cases a chamois vest may be worn over a thin undergarment to produce the effects of a dry pack.

Chest packs are of much benefit in pleurisy, colds, influenza of the respiratory type, during convalescence from pneumonia, in asthma, whooping cough, croup, etc. Under the pack, the skin should be warm and gently perspiring. The choice of a dry or moist pack will depend upon the vitality of the patient and the result to be obtained.

Moist Abdominal Bandage—M. A. B.

The *umschlag* or moist abdominal girdle is one of the most useful of the heating compresses. The inside part of the girdle (*Plate XXVIII, lower figure.*) consists of one thickness of linen or three or four of gauze, eight or nine inches wide and a little more than one and one-half times the circumference of the body. The outer flannel girdle should be about twelve inches wide and of the same length. The dry flannel is placed across the table and the gauze, wrung nearly dry from cold water, placed over it. The patient now lies back on the bandage so that the lower edge will be below the iliac crests. Each end of the wet linen or gauze is pulled tightly across the abdomen and tucked under the opposite side. (*Plate XXXIII.*) Both ends of the flannel are now folded tightly over these and securely fastened with safety pins. Darts may be taken on each side by means of safety pins in the same manner as in pinning a bandage after an abdominal operation. The flannel piece should project one and one-half or two inches beyond the wet gauze or linen. Where it is difficult for the patient to warm up the bandage, it may be moistened only over the abdomen.

The moisture may be retained by a bandage of oiled silk or mackintosh of the same width as the linen and applied between it and the flannel. This is spoken of as a protected girdle.

The sweating underneath will be more profuse than without the impervious covering. Since the moisture is retained it will not be dry by morning. The protected girdle is indicated in hyperacidity and where it is desirable to produce considerable relaxation.

The ordinary moist abdominal bandage is useful in nearly all forms of atonic indigestion, in neurasthenia, anemia of the liver, insomnia, catarrhal jaundice, constipation, etc. In these conditions it is usually warn only at night.

Heating Throat Compress

Four to six thicknesses of cheesecloth or two or three of ordinary cotton cloth about three inches wide and long enough to encircle the neck twice are used inside. The outside consists of two thicknesses of flannel not less than four inches wide. This compress being small, considerable water may be left in it and still be found dry by morning. The neck should be rubbed with cold water immediately after removing the compress in the morning. The "cold cloth around the neck" is a very common household remedy for sore throat, hoarseness, tonsillitis, etc. It is indeed a very efficient measure; its usefulness can hardly be overestimated. The heating throat compress is indicated in pharyngitis, acute laryngitis, tonsillitis, quinsy, and in inflammation of the Eustachian tube. It is also useful in clergyman's sore throat. In tonsillitis, quinsy, and inflammation of the Eustachian tube, the compress should extend upward about the lower part of the ear and may be held in place by a bandage over the top of the head.

Heating Joint Compress

Heating compresses may be applied to the foot, ankle, knee, hand, wrist, etc. Rarely more than two thicknesses of gauze are used. It is often necessary to use cotton for a covering to obtain close application to the skin surface. This may be held in place by a three-inch roller bandage or a broad flannel cloth.

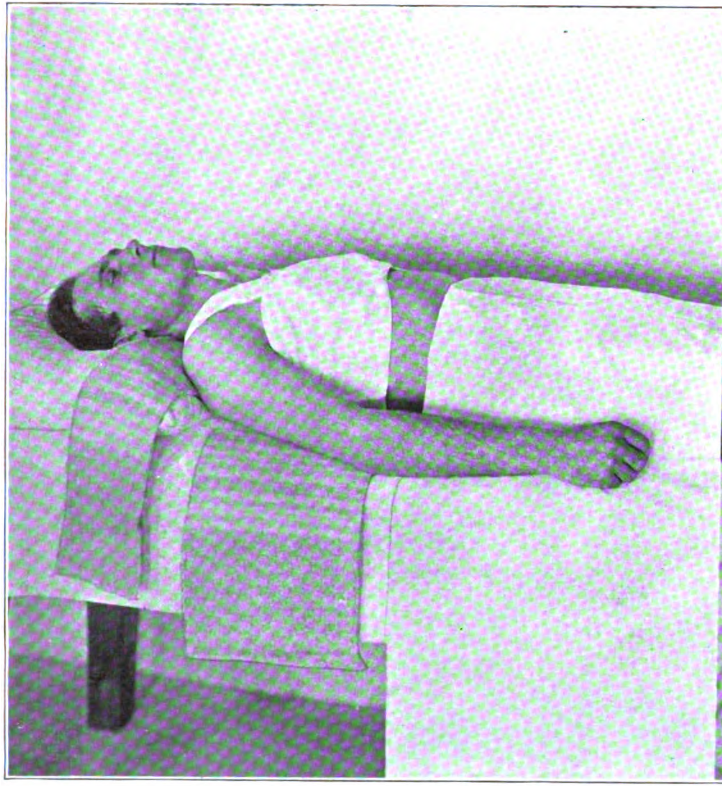

PLATE XXXI. The square chest pack—applying.

PLATE XXXII. The square chest pack—finished.

A dry pack may be made of cotton or soft flannel alone. In certain cases the joints may be rubbed with a medicated solution before being covered, or the gauze dipped in it. Alkaline or anodyne solutions are very frequently used in this way in cases of rheumatism. In rheumatic fever the joints may be rubbed with synthetic oil of wintergreen before the heating compress is applied. It helps to relieve the pain and by its action as a counter-irritant, the heating and circulatory effects are enhanced.

Medicated Compresses

Besides rubbing the parts with medicaments such as turpentine, camphorated oil, oil of wintergreen, etc., before applying the heating compress or pack, the gauze may be wrung from various solutions such as an alcoholic solution of menthol, mustard water, watery solution of bicarbonate of soda, saltpeter, etc. When counter-irritant drugs are used the effect of the heating compress is intensified. It is usually not desirable to produce a blister. For this reason the use of coal oil and turpentine should be discouraged. Not only may they produce blisters, but being inflammable, they are also dangerous. When using oil of wintergreen it is best to dilute it with two parts of oil of eucalyptus.

POULTICES

Poultices are very popular substitutes for the heating compress and have a similar effect. They consist of a mixture of various substances, having the consistency of mush and must be applied hot to produce the desired result. Flaxseed, onions, etc., are commonly used. The preparation may be applied directly to the skin or spread on a cloth and bound tightly to the part. They are often disagreeable, not to say uncleanly.

Probably the most useful poultice is that consisting of *white clay and glycerine* sold under various names. It is applied hot about one-quarter to one-half an inch thick and covered with cotton and a bandage. The results are partly due to the heat and partly to the water-absorbing (hygroscopic) properties of the glycerine.

The *charcoal* poultice is especially valuable in foul, sloughing ulcers or wounds. In may be prepared of charcoal alone or by adding equal parts of flaxseed meal and powdered charcoal to boiling water until the resulting mixture is the consistency of mush. This is evenly spread on a cloth and applied to the part, or directly on the part and covered with a muslin cloth and some impervious cloth as oiled silk.

TONIC FRICTIONS

A tonic friction is an application of cold water so combined with friction as to produce decided thermic and circulatory reaction. The effects are briefly described as stimulant and tonic. These have been discussed in detail in the chapter on stimulants and tonics, *q. v.*

Given in the order of their severity, the tonic frictions are as follows: Wet hand rub, cold mitten friction, cold towel rub, wet sheet rub, and dripping sheet rub. To these may be added the ice rub and salt glow. While the latter is not particularly an application of cold, the friction gives tonic results similar to the others, and the procedure is not far different. The ice rub may be used for stimulant or tonic purposes, but it is more frequently used as an antipyretic.

Cold Mitten Friction—C. M. F. or Cmf.

(*a*) *Articles Required.* A bowl or pail of cold water at 50° or 60° F. or ice water, a sheet, three Turkish towels, two friction mitts made of such coarse material as woolen moreene (*see corner figure in Plate XXXV.*), and compresses for the head and neck.

(*b*) *Procedure.* The patient should be warmly covered and the feet warm; if not, give hot foot bath. Bare one part of the body at a time. Do not expose any part longer than necessary; dry quickly and thoroughly and recover at once with warm dry covering. Before beginning the regular part of the treatment, bathe the patient's face and neck with cold water or apply cold compresses to the head and neck. This is especially necessary in treating patients with valvular heart disease. In this condition an ice bag should be placed over the heart before begin-

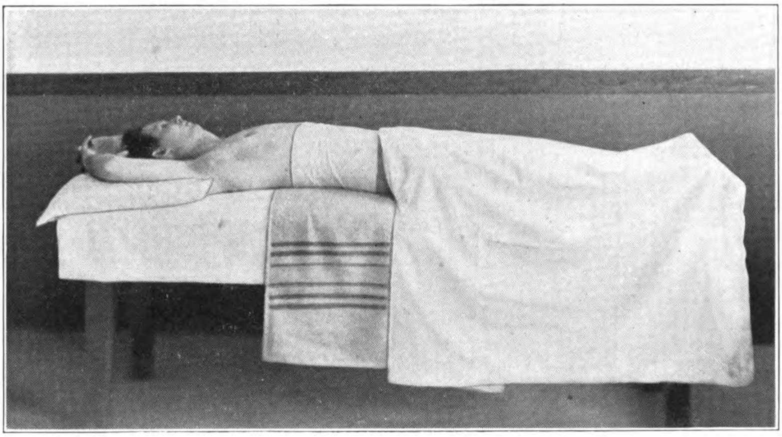

PLATE XXXIII. The moist abdominal bandage.

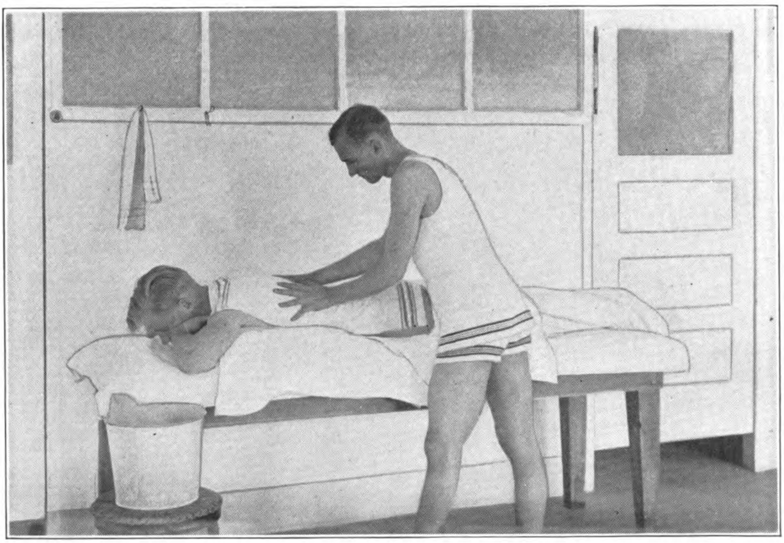

PLATE XXXIV. The cold towel rub—treating the back.

ning treatment. In other conditions it is not usually necessary.

Beginning with the right arm, place one towel under the arm and another around the shoulder to protect the table and patient. With the mitts on the hands, dip them into cold water and shake or squeeze out the excess of water. While the patient holds the arm at an angle of 45 degrees, rub the arm and hand with rapid to-and-fro friction movements until it is in a glow (*Plate XXXV.*). Quickly remove the mitts, dropping them into the bowl and cover the entire arm with one of the Turkish towels, having the patient hold the upper corners by closing the hand on them. It is better to steady the arm by grasping the patient's hand covered by the towel, under the operator's right arm. Dry by friction outside the towel and then rub with the towel until the arm is thoroughly dry and well reddened. Treat the left arm in the same manner.

Now covering the rest of the body, bare the chest and abdomen. Tuck a Turkish towel snugly under each side along the trunk and over the arms. Rub the chest with the mitten dipped in cold water in a manner similar to the arms, then cover the entire chest with one of the towels and have the patient catch the two upper corners as they lie next to the shoulders. Rub briskly with downward strokes over the towel. Then wrapping the towel neatly about the right hand, again rub the entire surface, around shoulders and down the sides, so as to dry all parts that have been wet.

Cover chest and expose the right leg and thigh. Flex the leg and place a Turkish towel under. Place another towel around the upper thigh at the groin. Begin the friction with the leg and foot; dip the mitts again for the thigh. Treat in like manner the left leg and thigh.

Have patient turn over and lie on a pillow placed under the chest. Treat the back in the same manner as the front of the trunk. To dry, cover the entire back with a Turkish towel and have the patient hold the upper end the same as for the chest; rub with downward strokes over the towel and then wrap the towel about the hand and rub the surface again until thoroughly dry. Some prefer to begin the treatment with the chest in cases of heart disease.

To vary the severity and tonic effects, the temperature of the water may be changed; more may be left in the mitts, or the mitts dipped two or three times in treating each part, or the friction given more vigorously.

Wet Hand Rub—W. H. R. or Whr.

The same order and general procedure is followed as for the cold mitten friction. One part at a time is bared, rubbed with the hand dipped in cold water, followed by percussion, then dried, finishing with brisk rubbing with the dry towel and the hands. Dipping from two to four or more times increases the tonic effect.

Cold Towel Rub—C. T. R. or Ctr.

In giving the cold towel rub, a plain hand towel is used instead of the mitts employed for the cold mitten friction. The same order is followed as in the two previous treatments, beginning with the arms, then the chest and abdomen, legs, and last, the back (*Plate XXXIV.*).

The arm is held vertically with the palm toward the feet; the towel is dipped in cold water and wrung lightly, quickly unfolded and wrapped lengthwise around the arm, turning the upper corners into the palm to be grasped by the hand of the patient, or the arm may be held nearly horizontal while the attendant wraps the towel spirally about the arm by a quick circular movement. The part is then rubbed with to-and-fro movements outside of the towel. Percussion may also be given to insure a greater reaction. The towel is now removed and the arm dried as after the cold mitten friction.

When the chest and abdomen are treated, the wet towel is spread out over the entire surface and the patient grasps the upper corners next the shoulders and holds tightly while the nurse rubs with downward strokes outside the towel. The other parts are treated in a similar manner.

It should be remembered that the cold towel rub takes more heat from the body than the cold mitten friction, and it therefore requires greater reactive ability on the part of the patient. Because it does abstract considerable heat from the body, it is

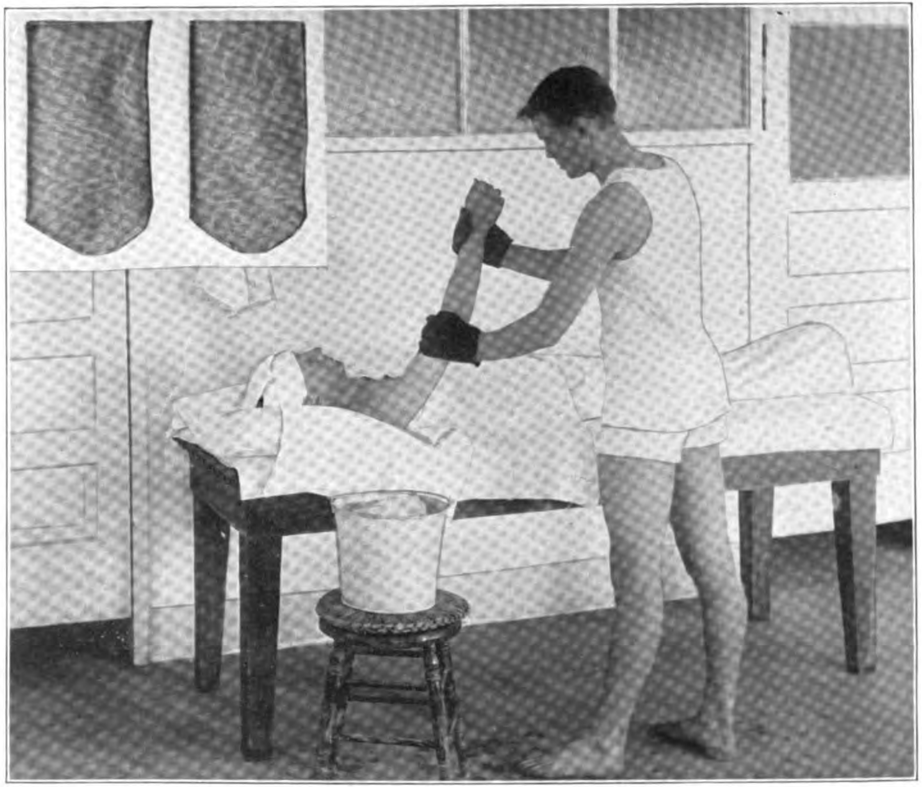

PLATE XXXV. The cold mitten friction—treating the arm. Corner figure—the friction mitts.

often used in fever as an antipyretic measure. By dipping the towel twice or more for a single part, its antipyretic effects are increased.

Wet Sheet Rub—W. Sh. R.

(*a*) *Requisites.* Two sheets, two towels, a tub containing hot water for the feet, a pail of water at 60°—70° F. Other temperatures may be used when indicated.

(*b*) *Procedure.* The patient should be warm to begin with. Apply a cold compress to the head. The patient now stands in the tub of hot water. A sheet is wrung from cold water so that it will not drip. Quickly wrap the sheet about the patient as follows: The patient holds up both arms. The upper left-hand corner of the sheet is placed under the patient's right arm; the patient then lowers the right arm, thus holding the corner of the sheet in place. Pass the sheet quickly across the front of the body and under the left arm, which is lowered. The sheet should then be carried across the back, behind and up over the right shoulder (*Plate XXXVI.*), then across the chest and around the neck over the left shoulder, tucking the corner under the edge of the sheet behind. Now tuck the sheet between the patient's legs; it is thus brought into close contact with every portion of the skin. Rub vigorously and give percussion over the sheet, covering the whole surface as quickly as possible until the sheet is thoroughly warmed (*Plate XXXVII.*). The patient is not to be rubbed *with* the sheet, but *over* the sheet. Two attendants are necessary to give the best results. Dry with a sheet and towels.

The wet sheet rub is a very vigorous tonic measure. It should not be used until the patient is able to react to the cold towel rub, the pail pour, and the cold percussion douche.

Dripping Sheet Rub—Drip. Sh. R.

For the dripping sheet rub, prepare three pails of cold water at about 70°, 65°, 60° F. respectively. Proceed as with the wet sheet rub, using the water at 70° from which to wring the sheet. After the sheet and patient are warmed by rubbing and percussion, without removing the sheet, pour over the shoulders the second pail of water, again rubbing vigorously until warm. Use the third pail in like manner. Dry as after wet sheet rub.

Ice Rub

The order of parts treated and the procedure in an ice rub are substantially the same as in the wet hand rub and cold mitten friction. In giving the ice rub, however, it is necessary to more thoroughly protect the bed or treatment table by covering with oil cloth and towels. Turkish towels should be tucked closely about each part so as to absorb the water as it runs off the skin. The cake of ice to be used may be held in the hand, or better yet, wrapped in one or two thicknesses of gauze.

The ice rub is not much used for general tonic purposes, but more frequently as an antipyretic. When used for this purpose, each part should be rubbed for some time and then dried without friction or percussion with the hands. Its prolonged application to the spine is more decidedly antipyretic than the same length of application elsewhere. When given in typhoid fever, the abdomen should be avoided. Cold compresses should be applied to the head and neck and also to the heart if necessary..

Salt Glow—Sgl.

Prepare about two pounds of coarse salt wet with warm water. The treatment should be given in a "wet room" or in a bath tub. The patient stands in a tub of hot water. While standing at the side of the patient, begin with the arm. Wet the entire skin surface of the shoulder, arm and hand with hot water from the foot tub. This is done by dipping the water with the hands. Next apply the wet salt, spreading it evenly over the skin. Now, with one hand on each side of the arm, rub vigorously with to-and-fro movements until the skin is in a glow. Stepping behind the patient to the opposite side, proceed in the same manner with the other arm.

Retain the last position to treat the front and back of the trunk. With one hand in front and one behind, wet the skin surface with hot water from the foot tub. Now spread the salt as before and rub the entire skin surface of the chest, abdomen, shoulders, back, and buttocks. Stepping behind the patient and with one hand under each arm, continue rubbing with the salt, treating the sides of the chest, abdomen, and the hips.

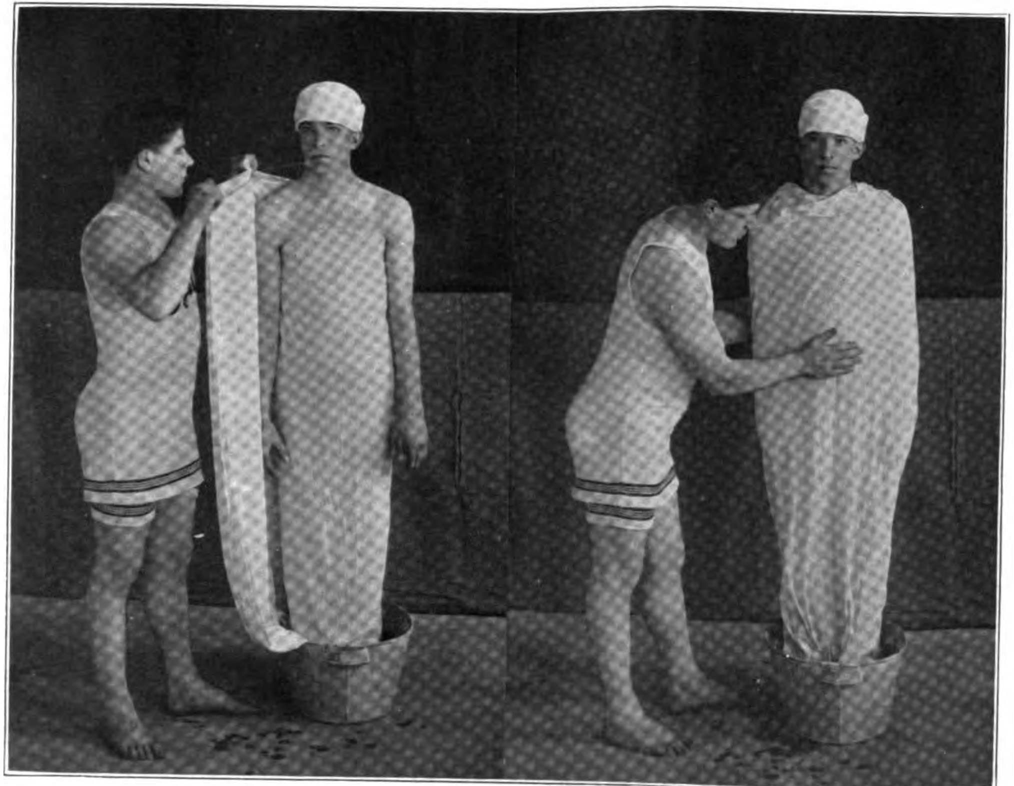

PLATE XXXVI. The wet sheet rub—applying the sheet.

PLATE XXXVII. The wet sheet rub—rubbing the patient.

Next proceed with the legs in like manner. For each limb have the patient put one foot on a low stool so as to bring the thigh about horizontal. Wet with water as before and rub the thigh, leg and foot with the wet salt. Finish the treatment by thoroughly washing off the salt. This may be done by a pail pour, shower or general spray. Dry with sheets, towels and fanning with a dry sheet as from any general wet treatment.

If for any reason the patient ought not to stand so long, he may be seated on a low stool while the salt glow is given. Proceed as follows: The patient sits on a stool with the feet in hot water. Beginning with the feet and legs, apply the water and then the salt, rubbing briskly with short strokes, the hands being on either side of the part treated. Next, treat each arm separately; then the chest, abdomen and back should be rubbed with the wet salt, the attendant standing at the side of the patient with one hand rubbing the chest and the other the back. The patient should stand while the buttocks and thighs are treated. Wash off the salt and dry as directed above.

The salt glow is a vigorous circulatory stimulant. Since no great amount of cold water is applied to the body, it does not require as great reactive ability as the wet sheet rub or cold douche.

SPONGING

Sponging consists in the application of a liquid by means of a sponge, a cloth or the bare hand, in which the chief effect is derived from the liquid applied. The term ablution is also applied to sponging.

Plain Water Sponging—Spg.

1. Hot Sponge—H. Spg. Hot sponging has a sedative effect because of the slightly atonic reaction which ensues. It is also used to reduce fever where chilliness exists. When prolonged to forty or fifty minutes the temperature does not rise as rapidly after the treatment as it does following a cold sponge.

