JOHN HARVEY KELLOGG (1352-1943)

LECTURES, SPEECHES, NOTES, AND ARTICLES, CA. 1890-CA. 1943 (UNDATED BY TOPIC)

THERMOTHERAPY

(Chap. on Thermotherapy.)

THERMOTHERAPY.

The employment of heat as a therapeutic agent technically includes applications at all temperatures and irrespectiveof the nature of the medi- through which the application is made. Properly speaking, hydriatic applications of all sorts, both hot and cold, vapor baths, hot and cold air baths, and even light baths, are thermic applications. The general plan of this series of volumes, however, requires that attention should be confined in this chapter to the consideration of such applications only as are capable of communicatingheat to the body, hence excluding cold applications of all sorts. Vapor and Russian baths, which may be properly termed thermic applications, are also omitted from this chapter, having received proper consideration elsewhere.

According to

Media of any sort, whatever the temperature above that of the body, are said to be "hot". Temperatures above 104° are termed "very hot".*

For a full understanding of thermotherapy, it is essential that one should be familiar with the fundamental principles of hydrotherapy, a concise statement of which would be in place were it not that the subject is elsewhere considered at length in this series of volumes. The limitation of Space will permit only of a brief statement of the physiological effects resulting from warm and hot applications, general and local, which statement will be followed by a description of the technique of hot applications and a summary of the therapeutic indications. of these.

GENERAL PHYSIOLOGICAL EFFECTS.-- The general effect of heat is that of an excitant or a physiological stimulant. Within physiological limits, the application of heat to living cells increases the activity of their protoplasm, an effect easily recognized in the quickened movements of

the amoeba, leucocytes, and other minute animal forms, when placed upon a warming-stage under the microscope. Heat is one of the most powerful of all vital stimulants. It increases the activity of all the tissues ~~with~~ which it ~~is brought in direct contact,-- the~~ glands, nerves, nerve-centres etc.

These effects whowever, are temporary, and are followed by secondary effects of an opposite character, ~~following this primary effect,~~ afterthe withdawal of the hot application, secondary depressant or atonic effect ~~appear, to which~~ are attributable the weakening or exhausting effects of thermic applications when improperly managed or inappropiately applied.

The actual effects of a thermic application depend upon the temperature, duration and form of the application, and also upon the condition of the patient. A prolonged applicaton ~~of heat~~ at a high temperature, is at first excitant, then very decidedly depressant. The excitation is the natural result of the elevation of the temperature of the blood. The depressing effects ~~are the result of a~~ lowering of the nerve tone and the exhausting of nervous energy ~~from~~ over-stimulation.

A very short application ~~of heat~~ at a ~~very~~ high temperature is very strongly excitant, and the depressing effects which follow may be so slight as to be quite imperceptible.

A less intense, and moderately prolonged thermic application is excitant to a moderate degree at first, depressant effects appearing later, with diminished tissue activity of all forms.

EFFECTS OF HEAT UPON THE SKIN:--

1. A very short and a very hot application produces a goose flesh appearance from contraction of the smooth, muscular fibres of the skin.

2. Heat also contacts the yellow elastic tissue, but relaxes the white fibrous tissue which constitute the chief element of ligaments and

tendons.

3. Increased perspiration. respiratory

4. An increased activity of the functions of the skin.

5. Tactile sensibility ~~is~~ increased at 98°, ~~and~~ decreased at 113°, and disappears at a temperature of 130° when painful sensations are experienced. acute sensibility

~~6.~~ Reddening of the skin ~~and~~ with dilitation of the small blood vessels, especially the veins.

~~7.~~ Contraction of the cutaneous vessels, with pallor, occurs some little time after the withdrawal of heat, the result of atonic reaction and chilling of the surface from evaporation.

~~8.~~ Increased heat elimination, following a hot application is the result of the increased movement of ~~the~~ blood through the skin, and the dilitation of the surface - vessels, increased conductivity of the skin, and the increased ~~glandular activity resulting in the evaporation of an increased amount of moisture.~~ xx

EFFECTS OF HEAT UPON THE MUSCLES:--

1. The energy of the striated muscles is increased by short, hot applications from 98° to 104°.

2. Very hot applications (104° to 130°) increase the excitability of the smooth or involuntary muscles.

2. ~~Long, very~~ Prolonged warm or hot applications ~~(106 to 120°)~~ lessen the excitabiltiy and the ~~vigor~~ energy of ~~the~~ voluntary muscles.

***

EFFECTS UPON THE NERVOUS SYSTEM:

1. The brain is ~~unduly~~ excited by very hot baths, and the result is nervousness, sleeplessness and exhaustion.

1 2. Very short hot applications excite the brain, nerves and nerve centers through the impressions made upon the skin.

2 3. ~~Long and very~~ Prolonged, general hot applications may give rise to ~~most~~ pronounced exhaustion of the brain, and spinal cord, ~~and may give rise to dangerous collapse.~~

EFFECTS UPON CIRCULATION:

1. The pulse rate is first slowed and then quickened. The pulse rate and tension diminish with the beginning of perspiration.

2. The surface vessels, especially the veins, are dilated by prolonged warm or hot applications, while very hot applications give rise to temporary contractions of the small vessels of the skin.

3. General hot applications induce an elevation of blood pressure when percussion or friction is administered at the same time.

EFFECTS OF HEAT UPON RESPIRATION:

1. Applications of hot, dry air hinders gaseous exchanges in the lungs, and interfere with the respiration.

2. A general application of moist heat increases ease of respiration.

3. General hot applications are followed by an increase in the rate and depth of respiration.

4. A temperature below 40° F increases CO_2 elimination; the same is also true of a temperature above 60° to 70° F.

EFFECTS UPON BODY TEMPERATURE:

1. A general application at a temperature above that of the body causes and elevation of the temperature of the blood by interference with heat elimination;-- for example, in a series of experiments in the author's physiological laboratory, the temperature of a young man was increased 3.2° F in thirty minutes, representing a gain of 345.6 heat units during the time named. A bath at a temperature of the body (100°) showed an increased temperature of .6°. The Russian bath for 25 minutes increased the rate of temperature 2.1°. An increase of the same amount (2.1°) was observed as the result of an electric light bath for 23 minutes, and increase of 1.7° resulted from a Turkish bath of one hour at 146° to 158°.

2. Water applications at a temperature of 92° to 96° do not material

ly affedt the body temperature, but exposure to air at a temperature above 60 to 70° increases heat production, while a temperature of 70 to 40°, more or less, has precisely the same effect. Careful experiments show that an increase of heat production in dogs exposed to a temperatre of 104° F, amounted to 350%.

2, 3. A short application of heat is followed by a fall of temperature, the result of increased heat elimination through dilitation of the surface vessels, and a diminution of heat production through the impression made through the ther-mic nerves upon the thermogenetic centers.

EFFECTS UPON THE BLOOD:

General hot applications decrease the blood-count, notably diminishing the proportion of leucocytes, and diminishing the alkalinity of the blood.

EFFECTS UPON THE FUNCTIONS OF THE ABDOMINAL VISCERA:

1. General hot applications diminish the secretion of hydrochloric acid.

2. General hot applications, and hot applications about the trunk of the body lessen the volume of blood in the liver and other abdominal viscera.

EFFECTS UPON METABOLISM:

General applications of heat increase the CO_2 production and nitrogen oxidation.

EFFECTS UPON CIRCULATION:

1. The pulse rate is first slowed and then quickened. The pulse rate and tension diminish with the beginning of perspiration.

2. The surface vessels, especially the veins, are dilated by prolonged warm or hot applications, while very hot applications give rise to temporary contractions of the small vessels of the skin.

3. General hot applications induce an elevation of blood pressure when percussion or friction is administered at the same time.

EFFECTS OF HEAT UPON RESPIRATION:

1. ~~Applications of~~ Hot, dry air hinders gaseous exchanges in the lungs, and ~~interfere with the~~ respiration.