A large, soft sea sponge may be used, a soft cotton cloth, a wash cloth of Turkish toweling, or several thicknesses of cheese cloth. The water should be as hot as can be borne. Bare one part at a time and treat in the following order: The arms, chest, abdomen, legs, thighs and back. The cloth or sponge should be dipped several times for each part. Dry thoroughly.

2. Tepid Sponge—Tepid Spg. The tepid sponge has an effect similar to that of the neutral bath, *i. e.*, it is sedative. It may also be used to reduce fever but is not as effective as either the hot or the cold sponge.

3. Cool or Cold Sponge—C. Spg. Cold sponging is used in the treatment of fever where the skin is hot and there is no tendency to chilliness. Each part should be gone over several times. The temperature of the water and the duration of the treatment should be governed by the intensity of effect desired.

Saline Sponge—Sal. Spg.

About four ounces of common salt are dissolved in a basin or bowl of tepid water. The bare hand is dipped in the salt water and each part rubbed lightly.

The saline sponge has a mild tonic effect. Because of the salt, it stimulates the vaso-motors to a greater extent than plain water.

Alkaline Sponge—Alk. Spg.

Use about two ounces of bicarbonate of soda to a small basin of hot or cool water according to the case. Apply with the bare hand, a soft cloth or sponge. The alkaline sponge is useful in itching, smarting and other abnormal sensations. It is usually applied only to the part affected.

Vinegar and Salt Rub

The vinegar and salt rub is very useful in checking the excessive perspiration or night sweats of phthisis.

Prepare a half pint of equal parts of vinegar and water to which add one or two tablespoonfuls of salt. Apply with the bare hand, drying lightly afterward. The application should be thorough to the parts that perspire the most; other parts may be gone over less thoroughly.

Alcohol Rub—Alc. R.

The alcohol rub is frequently used following a sweating treatment instead of the cold friction or spray. Its purpose is, of course, the prevention of taking cold. Use one part of alcohol to one part of water (proof spirit, 50 per cent). Dip the hands in the alcohol and rub each part, dipping the second time if needed. No drying with the towel is necessary.

Witchhazel Rub—Wzr.

The witchhazel rub has about the same effect as the alcohol rub. It is sedative and a mild astringent. The same procedure is used as for the alcohol rub.

Menthol Rub—Menth. R.

The application of menthol to the skin gives a sensation of cold. The effect is similar to that of the alcohol rub or cold sponging. Use one ounce of menthol liniment (menthol cryst. 1 oz., alcohol 1 pint) to three or four ounces of water.

Soap Wash

The soap wash is used for cleansing the skin in the case of bed patients. Using a bowl of water at 102° F., with soap and wash cloth go over each part separately. With another bowl of water at 75°—85° F. and another cloth, remove the soapy water and dry thoroughly with a Turkish towel. Each part is gone over with the soapy water followed by rinsing with plain cool water and then dried before the next part is treated.

RUBS AND FRICTIONS

These terms are applied to procedures in which the chief effect is derived from friction with the bare hands.

Centripetal Friction—C. F. or cf.

The centripetal friction consists principally of friction strokes from the periphery toward the center. It is designed to hasten the circulation, especially in the superficial veins.

General Order of Movements:—

1. Light to-and-fro friction, once.
2. Apply lubricant, twice.
3. Centripetal friction, three times.
4. Percussion, twice.
5. Stroking (centrifugal), three times.

Arms

1. Beginning at fingertips, give light, quick to-and-fro friction to the shoulder, being sure to cover thoroughly the whole surface. Let the hands glide back as in stroking the arm.

2. Apply lubricant with long strokes from fingertips to shoulder, returning with four rotary sweeps. Give twice.

3. Friction.

Hand.

(a) Heavy centripetal stroking to back of hand, three times.

(b) Palm of hand same as back of hand, beginning at fingertips. Finish with double rotary movement in palm. Give three times.

Arm and Forearm.

(a) Empty blood-vessels by heavy, even stroking from wrist to elbow. The patient's elbow rests on the table. With one hand on each side and using hands alternately, give three movements with each.

(b) Empty blood-vessels from elbow to shoulder, sweeping well over shoulder. With hands in the same position and alternating as for forearm, give three movements with each.

4. Percussion. With one hand on each side of the arm, which is held up by the patient, and with hands working together, give percussion from shoulder to fingers and return. Give twice. Place the patient's arm on the table at his side, give percussion down and up to external surface as far as hand.

5. Stroking, three times.

Legs

1. Leg flexed and foot flexed. Placing one hand on the sole, the other on the dorsum of the foot, give light, quick, to-and-fro friction transverse of foot. Then placing the foot flat, continue with rapid strokes to the sides of the foot, the leg and front of the thigh. Glide hands to knee; quick strokes to back of thigh; glide to toes.

2. Apply lubricant with long strokes to back of leg and front of thigh, coming down to knee with three rotary sweeps, then long strokes to back of thigh, down with three rotary sweeps from knee to ankle. Give twice.

3. Friction.

Foot (*leg extended*).

(a) Dorsum with one hand, three times.

(b) Each side with one hand, opposite hand supporting foot; come well up back of ankle, three times.

(c) Sole with palm of hand, three times.

(d) Rotary strokes to heel, three times.

Leg and Thigh (*leg flexed*).

a. Calf—empty blood-vessels by heavy, even stroking, hands following each other alternately, three times with each hand.

(b) Empty blood-vessels under knee, hands alternating, three times with each.

(c) With one hand on knee to support leg, give heavy stroking to front of leg, beginning at toes, three times.

(d) Rotary to knee, hands working together, three times.

(e) Empty blood-vessels of thigh, beginning with posterior surface, hands working together, three times.

(f) Anterior thigh, three times.

4. Percussion. With one hand on each side, give percussion from hip to ankle, down and up. Give twice.

5. Stroking, three times.

Chest and Abdomen

1. Making the hands work together, stroke the neck downward three times and give rotary movements as follows: Three above the clavicle and to shoulder; six from below clavicle to level of elbow (*i. e.*, nine down each side), returning up over median part of abdomen and chest. Give once or twice.

2. Apply lubricant with long strokes up center, four rotary sweeps down sides, covering whole surface thoroughly. Give twice.

3. Friction.

(a) Empty blood-vessels of neck and shoulders by stroking from back of ears downward to chest and shoulders, three times.

(b) Give strokes from shoulders to median line over the pectorals, three times.

(c) Using the thumb and thenar surface, give heavy stroking outward from median line over ribs and abdomen, about six times, advancing toward the pubes.

(d) Stroking from umbilicus outward and downward toward middle of Poupart's ligament, three times.

4. Percussion up and down left side, the same on right side. Give twice.

5. Stroking, three times.

Back

1. Light friction with the full hand down spine, hands alternating, three times each; to-and-fro friction, beginning well up on neck, covering shoulders, back and hips. Give three times.

2. Apply lubricant with long strokes up spine, four rotary sweeps down sides, twice.

3. Friction.

(a) Heavy friction with full hand down spine, hands alternating, each three times.

(b) Heavy rotary, full sweep to shoulders, three times.

(c) From shoulders down, following the ribs, cross the arms stroking toward the spine, six times.

(d) Lower back—heavy friction upward over buttocks toward spine, three times; upward on hips, three times; outward, using thumb and thenar surface over crest of ilium, three times.

4. Percussion up and down on left side, same on right side. Give twice.

5. Stroking.

(a) Full sweeps covering back, three times.

(b) Slow strokes with full hand down spine, six times.

Oil Rub—O. R.

The oil rub softens the skin and is frequently used as a protective after sweating treatments. It may be given in the same manner as the centripetal friction, omitting procedure number one (light friction) and procedure number four (percussion). If desired, the following abbreviated method may be used, always omitting the percussion after hot treatments.

General Order:—

1. Apply lubricant.
2. Rotary friction.
3. Percussion.
4. Stroking (centrifugal).

Arms

1. Apply lubricant; beginning at hands with a long stroke, go over the arm up to the shoulder, three times.

2. Beginning at hand, apply long stroke up to shoulder, returning with alternate rotary movements, three each to shoulder, arm, elbow, forearm, wrist and hand, three times.

3. Percussion up and down twice on external surface. Give same on inner surface; six percussion strokes to the hand.

4. Finish with long strokes from shoulder to fingertips, three times.

Legs

1. Beginning at foot, apply lubricant with long strokes up to hip with both hands, covering the entire surface, three times.

2. Apply long strokes from the foot to knee, returning with alternate rotary movements, three each to knee, calf, ankle and foot, twice. Return to hip with long stroke. With hands on anterior surface of thigh, from hip to knee, give eight or ten rapid alternate rotary friction movements. Give the same on the posterior surface of the thigh, three times. Continue with rotary friction from knee down as at first, once.

3. Percussion same as arm.

4. Long stroking movement from hip to toes, three times.

Chest and Abdomen

1. Lubricate; with hands working together, begin at median line below, going lightly up the median line and down the sides, three times.

2. Hands working together, stroke the neck downward three times; then give rotary movements three each above clavicle, to shoulder below clavicle, nine down each side, nine up over median part of abdomen and chest, three times.

3. Have patient take and hold a deep breath. Beginning well over at lower left side, give percussion up that side to top

of shoulder, down on same side of median line, up on right side of median line to top of shoulder, and down the right side, twice.

4. Stroking (movement same as in lubricating), three times.

BACK

Procedure the same as for the chest. Finish with six long gentle downward strokes to spine.

Tulcum Rub—Talc. R.

The talcum rub is useful where oil is objectionable, as in warm weather or where there is a tendency to too free perspiration after treatment. It dries rather than softens the skin. It is also useful in hives, and should be given after a prolonged cool bath. The procedure is the same as with the oil rub.

Dry Friction—D. F.

The procedure for dry friction or the dry hand rub (d. h. r.) is the same as for the oil rub except that no lubricant is used. If given briskly with vigorous to-and-fro friction and followed by percussion, the effect is to quicken the circulation in the skin and warm the surface. The treatment also stimulates heat production.

Slow, heavy friction without percussion, as to spine, forehead, etc., is sedative.

BATHS

Various procedures more or less similar and commonly called baths are included under this head.

1. PARTIAL IMMERSION BATHS

Hand and Arm Bath

The hand and arm may be immersed in neutral, hot or cold water, or the two latter alternately. For this purpose employ a foot tub (better one of elliptical shape) with sufficient water to immerse the hand and forearm to the elbow, or including the elbow. Very deep pails may be used. When hot water is used, it should be as hot as can be borne. Immersion of the hands in cold water is useful in controlling epistaxis.

To give hot and cold immersion to an infected hand or arm (blood poisoning) employ two pails or tubs,—one of the hottest water that can be borne, and the other of ice water with a block of ice in it. (*Plate XI.*) To the cold water may be added one-fourth or one-half dram of crystals of permanganate of potassium, and to the hot water about five times this quantity of oxalic acid. Immerse the hand in hot water for one and one-half to two minutes, then in the cold for fifteen to thirty seconds. Continue these alternations for twenty-five minutes to an hour, finishing with the cold. Hot water should be added to the tub as fast as can be borne. The procedure should be repeated from one to four times daily as indicated. Other parts of the body, as the foot, may be treated in a similar manner. Massage is strictly contra-indicated in infected conditions.

Foot Bath—Ft. B.

The foot bath is one of the most useful measures in hydrotherapy. Its chief use is as a preliminary or adjunct to other treatment. It may be given with the patient lying or sitting, and is sometimes given with the patient standing. Large pails may be used, but more conveniently tubs of an elliptical shape about sixteen inches long and eight to ten inches deep.

If the foot bath is given in bed or on a treatment table, protect the bedding or table coverings with an oil cloth. Protect the patient with a blanket or sheet, covering the knees and the foot tub. Tuck this covering about the limbs and foot tub so as to prevent the circulation of air. When the feet are taken out of the water, dry them thoroughly, especially between the toes, and immediately cover well with dry coverings or put on slippers.

1. Hot Foot Bath—H. ft. B. The water should rise above the ankles. The bath may be at a temperature of about 105° F., and should be gradually increased as fast as can be borne to a maximum of about 120° F. It may be continued from five minutes to half an hour. At the close the feet should receive a pour or dash of cold water and be thoroughly dried.

It is often necessary to use the cold head compress if the bath is very hot, continued for a long time, or if given with the patient sitting up, and in all cases where there is a tendency to faintness.

Effects. The foot bath is an efficient means of securing a derivative effect. It draws blood from all other parts, especially those that are congested. The cold pour or douche given at the close helps to maintain the blood in the feet. It is sometimes desirable to use a *mustard foot bath*, in which case add three or four tablespoonfuls of mustard to the water.

2. Cold Foot Bath—C. ft. B. The water should be from two to four inches deep at a temperature of 45°—60° F. The feet should be previously warmed and during the bath, rubbed with the hands or one foot by the other; duration, one to five minutes.

Effects. The shallow cold foot bath causes reflex contraction of the blood-vessels of the brain, pelvic organs and liver; also contraction of the muscles of the uterus, bladder, stomach and intestines. The cold foot bath should not be given during the menstrual period or in case of acute pulmonary, abdominal, or pelvic inflammation.

3. Alternate Hot and Cold Foot Bath—H. & C. ft. B. Use two tubs of water deep enough to well cover the ankles, one as hot as can be borne (temperature gradually raised) and the other at 45° F. Immerse the feet in the hot water for two minutes and in the cold fifteen to thirty seconds. Continue alternations for ten to fifteen minutes, wiping from the cold.

Effects. The alternate hot and cold foot bath produces powerful fluxion effects in the feet. For this reason the derivation secured by its use is very decided and enduring. It is especially useful in congestive headache, in which case it is well to apply a cold compress to the head or head and neck at the same time. It is also useful in treating infections of the foot, Charcot's joint at the ankle, tuberculosis of the ankle or bones of the foot and in gangrene to hasten the production of the line of demarkation.

Leg Bath—Lg. B.

For the leg bath a tub should be provided deep enough to immerse the legs to the knees. (*Plate IX.*) If used in the treatment room the tub should be fitted with an outlet at the base so as to obviate the necessity of tipping the tub over to empty it. It should be placed near or against the wall, so that it may be filled from a hot and a cold water wall faucet by two short rubber hose. Also provide a stool an inch or two higher than the tub. The patient should be covered with a sheet or blanket and, if the room is not warm enough, a large fomentation cloth or Turkish towel placed over the knees. If necessary, place a doubled fomentation cloth under the knees over the rim of the tub.

1. Hot Leg Bath—H. lg. B. Begin with the water at 103° F. and increase the temperature as rapidly as can be borne. Use cold cephalic and cervical compresses (or ice bags) and renew before they become warm. In case the leg bath is combined with other hot treatment, as fomentations to the spine, it may be necessary to use an ice bag over the heart, especially if the treatment is continued to profuse perspiration. The treatment should be continued in a given case until the desired effect is produced. This may require from five to thirty minutes according to conditions and the particular effect desired. Finish with a cold dash to the legs.

Effects. The hot leg bath is a much more powerful derivative measure than the hot foot bath and is one of the best treatments that can be used for this purpose. When combined with fomentations to the spine or chest, and especially when the patient drinks some hot liquid at the same time, very profuse perspiration is produced. If used in the home, such a sweating treatment should be concluded by a cold mitten friction, or if given in the treatment room, by a graduated or alternate hot and cold shower and spray. The pail pour is also sometimes used for the same purpose.

2. Alternate Hot and Cold Leg Bath—H. & C. lg. B. The procedure is the same as with the alternate foot bath. It is necessary to apply a cold compress to the head and often an ice bag to the heart.

Effects. The alternate hot and cold leg bath produces most powerful fluxion in the legs and feet. It is especially useful in treating edema of these parts whether due to heart or kidney disease. After two or three treatments have been given, pieces of ice should be added to the cold water. The treatment may be followed by heavy centripetal friction to the feet and legs.

Sitz Bath—Z.

For the sitz bath a porcelain sitz tub with special inlet and outlet is the most satisfactory; one of metal or an ordinary wash tub may be used. In addition there should be a foot tub for immersion of the feet in hot water. Also a pail of cold water with a hand towel for keeping the head cool (*Plate XXXVIII.*).

Protect the patient from contact with the tub by towels or fomentation cloths placed behind the back and under the knees. Cover the patient with a blanket or sheet. The temperature of the foot bath should be at least two or three degrees above that of the sitz bath.

1. Cold Sitz Bath—C. Z. Sufficient water should be used to cover the hips and come up on the abdomen; temperature, 55°—75° F.; foot bath, 105°—110° F.; time, one to eight minutes. Rub the hips to promote reaction. Friction mitts may be used. If desired, the water may be flowing. It adds somewhat to the effect.

Effects. If of brief duration (two to four minutes), it greatly stimulates the pelvic circulation and the musculature of the bowels, bladder and uterus. When given with very cold water (55°—65°) and vigorous friction (*cold rubbing sitz bath*) these effects are intensified. The cold rubbing sitz bath is very useful in constipation, in subinvolution and in hastening the absorption of residual thickening after pelvic inflammations.

With the temperature somewhat modified, it may be used in children in treating nocturnal enuresis.

2. Prolonged Cold Sitz Bath—C. Z. Temperature, 70°—85° F.; time, fifteen to forty minutes; foot bath, 105°—110° F. This may be begun at a higher temperature and very gradually lowered to the desired point (*graduated sitz bath*). It should not at any time cause chilliness, and rubbing is not desirable.

If necessary to give a sensation of warmth, a fomentation or wrapped spinal hot-water bottle may be applied to the spine.

Effects. The prolonged cold sitz bath causes extreme and lasting contraction of the pelvic blood-vessels and of the muscular wall of the uterus. It is therefore very useful in subinvolution.

3. Neutral Sitz Bath—Neut. Z. Temperature, 92°—97° F.; foot bath, 102°—106° F. Apply cool compress to the head. Time, twenty minutes to one or two hours; effect, sedative.

4. Very Hot Sitz Bath—H. Z. Begin at a temperature of about 100° F. and rapidly increase to 106°—115° F.; foot bath, 110°—120° F. It should be kept at least two degrees hotter than the temperature of the sitz bath. Keep the head cool by cold cephalic and cervical compresses; duration, three to eight minutes. At the close cool the bath to neutral for one to three minutes. If sweating has been produced, pour cold water over the shoulders and chest.

Effects. The hot sitz bath is used to relieve dysmenorrhœa and pelvic pain from various other causes. It is very valuable in both acute and chronic cystitis, hypertrophy of the prostate and acute retention of urine due to prostatic hypertrophy. It is also useful in amenorrhœa due to pelvic anemia, in sciatica and helpful in reducing femoral or inguinal hernia. For reducing hernia the temperature should not be lowered at the close.

5. Revulsive Sitz Bath—Rev. Z. Begin at a temperature of 100° F. and increase rapidly to 106°—115° F.; foot bath, 110° —120° F. Keep the head cool by cold cephalic and cervical compresses. Duration, three to eight minutes. Finish by a cold pail pour to the hips; temperature of the water, 55°—65° F.

Effects. The revulsive sitz produces a fluxion effect in the surface and deep blood-vessels. It is one of the most useful measures in treating chronic inflammatory conditions in the pelvic viscera such as various forms of salpingitis, ovaritis, cellulitis, prostatitis, prostatic hypertrophy, etc.

6. Alternate Hot and Cold Sitz Bath—H. & C. Z. Provide two sitz tubs installed side by side. Fill one with hot water at a temperature of 106°—115° F. and the other with cold water at 55°—85° F.; foot baths, 105°—115° F. Apply cold compresses to the head and neck. The patient sits in the hot water for two or three minutes, then in the cold for fifteen to twenty seconds, and again in the hot water. Three complete changes from hot to cold are made as is usual in *alternate* treatments.

Effects. The alternate sitz bath produces powerful fluxion effects in the pelvic viscera. It is useful in chronic pelvic inflammations after the patient has become accustomed to the revulsive sitz. It may also be used to great advantage in atonic constipation.

Hot Half Bath—H. ½ B.

The hot half bath is given in a full length bath tub. Fill the tub with water at 100°—102° F. and deep enough to reach the patient's navel when the patient is sitting. The patient now sits down in the tub with the shoulders covered by a sheet and the head kept cool by a cold wet towel (*Plate XXXIX.*). It is usually best to apply this just before the patient enters the bath. The temperature of the bath is gradually raised to 108° or 110° F. and continued for three to eight minutes. If necessary, an ice bag should be used over the heart. Conclude the treatment by a cold pail pour to the hips.

The effects and uses are the same as those of the revulsive sitz. This treatment must not be confused with the shallow bath which is given with cold water, and is a tonic measure.

II. Full Immersion Baths

The tub used for general or full immersion baths should be long enough so that the body may be completely immersed,—a 6-foot tub for men, in many cases a 5½-foot tub is long enough for women. The head should rest on an air pillow or small invalid ring, and for emaciated patients, a folded sheet placed under the nates. In a hot bath, the head must be kept cool by a cold compress. In the case of full tub baths it is especially necessary that the temperature of the water be tested by means of a thermometer. In ordering tub baths, the desired temperature should be specified on the prescription.

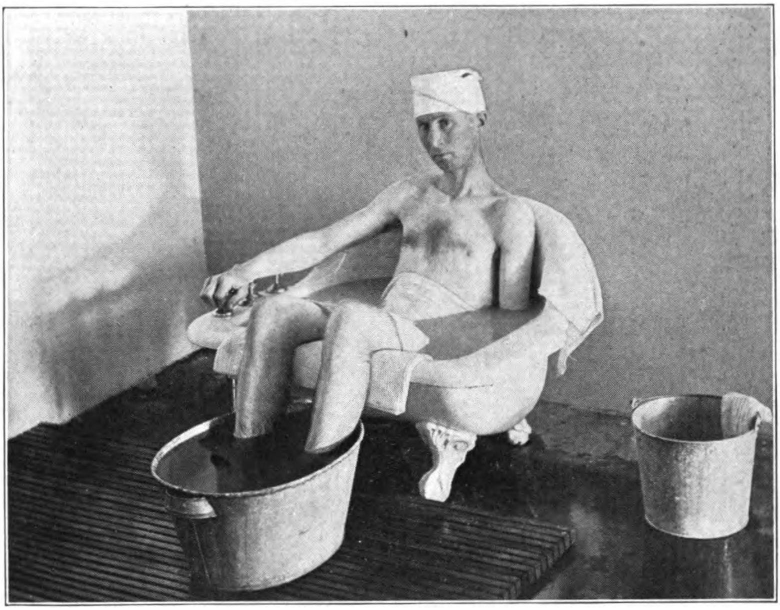

PLATE XXXVIII. The sitz bath.

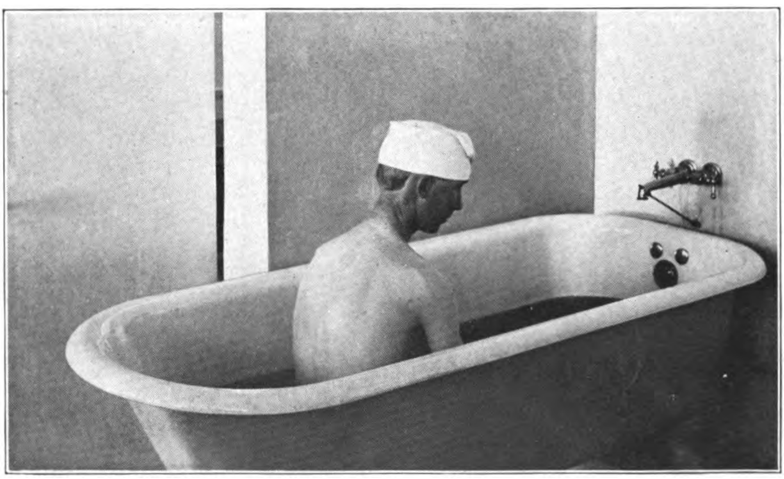

PLATE XXXIX. The hot half bath.

Plain Tub Baths

1. Hot Tub Bath—H. B. or H. Tub. Temperature, 100°—106° F.; time, two to twenty minutes. Give cold water to drink freely. Keep the head cool. If necessary, apply an ice bag to the heart and the back of the neck. It is usually best to begin the bath at about 98°, gradually raising the temperature to the desired point. The treatment may be finished by cooling the bath, or by a cold pour or shower given immediately after rising from the bath.

Effect. The effect varies according to the temperature and duration of the bath. If much prolonged or the temperature very high, profuse sweating is produced. The hot tub bath may be used as a preparation for cold treatment. A warm bath at 100°—102° is very effective in relieving opisthotonos in tubercular meningitis and is also beneficial in other diseases associated with spasticity of the muscles.