2. A general application of moist heat increases ease of respiration.

3. General hot applications are followed by an increase in the rate and depth of respiration.

4. A temperature below 40° F increases CO_2 elimination; the same is also true of a temperature above ~~60° to 70°~~ F.

EFFECTS UPON BODY TEMPERATURE:

1. A general application at a temperature above that of the body causes ~~and~~ elevation of the temperature of the blood by interference with heat elimination;-- for example, in a series of experiments in the author's ~~physiological~~ laboratory, the temperature of a young man was increased 3.2° F in thirty minutes, representing ~~a gain of 345.6 heat units during the time named~~. A bath at a temperature of the body (100°) ~~showed~~ caused an increased temperature ~~of .6°~~. The Russian bath for 25 minutes increased the ~~rate of~~ temperature 2.1°. An increase of the same amount (2.1°) was observed as the result of an electric light bath for 23 minutes, ~~and~~ An increase of 1.7° resulted from a Turkish bath of one hour at 146° to 158°.

2. ~~Water applications~~ Baths at a temperature of 92° to 96° do not ~~materia~~ increase the body temperature.

ly affedt the body temperature, but exposure to air at a temperature above 60 to 70° increases heat production, while a temperature of 70 to 40°, more or less, has precisely the same effect. Careful experiments show that an increase of heat production in dogs exposed to a temperatre of 104° F, amounted to 350%.

2, 3. A short application of heat is followed by a fall of temperature, the result of increased heat elimination through dilitation of the surface vessels, and a diminution of heat production through the impression made through the ther-mic nerves upon the thermogenetic centers.

EFFECTS UPON THE BLOOD:

General hot applications decrease the blood-count, notably diminishing the proportion of leucocytes and diminishing the alkalinity of the blood.

EFFECTS UPON THE FUNCTIONS OF THE ABDOMINAL VISCERA:

1. General hot applications diminish the secretion of hydrochloric acid.

2. General hot applications, and hot applications about the trunk of the body lessen the volume of blood in the liver and other abdominal viscera.

EFFECTS UPON METABOLISM:

General applications of heat increase the CO_2 production and nitrogen oxidation.

We will conclude this section with a brief statement of the anatomical and physiological facts and principles upon which the efficacy of localized thermic applications depend.

The effects of thermic applications to the surface depend (1) upon the elevation of the temperature of the parts to which the application is made; and (2) upon the effects induced in more or less remote parts from nervous reflex influence, and through anatomically related blood vessels.

Effects depending upon reflex nervous action are the result of the association, by means of different reflex arcs, of the internal viscera with clearly defined cutaneous areas, each viscus having its own area through which most intense cutaneous reflexes are perceived, while at the same time more remotely related with all portions of the surface. These cutaneous reflex areas are for the most part located upon those portions of the body surface which overly the individual viscera. The accompanying cuts, (Fig — and —) show diagramatically a number of these cutaneous areas which have been definitely worked out and which are clinically important.

Careful anatomical studies have shown that there is an equally intimate and more direct relation existing between the bloodvessels of deeply seated organs and overlying or adjacent cutaneous areas.

According to Woolsey (Text-book of Anatomy by American Authors. Gerrish), the vessels of the brain are freely connected with those of the scalp and the nose through the parietal foramen, the foramen cecum, the mastoid foramen, the posterior condylar foramen, the foramen of Vesalius, the foramen ovale, the foramen lacerum medium, the carotid canal, the anterior condylar foramen, and other openings as well as through the diploë of the cranial bones. 9/ The meningo-rachidian veins which form dense plexuses in the spinal canal, are freely associated with the cutaneous veins of the back and the dorsi-spinal veins

7 +3

through the anastomosing veins which issue from the canal through the intervertebral foramina and unite with the intercostal, vertebral, lumbar and sacral veins. ¶ The blood supply of ~~the eyeball,~~ the eyelids and of the skin covering the eyebrows and adjacent portions of the forehead, is ~~derived from~~ collaterally related with branches of the internal carotid, which supply the eyeball. ¶ The circulation of the middle ear is collaterally related with the circulation of the skin of the face and head of the same side through the common carotid. The circulation of the internal ear, on the other hand, is associated with the skin ~~of the organs~~ of the back of the neck, being ~~supplied by~~ derived from the vertebral arteries. ¶ The vessels of the nasal mucous membrane and of the pharynx are collaterally associated with those of the face and the sides of the head through the common carotid. ¶ The circulation of the ~~limbs~~ lungs is collaterally related to that of ~~the overlying skin and~~ the skin covering the arms, the chest and the upper part of the ~~chest and~~ back. The pericardium and the parietal pleura of the anterior portion of the chest is collaterally related to the skin covering the anterior portion of the chest wall through the internal mammary artery. The parietal pleura of the posterior portion of the chest and the visceral pleura are collaterally related with the intercostal vessels. A collateral relation also exists between the bronchial arteries, the nutrient arteries of the lungs, and the intercostals, especially those of the right side. The skin covering the arms is collaterally related with the pleura of the upper and anterior portion of the chest through the subclavian. The also exists a collateral relation between the nutrient vessels of the lungs and the vessels covering the anterior portion of the neck through the inferior thyroid arteries. The collateral relationship existing between the vessles of the skin and of the lungs is still further maintained by the connection of the bronchial viens with the azygos vein of the right

side, and with the superior intercostal or azygos vein of the left side. The kidneys are associated with the skin covering the loins through the renal branches of the lumbar arteries. The prostate in men, the uterus and ovaries in women, and the bladder in both sexes, are associated with the cutaneous vessels overlying the sacrum, the buttocks, the perineum, the external genitals, the groins, the inner surface of the thighs, and the suprapubic region, chiefly through the internal iliac. These organs are also associated with the skin of the legs through the common iliac. The rectum is similarly associated with the skin covering the anal region and the perineum and that of the lower extremities.

There is a collateral relationship both venous and arterial between the stomach, liver, spleen, ~~and~~ intestines, and even the pancreas, and the skin of the trunk which overlies those deeply seated organs. The portal circulation communicates with the systemic circulation, thus establishing a collateral relationship with the ~~superficial~~ cutaneous vessels by half a dozen or more communications, especially the following: the hemorrhoidal plexus, the esophageal veins, the left renal vein, the phrenic veins at the surface of the liver, the epigastric veins at the umbilicus, the circumflex iliac (Treves, Schiff). In a similar way, it may be stated that the upper half of the body is collaterally related with the lower half, a fact of which constant use is made when the lower extremities are warmed ~~and blood thus~~, diverted to blood from the head.

Understanding these interesting anatomical relations, it ~~will be easy to~~ readily be seen that the volume of blood in any internal viscus, no matter how remote from the surface, may be diminished either by a general hot application to the surface whereby one-half of all the blood in the body may be diverted into the skin, or to a lesser degree by localized ~~thermic~~ applications. By means of hot applicatinns suitably applied, the vessels of different portions of the brain may be drained into the

Star Just before Physiological Effects of Turkish Bath.

The Turkish bath affords an opportunity to secure the most pronounced effect possible upon the circulation of any internal viscus. which may be desired to influence. For example, in the case of chronic gastritis or chronic intestinal catarrh, chronic spinal congestion, cerebral hyperemia, or renal congestion, the general effect of the bath in relieving visceral congestion may be intensified by a suitably placed cold application consisting of an ice-bag, a cold compress or a cooling coil. In cerebral congestion, an ice-bag may be applied to the head or an ice-collar may be fitted about the neck. A towel wrung out of ice water may be applied to the face and ears. In renal congestion an ice-bag may be applied over the lower third of the sternum. In uterine and ovarian congestion or the so-called chronic inflammation of these organs, an ice-bag may be applied to the groins and the hypogastrium. In chronic inflammation of the stomach or intestines or congestion of the spleen liver or spine, the cold application should be made over the parts indicated. The application of cold in the manner suggested, especially to the head, renders a higher temperature tolerable and may permit of a longer duration of the bath.

The bases employed in thermotherapy are for the most part exceedingly simple and such as every one is more or less familiar with. Yet it must not be supposed that the therapeutic use of the procedures recognized in thermotherapy is by any means a simple matter or that those agents can be used successfully without attention to the most minute details and the exercise of the greatest care to adapt proper procedures to the case in hand. The successful practice of thermotherapy requires exactly as much painstaking accuracy and precision in diagnosis, in prescription making, in dosage and adaptation of means to individual conditions and idiosyncrasies as it is in the employment of powerful therapeutic measures of any other sort. Strychnia, morphia, and other powerful drugs may produce deadly effects when carelessly employed, but the effects resulting from the careless application of thermotherapy may be not less disastrous. It may be said , however, in favor of the physiological procedures of thermotherpy that they are to some degree self-adjusting and hence less likely to lead to injurious consequences than are powerful drugs. If this were not true, the extensive empirical and bungling employment of these agents by the laity would not long ago have lead to their abandonment.

Star page 10.

As space will not permit a detailed discussion of all points pertaining to the therapeutic effects of heat, many of which have been ably considered by others in the discussion of hydrotherapy and allied subjects, we present merely a summary of general principles involved.

Star page 11.

...as the small vessels of the skin may be properly called.

Star page 16.

... and in the drawing up of the legs when abdominal pain is present, an instinct which is possessed by the lower animals in common with man.

Double star page 16.

... being confined to the area of most acute reflex activity.

Star page 17.

Fig. .. illustrates a combined hydriatic application for relief of congested kidney. An icebag applied over the lower third of the sternum causes reflex contraction of the kidney vessels, as shown by ~~Marchand~~ Beni-Barde, while an application of heat made to the lumbar region relieves the congested organ by diverting blood from its arteries and veins into the overlying muscular structures.

In Fig. .. is graphically illustrated the operation of a simultaneous hot and cold application for relief of a congestion of the

Fig. .. illustrates a combined hydriatic application for relief of a congested kidney. An icebag applied over the lower third of the sternum causes reflex contraction of the kidney vessels, as shown by Beni-Barde, while an application of heat made to the lumbar region relieves the congested organ by diverting blood from its arteries and veins into the overlying muscular structures.

In Fig. .. is graphically illustrated the operation of a simultaneous hot and cold application for relief of a congestion of the pelvic viscera. The icebag applied to the hypogastrium and the groins causes contraction of the branches of the internal iliac which supplies the uterus and ovaries, thus lessening the blood supplied to those parts, while the hot hip and leg pack by dilating the cutaneous vessels diverts a large volume of blood into the external branches of the internal iliac and the cutaneous branches of the external iliac.

Star for page 23.

Physiological Effects:-- The physiological effects of the Turkish bath are essentially the same as those of other general hot applications. There are, however, certain characteristic difference s which may be noted with advantage.

The exposure of the entire body to a superheated atmosphere, and especially the inhalation of the dry hot air, excites the pulmonary mucous membrane as well as the skin. The great extent of this membrane, about two thousand square feet, gives importance to this fact. The great dryness of the air and the excitation of the mucous surface with which it comes in contact unquestionably facilitate the elimination of those volatile toxins which find exit through the pulmonary mucous membrane.

Shortly after the patient enters the bath, his pulse will be found considerably accelerated. The higher the temperature of the bath, the more rapid will be the pulse. During this period of blood tension, the patient experiences a sense of fullness in the head, some respiratory distress, and general discomfort. As soon, however, as the skin becomes reddened and moistened with ~~xxxxxxxx~~ perspiration, the pulse rate diminishes, tension is lowered, respiration~~x~~ becomes easy and uncomfortable sensations disappear. Breathing is likely to be thoracic in character.

The sudoriparous glands are powerfully stimulated. The amount of secretion may be increased from one and a half ounces per hour to fifteen or twenty times this amount. The writer has often seen patients lose two pounts or more in sweat as the result of an hour's exposure in the hot room of the Turkish bath. This fact emphasizes the importance of copious water drinking during the bath as the heart's action may be lessened in power and various other functions interfered with as the result of so considerable a reduction of the blood volume.

The large amounts of water discharged from the skin promote absorption from the alimentary canal. As a result of this patients who are taking Turkish baths daily are likely to suffer from constipation, unless this tendency is counteracted by copious water drinking.

The activity of the perspiratory glands excited during the bath continues in a modified degree for some hours after the bath as the result of the improved cutaneous circulation. Hence, water drinking must be practiced after as well as before and during the bath.

The intense congestion of the skin induced by the Turkish bath withdraws an enormous amount of blood from the liver, spllen, stomach, intestines, brain and other internal organs. The decongestion of these deep lying vascular areas is one of the most important results obtained by this procedure although one which seems to have been heretofore very little appreciated by those who have written upon this subject.

While it is not probable that any considerable amount of heat is communicated to the body from the heated atmosphere of the bath, heat production is increased to such a degree that a very decided elevation of temperature may generally be noted when the patient remains in the bath for half an hour or more. Experiments with the dog have shown that exposure to an atmosphere of a few degrees above the temperature of the body may increase heat production as much as 350%. At this rate, the heat loss from an hour's exposure in the Turkish bath might amount to nearly 400 calories or about one-sixth the daily output of energy, representing three and a half ounces of fat or twice this quantity of carbohydrate.

In the treatment of obese persons, it must be remembered that these patients have a much smaller skin surface in proportion to their weight than have smaller persons, and hence that heat elimination is greatly

hindered. For example, a person weighing 300 pounds has a skin area of only 13.2 square inches per pound, while a person weighing 120 pounds has a cooling cutaneous surface of 18 square inches for each pound of weight, or nearly fifty percent more. The obese person has a further disadvantage in that the surface vessels are in large part buried in fat, so that they do not come near the surface, whereas in a thin person the close approach of the 10,000 square feet of capillary network to the surface secures a rapid cooling of his blood.

For feeble subjects the Turkish bath should not be administered more than one to three times weekly. The ordinary patient may take a short Turkish bath daily, and when the bath is employed for reduction of weight, it may often be administered twice a day provided the exposure in the hot room is not more than thirty to forty minutes, at each seance.

Therapeutic Applications:- Although the Turkish bath is perhaps not capable of inducing any therapeutic effect which cannot be otherwise secured, and while it is perhaps inferior to the light bath as a thermotherapeutic measure, it is nevertheless capable of producing excellent therapeutic effects in almost every form of chronic disease. It must not be supposed, however, that its chief advantages are the result of theprofuse perspiration induced. As shown by Bouchard the amount of toxic matter removed by sweating is very small. The elimination of water by the skin seems to serve chiefly as a means of regulation of the body temperature. Neverthæless profuse perspiration is a most efficient alterative measure. General vital activity is accelerated by the large movement of fluid from the interior toward the periphery. Perspiration hence becomes an important means of promoting tissue activity in all chronic disorders accompanied by the

condition which Bouchard has termed "Ralentissment de Nutritien," a state in which all the vital processes are slowed resulting in a general deterioration of the organism through impaired tissue formation and accumulation of waste. The Turkish bath, hence, may render valuable servica in the treatment of obesity, fat diabetics, the chronic autointozication so commonly present in old dyspeptics, uric acid diathesis in all its forms, many cases of neurasthenia, hypochondria and melancholia, most forms of chronic nervous disease, xxx Ever cases of locomotor ataxia, chronic myelitis, arterio sclerosis, paresis, piralysis, neuritis and other equally obstinate maladies are materially helped by the judicious use of the Turkish bath, even though a radical cure may be in the majority of cases impossible.

As a hygienic measure the Turkish bath has long justly held a high place in the confidence of the laity as well as of the profession. Simply the thorough skin cleanliness which it secures is an advantage of no small consideration, yet its highest value is due to the fact that the combined hot and cold procedures which it involves in the highest degree promote vital activity and the building up of the bodily resistance to the causes of disease, thus counteracting to some degree the evil consequences of the artificial conditions imposed by civilized life and affording a considerable degree of protection against the various infectious agents and other dangers to which most civilized human beings are exposed.

In all forms of anemia and Chlorosis the Turkish bath is an admirable measure, promoting blood formation and relieving visceral congestion. Care must be taken, however, to avoid extreme temperatures and prolonged exposure in these cases on account of the degeneration of the blood vessels which is some times present in these affections.

as pointed out by Bouchard.

Contraindications and Precautions:-- The Turkish bath is contra-indicated in cases of cardiac dilatation, tachycardia, arterio sclerosis, organic affections of the heart in which there is evidence of deficient of failing compensation, apoplectic subjects, irritable skin affections, and all febrile disorders. The bath must be used with great care in all forms of nephritis and is contraindicated in advanced stages of renal disorder, also in exophthalmic goiter.

The pulse should be carefully watched, especially during the first seances and the first few moments after the patient enters the bath. Undue cardiac ~~di~~ excitation may generally be relieved by the application of an icebag over the heart. If the effect desired is not readily secure, the patient should be removed from the bath, and the incandescent electric light bath or some other heating procedure adopted.

To follow page 23.