2. Neutral Bath—Neut. B. Temperature, 94°—97°F.; time, fifteen minutes to three or four hours; usually twenty to thirty minutes. Wet the forehead and face in cool water. Cool the bath 2° or 3° just at the close. Dry the patient with a sheet directly from the bath. Use no percussion or unnecessary rubbing as this destroys the sedative effect.

Effects. The neutral bath is given for sedative purposes. To accomplish this, it must exert a relaxing effect and so equalize the circulation as to reduce the amount of blood in the brain and spinal cord. Its temperature will therefore vary with the condition of the patient, especially as regards the skin temperature. The season of the year must also be taken into account. For these reasons it may frequently be necessary to employ the upper limit of the neutral temperatures or raise the bath to 98° or even 99°. The air of the bath room should be warm, and if the bath is much prolonged, stretch a sheet over the tub. The cooling of the water 2° or 3° just at the close is usually necessary to prevent the slight sensation of chilliness which is likely to be produced by contact with the air on emerging from the bath. When used for insomnia, it should be given just previous to retiring.

3. Continuous Flowing Bath. This requires a special tub six feet long, which is provided with a large outflow and a large overflow vent near the top (*Plate XX.*). The inflow may consist of one large opening at the head of the tub or of several small openings along the sides. The water is supplied directly from a mixing chamber which is fitted with a thermometer. A continuous supply of hot water at a constant temperature and pressure must be assured, also of cold water. The water is regulated to the desired temperature in the mixing chamber before it is turned into the tub. The usual temperature is 98° F. When the tub is full and overflowing the quantity is reduced to a gentle stream. The patient rests on a canvas hammock which swings from the rim of the tub; he is protected by a canvas cover and provided with a rubber air pillow. An ice turban should be placed upon his head and he should be given cold water plentifully to drink. It is well to keep a bath thermometer in the tub and consult it frequently, not relying wholly upon the thermometer in the mixing chamber.

As this bath is used chiefly in maniacal cases, the patient must be watched constantly. Very excited or violent patients should be wrapped in a sheet or blanket pack, which must be securely pinned about them, and then placed in the tub. The duration of the bath depends upon the degree of sedative effect obtained. It may last for hours or days. In the latter case the patient must be removed once or twice in the twenty-four hours, the bowels given proper attention and the skin anointed with oil to prevent too great maceration. The continuous flowing bath is perhaps the most useful treatment in excited cases of insanity. It, together with the wet sheet pack, has revolutionized the treatment of mania.

4. Cold Bath—C. B. or C. Tub. Temperature, 55°—90° F.; time, a plunge only to twenty or more minutes, depending on the temperature and effect desired. It is necessary to employ rubbing constantly or at frequent intervals. The patient's face should be bathed in cold water before entering the bath, and it is imperative that the skin be warm before the bath is given.

Effects. When given to a patient with a normal temperature and lasting for a few seconds or minutes only, the effect is that of a stimulant and tonic. The *cold rubbing bath* is the most commonly employed method of treating typhoid fever in institutions where tubs are available and convenient to use. The strict Brand bath is too severe a measure for many patients. The methods, indications for and the precautions in the use of the cold bath have been very fully discussed under the treatment of typhoid fever, *q. v.*

5. Brand Bath. As advised by Brand for the treatment of typhoid fever the procedure is as follows:—

Temperature, 65°—70° F. Bathe the face and head in cold water or ice water. Lift the patient into the bath. He should be rubbed constantly to keep the blood in the skin. If chilling can not be prevented by vigorous rubbing, the patient must be removed from the bath. Time, fifteen minutes. Repeat when the temperature reaches 102.5° or 103° F. Effect, antipyretic.

6. Graduated Bath—Grad. B. The graduated bath is as efficient in lowering febrile temperature when much prolonged and is less objectionable to the patient than the Brand bath. As the bath is frequently used in typhoid, the patient should be made comfortable by an air pillow and hammock made by tying a sheet across the tub fastening the corners and sides underneath. Temperature, begin at 98° or above, depending on the height of the fever, *i. e.*, from 3°—5° lower than the mouth temperature. The skin must be warm to begin with. Apply cold compresses to the head. Gradually reduce the temperature of the bath to about 85° F.; when below 90° F. or if the patient feels chilly or shows goose flesh, he should be rubbed constantly to keep the blood in the skin, and so prevent or overcome chilling. A spine bag filled with hot water may be laid along the spine for the same purpose. Both pulse and temperature should be closely watched during the bath. The temperature of the patient should be taken every twelve or fifteen minutes. On removal, immediately wrap the patient in a sheet, drying quickly, and if there is goose flesh or chilliness, rub briskly with the hands until the blood returns to the skin. If very cyanotic, put the patient into a hot blanket pack for a few minutes and take him out with a cold mitten friction.

Effect, tonic chiefly or antipyretic according to the condition in which it is given.

7. Cold Shallow Bath—C. S. B. Fill the tub four to six inches deep with water at 65°—75° F. The patient's feet should be warm before entering, and the head kept cool by cold wet towels. The patient sits down in the cold water and rubs the arms, legs and chest vigorously while the attendant rubs the hips and back. Cold water dipped from the tub is dashed over the shoulders and back, and these parts are again rubbed. The patient now lies down in the bath and rubs the chest and abdomen, while the attendant rubs the legs. This procedure may be repeated once or twice if desired.

The entire treatment should last from two to four minutes, and on emerging from the bath, the skin surface should be in a decided glow, otherwise the proper effect has not been obtained. The cold shallow bath is one of the most vigorous tonic measures employed in hydrotherapy.

Hydro-Electric Baths

In giving the hydro-electric or electrothermal bath a neutral temperature is usually employed. The patient is completely immersed in the water with the head on an air pillow and kept cool by a cold wet towel. The electrodes should hang from the side of the tub, so they may be placed in any desired position along the sides or at the feet of the patient. The treatment is begun with one electrode at the feet and the other near the arm on the opposite side. The electricity is turned on to comfortable tolerance. Time, five to twenty minutes. After half the time has expired the electrode should be reversed, the one at the foot of the tub being brought up along the arm of same side, and the other near the opposite arm, being placed at the foot on the same side. These directions do not apply to the galvanic bath. In using galvanism the positive pole should be placed at the head, preferably dipping into the water underneath the pillow, and the negative pole at the feet.

Precautions. To avoid shock there should be no current passing when the patient steps in or out. Be sure all appliances are in good order before the patient enters the bath. Keep all parts of the generator or battery, switches, rheostat, etc., absolutely dry and clean. Do not handle the switches or the rheostat with wet hands.

In using a motor generator for sinusoidal or galvanic tub baths, do not start or stop the generator or turn the current on or off while the rheostat is turned on. After the patient enters the bath, the current switch is turned on and the motor or generator started; next gradually increase the current by turning the rheostat. Before the patient leaves the bath turn off the current by reversing these steps, *i. e.*, first gradually lessen the current by turning down the rheostat then stop the generator and turn off the switch.

1. Faradic Tub Bath—Neut. Farad. The induction coil used should be large enough to amply supply any current strength needed and the interruptor so arranged as to give any desired rate of vibration, at least both slow and rapid interruptions should be provided for.

Effects. Slow or medium faradic for five or six minutes is stimulating and tonic. It is beneficial in flaccid paralysis and in general atonic conditions of the muscular system. Rapid faradic given with less current strength and continued for twelve or fifteen minutes is sedative. The faradic tub bath is less satisfactory than the sinusoidal as the alternations of the current are sharp and therefore less agreeable to the patient.

2. Sinusoidal Tub Bath—Neut. Sinu. For the production of a sinusoidal current the sinusoidal dynamo devised by Kellogg is the most satisfactory. The slow sinusoidal current gives a maximum muscular contraction with a minimum of unpleasantness. The contraction of the muscles is vigorous and painless.

Effects. The slow sinusoidal for five or six minutes is stimulating and tonic. Rapid sinusoidal for a longer time is sedative. The slow sinusoidal is useful in all forms of flaccid paralysis, atrophied muscles, weak abdominal muscles, splanchnoptosis, etc. It is much more agreeable to the patient and more efficient than faradic electricity, and for these reasons should replace the faradic wherever possible.

3. Galvanic Tub Bath—Neut. Galv. Unless given from a battery of cells or a small dynamo not connected with a light-ing system, galvanic electricity is dangerous. Even then burns may result if carelessly used. Its administration should not be entrusted to a nurse unless specially trained in the technique and possessing the requisite knowledge of the physics of the galvanic current. Moreover the effects usually sought from the galvanic tub bath may be obtained in other ways without the risk to the patient.

Precautions. In the use of the galvanic tub bath all the precautions mentioned above should be carefully observed. The current must never be turned on before the patient enters, and always be turned off before he steps from the bath. If this is not done a severe shock may be occasioned as the patient places one foot in the bath with the other on a wet floor, thus making a grounding contact through a cement floor or worse yet through some metal pipe near by.

Always ascertain the polarity before the electrodes are placed. To do this, place the electrodes in water an inch or two apart and turn the current on. The bubbles formed at the negative pole are larger and more numerous than those formed at the positive pole. Place the positive pole at the head of the tub and the negative at the foot. Be sure that they do not come in contact with the skin at any point. Sinusoidal and the secondary faradic are alternating currents and there can therefore be no distinction as to polarity.

Effects. The positive pole is a vasoconstrictor; the negative pole a vasodilator. For this reason the positive pole decreases congestion, the negative pole increases it. The positive pole has a sedative effect; the negative pole a stimulant or irritant effect. These are the reasons for placing the positive pole at the head and the negative pole at the feet of the patient. As a neutral temperature is used the total effect is decidedly sedative. All forms of the electric tub bath are disagreeable to some persons. These idiosyncrasies should not be ignored.

The temperature and duration of the bath and the strength of the current should be specified on the prescription. The bath should last from ten to fifteen minutes and from twenty to thirty-five milliamperes be used. The amperage should not be high enough to produce an unpleasant sensation. If there are saline substances dissolved in the bath, the amperage will run much higher before the same effects are produced as with ordinary water. With thin subjects a comparatively low amperage must be used; with subjects in good flesh or overweight a stronger current may be employed.

Medicated Baths

A tub bath may be altered by the addition of various medicaments. Such baths are not of great practical importance except in a very limited number of skin diseases.

1. Saline Bath—Sal. B. Add from three to five pounds of common salt to the tub of water at 90°—94° F.; time, ten to twenty minutes. The addition of salt adds to the tonic effect through stimulation of the peripheral circulation so that the water may be a few degrees cooler than an ordinary neutral bath. The effect is similar to a bath in sea water.

2. Alkaline Bath—Alk. B. Add one-half to one pound of bicarbonate of soda to the tub of water at a neutral temperature. One-fourth pound of carbonate of soda may be used. Time, ten to twenty minutes; effects; relieves cutaneous irritation, itching, etc. Useful in certain skin diseases, as eczema, also in relieving the itching of hives and jaundice.

Nauheim Bath

The effervescent or artificial Nauheim bath is one in which the water is charged with saline substances and carbon dioxide gas. Many different formulae are used to prepare such a bath. To produce the carbon dioxide gas in the bath, it is necessary that an acid come in contact with an alkaline carbonate, setting free the carbon dioxide; or salines may be dissolved in the water and the carbon dioxide added from a generator.

Various proprietary mixtures prepared in cakes are offered for use. In using these, dissolve the sodium chloride and sodium bicarbonate in forty or fifty gallons of water. The bottom of the tub is then covered with rubber sheeting. On this rubber sheeting place the acid cakes. In about three minutes, when effervescence is well under way, the patient should lie down in the bath.

A very complete and satisfactory formula is the following:—

Sodium carbonate (sal soda) - -	1½ lb.
Sodium bicarbonate (baking soda) - -	½ lb.
Calcium chloride - - - - - -	3 lb.
Sodium chloride (common salt) - -	2 lb.
Sodium bisulphate - - - -	1 lb.

After mixing the first four, dissolve in a few inches of warm water in the bottom of the bath tub. When thoroughly dissolved, fill the tub with water at the desired temperature. The sodium bisulphate which is the acid part of the formula, should be granular or finely pounded and dissolved separately in a wooden or paper pail containing hot water. As it may require some time for this to dissolve, it should be prepared before the bath is to be given. When thoroughly dissolved, pour into the tub and quickly mix with the rest of the water. The bath is now ready for use. The amounts of the saline ingredients may be gradually increased for the succeeding baths of a course.

Three-fourths of a pound of commercial hydrochloric acid may be used in place of the sodium bisulphate. This should be mixed with two or three times its volume of water, and after the salts are all dissolved and the tub filled with water at the desired temperature, the bottle containing the acid should be opened under the water. It may be moved about to hasten the diffusion of the acid into the water of the bath.

The following is a simpler and less expensive formula; it is the formula we usually employ.

Sodium chloride - - - -	3 to 8 lb.
Sodium bicarbonate - - - -	¾ to 1½ lb.
Muriatic acid - - - - -	¾ lb.

The temperature of the bath should range from 85°—94° F. The lower temperatures should be used for the later baths of a series. The duration of the bath should at first be from five to eight minutes. The time may then be gradually extended to fifteen or even twenty minutes. A cold compress should be applied to the head and an ice bag to the heart. The patient should not be rubbed during the bath. About three baths a week may be taken for three or four weeks. Not over twenty baths should constitute a course.

Effects and Therapeutic Use. The effects of the bath are due to the cutaneous stimulation of the vasomotors produced by the carbon dioxide and salines dissolved in the water. The peripheral heart is stimulated and the cutaneous circulation greatly hastened. The heart beats slower and with greater ease. In normal individuals there may be a fall of ten or fifteen beats in the pulse rate following a single bath, while in case of a very rapid pulse the decrease may reach as high as twenty-five to forty beats per minute. Examination of the heart after the bath in cases of a valvular lesion or cardiac dilatation show a stronger, steadier beat; the rhythm becomes regular, the sounds clearer, and certain murmurs may disappear entirely. The pulse becomes full and blood pressure rises 20 or 30 mm. The area of dullness of an enlarged, dilated heart is often lessened one-half inch or more all around its border. Both the cystole and the diastole are lengthened.

The Nauheim bath also stimulates metabolism and hastens the elimination of gouty toxins. It exerts a beneficial effect upon nutrition and is therefore of much use in diseases of metabolism.

If a course of baths is continued too long, over-stimulation results, passive dilatation of the blood-vessels occurs and the heart beats with less force. The rhythm is disturbed and there will be palpitation. This may be guarded against by keeping the duration of the bath well within fifteen minutes, stopping short of the maximum number of baths that may be used in one course, and by using the ice bag over the heart during the treatment.

The heart should be carefully examined by palpation, percussion and auscultation both before and after the bath. This will enable the physician to prescribe much more intelligently and obviate any difficulty that may arise.

The Nauheim bath is useful in valvular insufficiency and stenosis, cardiac dilatation, hyperthyroidism and in cardiac neuroses. It is also useful in Bright's disease, chronic articular rheumatism, gout and obesity. The bath is contra-indicated in extreme arterio-sclerosis, in aneurism and in angina pectoris. It should not be used in acute inflammatory diseases nor in the acute stage of endocarditis. Some highly recommend its use in locomotor ataxia.

Oxygen Bath—O_2 B.

This bath is similar in effect and technique to the Nauheim bath. It was introduced by Sarason of Berlin in 1904. Instead of carbon dioxide, the bath water is charged with oxygen gas. To produce this, requires the action of a catalizer upon an oxygen-containing chemical. Oxygen generators are also used for the same purpose but are not regarded as so efficient because of the larger size of the bubbles. It is the oxygen that is dissolved in the water which produces the results rather than that which collects as bubbles producing effervescence.

The standard method of preparing the oxygen bath is as follows: Fill the tub with sufficient water at 95°—98° F. to cover the patient to his neck. Dissolve in this 300 grams of sodium perborate ($Na\ BO_3$) by sprinkling uniformly over the surface of the water. Next add the catalizer, 15 grams of manganese borate ($Mn_3(BO_3)_2$) by the same procedure. The patient gets into the water in one or two minutes after the catalizer has been put in. The liberation of oxygen continues for fifteen to twenty minutes. The patient should remain as quiet as possible, moving the limbs only occasionly. The sensation is that of an agreeable tickling and prickling about the spine, shoulders and limbs. At the end of twenty minutes remove the patient and dry with as little disturbance as possible. If a brownish sediment remains in the tub it may be easily rinsed off, if this is done immediately after the bath.

The baths may be administered on alternate days or for four or five days a week, a course consisting of twenty to thirty baths. The effects are similar to those of the carbon dioxide bath in the production of a powerful stimulation of the peripheral blood-vessels. The oxygen bath, however, differs essentially in the following points: Instead of the redness of the skin produced by the carbon dioxide bath, there is either no change or the skin is paler, the peripheral diversion of blood occurring into the skeletal muscles rather than the skin. A lowering of blood pressure occurs after the oxygen bath instead of a rise, as after the carbon dioxide bath. For this reason it is indicated in cases of high blood pressure and in cardiac and renal diseases associated with increased vascular tension.

It is also a powerful sedative to the nervous system, and is therefore a most efficient measure in the treatment of insomnia, also in asthma, neurasthenia and various paresthesias. Because of the tendency to paleness of the skin, it is an advantage to precede the bath by some heating procedure, such as a hot foot bath, fomentations to the spine or a short electric light bath. For the same reasons the bath is administered at higher temperatures than the carbon dioxide bath. For sedative purposes the bath should be administered in the afternoon or early evening, or at least an hour before retiring. In cases of hypertension reductions in blood pressure of from 15 to 35 mm. Hg. have been reported.

III. Miscellaneous

Russian Bath

The Russian bath consists in the immersion of the body in hot vapor. The steam, as it is turned into the Russian room, partially condenses and hangs suspended as a thick fog. For every gram of steam that thus condenses, 537 calories of heat are liberated. This fact accounts for the intense heating effect obtained by the use of this form of hot treatment.

For the Russian bath provide a steam tight room with a marble slab. A sliding window should be so arranged at the end of the slab that the patient's head may be outside of the steam room. (*Plate XL.*) The steam should enter below the slab so as not to strike the patient directly, and be controlled by a valve near the sliding window so that the attendant may regulate the amount of steam and keep the head cool at the the same time by frequently changed cold compresses to the head and neck.

Procedure. Move the bowels by an enema and give a preliminary hot foot bath. Have the patient drink water before and frequently during the bath. This is necessary in order to provide for the profuse perspiration which the treatment should induce. See that the slab is warm; if not, pour over it several pails of hot water. Warm the room to about 100° F., and cover the slab with a folded sheet.

The patient is now assisted onto the table and lies on the back with the head on an air pillow just without the opening. The window is lowered and a towel wrung from ice water is placed about the neck, or hung across the lower end of the window and tucked around the neck. Another cold compress is applied to the head and covers the temporal arteries. A third cold compress should be applied to the precordia. In some cases it will be necessary to use an ice bag over the heart.

Next turn on the steam, gradually raising the temperature of the room to 115° or 120° F. A small amount of steam should be constantly escaping to maintain the temperature. Change the compresses to the head and neck frequently. The patient should be closely watched during the entire time of the treatment. The bath should last from ten to thirty minutes. Just before the patient rises from the slab, renew the ice compress to the head. Finish the treatment with a graduated or alternate spray or shower, or better still, a shampoo and graduated shower. The spray or shower should be in the Russian room or only a few steps from it. (*Plate XLI.*)

Effects. The effects of vigorous sweating measures have been considered elsewhere. The "washing out" effect is, perhaps, the greatest; and the thoroughness of this depends very largely upon the water taken before and during the treatment. Sweating measures greatly increase catabolism, especially of carbohydrates and fats. The products of nitrogenous metabolism show more complete oxidation.

The Russian bath is of great service in obesity, chronic rheumatism with obesity, gout, Bright's disease, autointoxications, chronic alcoholism, and in arterio-sclerosis unless extreme. It is contra-indicated in diabetes, valvular heart disease, all diseases associated with emaciation and in extreme arterio-sclerosis.

Cabinet Vapor Bath

The principle involved in the cabinet vapor bath is the same as that of the Russian bath. Various water-proof cabinets are

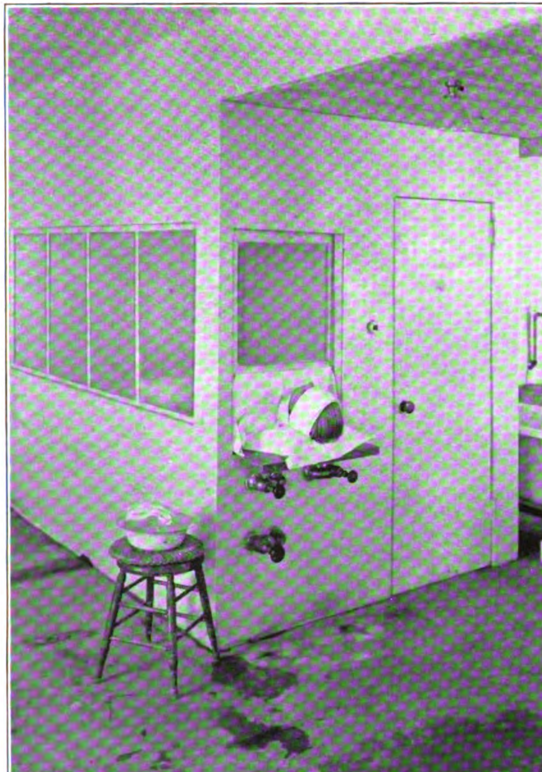

PLATE XL. Russian bath room—in use.

PLATE XLI. The Russian bath room—open, showing bath.

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offered for sale. They are useful in a home where more elaborate facilities can not be provided. An alcohol stove heats water in a basin under or near the stool provided for the patient. This is continued until the cabinet is full of vapor, when it is ready to enter. The patient sits on the stool with the head outside of the cabinet. The duration of the treatment should depend upon the rapidity of vaporization and upon the effect desired. The preliminaries, procedure and precautions to be taken are the same as in the Russian bath. Conclude the treatment with a shampoo, cold towel rub, graduated shower or other cold application.

Turkish Bath

The Turkish bath consists in the immersion of the body in hot air. The Russian room may be used for this purpose and conveniently heated by steam coils. Hot air boxes similar in shape and size to the upright electric light cabinet may be used (*Plate XLII.*). The patient is treated in the same manner as in the Russian bath. The head and neck should be kept cool by cold compresses and, if necessary, an ice bag applied over the heart. The temperature of the room should be gradually raised from 120° to about 170° F. The bath may last from fifteen to forty-five minutes. Perspiration is often somewhat delayed, in which case brisk friction to the skin may hasten its appearance. If perspiration is much delayed, the patient is likely to behave badly in the hot air bath, and for this reason should be closely watched until free perspiration is established. Owing to the difficulty with which some patients react to dry hot air, the applicability of the Turkish bath is somewhat more limited than that of the Russian bath.

The Turkish, or hot air bath, is of very great service in chronic Bright's disease. It may be used daily. It lessens nephritic dropsy both directly through increased perspiration and indirectly by aiding kidney elimination.

Superheated Air Bath

In the superheated air bath the temperature reaches 250°—350° F. Special metal cabinets for the entire body (*Plate*

XLIII.) or various parts (*Plates XV and XVI.*) may be purchased. The body or part to be treated should be thoroughly wrapped in Turkish toweling (*Plate XLIV.*) and should not rest on any part of the cabinet likely to become hot enough to burn. By means of a gasoline or other burner, the temperature of the air in the cabinet is gradually raised to 250° or 350° F. These burners are placed just below the cabinet; over them are fitted inverted funnels with a short, wide stem leading directly into the cabinet. The entering hot air should be spread by means of an asbestos shield so that it will not directly strike the skin surface. The patient's pulse and general condition must be watched very closely in giving a full hot air bath. An ice bag should be kept on the heart and ice compresses on the head and neck. These precautions are not so necessary where only a single part, such as the knee or foot and ankle are being treated. The treatment may be concluded by an alcohol or witchhazel rub. Great care must be exercised that the patient does not take cold afterward. The Turkish toweling with which the body or limb is wrapped quickly absorbs the perspiration, thus preventing its collecting on the skin in drops. Should it collect in drops, burning is more likely to result.

Effects. The superheated air bath is a much more vigorous measure than the Turkish bath. It is of special advantage in articular rheumatism, whether occurring in acute rheumatic fever, chronic gouty rheumatism or in specific arthritis. Where one or two joints are being treated, the application should continue from twenty minutes to an hour after the temperature has reached 300°—350° F. When the part is taken out a momentary dash of cold water may be given or the part cleansed from perspiration and a heating compress applied. In gonorrheal rheumatism this treatment may be followed by, or alternate with, the prolonged ice pack, *i. e.*, prolonged to about one hour's duration.