THE HOT AIR BATH:-- This bath resembles the Turkish bath, the essential difference being that the head is excluded from contact with the heated air, so that the patient is able to breathe ~~xtkr~~ air at ordinary temperatures while the entire body with the exception of the head is exposed to dry ~~duper~~-heated air.

Technique:-- The hot air cabinet may be a permanent structure of wood, zinc-lined, or it may consist of a portable cabinet of rubber, cloth, or other impervious material. In the absence of a specially constructed cabinet, a substitute can easily be improvised by placing the patient in a chair and covering him with a rubber blanket or with ordinary blankets between the folds of which newspapers have been placed.

Various sources of heat may be employed, as a small kerosene stove or even a large kerosene lamp or alcohol lamp, a small gas stove or even heated stones or bricks. For a permanent arrangement a steam coil is most convenient. The physiological and therapeutic effects are the same, however, no matter what the source of heat employed.

Fig. .. shows a convenient arrangement for a hot air bath. When patients are not able to sit erect, the bath may be administered in bed either by means of a special device or by an arrangement which may easily be improvised. It is only necessary to provide a space about the patient by means of a proper framework covered first with rubber cloth, then with ordinary blankets. Heat is supplied by means of a tin pipe which can be made by any tinner at a small expense, so arranged that one end can be slipped over the top of an ordinary lamp chimney while the other enters the enclosed space about the patient. Before entering the bath, the patient should take a glass of water, either hot or cold as he prefers. Perspiration may be promoted by repeated water drinking during the bath. The temperature may vary from 150° to 250° F.

..

A still higher temperature may be borne if the air is perfectly dry, but offers no advantages.

The duration of the bath may be six minutes to an hour, according to the effect desired. In case of febrile persons and when the purpose of the bath is simply to heat the skin in preparation for a cold application, the duration should be brief, not more than six to twelve minutes. When prolonged sweating is desired for eliminative effects, the duration may be twenty to sixty minutes. Ordinarily, however, the bath need not be employed for more than thirty to forty minutes to secure the maximum beneficial effects.

Before the patient enters the bath, the head or the face and neck, and in the case of men, the scalp also, should be well cooled by bathing in water at 60°F. Towels should be applied about the neck in the case of ladies, and to the head and face of men.

After the bath a cooling procedure of some sort should be employed. The rain douche, horizontal douche, wet sheet rub, shallow bath, and pail douche are the most generally am useful measures. In feeble cases, the cold towel rub and the cold mitten friction are preferable and should be employed at the beginning of this course of treatment. Later the more vigorous measures may be applied when the patient has by proper hydriatic training acquired greater ability to react. In certain cases cooling of the skin is not desirable, especially the case with chronic rheumatics when suffering from acute exacerbation with more or less elevation of temperature and much pain and tenderness in the joints. In such cases, the patient on removal from the bath cabinet should be quickly wrapped with warm blankets. If it is desirable to continue the perspiration, the patient is warmly covered and made to drink freely. If, however, prolonged perspiration is not desirable, the patient is more lightly covered and the face is from time to time

bathed with a little cool or tepid water until perspiration has ceased spontaneously and the usual pulse rate reestablished. The wrappings are then carefully remove, uncovering small areas at a time, as an arm, the chest or a leg, and an alcohol rub (See page ...) is administered.

Therapeutic Applications:- The therapeutic applications of the hot air bath and the contraindications are essentially the same as those of the Turkish bath (See page ...). It should be mentioned, however, that the hot air bath may be employed in cases in which the Turkish bath is inadmissible on account of the embarassment ~~afxt~~ experienced by the patient upon the inhalation of hot dry air. In the writer's opinbon all the therapeutic advantages of the Turkish bath may be obtained from the proper employment of the hot air bath.

THE LOCAL HOT AIR BATH:

Hot air may be applied to any circumscribed portion of the body, either by means of a current of super-heated air directed upon the part or by enclosing the part in a chamber the air of which is super-heated. The hot air douche was employed by the writer some eighteen years ~~ago~~ but was not found to possess advantages over the simpler methods of making local applications of heat. Recently various devices have been offered for local applications of hot air, especially to the joints. There are none, however, which are superior to a very simple device which can be easily constructed by any tinner. It consists simply of a tin box so arranged that it can be easily opened while the limb is being placed in position. The limb must be protected from contact with the metal portions of the box. This is easily accomplished by making the end pieces of wood. In use this box is so placed that a large kerosene lamp can be placed beneath it with just sufficient space between the chimney and the bottom of the box to secure a clear flame.

....

In a very short time, the air within the box will become sufficiently heated to secure the effect desired. With dry air a temperature of 300° to 400° F. may be tolerated. The effect of this application is to produce powerful revulsion by dilatation of the surface vessels. It is possible that certain trophic effects may also be induced by the impression made upon the thermic nerves.

At the conclusion of the application the parts should be quickly rubbed with the hands dipped in cold water, or if the parts are painful a towel wrung quite dry from cold water may be applied to the parts for ten or fifteen seconds. The parts are then quickly and carefully dried or bathed with alcohol and covered first with dry cotton, then with a mackintosh, and finally with flannel, so that the effect obtained by the application may be continued. In cases in which an active inflammation is present as indicated by an elevation of temperature and extreme pain, the heating compress should be applied instead of the cotton poultice. This consists of a single thickness of linen cloth, or three or four folds of cheese cloth, wrung quite dry out of water at 60°F., smoothly wrapped about the part and covered with flannel and mackintosh. The compress should warm up at once. .Ifit remains cold, injury will result. Great care should be taken to extend the mackintosh sufficiently above and below the flannel wrappings to leave no opening through which air can enter or evaporation can take place.

The fomentation and the heating compress, perhaps the most useful of all the local measures known to thermotherapy, have been elsewhere described in connection with other hydriatic procedures. Dry hot applications may be made by a variety of means, of which we need not mention only a few.

For instance, the application of dry heat may be made by means of the hot water coil (Fig. ..) which is simply a coil of rubber or aluminum

.....

through which a stream of water at the required temperature is made to flow continuously. The temperature of the coil is easily regulated by a tube compressor which controls the outflow. A rubber bag with an opening at each end may be employed in place of the coil but is somewhat less convenient. To avoid the inconvenience of emptying the water which has passed through the coil and filling the heated reservoir, the writer has arranged a heater on the plan of the ordinary range heater, consistingof a tank heated by a gas jet, from the top of which a pipe carries the water to the couch on which the patient lies while another pipe bringing back the water enters the tank at the bottom. The coil is connected with the two metal pipes and forms a part of the system through which the water circles. The rate at which the water flows is easily regulated by a stop cock in the pipe. Fig. .. is a diagram of this arrangementwhich is found very convenient.

Rubber bags, bottles or jugs filled with hot water, heated sandbags, heated bricks, heated blocks of wood, and other heated objects may be employed as a means of making localized applications of heat.

Therapeutic Applications:- Localized applications of heat are among the most useful of all means of relieving pain. The rationale of the effect produced differs in different cases. In neuralgia, for example, the relief may in some cases be due to the simple relaxation of the nutrient vessels of the nerve trunks. Du Bois-Raymond has shown that the pain of neuralgia may be due to pressure upon the nerve filaments by spasm of the vasa nervorum (?) as well as compress of the nerve trunk by the overfilling of the blood vessels of contiguous parts. It is evident that in either case the neuralgic pain may be relieved by simple revulsion or diversion of the blood to some other part adjacent or remote. It is important to bear in mind that the therapeutic effect desired can be obtained only by a long continuation of the

improved conditions secured by the application. An application lasting from ten to twenty seconds may, for example, give perfect relief for the time being, but as a rule the pain unless due to some some transient cause, will return and often with very discouraging promtness. The disappointment thus occasioned frequently leads to resort to an opiate when a more skilful applications would wholly obviate the necessity for an anodyne of any sort. The writer is glad to say that though formerly frequently compelled to employ morphia and other anodynes in the treatment of pain, since becoming better acquainted with the analgesic properties of thermotherapy and the technique of the procedures whereby these powers may be brought into play, he finds cases extremely rare in which pain even of a most excruciating sort may not be very promptly relieved or at least mitigated to such a degree that tolerance is easily possible until the cause of the pain can be removed by natural or artificial means.

It is a mistake, however, to suppose that the best results are always to be obtained by very prolonged hot applications. If the object of the application is to withdraw the blood from a part to a very remote part, as when a hot application is made to the feet and legs for relief of the cerebral circulation or to aid in controlling a pleuritic pain, or an acute bronchitis, the application may be continued for an hour or even longer, but it should be remembered that the application of heat to so extended an area as the legs may after a time elevate the general temperature , especially when febrile activity is already present and the heat regulating power of the body already lessened. In general, however, the hot applications should be interrupted at the end of fifteen to twenty~~minutes~~ or at the longest thirty minutes. This is especially true when the heat is applied directly over the affected

part, for the reason that a long continued hot application under such circumstances leads to an over-accumulation of heat in the part and dilatation of the deep lying ~~x~~ vessels, as the result of which the derivative or revulsive action may be interfered with. The derivative effect induced by the hot application and continuation of the heating processes may be secured by the application of a heating compress. This consists of a linen towel of one thickness or a cheese cloth of three or four thicknesses, wrung dry out of water at 60° and applied over the same area to which the hot application has been made, the wet cloth being covered with mackintosh extending an inch beyond the moist cloth on all sides, this being finally covered by several thicknesses of flannel, the whole bound firmly in place so as to prevent access of air to the moist cloth. If air is admitted, evaporation will take place and chilling will result. The cold cloth should be applied the instant the hot application is removed, and should be warmed up within a few seconds. Prolonged chilling will counteract the beneficial effects of the hot application. The latter may be renewed at the end of ~~xhxxxxxx~~ two or three hours or at shorter or longer intervals as may be required. By this means the affected part may be kept continuously under the influence of the thermal agents employed and definite results may be obtained. In many cases the application of a cotton poultice consisting of dry cotton covered with mackintosh and flannel, affords the most convenient means of maintaining the effect obtained until another application is made.

The other therapeutic applications of localized heating measures have been elsewhere mentioned (See page ..).

Note:-

It might be well to add further remarks with reference to the therapeutic effects specifying details of different maladies which might be benefitted by hot applications, estimating the rate at which fat can be reduced. Conrad Carr showed that a dog exposed to an atmosphere of 103 degrees produced heat at three and a half times the normal rate. This would increase heat production to about twenty-eight heat units a minute, or 1560 heat units per hour. At this rate a two hour sweat would involve a heat loss of one-third the total daily output of energy, the equivalent of about three and a half xxxxx ounces of fat or seven ounces of starch.

Mention the caution that in administering the hot applications, especially to very fat persons, it should be mentioned that the surface is much more in proportion to the weight than in small persons, and the heat elimination is greatly hindered by the thick layerof fat, the conductivity of fat being only one half that of muscle. In a fat person the cutaneous vessels are in large part buried in fat so that they do not come close to the surface as in a thin person. The blood is rapidly cooled by evaporation from the surface of a thin person. An obese person weighing three hundred pounds has a skin area of 13.2 square inches per pound. A person weighing one hundred and twenty pounds has a skin area of 18. square inches per pound.

Cuts for Thermotherapy.

Fig. 1. Cutaneous areas reflexly related with the viscera, front view.

Fig. 2. Cutaneous areas reflexly related with the viscera, back view.

Fig. 3. Cutaneous areas the vessels of which are collaterally related with those of the viscera, Front view.

Fig. 4. Cutaneous areas the vessels of which are collaterally related with those of the viscera, back view.

Fig. 5. Diagram illustrating the relationship existing between the skin and underlying muscle or other structures.

Fig. 6. Diagram showing the effect of dilating the cutaneous vessels by a hot applications in producing collateral anemia of the underlying muscle or other structures.

Fig. 7. Diagram illustrating the congested state of the vessels of a boil or other circumscribed superficial inflamed part.

Fig. 8. Diagram showing the effect of a hot application in diminishing the amount of blood in the vessels of an inflamed part by dilating the vessels of the surrounding parts.

Fig. 9. Diagram illustrating the operation of a hot and cold compress when applied for relief of congestion of the kidney.

Fig. 10. Diagram illustrating the distended condition of the blood vessels in inflammation of the uterus and the relation of these vessels to the internal and external iliac arteries and their branches.

Fig. 11. Diagram showing the effect of an ice-bag to the hypogastrium causing contraction of the vessels of the uterus with the simultaneous dilatation of the external branches of the internal iliac and the external iliac induced by a hot hip and leg pack.

Fig. 12. A hot air bath cabinet.

Fig. 13. A dry pack.

Fig. 14. The heating coil.

Fig. 15. Hot water circulation for the heating coil.

THERMOTHERAPY.

The employment of heat as a therapeutic agent technically includes applications at all temperatures and irrespective of the nature of the media through which the application is made. Properly speaking, hydriatic applications of all sorts, both hot and cold, vapor baths, hot and cold air baths, and even light baths, are thermic applications. The general plan of this series of volumes, however, requires that attention should be confined in this chapter to the consideration of such applications only as are capable of communicating heat to the body, hence excluding cold applications of all sorts. Vapor and Russian baths, which may be properly termed thermic applications, are also omitted from this chapter, having received proper consideration elsewhere.

Media of any sort having a temperature above that of the body are said to be "hot". Temperatures above 104° are termed "very hot". Temperatures near that of the skin are termed "warm". These terms with others relating to temperature are commonly used rather loosely. To secure accuracy in prescription it is better to indicate the exact temperature. When ordinary terms are employed they may be understood as expressing the following temperature values: Very cold, 32° to 55° F.; cold, 55° to 65° F.; cool, 65° to 80° F.; tepid, 80° to 92° F.; warm, 92° to 98° F. (neutral, 92° to 96° F.); hot, 98° to 104° F.; very hot, 104° F. and above.

For a full understanding of thermotherapy, it is essential that one should be familiar with the fundamental principles of hydrotherapy, a concise statement of which would be in place were it not that the subject is elsewhere considered at length in this series of volumes. The limitation of space will permit only a brief statement of the physiologi-

cal effects resulting from warm and hot applications, general and local, which statement will be followed by a description of the technique of hot applications and a summary of the therapeutic applications.

GENERAL PHYSIOLOGICAL EFFECTS.

The general effects of heat are those of an excitant or a physiological stimulant. Within physiological limits, the application of heat to living cells increases the activity of their protoplasm, an effect easily recognized in the quickened movements of the amoeba, leucocytes, and other minute animal forms, when placed upon a warming stage under the microscope. Heat is one of the most powerful of all vital stimulants It increases the activity of all tissues which it may be brought to bear upon,--glands, nerves, nerve-centers, etc.

The effects, however, are temporary, and are followed by secondary effects of an opposite character, depression, a sort of negative or atonic reaction after the withdrawal of the hot application. To these secon ary depressant or atonic effects are attributable the weakening or exhausting effects of thermic applications when improperly managed or inappropriately applied.

The actual effects of a thermic application depend upon the temperature, duration and form of the application, and also upon the condition of the patient.

A prolonged application at a high temperature is at first excitant, then very decidedly depressant. The excitation is the natural result of the elevation of the temperature of the blood. The depressing effects appear to result from the lowering of the nerve tone and the exhausting of nervous energy by over-stimulation.

A very short application at a high temperature is very strongly excitant, and the depressing effects which follow may be so slight as to be quite imperceptible.

A less intense, and moderately prolonged thermic application is excitant to a moderate degree at first, depressant effects appearing later, with diminished tissue activity of all forms.

EFFECTS OF HEAT UPON THE SKIN:--

1. A very short and a very hot application produces a goose flesh appearance from contraction of the smooth muscular fibres of the skin.

2. Heat also contracts the yellow elastic tissue, but relaxes the white fibrous tissue which constitutes the chief element of ligaments and tendons.

3. Increased perspiration.

4. An increased activity of the respiratory function of the skin.

5. Increased tactile sensibility at 98° F., decreased at 113° F. Tactile sensibility disappears at a temperature of 130° F. when painful sensations are experienced.

6. Momentary pallor when the temperature is high (110° F. upwards), quickly followed by reaction with reddening of the skin from dilatation of the vessels. Lower temperatures produce immediate reddening of the skin with dilatation of the small blood vessels, especially the veins. Contraction of the cutaneous vessels, with pallor occurs some little time after the withdrawal of heat, the result of atonic reaction and chilling of the surface from evaporation.

7. Increased heat elimination following a hot application is the result of the increased movement of blood through the skin, and the dilatation of the surface vessels, increased conductivity of the skin, and the increased evaporation occasioned by the largely increased amount

of moisture thrown upon the surface by the sweat glands.