Electric Light Bath—E. L. B.

In giving the electric light bath, special upright or reclining cabinets fitted with mirrors and incandescent lights are used. (*Plates XLVI and XLVII.*)

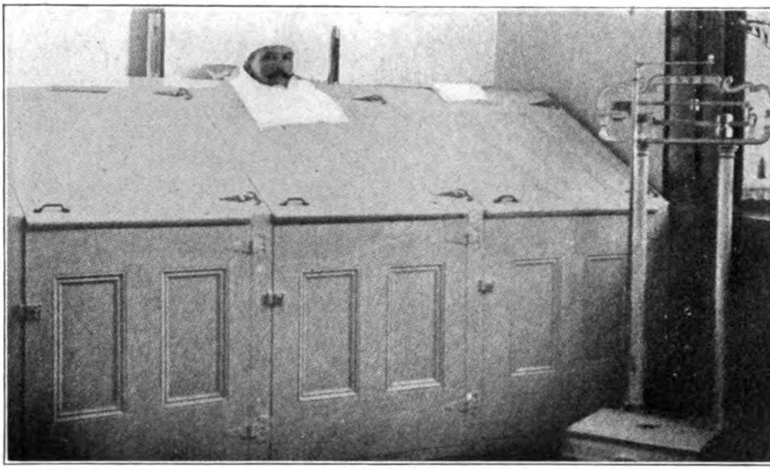

PLATE XLII. Row of hot air cabinets for Turkish bath. (Dieffenbach.)

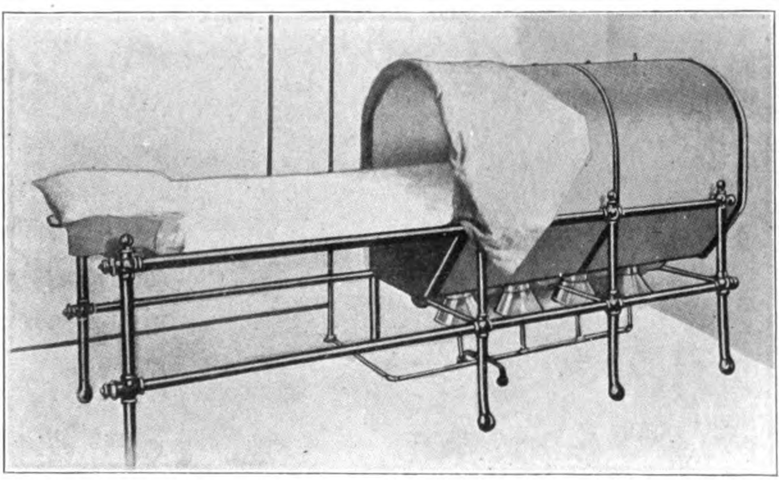

PLATE XLIII. Superheated dry hot air bath ready for use.

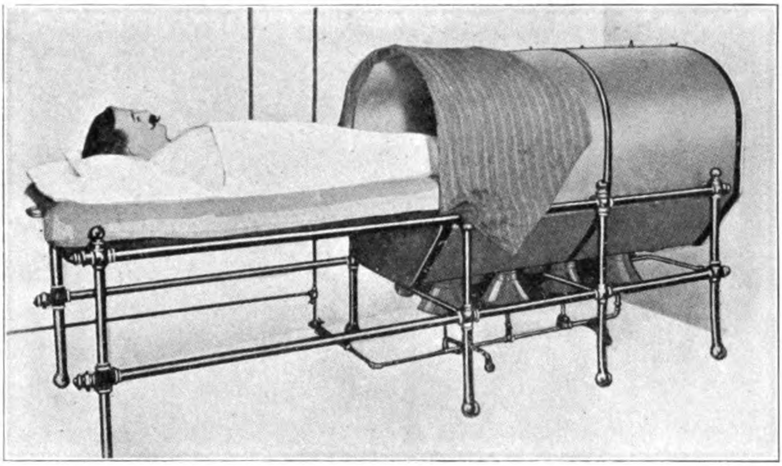

PLATE XLIV. Superheated dry hot air bath. Patient in Turkish toweling suit ready to be slid into cabinet.

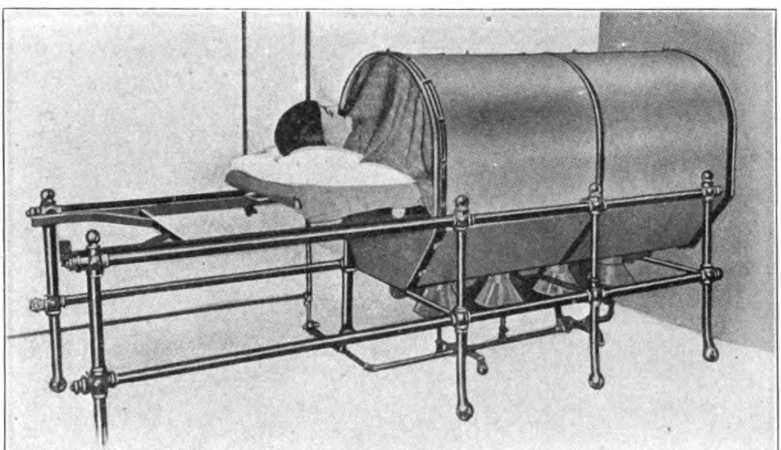

PLATE XLV. Superheated dry hot air cabinet in use.

The feet should be warmed beforehand, or with the upright cabinet a hot foot bath should be used. Cover the stool with a folded Turkish towel. Turn on the desired number of lights; when the cabinet is warmed, have the patient enter. Then close the cabinet and apply a cold wet towel to the head and neck. Renew this frequently. If there is a tendency to faintness or rapid pulse, use an ice bag to the heart as well. If a horizontal cabinet is used, cover the table with a folded sheet. Warm the cabinet and place a rubber pillow for the patient's head. The patient then lies down and is rolled into the cabinet, or the top is lowered according to the style of cabinet used. The patient's head should be kept cool by cold compresses. There is less tendency to fainting with the horizontal than with the upright cabinet.

The patient must be watched very carefully and constantly in order to guard against fainting. On leaving the cabinet, a blanket or sheet should be thrown about the patient if it is necessary to go more than a few steps for the next part of the treatment. Finish with a spray or shampoo and spray. Where only general tonic effects are desired, the electric light bath should last from three to five or six minutes; for profuse sweating and eliminative effects, continue it from ten to eighteen or twenty minutes.

Effects. The incandescent electric light is not so much a generator of actinic rays as of heat rays. It is said that only five to eight per cent of the radiant energy of the incandescent light consists of actinic rays, while ninety-two per cent is in the form of heat rays. For this reason the use of blue globes adds nothing to the chief effect of the bath, but rather detracts from it, since the volume of the heat rays is lessened. The incandescent electric light bath is not a phototherapeutic but a thermotherapeutic appliance.

The air of the cabinet is not warmed to the same extent as the skin of the patient, since the heat is in the form of *radiant* energy. In this particular the electric light bath differs essentially from the Russian or Turkish bath and from the effect produced by hot applications applied directly to the skin. This means that the heat of the electric light is not communicated to the body by direct conduction or by convection, but by absorption of the rays of radiant energy as they are retarded and stopped by the skin and subcutaneous tissues.

On the other hand, for strong derivative effects, the electric light bath is unsatisfactory. For derivative purposes the heat must be brought in actual contact with the skin by applying the heated substance directly to the skin. For this reason, stronger derivative effects are secured by partial or full hot baths and hot packs.

The uses of the electric light bath are numerous and considerable space would be required merely to enumerate them. However, it is of special advantage in Bright's disease, arteriosclerosis, lead poisoning and other toxemias, obesity, gout, acute and chronic rheumatism, neurasthenia, diabetes, skin diseases and also for general tonic and sudorific effects. It seems to be almost a specific in treating morphine habitues. They obtain from it more relief than from any other measure.

SHAMPOOS

Swedish Shampoo—Ssh.

For giving the Swedish or slab shampoo, provide a pail of water at 103°—105° F. on a stool of convenient height near the head of the slab, also a shampoo brush and a half bar of soap. If the slab is not kept warm by being in a warm room, pour over it two or three pails of hot water. Cover the slab with a doubled sheet and assist the patient onto the slab, placing the head on an air pillow. Quickly lather an arm by dipping the brush and soap in the pail of hot water and rubbing together over the part. With brisk short movements go over the part thoroughly, using as much friction as is comfortably borne. Do the same with the chest, abdomen and legs.

Next assist the patient to turn over on the slab by putting one arm under the neck and grasping the opposite shoulder, and the other arm under the near leg and grasping the opposite knee. Treat the back, hips and backs of the legs in the same manner as the front of the body. Pour the remaining water in the pail over the patient to rinse off the soap suds. Follow the shampoo by a warm and cold shower or spray.

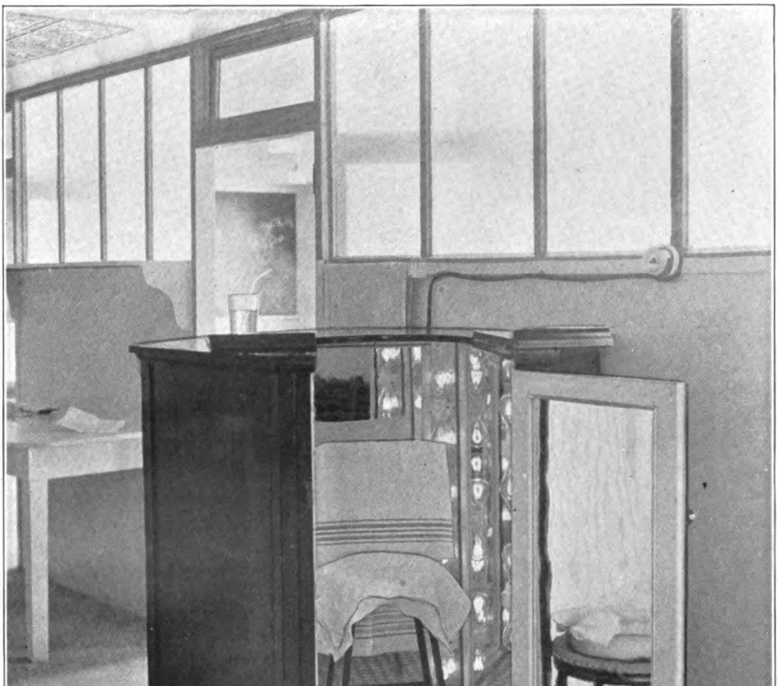

PLATE XLVI. Electric light bath cabinet (upright form) ready for use.

Tub Shampoo—Tub Sh.

Fill a bath tub with water at 98° F. The patient may sit on a wooden stool in the tub or, if likely to chill, he should lie down in the tub with the water deep enough to cover the chest. If given with the patient sitting on a stool, begin with the arms, back, chest and abdomen, then the legs. If given with the patient immersed, raise one part at a time above the water and proceed as usual, having the patient sit for the back and chest. Finish by complete immersion in the tub followed by a cold pail pour or shower.

Turkish Shampoo—Tur. Sh.

The Turkish shampoo is given after sweating baths such as the Turkish, Russian or electric light bath. The shampoo proper is preceded by manipulations and heavy friction to loosen the outer epidermis (so-called dead skin). It is the most thorough cleansing measure used.

(*a*) *Articles Necessary*. Two pails of water at 90° F., one at 100°—105° F., loofah or shampoo brush, soap, two Turkish toweling mitts, two sheets and towels. In treating women, the hair should be protected by a rubber cap.

(*b*) *Procedure*. If the sweating bath has not been taken in the shampoo room, it must be well heated and the slab warmed by pails of hot water poured over it. Cover with a doubled sheet and assist the patient onto the slab. Place an air pillow under the head.

Manual Rubbing. Wet the face with water at 90° F. With the hands, dash water over every part separately, using long strokes and quickly covering the body. Beginning with the neck, about the ears, hair, forehead, over the nose and chin, rub until the dead skin is thoroughly loosened. Wash off the loosened epidermis, dipping the hands frequently. For the chest and abdomen, after applying the water, use transverse wringing and re-enforced rubbing, covering each part several times. Then wash off with water. For the arms use spiral friction and wringing; for the legs, the same; with the thumbs, rub well about the ankles, soles of feet, knees, etc. Turn the patient and proceed with the back in the same manner as with the chest, also the thighs and legs. Wash off the entire surface with water.

Friction Mitt. Dip the mitt in the second pail of water at 90° F., and beginning with the back and backs of thighs and legs, go over each part twice rubbing all thoroughly. Then turn the patient and treat the chest, abdomen, arms and legs in the same manner. Wash off with the rest of the pail of water at 90° F.

Shampoo. Treat each part as in the Swedish shampoo, using hands, a loofah, or bath brush and the pail of water at 105° F.

Finish with prolonged tepid or cool shower or spray, and at the close a short cold spray. Dry thoroughly with sheets and towels. The patient should be careful not to take cold afterward.

PACKS

Packs are procedures in which a considerable portion of the body is enveloped in wet sheets or blankets for therapeutic purposes.

I. Hot Blanket Packs

The hot blanket pack is a procedure in which hot blankets are used to communicate heat to the body.

Full Hot Blanket Pack—H. B. P.

(*a*) *Articles Necessary.* Two double blankets or one single and one double blanket; one hot water bottle and three spine bags half filled with hot water at 160° F., a bowl or pail of ice water with compresses for the head, neck and heart; two Turkish towels; a tumbler, a drinking tube and pitcher of hot water for drinking.

(*b*) *Preliminaries.* Move the bowels by enema, give a hot foot bath, and have the patient drink hot water.

(*c*) *Procedure.* Spread a double blanket on the treatment table or bed. Adjust a cold compress to the patient's head while his feet are still in the hot foot bath. Fold the single blanket or another double blanket (the latter holds the heat longer) lengthwise in convenient width for passing through a wringer or wringing by hand. Wring from boiling water,

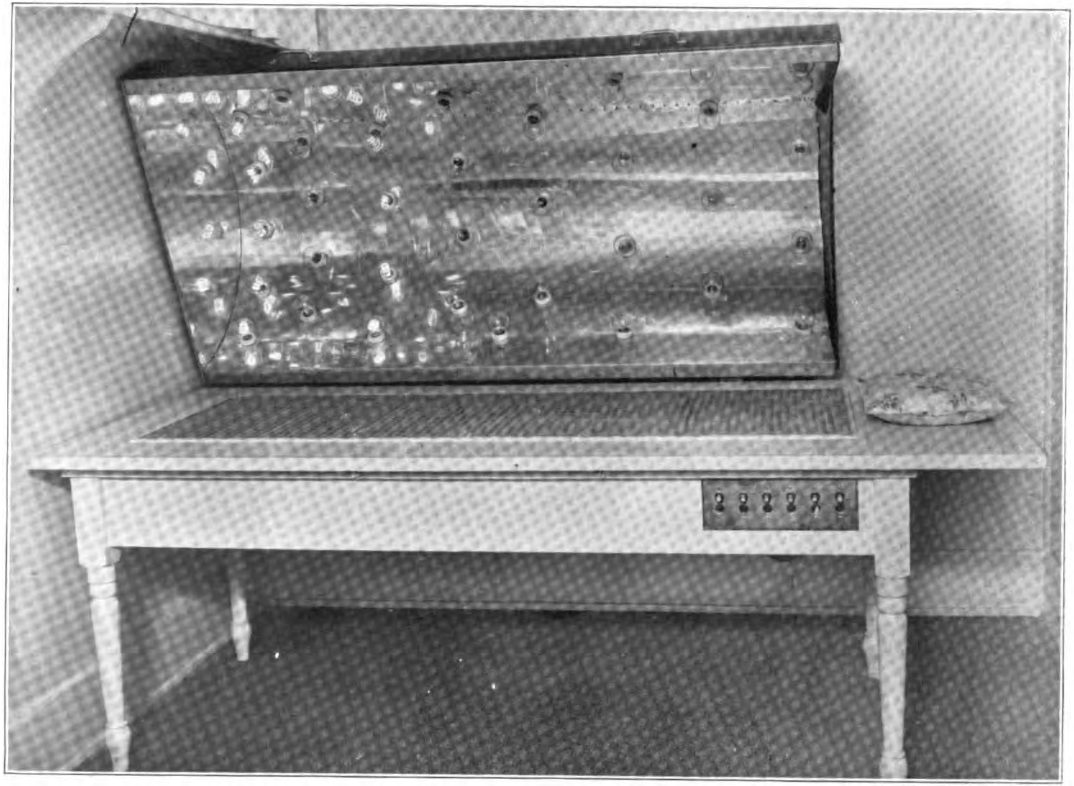

PLATE XLVII. Electric light bath cabinet, horizontal form.

quickly unfold and spread out over the dry blanket on the table.

Assist the patient to lie on the hot blanket; or with a bed patient, lift onto the blanket. As quickly as possible or as rapidly as can be borne, envelope the entire body except the head in the hot blanket. Place one spine bag between the legs with one thickness of dry blanket between it and the moist blanket, and the hot-water bottle at the feet. The other spine bags should be placed along the sides of the trunk in the same way as the one to the legs. Tuck both wet and dry blankets in well, especially at the feet and about the shoulders and neck, so as to exclude the air. See that the wet blanket comes in contact with the body over its entire surface, so that no air spaces will be left. (*Plate XLVIII.*)

Place cold compresses about the head and neck and protect the chin from the hot blanket by a soft dry towel. Renew the compresses before they are warmed to any extent.

For general sweating effects a dry blanket may be placed between the patient and the wet blanket, but for strong derivative effects the wet blanket should come into immediate contact with the skin.

The patient should perspire in a short time. If perspiration does not begin in about ten minutes, give hot water to drink or a hot foot bath, or both. In giving the hot foot bath, the blankets should fall closely about the tub so as to prevent the circulation of air.

Continue the pack for twenty to thirty minutes, *i. e.*, until it ceases to have a heating effect; for tonic effects, five to ten minutes. Take the patient out by a cold mitten friction or a cold towel rub, removing the blanket from one part at a time and covering with a dry blanket or bedding immediately after. It is usually most convenient to begin with the arms, then the chest and abdomen, the legs last, giving the cold friction to the back after the wet blanket has been entirely removed.

(*d*) *Precautions*. Too much water left in the pack makes it feel very hot at first, but it cools more rapidly than when wrung nearly dry. For this reason the pack should be wrung as dry as possible.

If the hot-water bags are too near the patient (not sufficiently covered) there is danger of burns resulting. If complaint is made, they should at once be covered more thoroughly.

In some cases it is necessary to use a cold compress or an ice bag to the heart.

General free perspiration should be induced by the pack. Long continued heat without perspiration results in harm.

In giving packs in case of paralyzed sensation, unconsciousness, under or soon after anesthesia, in diabetics, dropsy and the insane, it is safer if a thickness of dry blanket intervene between the patient and the wet blanket. Hot-water bottles should be more thoroughly covered and the water used in them should be at a lower temperature than ordinary.

(*e*) *Effects*. The hot blanket pack is a vigorous sweating measure. It also produces decided derivation. Any sweating treatment decreases internal congestion, but this action is much more marked when the wet blanket is placed next to the skin. Where the congestion is not localized in some particular part, but consists of a general internal congestion, a general sweating treatment is usually sufficient for its relief. This is the case in the first stage of many fevers, especially the exanthemata, in colds, la grippe, etc.

In uremia, eclampsia and acute Bright's disease, both sudorific and strong derivative effects should be secured. In other forms of renal congestion this is also necessary. In kidney insufficiency the skin excretes much larger quantities of poison than in health. Free or profuse perspiration greatly aids in this vicarious function. This effect is not, however, the only one nor the most important effect of sweating measures. The congestion of the skin secured by a hot pack reduces the congestion and high blood pressure in the kidney so that it soon begins to functionate when these causes are removed. The hot blanket pack is also useful in pneumonia and sometimes in typhoid fever. It is almost indispensible in the treatment of renal colic and gall-stone colic. In these conditions the pain is decreased immediately the pack is applied; in some cases it entirely obviates the necessity for morphine, while in others the dose may be cut to one-third or one-fourth the amount that would otherwise be required.

Dry Blanket Pack—D. B. P.

Sweating may be produced by enveloping the body in a dry woolen blanket and using hot-water bottles in the same way as with a wet pack. The same preliminaries should be observed, especially the giving of the hot foot bath before. It is quite essential that the patient take a considerable quantity of a hot drink during the treatment. Hot lemonade is ideal as it favors both diaphoresis and diuresis. The sweating may be as profuse as with the wet pack but the derivation is less efficient. Since no wet blanket is used, the patient may be first wrapped in a dry sheet and then in the dry blanket. The perspiration will be absorbed by the sheet and so, in a short time, the effect will somewhat approach that of the sweating wet sheet pack.

Hot Trunk Pack—H. Tr. Pk.

The method of applying the hot trunk pack is the same as with the full blanket pack. The wet blanket should include the pelvis but exclude the arms, reaching up to the axilla. The outside dry blanket should include the whole body but be used only for protection; it should not be wrapped tightly about the patient. It is usually best to apply a large dry fomentation cloth between the patient and the wet blanket. Place a hot-water bottle over the abdomen between the folds of the dry blanket, and spine bags on either side of the trunk. A hot foot bath should begin before and continue during the pack. Time, twenty to thirty minutes. If given for the relief of the pain of any form of colic, omit the cold friction at the close.

The hot trunk pack has the same general effect as the hot blanket pack. Since it covers less surface the derivative effects are less. It is especially useful in digestive disturbances and in relieving the pain of renal and biliary colic, also in intestinal colic.

Revulsive Trunk Pack—Rev. Tr. Pk.

The revulsive trunk pack consists of a hot trunk pack given as directed above and followed by a wet sheet trunk pack. Only this one change from heat to cold is made. The wet sheet is wrung from water at about 60° F. and applied to the trunk after removing the wet flannel blanket. The method is described under the heading of wet sheet packs.

The hot blanket should be removed while it is still hot and the wet sheet applied at once in much the same manner as for the revulsive compress. The wet sheet trunk pack should remain in place until the heating stage is reached when it may be removed and a cold mitten friction or alternate hot and cold spray douche given to the parts covered by the pack, finishing with the same to the feet. If desired, the wet sheet trunk pack may be made a hot and heating trunk pack by inserting a hot-water coil or a hot-water bottle over the stomach.

The revulsive trunk pack is used for tonic purposes, also in chronic congestions of the liver and the other digestive organs.

Hot Pelvic Pack—H. Pelv. Pk.

The hot pelvic pack is applied in the same manner as the hot trunk pack. It should come well above the crests of the ilia and include nearly half of the thighs. It is useful in the relief of pelvic pain from dysmenorrhea, cystitis, proctitis, etc. Its effects do not greatly differ from those of the hot sitz bath or large, very hot fomentations to the pelvis, both of which treatments are much easier to apply.

Revulsive Pelvic Pack—Rev. Pelv. Pk.

This treatment is applied in the same way as the revulsive trunk pack. The cold pack should be prolonged to the heating stage. The effects are somewhat similar to those of the revulsive sitz and hot half bath. It is useful in chronic congestions and chronic inflammations of the pelvic organs, such as chronic metritis and endometritis with much thickening, also in subinvolution.

Hot Hip and Leg Pack—H. Hp. & Lg. Pk.

The hip and leg pack should include the feet, legs, thighs and pelvis, reaching slightly above the crests of the ilia. A hot-water bottle should be placed at the feet within the folds of the dry blanket and a spine bag between the legs. Time, twenty to forty minutes. Taking one limb out at a time, finish with a cold mitten friction to retain the blood in the limbs, thus maintaining the derivation secured by the hot pack.

Effects. The hot hip and leg pack is one of the most efficient derivative measures used in hydrotherapy. It is indicated in a large number of conditions, and is especially useful in depleting acutely inflammed organs when combined with the use of an ice bag over the congested part. (See hot packs with ice bags.)

Hot Leg Pack—H. Lg. Pk.

The hot leg pack should include the feet, legs, knees and half or more of the thighs. Hot-water bottles are used the same as above. Conclude the treatment in the same way.

The leg pack is somewhat less effective than the hip and leg pack. It is used for the same purposes, and is convenient where it is undesirable to move the pelvis in giving treatment. A large fomentation may be used over the anterior surface and sides of the pelvis at the same time, so as to cover nearly as much surface as the hip and leg pack.