EFFECTS OF HEAT UPON THE MUSCLES:--

1. The energy of the striated muscles is increased by short, hot applications from 98° to 104° F.

2. Prolonged warm or hot applications lessen the excitability and the energy of voluntary muscles. It is thus that heat becomes of service in relieving muscular cramp. Cold produces the opposite effect.

3. Very hot applications (104° to 130° F.) increase the excitability of the smooth or involuntary muscles.

EFFECTS UPON THE NERVOUS SYSTEM:--

1. Very short hot applications excite the brain, nerves and nerve centers through the impressions made upon the skin.

2. Prolonged general hot applications may give rise to pronounced exhaustion of the brain and spinal cord. Warm and hot applications lessen general nervous sensibility to a most remarkable degree. This is especially true of very hot applications. This may be due in part to the absorption of moisture by the terminal nerve filaments in the skin. It has also been suggested that this result may be brought about by the stimulation of the temperature nerves. It is well known that the skin is much more sensitive to thermic impressions than to any other form of stimulus which it is capable of recognizing.

3. Applications of heat to the skin generally produce an agreeable sense of comfort and well-being. When long continued, languor, lassitude and depression result.

4. Short very hot applications are, like short cold applications, exciting.

EFFECTS OF HEAT UPON THE CIRCULATION.-

Heart:-- In general heat applied over the heart tends to lessen the length of the systole while cold produces the opposite effect.

General hot applications at first slow the heart, then increase the pulse frequency. Cold produces exactly the opposite effect.

Blood Vessels:-- Very hot applications at first contract, then relax the blood vessels.

Under the influence of heat the skin assumes a dusky red hue from slowing of the blood circulation in the skin due to the fact that the veins appear to be influenced by heat more than are the arteries. The vascular dilatation accompanying the reaction which follows a cold application influences the arteries especially, giving rise to a bright red hue.

Large arterial trunks are dilated by applications when prolonged sufficiently to heat the intervening tissues of applied at points at which the vessels approach near the surface, as the groins, the axillae, the neck, the bend of the elbow and the knee.

The principle of fluxion or revulsion which furnishes the foundation of one of the most important therapeutic uses of heat depends upon the fact that when the vessels of one portion of the peripheral area to which blood is supplied by an arterial trunk are in a state of dilatation, the result is contraction of the vessels of the other portion of the area and diversion of blood therefrom. In other words, the local hyperemia induced by an application of heat gives rise to a compensatory or collateral anemia in the area in vascular relation therewith. This explains the relief afforded by an application of heat about a rheumatic joint or over an inflamed or congested muscle. This likewise explains the relief of visceral pain which results from a general hot application.

Blood Pressure:- Cold raises blood pressure while general hot applications lower blood pressure, though the blood vessels may be dilated in both cases.

The dilatation which accompanies the reaction following a cold application does not lower blood pressure because of the increased vigor of the heart action resulting from reflex stimulation. A very hot application may raise blood pressure by reflex excitation of the heart, producing a quick, strong pulse, but in general hot applications lower blood pressure by dilatation of the cutaneous vessels, whereby peripheral resistance is lessened. The skin is capable of holding one-half to two-thirds of all the blood in the body. Hence a general hot application by dilating the surface vessels and especially the veins of the skin, draws a large amount of blood from the internal circulation. The ventricles of the heart are not so well filled and the heart contractions are lessened in force.

A hot douche produces an elevation of blood pressure while at the same time dilating the surface vessels to the fullest degree by reason of the strong mechanical or percutient effect, characteristic od this form of bath, whereby the heart is stimulated.

EFFECTS OF HEAT UPON RESPIRATION:

1. Hot, dry air hinders the gaseous exchanges in the lungs, and renders the ease and frequency of respiration more superficial.

2. Air saturated with moisture interferes with elimination through the lungs.

3. A general hot bath increases the rate and frequency of respiration. The depth of respiration is at first diminished but when the bath is continued sufficiently long to raise the temperature of the blood and increase CO_2 production, the depth of the respiratory movements is increased.

4. A frog breathes with its skin; a dog sweats with its lungs,; man not only sweats with his skin and breathes with his lungs, but like the frog to some extent breathes with his skin and like the dog sweats with his lungs. Hot baths not only promote the perspiratory activity of the skin but the elimination of moisture through the lungs, thus aiding in the escape of those toxic substances which, as Charrin has pointed out, are probably eliminated from the bronchial mucous membrane.

THE EFFECTS OF HEAT UPON BODY TEMPERATURE:

1. A general application at a temperature above that of the body causes elevation of the temperature of the blood by interference with heat elimination. For example, in a series of experiments in the author's laboratory, the temperature of a young man weighing 108 pounds was increased 3.2°F. (1.8°C.) in thirty minutes, representing an accumulation of 88.2 calories. A bath at a temperature of the body (100°) caused an increase of 0.6°F. in temperature. Baths at a temperature of 92° to 96° F. do not increase the body temperature. The Russian bath for twentyfive minutes increased the temperature 2.1°F. An increase of the same amount (2.1°F.) was observed as the result of an electric light bath for twenty three minutes, An increase of 1.7°F. resulted from a Turkish bath of one hour at 146° to 158°F.

The elevation of body temperature induced by prolonged hot baths is not wholly due to diminished heat elimination, since it has been shown that heat production is increased in dogs exposed to a temperature of 104°F. to three and one-half times the normal. T

2. A short application of heat is followed by a fall of temperature, the result of increased heat elimination through dilatation of the surface vessels, and a diminution of heat production through the refelx influence of the thermic nerves upon the thermogenic processes.

THE EFFECTS OF HEAT UPON THE BLOOD:

General hot applications decrease the blood count, notably diminishing the proportion of leucocytes. They also diminish the alkalinity of the blood thus diminishing the vital resistance, as has been shown by Charrin. This fact emphasizes the importance of concluding every general hot application with a general cold application of some sort, cold having the effect to restore the alkalinity of the blood and increase vital resistance. When profuse sweating is induced, the volume of the blood is diminished, unless the loss is made good by the ingestion of water.

THE GENERAL EFFECTS OF HEAT UPON THE ABDOMINAL VISCERA:

As observed above, heat lowers the tone of voluntary muscles while cold raises it. In other words, heat relaxes muscles while cold contracts. This effect is particularly marked where applications are made to the muscles of the abdominal wall, a fact which has long been taken advantage of in the treatment of strangulated hernia, and more recently in the examination of the pelvic and abdominal viscera while the patient lies in a hot bath.

The tension of the abdominal muscles is a matter of no small importance in relation to respiration and especially the blood movement in all the viscera lying below the diaphragm. With the relaxation of the abdominal muscles intra-abdominal tension is diminished and the portal vessels become distended with blood. All the viscera are congested. The stomach and intestines become distended with gas, and stasis in the stomach and colon occurs, resulting in gastric indigestion, and constipation with fermentations and putrefactive processes which lead to autointoxication and various nutritive disturbances.

Cold when applied to the abdominal wall, contracts not only the external voluntary muscles but the internal involuntary muscles of

the stomach and intestines, bladder, gla gall bladder, together with the muscular structures found in the spleen and the liver, and the muscular walls of the blood vessels. Hot applications to the abdominal walls produce the opposite effect. It is apparent that hot applications of this sort are not therapeutically valuable except for the relief of conditions of muscular spasm, either in the external voluntary muscles or the internal involuntary muscular structures.

Long continued warm applications to the abdominal surface appear to lead to concentration of blood in the portal circulation, doubtless by relaxing the visceral vessels.

Very hot applications on the other hand appear to divert blood from the internal viscera by widely dilating the surface vessels. This effect is made possible by the anatomical connection which exists between the cutaneous vessels and those of the viscera which will be mentioned in detail a little later.

By the alternate application of heat and cold the blood movement through any internal viscus may be very readily and perfectly controlled. Cold contracts the visceral vessels through reflex action of the thermic nerves while heat produces the opposite effect. By the alternation of these effects a veritable pumping action may be instituted whereby functional activity may be influenced and disease processes controlled.

Very hot as well as very cold applications when brough in direct contact with the gastric mucous membrane excite both motor and secretory activity, producing also a very decided stimulating effect upon the heart. Cold applications applied over the stomach as well as cold applications to the general surface increase the motility of the stomach and stimulate the secretion of the gastric juice. Unless prolonged, very hot applications,either general or local,produce similar effects.

It should be noted, however, that when the general hot application is prolonged until profuse perspiration is induced the secretion of gastric juice is greatly diminished. Puschkin claims to have shown that the amount of the gastric juice and its digestive activity is greatly increased by the application of heat to the epigastrium after eating. The clinical results obtained by the writer in the use of this measure as a meas of promoting digestion in the last twenty five years, enables him to say that Puschkin's claims are fully corroborated by clinical experience. Applications to be beneficial in this way must be very hot. Warm applications doubtless tend to diminish the secretory activity of the stomach and to lessen motility.

THE EFFECTS OF HEAT ON THE LIVER AND THE SPLEEN:

According to the exact observations of Kowalski, hot applications over the region of the liver followed by cold applications increase the secretion of bile. This effect is doubtless produced by the increased movement of blood through the organ induced by an application of this sort,as has been previously explained. The beneficial results obtained in hydriatic practice by the employment of fomentations ofer the liver followed by the heating compress, fully corroborate Kowalski's claims. For more than a hundred years this measure has been employed, largely empirically but nevertheless successfully, in the treatment of hepatic affections, so that it cannot be doubted that the liver may not be perfectly influenced by this means.

The effect of thermic applications over the spleen, hot, cold, or alternate hot and cold, is clearly shown in the rapid diminution in size which may thus be secured in cases of splenic enlargement from malarial infection and allied conditions not involving structural changes in the organ.

THE EFFECTS OF HEAT UPON RENAL ACTIVITY:

General hot baths promote renal activity and increase the amount of urine when the temperature is sufficiently high to increase blood pressure (104^{o} to 110^{o}F.). Renal secretion is diminished, however, when a general hot application is prolonged sufficiently to induce profuse perspiration. The powerful effects of general hot applications upon the kidneys is shown by the remarkable beneficial results obtained by the employment of the hot bath and allied hot applications in the treatment of acute nephritis.

THE EFFECTS OF HEAT UPON METABOLISM:

General applications of heat, if sufficiently prolonged to elevate the temperature of the blood, increase CO_2 production and nitrogen oxidation. Nitrogen oxidation appears to be particularly favored by an elevation of temperature induced by a gneral hot application.

The elevation of temperature induced by general hot applications appears to aid the body in the formation of alexins and antitoxins. It has been shown that animals suffering from infectious diseases live longer when subjected to the influence of heat. The recognition of this fact has led to the discovery that fever and the high elevation of temperature which occurs in connection with most acute infectious diseases is a remedial process. By reverse reasoning we are led to the conclusion that a fever artificially induced by a general hot application may be beneficial through its influence upon tissue activities.

Local applications of heat doubtless in many instances operate beneficially by concentrating the blood in a part and thus aiding leucocytosis, one of the most important of all forms of remedial activity.

ANATOMICAL BASIS OF THERMOTHERAPY.

The physiological effects of thermotherapy are determined experimentally. The therapeutic applications are suggested by inference or determined by clinical experience. For a full understanding of the rationale of both physiological and therapeutic effects, it is necessary to bear in mind a few anatomical facts of special interest in this connection. This is especially true in relation to local thermic applications.

The effects of thermic applications to the surface depend upon

1. The elevation of the temperature of the parts to which the application is made and of the general body temperature;

2. The effects induced in more or less remote parts through nervous reflex influence; and

3. The vascular relations existing between different body organs and regions.

The effects depending upon reflex nervous action are the result of the association, by means of reflex arcs, of the internal viscera with clearly defined cutaneous areas, each viscus having its own area from which the most intense reflex impressions are received while at the same time more remotely related with all portions of the surface. These cutaneous reflex areas for the most part overly the individual viscera. The accompanying cuts (Fig. .. and ..) show diagramatically the principal of these cutaneous areas which have been definitely worked out and which are clinically important.

Careful anatomical studies have shown that there is an equally intimate and more direct relation existing between the blood vessels of deeply seated organs and overlying or adjacent cutaneous areas.

According to Woolsey (Test-Book of Anatomy by American Authors.

Gerrish), the vessels of the brain are freely connected with those of the scalp and the nose through the parietal foramen, the foramen cecum, the mastoid foramen, the posterior condylar foramen, the foramen of Vesalius, the foramen ovale, the foramen lacerum medium, the carotid canal, the anterior condylar foramen, and other openings as well as through the diploé of the cranial bones.

The meningo-rachidian veins, which form dense plexuses in the spinal canal, are freely associated with the cutaneous veins of the back and the dorsi-spinal veins through the anastomosing veins which issue from the canal through the intervertebral foramina and unite with the intercostal, vertebral, lumbar and sacral veins.

The blood supply of the eye lids and of the skin covering the eye brows and adjacent portions of the forehead is collaterally related with branches of the internal carotid which supply the eye ball.

The circulation of the middle ear is collaterally related with the circulation of the skin of the face, and head of the same side through the common carotid. The circulation of the internal ear, on the other hand, is associated with the skin of the back of the neck, being derived from the vertebral arteries.

The vessels of the nasal mucous membrane of the pharynx are collaterally associated with those of the face and the sides of the head through the common carotid.

The circulation of the lungs is collaterally related to that of the skin covering the arms, the chest and the upper part of the back. The pericardium and the parietal pleura of the anterior portion of the chest is collaterally related to the skin covering the anterior portion of the chest wall through the internal mamary artery.

The parietal pleura of the posterior portion of the chest and the

visceral pleura are collaterally related with the intercostal vessels. A collateral relation also existsts between the bronchial arteries, the nutrient arteries of the lungs, and the intercostals, especially those of the right side. The skin covering the arms is collaterally related with the pleura of the upper and anterior portion of the chest through the subclavian. There also exists a collateral relation between the nutrient vessels of the lungs and the vessels covering the anterior portion of the neck through the inferior thyroid arteries. The collateral relationship existing between the vessels of the skin and of the lungs is still further maintained by the connection of the bronchial veins with the azygos vein of the right side, and with the superior intercostal or azygos vein of the left side. It is in the highest degree interesting to note the extensive communications between the pulmonary circulation and that of the cutaneous surface.

The kidneys are associated with the skin covering the loins through the renal branches of the lumbar arteries.

The vessels of the prostate in man, the uterus and ovaries in women, and the bladder in both sexes, are associated with the cutaneous vessels overlying the sacrum, the buttocks, the perineum, the external genitals, the groins, the inner surface of the thighs, and the suprapubic region, chiefly through the internal iliac. These organs are also associated with the skin of the leg through the common iliac.

The rectum is similarly associated with the skin covering the anal region and the perineum and that of the lower extremities.

There is a collateral relationship both venous and arterial between the stomach, liver, spleen, intestines, and even the pancreas, and the skin of the trunk which overlies those deeply seated organs.

The portal circulation communicates with the systemic circulation,

thus establishing a collateral relationship with the cutaneous vessels by half a dozen or more communications, especially the following: the hemorrhoidal plexus, the esophageal veins, the left renal vein, the phrenic vein at the surface of the liver, the epigastric veins at the umbilicus, the circumflex iliac (Treves, Schiff).

In a similar way, it may be stated that the upper half of the body is collaterally related with the lower half, a fact of which constant use is made when the lower extremities are warmed to divert blood from the head.

The cutaneous vascular areas connected with the several viscera are diagramatically indicated in the accompanying cuts (Fig. .. and ..). It should be remembered, however, that every portion of the cutaneous surfaceis remotely,at least,related vascularly to every internal part. It is also interesting to note that the vascular areas connected with the several internal viscera do not altogether correspond to the reflex cutaneous areas connected with the same parts, although in the main the reflex areas and vascular areas are practically identical. For example, the skin covering the front of the chest is of greatest importance as a means of reflexly influencing the pulmonary circulation, whereas the cutaneous vessels of the skin covering the back of the chest are more intimately related with the vessels of the lungs than are those of the anterior surface. A most important reflex relation exists between the skin covering the lower portion of the sternum and the kidneys, whereas the principal vascular relation exists between the kidneys and the skin covering the loins. The portion of the body below the umbilicus is collaterally related to the head, the arms, and the upper half of the trunk, and the legs are likewise in collateral relation with all parts of the body above them, especially those which occupy the pelvic cavity.