Hot Packs with Ice Bags

Hot packs, combined with the use of ice bags or the ice water coil, are the most powerful and efficient derivative measures known to hydrotherapy. They are especially useful in reducing internal congestions, reducing or aborting local inflammation of deep parts and relieving the pain incident to the inflammatory process. For these purposes they are used only in the acute stage of the inflammatory process. The effects have been fully discussed in the consideration of inflammation and antiphlogistic effects, *q. v.*

The hot pack depletes the congested part by *drawing* the blood away to establish a collateral hyperemia (pull effect) while the ice bag *drives* the blood away by reflexly stimulating prolonged and extreme contraction of the deep vessels of the inflamed part (push effect). (*Plate X.*) The cold mitten friction given at the close causes retention of the blood in the skin by changing the passive hyperemia to an active arterial hyperemia.

These treatments are sometimes spoken of as hot and cold packs, but this designation may cause confusion with the revulsive pack in which a cold (heating) wet sheet pack follows the hot blanket pack.

Ice bags may be used with the full pack or with any of the partial packs. The following combinations are useful in the acute stages of the diseases indicated:—

APPENDICITIS—Hot hip and leg pack, with ice bag to the appendiceal rigion.

PERITONITIS—Hot hip and leg pack, or leg pack only, with an ice compress or ice cap to abdomen.

PUERPERAL INFECTIONS AND ACUTE SALPINGITIS—Hip and leg pack, with ice to pelvis (suprapubic region).

PNEUMONIA—Hip and leg pack or full blanket pack with cracked ice compress or ice bags over lobe affected.

MENINGITIS—Hot leg pack, with ice cravat, ice cap and ice bag to base of brain and upper spine.

MASTOIDITIS—Hot hip and leg pack or full blanket pack with ice cravat or ice bag over the carotid artery, ice cap to head, and fomentations to mastoid.

ALVEOLAR ABSCESS—Same as mastoiditis, except give fomentations to the jaw.

RENAL CONGESTION—Hot trunk pack or full blanket pack with ice bag to lower third of sternum.

Other combinations will suggest themselves to the resourceful mind.

Electrothermal Pack—Elec. Pk.

The electrothermal pack is given by means of a specially prepared blanket containing flexible resistance wire. If it is to be used dry, the body or part to be treated should be wrapped in a dry sheet or thin flannel blanket, and then in the electric blanket, and the electricity turned on. The amount of heat and consequent effect may be governed by the strength of the current. If to be used wet, wrap the patient in a sheet wrung nearly dry from cold or tepid water, and then in the electric blanket. The treatment is concluded by a cold mitten friction, spray or douche.

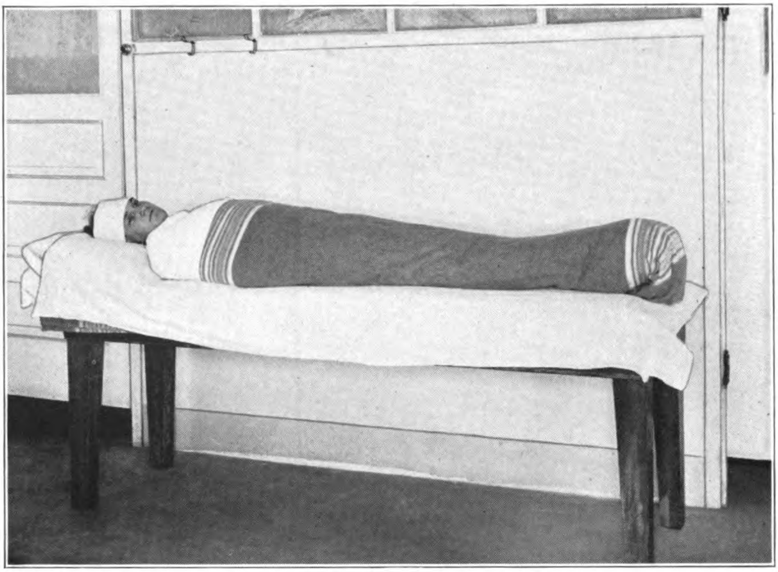

PLATE XLVIII. The hot blanket pack.

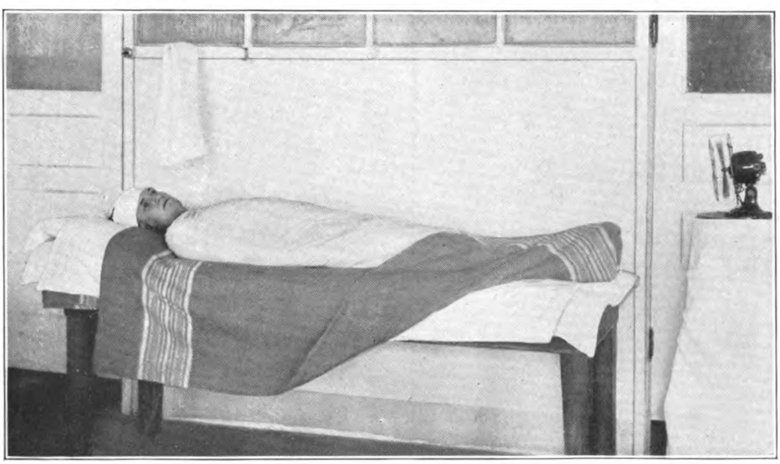

PLATE XLIX. The evaporating wet sheet pack,

Effects. While the heat is not as intense with the electric blanket as with a blanket wrung from boiling water, it is a gradually increasing heat, and so, more desirable for some purposes. It is useful for general sweating effects, and for this purpose may be used with or without the wet sheet. The dry pack may be used where mild continuous heat is desired, as after an operation. In this case it should usually be applied only to the legs or the pelvis and legs. A Turkish towel should be placed so as to form a pad under the heels, and then folded over the toes. All bony prominences should be similarly covered. The electric blanket may be used to reenforce other packs and so increase or prolong the effects.

The electric blanket should not be folded sharply at any place, as the wires are likely to be broken.

II. Wet Sheet Packs

A wet sheet pack is a procedure in which the body is wrapped in a wet sheet, outside of which is a dry blanket covering designed to regulate the evaporation.

Full Wet Sheet Pack—W. S. P.

(*a*) *Articles Necessary*. Two blankets, a sheet, a large hand towel, a Turkish towel, a pail of water at 60°—70° F., a hot-water bottle.

(*b*) *Preliminaries*. The feet and entire body must be warm before the pack is applied. Chilliness, cold skin or cyanosis are contra-indications. In case the skin is not warm, it is necessary to give a hot blanket pack or some other general hot treatment. The head should be cooled by cold compresses before entering the pack.

(*c*) *Procedure*. Place a double blanket lengthwise of the treatment table, with the edge opposite the attendant hanging farther over the edge of the table than the near edge. The upper end should be about eight inches from the head of the table and cover the lower third of the pillow. Wring the sheet as dry as possible from cold water and spread out upon the blanket so that its upper end will be a little below the upper end of the blanket. The patient now lies down upon the wet sheet with the shoulders three or four inches below the upper edge. Both arms should be raised while one side of the sheet is quickly wrapped around the body drawing it tightly in contact at all places and tucking the edge under the opposite side. Below the hips the sheet is wrapped around the leg of the same side. The arms are now lowered and the opposite side of the sheet drawn tightly over the body and tucked in. The sheet is now folded over the shoulders and across the neck. The narrower edge of the blanket is drawn tightly around the body and tucked in along the side. The wider edge is disposed of in a similar manner, pulling it tightly to bring all parts in close contact and the extra amount wrapped entirely around the patient. The foot end is doubled under the feet. A Turkish towel is placed about the neck to protect the face and neck from contact with the blanket and more perfectly exclude the air. An additional blanket may be laid over the patient and tucked in along the sides and about the feet, or two blankets may be placed on the table at first.

(*d*) *Precautions.* The wet sheet must come in close contact with the body at all points. The dry blanket must effectually prevent the entrance of air, otherwise chilling will result. "Warming up" should occur promptly. The feet must be kept warm during the entire treatment. It is permissible to place a hot-water bottle to the feet to hasten reaction in case this is delayed.

(*e*) *Stages.* According to the degree of warming the pack undergoes, it passes through four stages, *viz.*, *cooling or evaporating*, *neutral*, *heating and sweating*. It is often desirable to prolong the effect of one stage so that this effect may predominate. Accordingly the treatment is varied as follows:—

1. Cooling or Evaporating Wet Sheet Pack—Evap. W. S. P. This is the first stage of the pack before the sheet has been warmed to the temperature of the body. It requires from five to twelve minutes to accomplish this. If at the end of this time the sheet is removed and another applied, the effect is intensified, or the blanket may be folded back and cold water sprinkled on the patient over the wet sheet. In case of vigorous patients the dry coverings may be omitted entirely, considerable water left in the sheet, and the patient fanned to hasten evaporation, more water being sprinkled on the sheet as soon as it is warmed slightly. The electric fan may be used where very rapid evaporation is desired. (*Plate XLIX.*)

Effects. The evaporating wet sheet pack is a powerful antipyretic measure. It is useful in typhoid fever and in other continued fevers where repeated antipyresis is necessary. It is usually best not to remove the pack for renewal but sprinkle on more cold water. As in the use of the cold tub bath in typhoid fever, rubbing is necessary if the water is very cold or the sheet sprinkled frequently. This is known as the *rubbing wet sheet pack.* Percussion should not be used. The greater the amount of water applied to the body, the stronger are the antipyretic effects, and consequently the quicker is the temperature of the patient reduced.

If desirable, the sheet may be wrung from hot water, the coverings being omitted. This is spoken of as a *hot evaporating sheet.* It is useful where slight chilliness exists. This treatment is not only antipyretic but also lessens heat production because of the initial heat and the consequent atonic reaction.

2. Neutral Wet Sheet Pack—Neut. W. S. P. The neutral stage begins when the temperature of the pack reaches or slightly exceeds the temperature of the skin, *viz.*, about 94° F. It may be prolonged by removing all but one or two dry coverings after the warming up has well begun. This allows of sufficient evaporation to prevent the accumulation of heat above the temperature of the body. The protection must be uniform and the entrance and circulation of air prevented.

Effects. The effects of the neutral wet sheet pack have been considered under the treatment of insomnia. A neutral temperature is secured the same as in the neutral bath. The marked sedative effects of the neutral pack are due more to the derivation secured than to the neutral temperature. In normal sleep there is a lessening of the amount of blood in the brain and a local decrease of blood pressure. The neutral pack brings about these changes and so aids in inducing relaxation and sleep.

If the pack is removed before sleep is produced, uncover one part at a time, drying thoroughly and wrapping it in a warm dry sheet, or entirely remove the pack and immediately wrap the patient in a warmed sheet, finishing the drying as quickly as possible.

If the pack is removed after the patient has slept, conclude the treatment by a wet hand rub or cold mitten friction according to the degree of tonic effect desired.

The neutral wet sheet pack is also of use in the delirium of fevers, in mania, epilepsy, chorea, infantile convulsions and various other agitative neuroses. (*Plate XXI.*)

3. Heating Wet Sheet Pack—Heat. W. S. P. The heating stage begins when the warming of the pack raises the skin temperature slightly above its usual degree; it ends at the beginning of general perspiration which marks the establishment of a full reaction. For tonic effects the pack should continue about twenty minutes. When the stage of a pack is not prescribed, this treatment is intended.

Effects. Tonic and heating effects are secured by it. These may be prolonged by applying cold water to the head and neck continuously so as to check extreme sweating. The chief effect of the heating wet sheet pack is the production of derivation. The reaction and heating up of the skin, caused by the accumulation of body heat, congest the skin and so lessen the amount of blood in the internal organs. The distinction between the neutral and the heating wet sheet packs is not of great importance. Like the neutral and warm baths, the effects differ more in degree than in kind. Both produce derivation. As used in insomnia and mania, the pack is prolonged and is consequently at the heating stage during the greater part of the treatment.

The heating pack possesses quite a range of usefulness in securing mild tonic and derivative effects. It may be used in anemia, chlorosis, infectious fevers, convalescence from fever, neurasthenia, diabetes, etc.

4. Eliminative or Sweating Wet Sheet Pack—Sweat. W. S. P. The production of general perspiration marks the beginning of the sweating stage. The sweating may be increased or prolonged by additional coverings, hot-water bottles placed within the folds of the dry blanket, or the drinking of hot water or lemonade at intervals. The cold compresses on the head should not be very cold or renewed too frequently as this depresses the thermogenic centers and prevents sweating.

Effects. The sweating wet sheet pack is a very valuable eliminative and spoliative measure. It is one of the most useful means in the treatment of the transient fevers of infants and children, in capillary bronchitis, colds and the grippe.

For purposes of elimination it is useful in such toxemias as alcohol and nicotine poisoning, lead poisoning and various auto-intoxications. It is useful in chronic Bright's disease and, if not too prolonged, it may be used in jaundice. For spoliative purposes it is useful in obesity and obese rheumatics.

Half Pack or Heating Trunk Pack—1-2 Pk.

The heating trunk pack is given in the same manner as the heating wet sheet pack, except that it includes the trunk and hips only, the arms and legs being excluded. A full blanket should be spread out on the treatment table and over this placed a sheet wrung from water at 60° F. and folded to the proper width to include the trunk and hips. The patient now lies on the wet sheet and it is drawn tightly about the body. The dry blanket is next folded over so as to bring the wet sheet in close contact with the skin surface. A moderately hot foot bath is given at the same time and continued during the treatment. The dry blanket should be laid loosely over the limbs. The pack and the patient should not be so thoroughly covered as to produce general perspiration. It is well to have a dry sheet or towels intervene between the blanket and the patient at all places not covered by the wet pack. For this purpose a dry sheet may be spread out on the dry blanket before the wet sheet is placed for the trunk. The treatment should last about twenty or twenty-five minutes and be concluded with a cold mitten friction, or an alternate spray douche to the parts covered by the pack and to the feet and legs. The effects, though less pronounced, are in general the same as those of the hot and heating trunk pack, *q. v.*

Hot and Heating Trunk Pack—H. & Heat. Tr. Pk.

This treatment is the same as that previously described under the heading Winternitz coil. A single blanket is placed crosswise of the treatment table or bed so that the upper edge may reach well up under the arms. A sheet doubled (in case of feeble patients a single thickness) to a width which will reach from the axilla to below the hips is wrung from cold water and placed over the blanket. The patient lies down on this and while both arms are raised, one end of the wet sheet is pulled tightly across and around the trunk. Over the epigastric and umbilical regions outside of the sheet, place a three-quart hot-water bottle half filled with water at 135°—140° F. (*Plate XIX.*) Wrap the other end of the sheet about the trunk over the hot-water bottle and cover snugly with a dry blanket, folding over one end at a time. A Winternitz coil (*Plate XVIII.*) or an electric pad may be used in place of the hot-water bottle. Continue the treatment from forty minutes to two hours. General sweating should not be produced. It may be begun half an hour before the meal. Take the patient out with a cold mitten friction or an alternate spray douche to the abdomen and spine.

Effects. The hot and heating trunk pack is the *most efficient* hydrotherapeutic measure for the treatment of *digestive disturbances*. It promotes gastric secretion and gastric digestion. Liver activity and intestinal digestion proceed more normally. Excessive or reverse peristalsis (vomiting) is checked, and in decreased gastric motility stomach movements are hastened. Because of more perfect digestion and more normal peristalsis, gas formation is markedly decreased or entirely checked.

The hot and heating trunk pack is indicated in persistent vomiting, dyspepsia, flatulence, splanchnic neurasthenia, chronic congestion of the liver and in anemia of the liver.

In cases of almost complete arrest of gastric digestion or in persistent vomiting, the pack should be applied about twenty minutes before the meal and continued for two or three hours. A cold mitten friction should be given at the close. The feet should be warmed by a hot foot bath before the treatment and kept warm during the treatment. The hot foot bath may be continued while the treatment lasts, if this is not over thirty minutes, otherwise it is well to dry the feet and wrap them in dry flannel so that the patient may rest more perfectly. For further details of the uses and effects, see treatment of atonic dyspepsia.

Heating Pelvic Pack—Heat. Pelv. Pk.

On the treatment table spread a blanket as for a full pack. Next fold a single blanket to form a square and then diagonally to form a triangle. Arrange this on the large blanket so that the base is upward and the apex downward where it may be folded about the pelvis when the patient reclines. Over this place a sheet similarly folded and wrung nearly dry from water at 60° F. The patient now reclines, and with legs flexed and knees separated, the apex of the wet sheet is brought into close contact with the perineum and spread over the abdomen. With legs extended, each lateral angle of the wet sheet is drawn down tightly across the hips, lower abdomen and upper thigh. The triangular piece of dry flannel is now applied in the same manner, and the patient covered with the large blanket. Continue the pack twenty or thirty minutes.

Effect. The heating pelvic pack is a mild tonic and derivative means the same as the heating trunk pack. It helps to equalize the pelvic circulation and reduce congestions of the pelvic viscera. It relaxes hypertonic muscles and stimulates atonic muscles. The heating pelvic pack is not used as much as the sitz bath in the treatment of pelvic disorders. It is indicated in chronic congestions of the pelvic organs, amenorrhea, chronic metritis, backache, chronic colitis, etc. When used in cases of much pelvic pain or other pelvic distress, a hot-water bottle or coil should be placed next to the wet sheet over the lower abdomen and suprapubic region in the same manner as in the hot and heating trunk pack.

SPRAYS AND DOUCHES

A spray or douche consists in the projection of one or more streams of water against the body. Many different appliances are used in giving these treatments. They possess such a wide range of adaptability that almost any desired effect may be produced by them. For this reason both the physician and the nurse should become thoroughly proficient in the use of the spray and douche controller. For a description of the controller, see the section on hydrotherapeutic apparatus also *Plate L* and *Figs. 67, 72.*

Shower Bath—Sh.

A shower or rain bath consists in the projection of water in many fine streams falling upon the patient. In the shower bath gravitation is the principal force utilized; the effect, however, is often enhanced by added pressure. The perforated disc from which the water descends should be about eight inches in diameter and from ten to sixteen inches above the patient's head. There should be sufficient force to cause the water to flow rapidly. The room should be very small and protected from drafts. See that the patient's feet are warm before entering the shower. If the wetting of the hair is objectionable, as with women, protect by a rubber or mackintosh cap, or with a shower head attached by a ball joint turn it forward at an angle of forty-five degrees. Turn on the shower and adjust to the proper temperature before the patient enters.

1. Hot Shower—H. Sh. Begin the hot shower at 100°—105° F., and gradually raise the temperature to from 110°—115° F., or slightly above. Time, one to five minutes. It is used chiefly as a preparation for the cold shower or douche. It may be necessary to use a cold compress to the head during the hot shower. If only a hot shower is prescribed, cool rapidly to 90° or 85° F., and dry quickly with sheet and towels, finishing by fanning the patient with a dry sheet.

2. Cold or Cool Shower—C. Sh. The cold shower is usually preceded by a hot shower. When the patient has been warmed, lower the temperature rapidly from hot to the limit of tolerance or reactive ability of the patient and maintain at this point long enough for a vigorous tonic effect. Those who have become accustomed to cold treatment may take the cold shower

PLATE L. Hydrotherapy control table devised by the author.

without the preliminary hot shower. Cool, 70°—90° F.; cold, 55°—70° F. At first, before the patient becomes accustomed to the shower, the upper limits should be utilized and in each succeeding treatment the temperature lowered by 1° or 2° daily and the time prolonged to from one-half to three or more minutes. Effects, tonic.

3. Neutral Shower—Neut. Sh. In giving a neutral shower, begin with the water at 100° F., and very gradually lower it to 97°—94° F. The treatment should last from three to five minutes. The patient should be dried quickly without percussion or unnecessary friction. Effects, sedative.

4. Graduated Shower—Grad. Sh. After a prolonged or vigorous sweating bath where much heat has been communicated to the body, it is desirable to lower the temperature of the shower slowly for gradual cooling and to abstract as much heat from the body as possible without producing a decided thermic reaction. Apply a cold compress to the head before the patient leaves the hot bath. Begin at 108°—110° F., quickly raising the temperature to 115° or 118° F. Maintain this until the patient feels well warmed and is ready to welcome the cold. Gradually lower the temperature to between 80° and 90° F., maintaining it at this point for from two to four minutes. Dry as quickly as possible with sheets and towels and see that the patient is not exposed to cold air or drafts for at least an hour after.

5. Revulsive Shower—Rev. Sh. Begin the shower at 105°—108° F. and gradually raise the temperature to from 110°—115° F. or slightly above; continue at this point for one to two minutes. When the patient has been thoroughly warmed, turn the mixer quickly to cold at a temperature of 60°—85°. After five to ten seconds turn the mixer valve back to the former temperature for one to two minutes. Three complete changes from hot to cold are made. After the last cold, dry quickly with sheets and towels as usual.

Effects. The revulsive shower has a mild tonic and stimulant effect. The patient should become accustomed to it before taking the alternate hot and cold shower. The change from one to the other may be made gradually by lengthening the duration of the cold with each succeeding treatment.

6. Alternate Hot and Cold Shower—H. & C. Sh. To obtain the best results the changes should be abrupt from hot to cold. As the water must traverse about fifteen feet of pipe before it reaches the patient, an absolutely instantaneous change is impossible. Begin with the hot at a temperature of 106°—110° F., raising the temperature quickly to the limit of tolerance and continue it about one minute; then turn the mixer valve quickly to cold and continue fifteen to thirty seconds. Reverse again to hot for about one minute and follow this by a second cold and so on for three complete changes of hot and cold, finishing with the cold and drying as usual.

Effects. The alternate hot and cold shower is a vigorous tonic and stimulant. It should not be ventured upon without considerable preliminary training by milder measures. Some find it more agreeable than the spray and easier to react to.

Sprays—Spr.

A spray bath consists in the simultaneous projection of water against all parts of the body by horizontal jets surrounding the patient. For this purpose four upright pipes, arranged in a square and having perforations on the side of each toward the center, are used. Since these pipes are stationary, it is necessary to have a short patient stand on a stool so that the water may not strike the face. A tall patient must bend the knees in order to have the spray cover the entire trunk. To overcome this inconvenience and to spread the streams of water still more, four rosettes may be arranged along each pipe at intervals of sixteen inches, the upper row being moveable. The effects and uses of the spray are the same as those of the shower, with the possible difference that the application is somewhat more general and there is more or less mechanical stimulation due to percussion or pricking of the jets. This is greater as the pressure is increased by the full opening of the spray valve. However this depends entirely on the size of the openings in the pipes or rosettes. If many and very fine the treatment is most agreeable. Hot, cold, neutral, graduated, revulsive and alternate treatments are given in the same manner as with the shower.

Douches—D.

The douche is a local application consisting of a single or multiple column of water directed against some part of the body. It is certainly one of the most useful of all hydrotherapeutic measures. The effect of almost every other form of treatment commonly given to ambulatory patients may be approached and usually exceeded by the douche in the hands of one skilled in its application. The necessary attachments are not numerous. (*Figs. 70, 71.*) These should consist of a straight nozzle; a spray nozzle or rosette like the sprinkler of a watering pot except that the perforated dish should have a nearly flat face; a fan douche nozzle, a movable flat piece attached to the straight nozzle will answer the same purpose; a stool with an open seat and attached up-shot spray douche nozzle for administering the perineal douche.

The jet nozzle is used whenever percussion effects are desired. The pressure may be increased by opening wide the douche valve, or by turning into the nozzle compressed air from a separate tube. Where a percussion douche (Perc. D.) is ordered, the jet is understood. Both cold and percussion produce a decided thermic reaction and increase the vigor and permanency of the circulatory reaction. The spray douche is useful where percussion is not desirable. The jet douche may be "broken" by placing the finger so as to interfere with the stream. It then resembles the spray douche in effect. The effects in general vary according to the mass, pressure and temperature of the column of water striking the body.

In prescribing douches the form of nozzle desired should be specified and such designations used as will indicate the part of the body to be treated. The cerebral circulation will be steadied and better general and local results obtained if all applications of the douche begin and end with the feet. The patient should dip the hands in cold water and bathe his face and head before the douche is applied. In applying the douche some definite plan should be learned and systematically followed, making changes when necessary for the particular case and condition in hand. In order to guard against burning, if possible, keep the index finger of the hand holding the douche in contact with the stream of water as it emerges from the nozzle. This should be done with the most perfect of appliances and even when no trouble at all is anticipated. Keep a steady hand, apply the douche accurately to the part to be treated and have the thermometers under constant observation.

The following are the general directions for douches of different temperatures. In giving these any form of nozzle may be used and any portion of the body treated. To enumerate all the possible variations and the particular surface to be treated together with the reflex or hydrostatic effects derived from each would require a small volume in itself. As in all hydrotherapeutic procedures, practical instruction is of far more value than any amount of text description and text illustration. Such designations as the Scotch douche, Charcot douche, etc., are non-descriptive and as far as possible should be dropped from hydrotherapeutic nomenclature.

In giving douches it is essential that the changes be abrupt from hot to cold. This is best secured by two douche units each with its own mixer so that both may be kept going during the entire treatment, the changes being made by using the two alternately. In this way the changes are absolutely instantaneous. The following types serve only as a general guide. The successful physician will find use for many gradations between the revulsive and alternate hot and cold douche. The treatment must be adapted to each individual case.

1. Hot Douche—H. D. Where the hot douche alone is used it is given for a relatively long time, two to five minutes, at a temperature of 105°—125° F., and followed by a very brief application of cold, five to fifteen seconds; temperature 60°—90° F. This is supposed to be just long enough to remove from the skin the heat communicated by the hot douche. The principle is identical with that of the revulsive douche except that in the latter, three or more changes are employed, while here only one is given and the duration is much longer.

Effects. The hot douche produces dilatation of the cutaneous vessels and so where applied to a considerable area, effective derivation is secured. Where applied to a small area, the dilatation of the vessels in the deep part through a reflex channel may equal or exceed the hydrostatic effect. Percussion intensifies the reflex effect. The hot douche is used for the relief of pain, irritation, neuralgia, sciatica, etc. In these cases percussion is undesirable.

2. Neutral Douche—Neut. D. Temperature, 94°—97° F.; time, three to six minutes. The broken jet or spray douche is used since sedative effects are sought. The neutral spray douche is especially beneficial when given to the spine. No force should be used and the patient should sit on a stool with the back to the operator. If given properly this treatment is essentially a neutral pour.

3. Cold Douche—C. D. Temperature, 55°—70° F. The cold douche is seldom given alone, but when not preceded by hot, the percussion jet should be used. Given in this way, vigorous fluxion is produced in the part treated with a corresponding derivation from other parts. For this reason it is very effective in relieving cold feet.

4. Revulsive Douche—Rev. D. Three abrupt changes from hot to cold are used. Temperature of the hot, 112°—115° F.; time, a half to two minutes; temperature of the cold, 55°—70° F.; time, five to ten seconds. Unless given with high pressure, (percussion) the reaction is chiefly circulatory. Percussion is not usually desirable with the revulsive douche.

Effects. It will be noted that the duration of the cold is exceedingly brief as compared with the duration of the hot. In this item lies the difference between the revulsive and the alternate hot and cold douche. The effect of the revulsive douche is chiefly circulatory and greater in the surface blood vessels than in the deep part, *i. e.*, the reflex effect is not prominent. The surface effect is that of fluxion and if a sufficient surface is covered by the treatment, a hydrostatic (derivative) effect upon other parts is produced.

The revulsive spray douche is especially applicable to the chest, abdomen and over the liver and spleen, also to the spine, pelvis and perineum.

5. Alternate Hot and Cold Douche—H. & C. D. The method of giving the alternate douche is the same as for the revulsive douche except that the cold application is of greater duration, being from one-third the duration of the hot to equal with it, so that where the hot is given for one minute the cold should last twenty seconds to one minute, depending upon the reactive powers of the patient. Percussion (H. & C. Perc. D.) adds much to the vigor and permanency of the reaction.

Effects. The alternate hot and cold douche produces vigorous fluxion in the surface treated. When percussion is used the reflex effects become prominent especially if the douche is applied to only one or two parts of the body. As a general treatment, for example, the alternate hot and cold percussion douche to the spine and legs, powerful tonic and stimulant effects are produced. The alternate percussion douche to the feet and legs is a most efficient derivative measure, especially when preceded by the hot leg bath. The extreme fluxion it induces in the feet and legs produces a decided and enduring derivation.

The following list of treatments, which may be given by means of the spray and douche apparatus, will help to show the technique and something of the principles involved in the effects desired.

As a General Tonic—H. & C. Perc. D. to spine, legs and feet.

To Produce Reaction in One Unaccustomed to Cold—H. Spr. with H. & C. Perc. D. to spine and legs at same time.

To Relieve Congestive Headache—H. & C. Perc. D. to feet with C. Comp. to head.

Passive Congestion of the Liver—Rev. or Alt. H. & C. D. (Perc. or Spr.) over hepatic area.

Sciatica—Prolonged H. Fan D. over sciatic nerve.

Varicose Ulcers—H. & C. Spr. D. to legs, six to ten changes.

Hypochlorhydria—Rev. Spr. D. to epigastrium and H. & C. Perc. D. to mid-dorsal spine.

Lumbago—H. & C. Perc. D. to lower back.

LOCOMOTOR ATAXIA AND OTHER FLACCID PARALYSES—Alt. H. & C. D. to spine.

SPASTIC SPINAL PARALYSIS—Prolonged Neut. Spray D. to spine.

CHOREA—Neut. D., Sh. or Spr.

RENAL CONGESTION (CHRONIC)—H. & C. Perc. D. to lower third of sternum and over kidneys at back.

CHRONIC PELVIC CONGESTIONS—C. D. or Alt. H. & C. D. to lumbar and sacral regions.

AMENORRHŒA—Short C. Perc. D. to feet.

SPECIFIC URETHRITIS, PRURITIS ANI, CHRONIC PROSTATITIS, ETC.—Rev. or Alt. H. & C. Spr. D. to perineum (called also "up spray").

CHRONIC PLEURISY, UNRESOLVED PNEUMONIA, ETC.—Rev. or H. & C. Spr. D. to chest over area affected (use no force) followed by H. & C. Perc. D. to feet and legs.

ATONIC CONSTIPATION—Alt. H. & C. Fan D. to abdomen.

CHRONIC MALARIA—Alt. H. & C. D. to spine and legs; Alt. Fan D. to splenic area.

Affusions

An affusion is the pouring of water from a convenient receptacle over the entire body or a portion thereof. Since the perfection of the spray and douche apparatus, the affusion has fallen into disuse in institutions equipped with such appliances. However, the pour has certain advantages which are not outweighed by the greater convenience of more complicated appliances. The flow of a considerable volume of water over a part has a somewhat different effect from a douche. Since it may be used in any home, it has a wide range of usefulness.

1. Pail Pour or General Affusion—P. P. The patient should be warm beforehand. If given in a bath tub he may sit, or if given while standing, the feet should be in a tub of hot water, and in either case apply a cold cephalic compress. Prepare three pails of water at different temperatures, according to the effect desired. These should be poured over the shoulders, using the warmest first. For a mild tonic employ pails of water at 100°, 90°, and 85° or 80° F., respectively. If the patient has just come from a warm bath of some sort, a lower temperature may be used for the first pail and the others correspondingly lower, or only two pails used. In succeeding treatments lower the degree of the applications until water at 50°—60° is used for the third pail. Rub the patient vigorously after the last pail and dry as from spray or shower. The pail pour is conveniently used after the tub or slab shampoo, salt glow, etc. A cold pail pour to the hips is given after the hot half-bath and the hot sitz bath for revulsive effects.

2. Local Affusions. These may be designated according to the part treated and the temperature of the application. A hot affusion relieves pain. The circulatory excitation soon gives way to an atonic reaction. A neutral affusion, especially to the spine, is sedative. A cold affusion, if short, is stimulating and tonic; if prolonged, it reduces congestion and inflammation, stimulating phagocytosis. A long continued cold pour to the head is strongly antipyretic. The alternate hot and cold pour is a powerful stimulant and tonic, producing fluxion in the part treated, with derivation from other parts. It produces a decided local leucocytosis and stimulates phagocytosis. Because of these effects it is a very useful measure in treating an infected part where it is impossible or undesirable to completely immerse the part in water.

In giving an affusion to the spine, the patient may sit on the edge of a bath tub or on a stool in the tub. In giving a pour to the arm, hand, foot, etc., the part may be held over a small tub while the water is poured from a pail or large pitcher. To treat the head by a pour the patient should lie on a cot with head resting over the end and a tub underneath. In giving local affusions the water should fall a distance of three or four inches to one or two feet according to the part treated and effects desired.

ENEMATA

An enema is an injection of fluid into the rectum.

General Directions:—

(*a*) *Articles Necessary.* An enema can with a capacity of one-half to two gallons or a fountain syringe or combination bag.

Five or six feet of rubber tubing with cut-off.

A glass or hard rubber enema tube.

A disinfectant solution for the enema tube. One to three per cent lysol acts both as a disinfectant and a soap for cleansing. A water thermometer. Toilet paper.

If given in the room, there should be in addition a standard or hook for suspending the enema can, a bed pan, slop jar and several newspapers.

In the treatment room shelves or hooks are most convenient for holding the can, they should be so arranged that the elevation of the enema can may be varied from one to four feet above the patient. (*Plates LIII, LIV, LV.*)

(*b*) *Procedure.* Fill the can with from two to six quarts of water at the proper temperature (test with a thermometer).

The patient should be warm, especially the feet. All clothing not removed should be loose.

Position of the patient—dorsal, sitting, right Sims or knee-chest.

Release the cut-off and allow the water to run until the stream is at the same temperature as the water in the can. Close cut-off and lubricate the enema tube, being careful to wash it beforehand, removing the disinfectant solution.

The patient should insert the tube unless very ill or unable to do so. Instruct the patient to take as much water as possible. To make it easier to do this, stop the flow by pinching the tube two or three times during the taking of the enema. Close cut-off and remove the tube. If possible the patient should retain the water a few minutes before discharging.

Repeat until a thorough bowel movement is secured or other desired result is obtained.

I. Plain Water Enemata

Rectal Injection or Enema—E. or En.

In the ordinary enema the desired amount of fluid is injected, allowed to remain a short time and then passed. The procedure is different from rectal irrigation, in which there is a continuous inflow and outflow of fluid.

1. Hot Enema—H. En. The temperature of the hot enema should vary from 103°—110° F. according to the condition of the patient and the result desired. It is useful in relieving irritation, the pain of inflammation in the rectum or prostate and pain of hemorrhoids. It also aids in expelling gas, and helps to check diarrhœa by decreasing rectal tenesmus. It may be used as a preliminary measure in the treatment of dysmenorrhœa. The hot enema is also used to warm and stimulate the body in shock. It markedly relieves the pain in acute pelvic and lower abdominal inflammations such as salpingitis and appendicitis.

2. Warm Enema—En. The ordinary enema for cleansing purposes should be given at a temperature of 95°—100° F. Where it has to be repeated frequently it is better to use tepid water, *i. e.*, 80°—92° F., to avoid as far as possible the relaxing effect of warm water.

3. Cold Enema—C. En. In giving the cool or cold enema, the temperature of the water may vary from 55°—80° F. Up to about 70° F. it may be regarded as cold, and from 70°—80° F. as cool. The cold enema is a powerful stimulant to bowel movements and should be more generally used for this purpose in place of the warm enema. For this reason it is useful in overcoming the enema and cathartic habits. If retained ten or fifteen minutes or frequently repeated, is useful in shrinking hemorrhoids. It may also be used in fever, but for this purpose prolonged rectal irrigation is much more convenient and effective.

Graduated Enema—Grad. E.

The graduated enema is not a single treatment, but a series of treatments. It is used to overcome the enema or cathartic habits. As usually given, it extends over a period of ten to twelve days. It should be preceded on two or three successive days by thorough coloclysters of water at 90°—100° F. to remove accumulated feces. The series of enemata is begun with a large amount of tepid water and finished with a small amount of cold water, one enema being given daily. In some cases the first two or three of the series may be omitted.

1st day	$4\frac{1}{2}$ pints	at 94° F.		6th day	2 pints	at 74° F.
2nd day	4 pints	at 90° F.		7th day	$1\frac{1}{2}$ pints	at 70° F.
3rd day	$3\frac{1}{2}$ pints	at 86° F.		8th day	1 pint	at 66° F.
4th day	3 pints	at 82° F.		9th day	$\frac{1}{2}$ pint	at 62° F.
5th day	$2\frac{1}{2}$ pints	at 78° F.		10th day	$\frac{1}{4}$ pint	at 58° F.

The above program is suggestive only; the variations in the amount and temperature of the water should be made to suit the needs of the case. The entire series with the exception of the temperatures above 80° F., may need to be repeated. Cold enemata should not be given during the menses.

Effects. After prolonged use of cathartics, the muscular part of the intestinal wall becomes relaxed and atonic because of overstimulation. The response to drug and chemical excitants is worn out and it is necessary that the atony be overcome by some more physiologic means. The restorative effect of cold upon muscular tissue and muscular capacity has been discussed in detail in chapter XIII. Repeated use of the warm or hot enema also causes relaxation with stretching and distention of the wall of the rectum and lower sigmoid flexure.

The contact with the cold water introduced into the bowel is an effective means of combating this atony and distention. The gradual reduction in the temperature makes it possible to bring about a response even after the atony has existed for some time.. Both this treatment and alternate hot and cold rectal irrigation are very efficient in the treatment of atonic constipation. They may be advantageously combined with the use of slow intra-rectal and abdominal sinusoidal electricty, abdominal massage and spinal nerve stimulation.

Rectal Irrigation—Rec. Irrig.

In giving rectal irrigation a special tube is used provided with an inlet and a return flow, so that the fluid passes into the rectum bathing the mucous membrane, and returns through the outlet. These are made of hard rubber or metal. The patient should be in the dorsal or Sims position. The enema can should be eighteen inches to two feet above the patient. The outflow tube should be lengthened by attaching to it a piece of rubber tubing so as to carry the outflow into the toilet fixture or, if given to a bed patient, into a jar placed at the side of the bed.

1. Hot Rectal Irrigation—H. Rec. Irrig. When the water used is at a temperature of 102°—105° or 106° F. the treatment produces decided effects in the relief of pain and rectal tenesmus. It may also be used with great benefit in cases of chronic cystitis with frequent and painful urination.

2. Cold Rectal Irrigation—C. Rec. Irrig. Cold rectal irrigation is a very useful antipyretic measure. For this purpose the water should not be very cold, but from about 70°—85° F. and the treatment continued about forty-five minutes at a time. Cold irrigation is also useful in stimulating bowel movement, but for this purpose it possesses no advantage over the cold enema.

3. Alternate Hot and Cold Rectal Irrigation—Alt. H. & C. Rec. Irrig. In giving alternate hot and cold irrigation it is necessary to use two enema cans with tubing connected by a Y-tube so that the alternations may be controlled. The hot should be allowed to run from one-half to two minutes and the cold from fifteen to thirty seconds. From five to twelve or more complete changes may be made in a single treatment. The greater the extremes of temperature, the greater will be the effect. It is possible to use a plain enema tube, injecting but a small amount and allowing the water to pass out through the enema tube after each injection.

This treatment is a most efficient measure in the relief of chronic inflammations of the pelvic organs, especially of the bladder, prostate, posterior urethra and rectum. For these purposes it should be given daily or three or four times a week. It is also one of the most effective means of combating chronic atonic constipation.

Coloclyster—Ccl.

In a coloclyster the fluid is introduced into the colon.

When the coloclyster is used to produce thorough cleansing of the large bowel, four to six pints of water or saline solution at a temperature of 100° 104° F. are used for each injection. An ordinary enema, and if necessary a soap-suds enema, is first used to cleanse the lower bowel. Have the patient take the knee-chest or right Sims position. Use an ordinary enema tube, but if results are not obtained, it may be necessary to use the high bowel catheter (colon tube). As the water enters, rub along the colon up the left side, across the abdomen and down on the right side so as to fill well the large bowel. As much water as possible should be injected, but this should be done slowly. Remove the enema or colon tube and, as the water is expelled, reverse the movements along the colon to favor complete emptying. It may be necessary to repeat the procedure.

Effects. The coloclyster is used to produce a full and complete evacuation of the bowels, and for cleansing the large bowel in cases where an ordinary enema does not produce the desired results. It is also used to remove fecal impaction. When some medicament or antiseptic is introduced it may be used to disinfect the large intestine or destroy parasites, as the amœba coli. (See quinine also quassia enema.)

II. Medicated Enemata

Saline Enema—Sal. En.

For whatever purpose the saline enema is used, it should be preceded by a thorough cleansing enema unless the bowel has already been cleared of feces.

1. Saline Enema to be Retained and Absorbed. The absorption of saline fluid from the rectum is useful in hemorrhage, surgical shock and pelvic and abdominal abscesses after drainage has been instituted. To be absorbed most rapidly, the sodium chloride solution should be isotonic with blood serum or slightly hypotonic. A physiologic salt solution is so called because it is isotonic with blood serum.

Intermittent Proctoclysis. One-half pint of physiologic salt solution (0.95 per cent) at a temperature of 100°—105° F. is given slowly or by high bowel catheter. To make this, use one level teaspoonful (4.5 grams) of salt to the pint of water. For a hypotonic solution (more rapid absorption) use a little less salt. After this has been absorbed, another one-half pint may be given. If this amount is not readily retained, use four or five ounces only.

Continuous Proctoclysis. Murphy Method.[1] The fluid should be administered through a fountain syringe to which is attached a three-eights inch rubber hose with a hard rubber or glass vaginal douche tip with multiple openings. This tube should be flexed almost to right angles three inches from its tip. A straight tube must not be used, as the tip produces pressure on the posterior wall of the rectum when the patient is in the Fowler position. The tube is inserted into the rectum to the flexion angle and secured in place by adhesive strips, binding it to the side of the thigh so that it can not come out; the rubber tubing is passed under the bedding to the head or foot of the bed, to which the fountain is attached.

Two or three inches from the fountain syringe interpose a Y-tube and to the upper limb attach a piece of rubber hose of the same size as the outlet tube. Fasten the free end of this to the top of the fountain syringe so that what returns through it will fall into the container. When flatus is voided, the gas passes more readily through the upper tube than directly into the fountain syringe. This reduces the pressure at such times and so aids in preventing expulsion of the fluid onto the linen.

The fountain syringe should be suspended from six to fourteen inches above the level of the buttocks and raised or lowered to just overbalance hydrostatically the intra-abdominal pressure, *i. e.*, it must be just high enough to require from forty to sixty minutes for one and one-half pints to flow in, the usual quantity given every two hours. *The flow must be controlled by gravity alone, and never by a forceps or constriction on the tube*, so that when the patient endeavors to void flatus or strain, the fluid can rapidly flow back into the can, otherwise it will be discharged in the bed. *It is this ease of flow to and from the bowel that insures against over-distention and expulsion onto the linen.* The fountain had better be a glass or graded can, so that the flow can be estimated. The temperature of the water in the fountain can be maintained at 100° by encasement in hot-water bags. The fountain is refilled every two hours with

1 Slightly modified from the original description by J. B. Murphy.

one and one-half to two pints of solution. Instead of the usual solution, a teaspoonful of calcium chloride may be added to the pint of saline solution. The tube should not be removed from the rectum after each emptying of the syringe but may be left in place for two or three days if necessary. Since the introduction of this method by Doctor Murphy a great many appliances have been devised for regulating the rate of flow and maintaining the temperature of the water. *Plate LI* shows a seepage apparatus[2] with a device for warming the water just before it enters the rectum. The same thing may be accomplished by placing an ordinary hot-water bottle over the rubber tubing at its lower end (*Plate LII.*). A dropping device which may be inserted between the Y-tube and the irrigating can is shown in *Plate LII*, corner figure. It is helpful in regulating the rate of flow. From 40 to 60 drops per minute will be absorbed by the bowel without difficulty and more than this if much blood has been lost. For the effects of enteroclysis see chapter IX.

2. Saline Enema to Cause Exosmosis, acting like a saline cathartic. Used to produce exosmosis, the enema is designed for thorough cleansing of the mucous membrane and is of inestimable value in chronic mucous colitis.

To produce exosmosis, *i. e.*, draw from the tissues into the bowel, the solution must be hypertonic, *i. e.*, of greater concentration than blood serum. Three pints of warm or hot water are used, containing two teaspoonfuls of salt to the pint or one-fourth teaspoonful of Epsom salts may be added to each pint of physiologic salt solution. The enema should be introduced into the colon by high bowel catheter or its flow into the colon aided by the knee-chest position. Let it be retained fifteen to twenty minutes or longer. If retained much over half an hour, some fluid will be absorbed. The treatment should always be preceded by an ordinary enema to remove feces.

Soap Suds Enema—S. S. En.

Prepare two or three pints of warm soap suds solution, made by scraping castile or Ivory soap and mixing thoroughly in

2 Made by the Boston Surgical Supply Company.

water at about 100° F. Follow by a plain enema to remove the soap suds.

Effects. The soap suds enema facilitates evacuation of the bowels and should be used where the plain enema fails to produce results.

Oil Enema—Oil En.

In administering the oil enema, use the colon tube with a small enema can giving one and one-half to three or four ounces of warmed cotton seed or other vegetable oil. It should be retained from two to ten or twelve hours or over night. Pass it the next morning and follow by soap suds and plain enemata.

Effects. The oil enema is used to remove hardened or impacted feces. It has a soothing, relaxing effect, and is therefore used to overcome spastic constipation, as of chronic lead poisoning. When given two or three days after an operation for hemorrhoids it softens and loosens the clot so that it passes without causing pain or starting fresh bleeding.

Honey or Molasses Enema

Give one-half to one pint of a warmed solution consisting of two parts soap suds and one of molasses by high bowel catheter. Follow by plain enema. For less of the cathartic action use four ounces of honey or molasses to the pint of plain warm water.

Effects. The honey or molasses enema has a purging effect similar to that of the hypertonic saline enema. It aids in removing the mucous casts and mucous accumulations of chronic colitis.

Asafoetida Enema

To one pint of warm water add four ounces of an emulsion of asafœtida, prepared by agitating one-half dram of asafœtida powder in four ounces of water; or add one ounce of tincture of asafœtida to a pint of warm water. Give as an ordinary enema. It is used to expel flatus.

Turpentine Enema

To a pint of soap suds solution add ten to twenty drops of oil

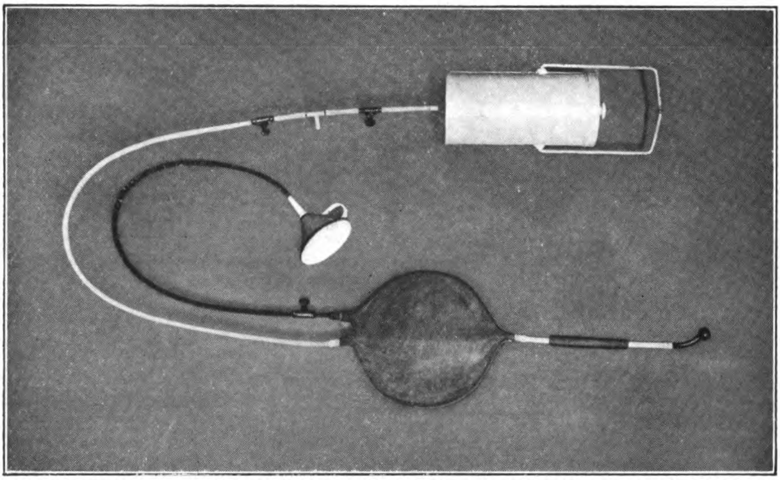

PLATE LI. A seepage apparatus with device for warming fluid.

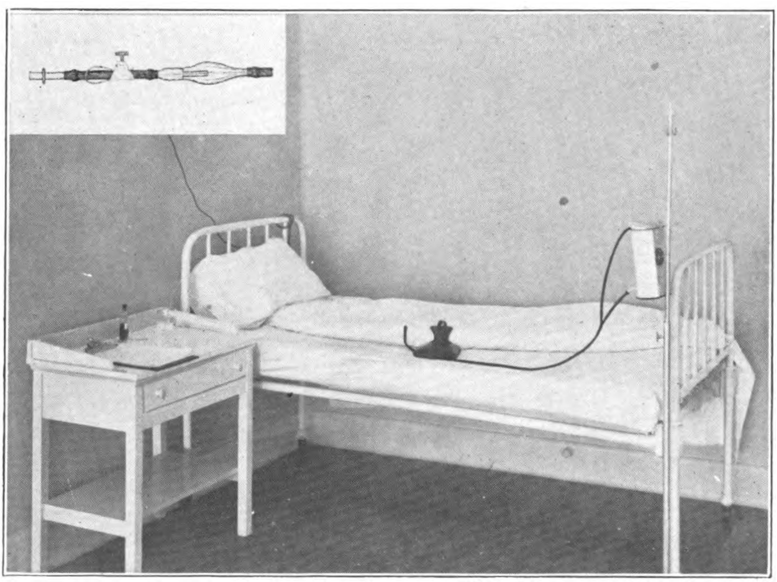

PLATE LII. Continuous proctoclysis with hot-water bottle for warming fluid; corner figure—dropping device.

of turpentine. Follow by a plain enema. The turpentine enema is given in the same way and for the same purpose as the asafœtida enema. Its action is somewhat more vigorous. It should not be used where there is kidney irritation or Bright's disease.

Glycerine and Epsom Salts Enema

The glycerine and Epsom salts enema is a vigorous purgative. It is used in cases of fecal impaction and obstinate constipation (obstipation).

Just before using, prepare a mixture consisting of two ounces of magnesium sulphate, two ounces of glycerine, and sufficient warm water (about two ounces) to make it pass readily through the colon tube.

First, cleanse the lower bowel from feces and then inject the mixture by high bowel catheter, using gentle pressure with a rubber bulb if necessary. Considerable patience and persistence may be necessary to secure results. In supposed cases of fecal impaction, great care should be exercised in diagnosis that a case of intussusception is not treated in this way.

Starch Enema

The warm starch enema is given to relieve irritation and check diarrhœa. Make a thin paste of starch in one or two ounces of cold water. Add hot water enough to make from four ounces to one pint of solution. Inject slowly after giving a hot cleansing enema. The sedative effect may be made much greater and pain relieved by adding five to twenty drops of laudanum.

Astringent Enema

An astringent mixture is useful in controlling or checking diarrhœa and dysentery; also in inflammation of the rectum. The bowel should be cleansed by a plain enema of warm or hot water before the astringent is injected. Usually from four to eight ounces is all that is desirable. Either of the following formulæ may be used:—

(*a*) A heaping tablespoonful of tannin to one pint of water at 100° F.

(*b*) An ounce of glycerite of tannin to one pint of water at 100° F.

Quassia Enema

The quassia enema is used to destroy and remove thread or pinworms (oxyuris vermicularis). Prepare an infusion of quassia by pouring over one and one-half drams of finely rasped quassia wood, twenty ounces of warm water; let it stand twenty to thirty minutes and strain. Use a plain cleansing enema first; then cleanse the colon thoroughly with warm water containing a teaspoonful of borax to the pint. Now inject into the colon (coloclyster) a half to a pint of the infusion of quassia; retain as long as possible. A 1—10,000 bichloride solution may be used instead of the quassia. It should not be retained very long.

Quinine Enema

The quinine enema is used for amœbic dysentery. After thorough cleansing of the bowel by low enema and colon flushing, inject by high bowel catheter, from two to four or more pints of a warmed solution of quinine; 1—1000 or 2500. Large and frequently repeated coloclysters of cold water may be used. Quinine kills the amœbæ. Cold water paralyzes them for a time. Position of patient—hips elevated.

In very obstinate and long standing cases of amœbic dysentery, colonic flushings with cold water or the quinine solutions are sometines carried out by means of appendicostomy.

VAGINAL DOUCHES OR IRRIGATION

A vaginal douche consists in the flushing or irrigating of the vaginal cavity by a fluid.

General Directions:—

(*a*) *Articles Necessary in the Treatment Room.* Douche bench, fountain syringe or douche can with a capacity of one or two gallons, five or six feet of rubber tubing, douche tube of glass or hard rubber, lubricant, disinfectant, sheets and napkins. Additional need in private room: Standard or hooks for douche can, a douche pan, slop jar, and rubber sheeting or papers.

(*b*) *Procedure.* Preparation of the douche. Fill the can with from two to four quarts of water at the prescribed temperature and place it from three to four feet above the patient. Always use a thermometer in preparing vaginal douches.

Preparation of patient. If the clothing is not removed, protect thoroughly. Always cover the patient with a sheet. Lubricate the tube with vaseline or soap. Release the cut-off and allow the water to run a few seconds. Instruct the patient to insert the tube unless helpless.

Position of patient. Dorsal position with hips raised and thighs and legs flexed.

I. Plain Vaginal Irrigation

Vaginal Irrigation for Ordinary Use

1. Hot Vaginal Irrigation—V. I. This is used for cleansing purposes. Two to four quarts of water are employed at a temperature of 105°—115° F. Finish with a pint of water at 70° F.

In the treatment of pelvic inflammations, the hot vaginal douche is usually given as a preliminary to the use of the sitz bath, hot half-bath or the hip and leg pack.

2. Very Hot Vaginal Irrigation—H. V. I. The very hot vaginal irrigation is designed for the relief of pain or to check hemorrhage. Two to four quarts of water are used at a temperature of 110°—125° F.

3. Alternate Hot and Cold Vaginal Irrigation—H. & C. V. I. Alternate hot and cold vaginal irrigation is given for tonic and stimulating effects. It is also used in chronic pelvic inflammations. Use two cans with a Y-tube connection. Put four quarts of water in one can at a temperature of 110°—120° F., and two quarts of water in the other at a temperature of 70° F.

Give the hot fifteen to thirty seconds and the cold five to ten seconds. Continue the alternations for five to ten minutes, beginning with hot and finishing with cold.

Vaginal Irrigation During Pregnancy

During pregnancy certain precautions must be observed. The pressure of the water must not be too great, *i. e.*, the douche can must not be placed too high. Very cold water or extremely hot water should not be used. It is positively necessary that the openings in the bulb of the douche tube be lateral and not directly on the end. During pregnancy vaginal irrigation is given chiefly for cleansing, for the treatment of leucorrhœa and for the relief of irritation. Use two to four quarts of water at a temperature of 98°—105° F. Hang the douche can twelve to eighteen inches above the hips.

II. Disinfectant and Medicated Douches

Soap Suds Vaginal Irrigation—S. S. V. I.

Use two quarts of soap suds solution prepared from laundry soap or green soap solution at a temperature of 105°—110° F. Wrap the tube in cheesecloth and swab the vagina carefully, but thoroughly, while the water is flowing. Follow by plain vaginal irrigation, then give a permanganate or bichloride douche.

The soap suds vaginal irrigation is used to prepare patients for surgical operations or for special cleansing and disinfectant purposes.

Permanganate of Potassium Vaginal Irrigation—P. V. I.

To one quart of water add two drams (two teaspoonfuls) of a saturated solution of potassium permanganate (1—2000). Temperature, 110°—120° F. Precede by a plain vaginal irrigation. Oxalic acid (sat. sol.) will remove the stain.

The permanganate douche is used as a deoderant and disinfectant in the treatment of vaginal inflammations, leucorrhœa, etc., also as a disinfectant preparatory to operation.

Bichloride of Mercury Vaginal Irrigation—Bichlor. V. I.

Use one dram (a teaspoonful) of a saturated solution of bichloride of mercury to one or two quarts of water (1—4000 or 8000). Temperature, 110°—115° F. Always precede by plain vaginal irrigation, so as to remove all mucus and other secretions. If this is not done the disinfectant properties of the bichloride are lessened by its combination with albuminous substances.

Carbolic Acid Vaginal Irrigation—Carb. V. I.

Use one-half ounce of a five per cent solution to one quart of water. Temperature, 110°—115° F. Be sure that the solution is thoroughly mixed with the water, otherwise a carbolic acid burn may result. Always have alcohol at hand in giving this douche.

Creolin or Lysol Vaginal Irrigation

Use a one or two per cent solution of either lysol or creolin in water at a temperature of 110°—120° F. These disinfectants are much used after confinement where puerperal infection has occurred or in case of a suspicious odor to the lochia.

Acetic Acid or Vinegar Vaginal Irrigation

The acetic acid douche is used to check hemorrhage. Use one quart of boiled vinegar to one quart of water or one ounce of glacial acetic acid to one quart of water. Temperature, 115°—120° F.

Alum Vaginal Irrigation—Alum V. I.

The alum douche is also used to check hemorrhage or prolonged menses. Add one pint of a saturate solution of alum to one pint of water. In extreme cases the sat. sol. may be used. Temperature, 115°—120° F. Precede by plain hot vaginal irrigation.

PRESCRIPTION WRITING AND TREATMENT COMBINATIONS

NEITHER the art of prescription writing nor a working knowledge of therapeutic effects can be obtained without preliminary training and experience in the technique of hydrotherapy. Treatment combinations which are agreeable and pleasing to the patient are perfectly compatible with scientific arrangement; in fact, combinations which are disagreeable are rarely efficient and need alterations or additions in order to become so. On an average, treatments given to ambulatory patients in the treatment rooms should require about forty-five or fifty minutes. Except with certain applications, a longer time is usually detrimental rather than beneficial. With bed patients, in cases of nephritis, pleurisy, pneumonia and other inflammatory diseases, organic nervous diseases, etc., each case should be a law unto itself as to the duration of treatment and the frequency with which applications are to be repeated. A mistake very commonly made in prescribing hydrotherapy is the giving of a different treatment each day. If a medicine were to be taken, no one would think of altering it for each day. For the same reason hydrotherapeutic treatment should vary only as the patient's condition varies, as improvement occurs, or some special result is to be obtained.

In the proper combining of procedures lies the philosophy of securing a predetermined physiologic effect, and hence a desired therapeutic result in a given case. It requires a far more intimate knowledge of normal and abnormal physiology in order to prescribe hydrotherapy than it does to prescribe medicinal substances for internal medication. The securing of results in difficult cases requires also a much closer personal supervision.

In making treatment combinations it should be a general rule *to combine for simultaneous application as many of the individual procedures to be given as possible and secure the desired result.* For example, in giving a hot foot bath, hot and cold to the spine, and a cold mitten friction, the patient may take the hot foot bath and the hot and cold to the spine simultaneously, if they are able to sit up. The cold friction should be begun with the arms when the last fomentation has been applied to the spine. After treating the arms, the fomentation is removed from the spine and the cold friction given to the back. The feet are removed from the hot water only when the attendant reaches the legs and feet with the cold friction. This combination is more pleasing to the patient, it secures better results, and requires less time than where each procedure is given separately, one following the other. Such a combination is much easier to give in case of a prescription for a hot foot bath, fomentations to the abdomen and a cold mitten friction. The patient may recline for all of the treatment. The hot foot bath is started, then the fomentations to the abdomen, and when the third one has been placed, begin the cold friction with the arms, removing the fomentation to the abdomen when ready to treat the anterior part of the trunk. The feet are next removed from the hot water and the friction given to the legs and the feet. Lastly the patient turns and the back is treated. Given in this way, the reaction from the cold friction is more prompt in appearing and more complete, because the hot applications give a sensation of heat. The use of the hot foot bath, the ice bag to the heart, the cold compress to the head and neck simultaneously with other applications *act precisely like adjuvant and corrigens agents in medicinal therapy.*

Also as a general rule, *treatments to be given on a treatment table should precede treatments to be given in the wet rooms.* For example,—fomentations over the liver, a salt glow, and a hot and cold percussion douche to the spine and legs. Coming in any other order than that given would entail repeated drying of the skin surface, and so lessen the pleasing effect of the treatment.

This same prescription serves to illustrate the principle that *the milder procedures should be given first, those which produce the greatest reaction last.* The fomentation is a mild application, the salt glow is more vigorous, and the hot and cold douche to the spine and legs the most stimulating of the three. The first two prepare the patient for the last application. Given in any other order, the treatment would resemble an anticlimax.

Somewhat the same principle is involved in the rule that *in a single treatment there should not be given two generalized applications of cold, both of which are designed to produce a tonic reaction.* For example,—a cold mitten friction and a wet sheet rub should not be given in the same treatment, nor a cold towel rub and a hot and cold douche to the spine and legs. Such combinations draw too heavily upon the patient's reactive powers.

Such sweating treatments as the electric light bath, Russian or Turkish baths should be immediately followed by a shower, spray or pail pour so as to wash off the skin surface, cool the body quickly and produce such a reaction that the patient will not take cold.

In the application of therapeutic agents the physician should incline more and more to *specific* therapy. But each case should be studied with a view to individualizing the treatment so as to treat the patient, not merely his disease.

The following prescriptions will serve to illustrate the rules given above and in a general way be suggestive of the proper treatment in the conditions named.

Onset of Grippe

H. Lg. B., Fo. Sp., C. C. Hd. & Nk., drink hot lemonade (to free perspiration), Grad. Sh. 115°—90°, 5 Min.

Chronic Cold in Head

H. Ft. B. or H. Lg. Pk., Alt. H. & C. Hd, 30 Min.; C. C. Hd. & Nk., H. & C. Perc. D. Ft. (6 changes).

Dilated Colon and Atonic Constipation

Fo. Abd., C. rub Z. 80°, 5 Min.; Alt. H. & C. Fan. D. Abd., Alt. H. & C. Perc. D. to lower D. and L. Sp., S. Sinu.—stabile electrode to lower D. and L. Sp., labile hand Spg. to Abd. over colon.

Acute Salpingitis (Left)

H. Hp. & Lg. Pk., ice bag above left groin, 20—30 Min., Cmf. Leave ice bag over tube or apply heating compress.

Acute Pleurisy (Right)

H. Ft. B., Fo. Rt. Ch. (until pain is relieved, 4 or 5 if needed), Cmf. (to all but Rt. Ch.), apply dry Ch. Pk. or warm flannel vest.

Chronic Pleurisy (Right)

H. Ft. B., Fo. Rt. Ch., Alt. H. & C. Spr. D. Rt. Ch., Perc. D. to Ft.

Acute Uremia

Hypotonic Sal. En. 1 Pt., H. B. P. reinforced with hot-water bottles, ice Bg. over Ht. and lower sternum about 30 Min., tepid Spg. or light Cmf. Place between warm blankets.

Acute Mastoiditis

H. Lg. B., ice bags over carotids, large Fo. over mastoid, 30 Min.; Cmf. to Lgs.

Acute Pharyngitis

H. Ft. B., Fo. Th. and upper Ch., C. C. Hd., Cmf., Heating C. Th.

Bronchopneumonia in Five-year Old Child

Warm tub bath, 102°, 6 Min., Heat. W. S. P., leave child alone if it sleeps, if not remove in 1 Hr. by tepid Spg.

Acute Gonorrhœal Arthritis of Knee

Ice Pk. knee 1 Hr., Alt. H. & C. Spr. D. knee.

Chronic Syphilitic Arthritis of Knees

Fo. knees, Alt. H. & C. Spr. D. knees (6 changes).

Acute Cholecystitis

H. Ft. B., Fo. liver and upper Abd., Cmf. (avoid Abd.), M. A. B.

Mucous Colitis

Hypertonic Sal. En. (knee Ch. position) (pass in 20 Min.), Fo. Abd., Cmf.

Prostatic Hypertrophy and Chronic Cystitis

H. Ft. B., Fo. lower Abd., Rev. Z.

Old Gleet

Alt. H. & C. Rec. Irrig., Rev. Z., Alt. H. & C. perineal D.

Splanchnic Neurasthenia

H. Ft. B., C. coil Abd., C. C. Hd., 30 Min.; Cmf.

Persistent Vomiting

Hot & Heat. Tr. Pk. (apply 10 Min. before meal, leave on 1 to 2 Hrs., Cmf.

Hyperchlorhydria

Two glasses hot water 15 Min. before meal; ice Bg. over St. after meal 20 Min.

Chronic Mitral Insufficiency
(with cardiac liver and edema of legs)

Ice Bg. Ht., Rev. C. liver, Alt. H. & C. Lg. B. (6 changes), Cmf., Cf. Lgs.

Acute Endocarditis with Dilated Heart

Ice Bg. over Ht. 30 Min. every Hr., H. Lg. Pk. (up to knees only), ice Bg. Ht., Cmf. (give twice daily).

Insomnia

Fo. Sp., O_2 B. (5 P. M.).

Varicose Ulcer

Alt. H. & C. Lg. B., 30 Min. daily (increase usual duration of cold to equal with, then greater than, the hot), Alt. H. & C. Spr. D. Lgs.

Lumbago

Fo. lower Bk., H. & C. Perc. D. to same, short static spark to painful muscles.

Trophic Ulcer or Diabetic Gangrene of Foot

Alt. H. & C. Ft. B., 30 Min. twice daily.

Hemorrhoids

Prolonged C. Shal. Z., 90°—70°, 10 to 15 Min.; Alt. H. & C. perineal D.

HYDROTHERAPEUTIC APPARATUS AND TREATMENT ROOMS

THE plan and equipment for hydrotherapeutic treatment rooms must of necessity vary with the institution in which they are to be used and the class of cases to be treated. We shall have most to say of treatment rooms for general use in institutions that accept all classes of medical and surgical cases and the ward equipment in general hospitals.

In hospitals for the insane the equipment need not be extensive in variety, but many pieces of the same kind are necessary. Especially should the receiving ward appliances for the treatment of mania be numerous enough to treat many cases simultaneously. The tubs for the continuous flowing bath together with their mixers and controllers and the pack tables with their outfit make up the chief equipment required. These should be separate from other appliances. as perfect quiet is essential. For general use, another room or rooms should be fitted with a spray and douche controller and its spray, shower, douches, bidet or other attachments. Sitz tubs and flowing bath tubs are best not connected with the spray and douche controller, but should be separately controlled. In the same room or an adjoining room should be the electric light bath cabinet and the hot air and steam cabinets for the Turkish and Russian baths. Here and there, convenient to the general wards of the institution, should be arranged pack tables and tubs for the flowing bath, also a fomentation tank and an enema and vaginal douche bench.

General Treatment Rooms

In sanataria and office treatment rooms the plan and equipment should be ample for administering all forms of hydrotherapy. Convenience of use and economy of operation are most essential. In any but very small institutions separate rooms should be provided for men and women so that they may be used at any hour of the day or night. Considerably more than fifty per cent of all cases are best treated in the forenoon hence the disadvantage of common rooms in which separate hour must be arranged.

As far as possible treatment rooms should be on the ground floor because of the great expense not to say almost impossibility of rendering floors wholly non-leaking. However this may be accomplished by the use of sheet lead as a base for cement or the use of the more expensive floorings of woodstone, plastone, etc. Glazed tile walls and unglazed tile flooring are very serviceable but are not proof against cracking. Marble is excellent for the walls of spray and douche stalls but solid concrete walls are equally durable.

Every treatment room should be divided into three separate sets of apartments by partitions from floor to ceiling so that a different temperature may be maintained in each. This is an essential which should not be overlooked or disregarded as otherwise great annoyance, inconvenience and even danger may result to patients from overheating and taking cold. The first room should contain the matron's, treatment director's or head nurse's office, the linen supplies, waiting room, and the patient's dressing rooms. The temperature of this room should be about 68° F. and well ventilated. The next room should contain the individual treatment rooms, each provided with a treatment table, a stool and hooks or bars for towels, sheets, etc. The temperature of this room should be about 80° F. or so that it is comfortable for patients while taking packs, fomentations, cold frictions, massage, etc.

The third room which we may appropriately speak of as the wet room is to be maintained at a higher temperature and contains at one end sitz tubs, leg tubs, the full length bath tubs, salt glow room, etc. If the temperature of the wet rooms is too high these appliances should be separated from it. At the other end of the wet room should be installed the spray and douche controller and its attachments and all the appliances for hot baths such as the electric light, Turkish and Russian cabinets or rooms. If thought best these latter may be placed in a room immediately adjoining the spray and douche apparatus but in any case the patient should have to go only a few steps from any hot bath to the spray, so that there will be no opportunity for chilling. A drying room opening from the spray room is also a distinct advantage. The fomentation tank and steam boxes should be convenient to the treatment tables so as to save unnecessary steps. They should have hoods over them for carrying off the steam. If these are not provided the steam boxes should be installed in the wet rooms.

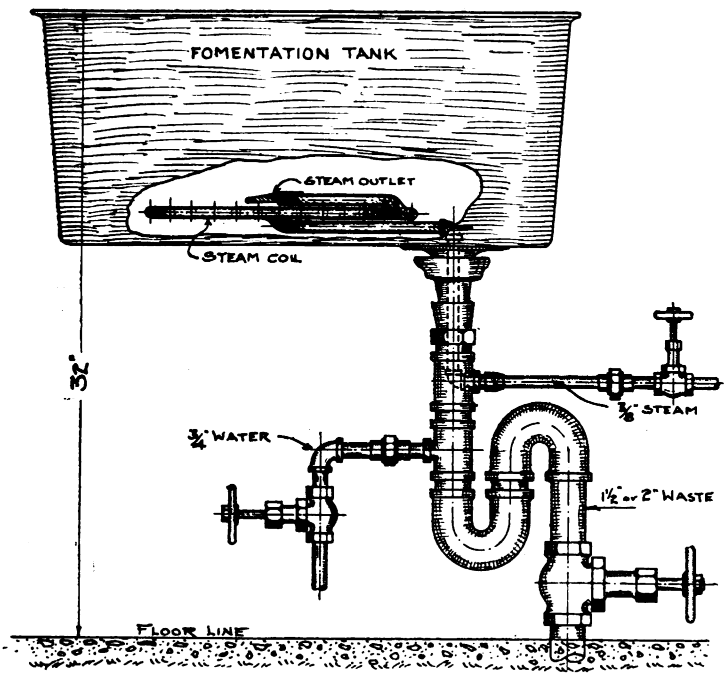

Fig. 61. Plan of fomentation tank.

The walls, ceiling, and all partitions in the wet rooms should be of some impervious material upon which water and steam will have no effect. Cement is best and cheapest for floors. Cement on metal lath for partitions and frosted or figured glass above six feet is most serviceable and durable. Marble or tile may be used but is more expensive and no more durable. Figured pressed metal may be used for ceiling if the joints are perfect and the whole painted and enameled.

Treatment Appliances

The Fomentation Tank. This should be an enameled iron tank of oblong deep form preferably with an end outlet. If it is to set against the wall it may be filled by an ordinary wall faucet. Where many nurses are working at the same time it is best to have the fomentation tank set away from the wall so that two wringers may be attached (*Plate XXIII*). In this case the inlet should be from below just above the trap for the waste (*Fig. 61*). The waste should be controlled by a valve, never by the ordinary plug in the bottom of the tank. The

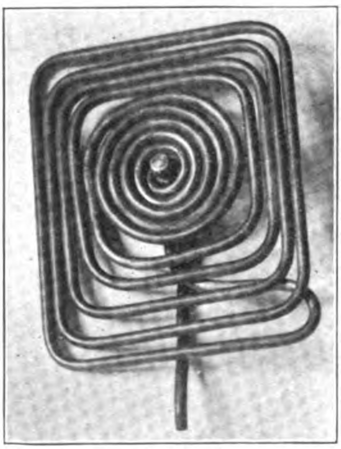

Fig. 62 Steam coil for heating fomentation water—obverse.

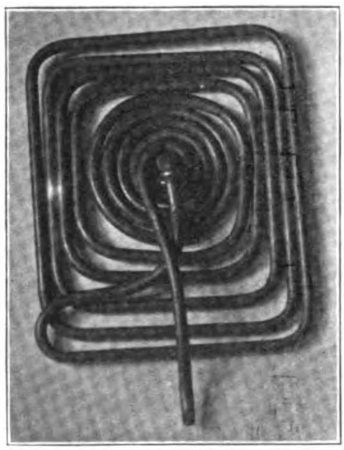

Fig. 63. Steam coil for heating fomentation water—reverse.

water should be heated by a long copper coil (twelve or fifteen feet of eighth-inch pipe) through which live steam passes. The supply pipe to this coil also enters from below and is controlled by a valve. The entering steam should go to the center of the coil and the steam exit be by a perforated disk also at the center of the coil (*Figs. 62 and 63*). This arrangement prevents "bumping" and the operation of the coil is absolutely noiseless even in cold water. The wringers should be extra long and may be made by replacing the rubber-covered rollers of an ordinary steel spring wringer by rollers made of two-inch galvanized iron pipe. When bolted on at the end of the tank and ready for use, the rollers should be covered with heavy unbleached muslin by rolling the cloth on so as to make the covering about three layers thick.

Steam Boxes. When heated directly by live steam, fomentations and packs are hotter and the heat is retained longer than when wrung from boiling water. For this purpose steam boxes may be provided or several cloths steamed in a papier

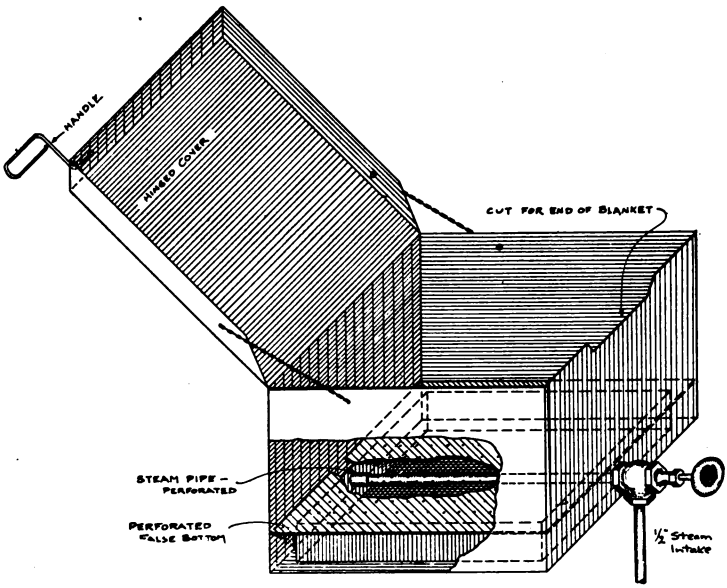

Fig. 64. Plan of steam box.

mache pail. In the former case the boxes may be arranged as shown in *Plates XXIV and XXV.* The steam inlet should be by a perforated pipe below a perforated false bottom (*Fig. 64*). The box should have an outlet for the condensed steam. One end of the box should have a long shallow notch in it through which the end of the folded fomentation cloth or pack blanket may project. The cover should have turned down edges one and one-half or two inches wide which should fit over the walls of the steam box. The steam should be turned off when the box is opened.

Leg Tubs. These should be made of heavy galvanized iron. They should be sixteen inches in diameter and twenty-four inches high. The bottom should be set up about two inches from the base. It should have an extra ring of galvanized iron soldered underneath to help support the weight of the water. The outlet may be by a large size molasses faucet (*Fig. 65.*) or a flume gate of galvanized iron (*Fig. 66. and Plate IX.*). Two such tubs are necessary.

Foot Tubs. Foot tubs should be made of medium weight galvanized iron. An elliptical shape is best with rigid handles at the ends. The base should be about eleven inches in cross diameter and fifteen inches long. The sides should flare to a cross diameter of about fifteen inches and a long diameter of

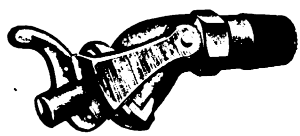

Fig. 65. Molasses faucet outlet for leg tub.

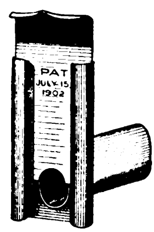

Fig. 66. Campbell flume gate outlet for leg tub.

nineteen or twenty inches. The tub should be nine inches deep. Two extra sets of hot and cold water faucets should be provided at some convenient place for the filling of foot tubs, pails, basins, etc., so that it will not be necessary to go to bath tubs or the douche controller for this purpose.

Bath Tubs. Bath tubs should be six feet long for men and five and a half or six feet for women. They should be set up from the floor four to six inches. If this extra base is of well painted wood it will serve also for the insulation necessary in giving electro-thermal baths. For the latter purpose the mixing faucet supply should be attached to the wall at the foot of the tub and have no connection with the tub itself (*Plate XXXIX*). The outlet should also be disconnected from the plumbing, the waste water running into a cement gutter. The overflow should be carried up under the roll of the tub and curve down so as to discharge into the same gutter. This allows of filling the tub to nearly its full capacity, as is desirable in giving the neutral bath and the oxygen bath. A drill hole at the highest point of this overflow will prevent siphonage. Where the Nauheim bath is given frequently, a wooden, or better a glass tub, should be provided as the acid soon destroys the metal fittings.

Sitz Tubs. These should be of the deepest pattern that can be secured. They should have a broad roll under the knees and a high back. If the overflow does not permit of filling the tub nearly to the knee roll it should be altered so that this may be done, as many abdominal as well as pelvic conditions are amenable to a very deep sitz bath. For giving the alternate hot and cold sitz, two such tubs should be installed side by side.

Electric Light Cabinets. For the upright cabinet a hexagonal shape brings the lights nearest to the patient and the mirrors concentrate the light upon the patient more perfectly (*Plate XLVI.*). Thirty-six incandescent bulbs arranged in six upright rows of six each at the angles of the cabinet are sufficient if the mirrors are perfect and of large size. Some manufacturers use fifty lights. Each row is controlled by a separate switch or all may be turned on from one switch. The mirrors should cover the entire space between the columns of lights. A small bunch of lights may be arranged under a heavy glass at the feet or they may be more effectively warmed by a hot foot bath. For the horizontal cabinet, some manufacturers use a cylindrical cabinet with a sliding table similar to the cabinet used for the superheated air bath (*Plate XLIII.*). We prefer a cabinet made of an extra wide treatment table with cane top under which about three bunches of lights are arranged so that these may be turned on for the feet and legs only or the hips or spine only; and over which is fastened by hinges at one side a large semicylinder likewise fitted with lights arranged in circular rows so that one or more of these may be turned on as desired (*Plate XLVII.*). This cylinder is shorter than the table so that the head may be outside. The opening for the neck in either the upright or the horizontal cabinet should not be of rigid material as it is too suggestive of confinement in nervous patients and is undesirable in any case.

Russian and Turkish Bath Rooms. The construction of these has been quite fully considered under technique. We prefer a cabinet in the form of a room so that the patient may recline on a marble slab with the head outside a sliding window. There is less danger of fainting with the patient in this position and the same may be said of the horizontal electric light cabinet. Besides this the marble slab may also be used for shampoo purposes and a shower for cooling off the patient be installed in the same room (*Plates XL and XLI*). Where steam coils are arranged under the marble slab a thick layer of some non-conductor of heat should be placed over these coils so that the marble will not become overheated.

Dryer. A dryer for fomentation cloths, sheets and towels is a necessity in every treatment room. This may be made after the plan of a laundry dryer being heated by steam coils. It is well to have several trays or carts that pull out separately. These may conveniently run on sliding door hangers or a similar device. Each one should be seven or eight inches wide by five or six feet high and consist of five or six half-inch gas pipe bars six feet long. The number of such pulls required will depend upon the number of patients to be treated. A dryer of six takes up but little space and is ample for twenty-five to forty patients a day. It is well for sake of convenience to install this near the fomentation tank and in the part of the wet rooms where the greatest amount of heat is needed. This economizes both time in labor and expense in heating as some heat will inevitably escape from the dryer, even though tightly built and separate ventilation provided for.

Enema and Douche Outfit. These rooms should be so arranged that they are ventilated entirely separate from the general treatment rooms, best directly to the outside. A bench of drain board material six feet long and about twenty-four inches wide should be fitted over the toilet fixture in place of the ring and lid. At the right hand end of this should be placed the standards for hanging the enema and douche cans. *Plate LIII* shows a standard for holding two irrigating cans

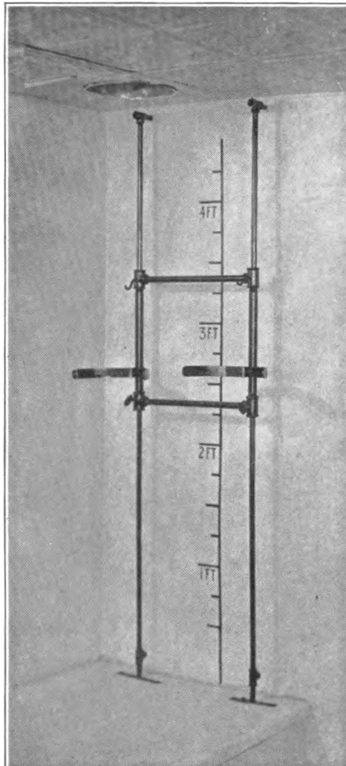

PLATE LIII. Adjustable standard for enema and douche cans.

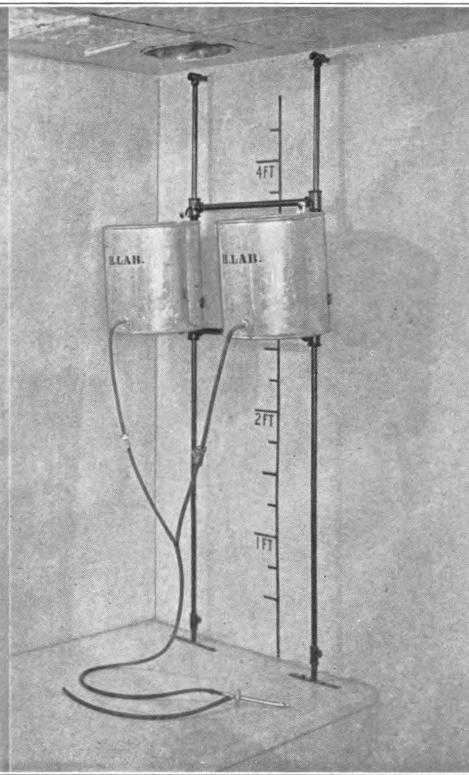

PLATE LIV. Enema cans arranged for alternate hot and cold rectal irrigation.

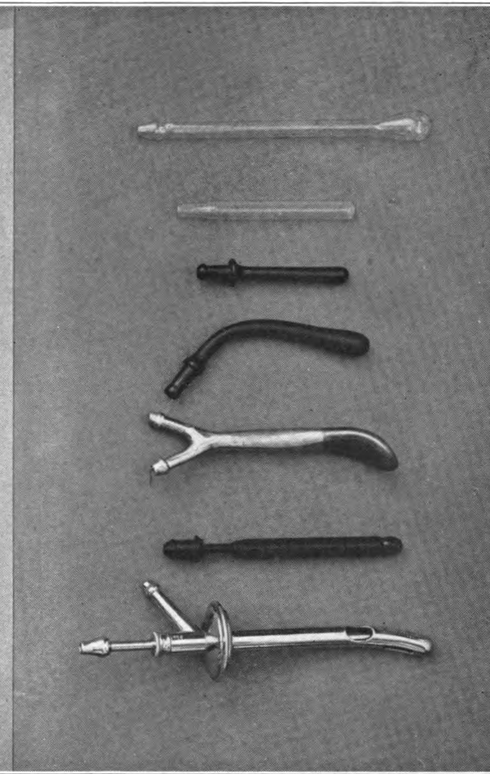

PLATE LV. Rectal and vaginal tubes.

each of two and a half gallons capacity. This standard consists of two one-fourth inch pipes fastened firmly against the wall fourteen inches apart. On these slides a piece fourteen inches high and fourteen inches wide made of two one-half inch upright pipes fastened together by three-eighth inch pipe. Hooks for the ears of the irrigating can are fixed in the upper T's and thumb screws in the lower T's. Near the bottom are fixed curved metal strips which hold the cans firmly and prevent rocking. This device allows of placing the cans at any desired height and holds them firmly in place. It is simple and inexpensive. *Plate LIV* shows two enema cans arranged for giving alternate hot and cold rectal irrigation.

The enema and douche can is made of heavy tin nine inches in diameter and ten inches high. The bottom is set up a little from the base and slants forward to the outlet which is bent downward at its free end to prevent breaking of the rubber tubing. The lower end of this outlet is slightly above the base of the can so that it may set squarely on a flat surface. In the enema and douche room should be provided a stationary wash bowl with pantry cocks or a small sink with high set faucets so that the cans may be filled directly from the faucets without using a dipper.

Plate LV shows the rectal and vaginal tubes needed with the enema and douche outfit. From above down they are—glass vaginal tube, glass enema tube, hard rubber enema tube, bent hard rubber rectal tube for Murphy enteroclysis, prostatic cooler or psychrophore, hard rubber rectal irrigation tube, metal rectal irrigation tube. Besides these there should be a large bowel catheter or colon tube.

Spray and Douche Controller. This apparatus is an absolute essential to any treatment room. By means of it the effect of almost any other treatment that may be given to ambulatory patients can be duplicated and in many cases the effects are greater and more lasting. The construction of a hydrotherapy controller is a very important matter, for without perfect construction, efficient work can not be done and the results are disappointing. The construction must be such as to make possible absolute precision of application.

There are certain essentials without which satisfactory results are impossible. Of first importance is the water supply. The controller must be supplied with hot and cold water by pipes directly from reservoirs or tanks. These pipes should supply no other fixtures. They should be entirely independent of all other attachments. If this is not done the temperature of a douche stream or of the spray will vary whenever water is drawn from attached faucets. For example, if the hot and cold water supply to a nearby bath tub comes from the pipes

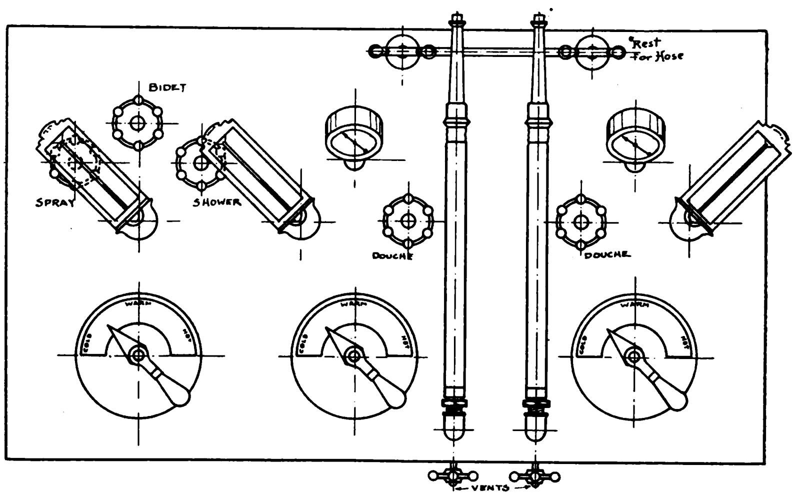

Fig. 67. Plan of top of table control shown in Plate L.

supplying the controller and, while a douche is being given at 115° F., the attendant at this bath tub opens the cold water faucet the pressure on the cold water supply to the douche being lowered, the proportion of cold water in the mixer will be instantly lessened and just as instantly the temperature of the douche will shoot up ten, twenty, or more degrees and the patient will be burned. Even with wholly independent supply pipes the pressure of the incoming water should be controlled by pressure regulators so that the pressure of the hot water and of the cold water may be adjusted to the same number of pounds. The temperature of the hot water should be regulated at the tank by a thermostat which should be arranged for about

185° F. The cold water should be supplied at a temperature of 40°—55° F., and except in summer does not usually require cooling.

There are two types of controller—the table control and the wall control. The table control is usually more complete and more satisfactory. It is a more elegant piece of furniture but is likewise more expensive. The wall controllers on the market are most of them incomplete and less satisfactory than the table control. However, the handling of the douche hose is more convenient and with attention to the essentials of construction the wall control may be made nearly as complete and satisfactory as the table control.

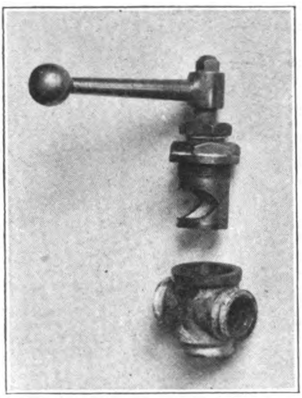

Fig. 68. Martinson mixer, showing its construction.

Plate L illustrates a hydrotherapy control table devised by the author. *Fig. 67* shows the arrangement of the top of this table. As will be seen it is a three unit controller, *i. e.*, it will deliver three independent streams of water at different temperatures. This requires three mixers, two of which supply douche hose—one for the hot douche and one for the cold douche. The third mixer supplies the spray, the shower, and the bidet, no two of which attachments is it desirable to use at the same time.

The internal construction is as follows: The pressure regulators are attatched to the supply pipes just before they divide for the three mixers. These pipes, one for the hot and one for the cold water, are one and one-half or two inches in diameter. From each are taken off three one-inch pipes, each of which latter are fitted with valves and check valves, the latter being placed as close to the mixers as possible. These check valves are an absolute necessity as otherwise the cold water pipes may fill with hot water through the mixer, or vice versa, even with a very slight difference in pressure. *Figs. 68 and 69* show two styles of mixer valves. The first is less expensive and quite satisfactory. The second costs a little more but responds a little more evenly and hence is more satisfactory. Where used without other valves, it must open with the cold water first, and is therefore said to be non-scalding.

From the mixer the water passes over the bulb of the thermometer, which should be placed as close as possible to the mixer so that any changes in the temperature will be registered without delay. Beyond the thermometer is the valve which opens the douche and regulates the volume and pressure of the stream. Just beyond this valve the pressure gauge is attached.

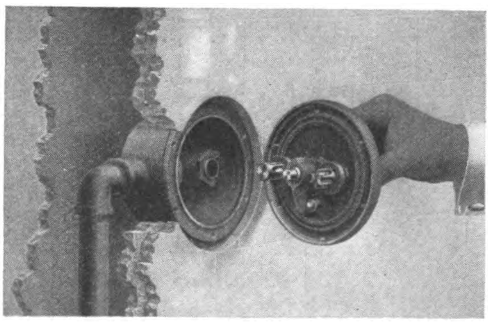

Fig. 69. Niedecken mixer, showing working parts.

It is placed here so as to register the "using" pressure, *i. e.*, the pressure administered to the patient. Still beyond this, but below the marble top of the table, the inch pipe divides into two three-fourth inch pipes, one for the douche hose and one to serve as a vent which latter is controlled by a valve. The vent valve should be opened whenever the douche is being used in order to keep going through the mixer the large volume of water, which is always required to maintain a constant unfluctuating temperature. Were there no vent, the temperature would rise unduly when a low pressure is being administered. In operating a controller with only one douche unit, it is impossible to secure absolutely instantaneous changes from hot to cold. For the method of operating the douche units the reader is referred to the section on spays and douches.

The nozzle attachments for the douche and the shape of the streams they produce are shown in *Fig. 70*. The upper figure is the jet, or percussion douche. The middle figure shows the spray douche and the rosette attachment for producing it.

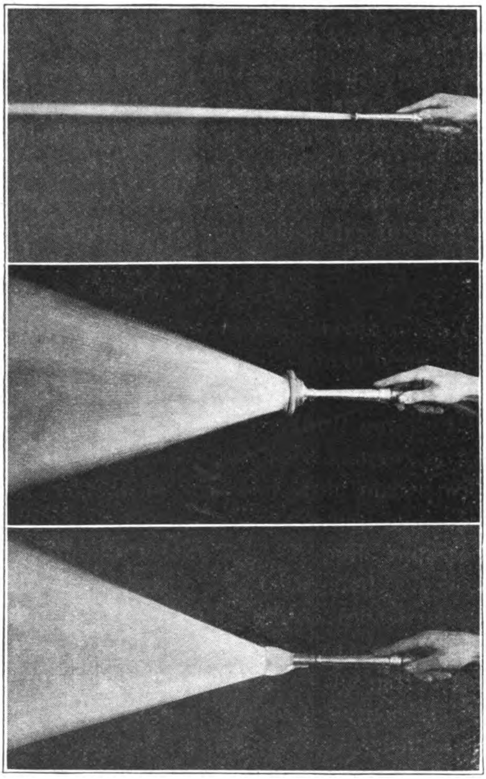

Fig. 70. Jet douche, spray douche, fan douche.

This is used where percussion is not desirable and a large surface is to be treated. The lower figure shows the fan douche. It is produced by a flat blade attachment which spreads the stream into a sheet of water. Both the fan and the rosette are attached by screwing onto the jet nozzle.

The stall for the shower and spray should be located about eight feet from the control table. The shower head should be eight inches in diameter. It is best to have it attached by a ball joint union so it may face directly downward or be inclined forward at an angle of forty-five degrees, so that the patient's head need not be wet. In *Plate L* the shower head is shown facing straight down. The spray is constructed of four upright pipes, to each of which are attached four rosettes. The upper row of rosettes are attached by ball joint unions so that they may be adjusted upward or downward for individuals of different heights.

The arrangement of the bidet is shown in *Fig. 71.* A ball union makes it possible to turn the arm carrying the rosette out of the way and back against the wall when it is not in use.

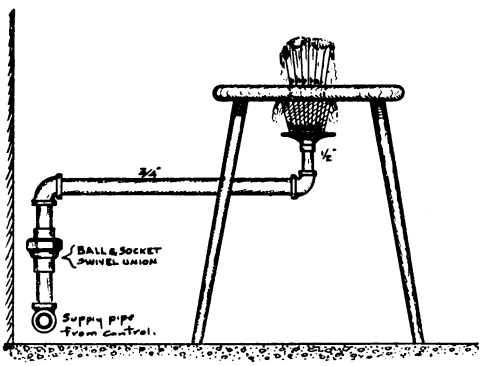

Fig. 71. Plan of seat spray for perineal douche.

The stream should not be a jet, but a spray douche, obtained by a rosette, as it is desired to cover a medium size surface without percussion. Since the volume of water is not large, the shower valve should be opened to act as a vent. In the case of the two unit wall control (*Fig. 72.*) the bidet is attached to the same mixer that supplies one of the douches, so that a regular vent is provided.

Fig. 72 shows a spray and douche controller of the wall type devised by the author. It consists of two instead of three units. One treatment combination, *viz.*, a hot spray simultaneous with an alternate hot and cold douche to the spine and legs it is impossible to give with this machine. If the changes in the douche temperature were made by the mixer, it would alter the temperature of the spray, hence this treatment is impracticable without three units. Nevertheless, for all other treatments it is equally as efficient as the table control. On the other hand, it has the advantage that the operator sitting on a high stool facing the controller can keep his finger in the

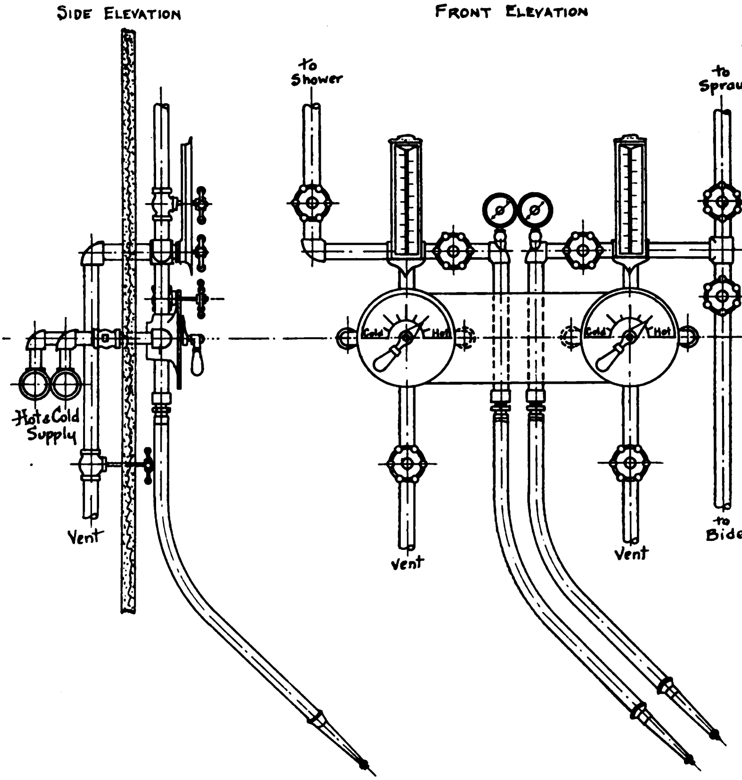

Fig. 72. Wall control, showing front and side elevation plans.

stream of water from the douche hose, and so add this element of protection to the patient in case the temperature of the water should suddenly run up while his eyes are on the patient instead of the thermometer. However, with the table control the thermometer and the patient are both in front of the operator and but a slight turn of the head or eyes is necessary to glance from one to the other.

The wall control should be supplied by independent pipes in the same way as the table control. It must also have pressure regulators, check valves, vents, etc. The thermometers, valves for douches, spray, shower, and bidet and the pressure gauges are in the same relative position as in the other type. The wall control may be fitted on an upright marble slab so that the pipes are concealed and only the valve wheels, thermometers, pressure gauges, faces of the mixers and the douche hose are visable. This makes a very presentable appearance. However, for practical purposes, the visable form made of nickeled pipe is just as good and less expensive. Having all the parts open to inspection, the mechanism is readily grasped by the learner. The thermometers should be turned so as to be read from a single observation point.

If ordinary pressure reducers, instead of automatic pressure regulators, are used to equalize the pressure on the hot and cold water supply, they should be so placed as to be readily accessible as they will need readjustment from time to time in case of large changes of pressure in the main supply. Let it be remembered that *constancy and equality of pressure* in the hot and cold water supply is the most important requisite to the satisfactory operation of any form of hydrotherapy controller.

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