These relationships render it possible to employ the reflex and the fluxion methods at one and the same time, a cold application of small extent being applied over the center of greatest reflex activity while a hot application is made over the area which is in closxest vascular relation with the interested part. When the vascular cutaneous areas and the reflex areas connected are identical, the cold application is made to the reflex area while the hot application is made to the feet, legs, and lower half of the body, or even to the entire cutaneous surface of the body when the largest possible effect is desired.

Understanding these interesting anatomical relations, it is readily seen that the volume of blood in any internal viscus, no matter how remote from the surface, may be diminished either by a general hot application to the surface whereby one-half of all the blood in the body may be diverted into the skin, or to a lesser degree by localized applications. By means of hot applications suitably applied, the vessels of different portions of the brain may be drained into the communicating skin areas. The longitudinal sinus is drained by means of applications to the sides of the head. The lateral sinus may be drained by applications to the skin areas behind the ears; the cavernous sinus by applications over the face, ears, and side of the neck; the occipital sinus by applications to the back of the neck. Congestion of the spinal cord may be relieved by hot applications to the back from the base of the cranium down. Congestion of the eye ball may be relieved by hot applications made over the eye and the forehead above, not extending below the eye. Congestion of the middle ear is relieved by hot applications over the sides of the head and face; the internal ear by hot applications to the arms and legs; the nasal cavity and the pharynx by a hot application to the face and sides of the head,; the larynx by hot applications to the front of the neck, the arms, the back,

✓ first revision
Not Revised

THERMOTHERAPY.

As is the case with all physiological therapeutic measures, the therapeutic effects of heat are clearly foreshadowed in the physiological effects of this agent. These effects may be briefly summarized as follows:

(1) The general effects of heat render the highest service in most conditions of extreme exhaustion, as in surgical collapse, extreme fatigue from violent exertion, the collapse of typhoid and other infectious fevers, in certain cases of poisoning, and in acute autointoxication.

(2) The general excitant effects of heat render service in all cases in which active diaphoresis is called for, as after taking a cold, acute rheumatism, certain forms of chronic rheumatism, some cases of pneumonia and other acute infectious febrile disorders, and as an alterative or spoliative measure in diathetic maladies.

(3) Short general applications of heat serve an extremely useful purpose in modifying metabolism. Short applications lessen heat production and encourage heat elimination, while prolonged applications raise the body temperature by preventing heat elimination and also by communicating heat to the body.

(4) The increase of oxidation which accompanies a prolonged hot bath renders applications of this sort of the highest value in cases of obesity, diabetes, and the uric acid diatheses. Cold applications to a marked degree increase the oxidation of carbohydrates, but a general application of heat administered in such a way as to cause a decided elevation of the body temperature is the most effective of all means of securing increased oxidation of proteid wastes and thus facilitate their removal from the body. This fact alone renders general hot applications of some sort almost indispensable in the treatment of most forms of chronic disorders, including cases of spinal sclerosis,

locomotor ataxia, and many other disorders accompanied by organic changes, all of which probably have some form of autointoxication with accumulation of proteid wastes as their real etiological foundation.

(5)General hot applications are indicated in all forms of chronic visceral congestion,including chronic bronchial catarrh, chronic gastritis, instestinal catarrh, so-called chronic inflammation of the pelvic viscera, chronic cerebral congestion. The skin being capable of holding one-half to two-thirds of all the blood in the body, the filling of this immense vascular area comprising a surface of more than ten thousand square feet, if we include the capillary network distributed in the walls of the tubules of the sweat glands, relieves visceral congestion by divert ng the blood to the surface and accomplishes a therapeutic purpose which cannot be so satisfactorily obtained in any other way. The permanency of the effects thus obtained must be secured by following the hot application by a short cold application whereby strong reaction effects are produced with the accompanying dilitation of the small arteries and an increased rythmical activity of the peripheral heart.

(6) Still another important indication for general hot applications is the pre;aration of the skind for the cold douche, the shallow bath, wet sheet rub, set sheet pack, or any other hrdriatic application at a temperature below that of the body. This preparation is especially important in fever patients. It may be advantageously employed in all cases. When employed for this purpose, the application should be of brief duration, ordinarily from three to five minutes, or only sufficiently long to thoroughly heat the skin, and the maximum desirable effect is obtained with the skin becomes slightly moistened by perspiration.

Thermotherapy)

(7) General hot applications are of service as a means of intensifying the effects of cold hydriatic applications. When employed for this purpose, the hot and the cold applications are made in alternation. A somewhat prolonged hot application of two or three minutes may be followed by a short cold application of five to twenty seconds. Such an application is purely excitant to the circulatory system and produces profound revulsive effects. Short application of equal duration, ten to twenty seconds, the so-called alternate applications, are powerfully excitant. Such applications are generally made by means of the alternating general douche for which the horizontal jet, the ring, or needle douche may be employed. The vapor douch and a cold air douche may be thus employed in alternation, or the patient may be exposed in alternation to the hot air of the vapor bath, the electric light bath, the hot air bath, and the refrigerant effects of the cold horizontal jet, the shower, or the plunge. Such applications produce exceedingly powerful effects, two powerful in fact for use except in extraordinary cases when it is important to rouse the sluggish functions by most powerful thermic stimulation. Applications of this sort may sometimes be advantageously employed in obesity and in fat diabetics.

(8) Finally we may refer to the value of hot applications as a means of rendering tolerable cold applications which could not otherwise be borne, as the so-called simultaneous hot and cold application, a measure which the writer first introduced into therapeutics. Various combinations may be made, as for example, a hot shower bath combined with a cold douche to the spine, hepatic gastric, lumbar, or hypogastric region, or the extremities, as may be desired; or a cold douche may be administered to any part of the body while the patient is enveloped in hot vapor in a Russian bath or warmed by means of the vapor douche. The ideal application of this sort is the combined cold douche and the

incandescent light bath. The patient sits in a recess surrounded on three sides by incandescent bights closely placed in front of a reflectig surface by which the skind is strongly heated,while at the same time a jet of cold water is made to play upon any part of the surface which it is desired to impress in this way.

The purpose of a combination of this sort is to make a strong reflex effect upon some internal viscus while maintaining the highest degree of activity of the cutaneous surface. By this means we may prevent the general contraction of the surface vessels which very commonly follows the application of cold to a circumscribed area as well as when the general surface is acted upon. For example, a cold application over the stomach excites the peptic glands to activity while at the same time lessening the gastric congestion by causing contraction of the gastric vessels and also increases the motility by the stimulation of Auerbach's plexus. The application of a cold douche over the stomach gives rise to a general chilling of the surface, and the retrostasis of the blood resulting must necessarily increase the volume of blood in the gastric vessels so that the purpose of the gastric application may in part be defeated; but by a simultaneous general hot application this undersirable retrostatic action may be prevented.

The same principle applies to localized cold applications made for the purpose of relieving congestion of the lungs, liver, spllen, spi nal cord, pelvic viscera, or any other internal parts. This principle is put in operation whenever a cold compress is applied to the head, face or nesk of a patient who is receiving a general hot bath, as a vapor, Russian or Turkish bath. A cold application upon the face and scalp by reflex action maintains contraction of the blood vessels of the brain and so prevents the occurence of congestion from

cardiac excitation and elevation of the blood temperature. In like manner very strong thermic therapeutic impressions may be made upon the stomach, liver, spine, and other internal viscera by the application of an ice-bag or an ice-compress to the cutaneous area reflexly associated with the particular viscus while the patient at the same time receives a general hot application by means of the Turkish, hot air, vapor, or Russian, ~~bath~~ or electric light bath, or in the absence of any of these, the general hot pack, the hot blanket pack, or the dry pack. An application of this sort gives almost magical relief from visceral pain of all sorts when due to congestion, as ovarian neuralgia, gastric pain of gastralgia, cancer. The dreadful pain following the operation of ovariotomy or hysterectomy which generally leads the patient to plead most earnestly for an opiate, rarely fails to yield almost instantly to the application of an ice-bag over the seat of pain in combination with the hot blanket pack applied to the whole body or even to the hips and legs only. The convulsions of hysteria generally yield readily to the application of the spinal ice-bag with the hot blanket pack. The paroxysms of the epileptic state yield to the applications of ice to the head, neck and face, simultaneously with the hot blanket pack applied to the trunk and limbs.

General thermic applications are made by means of the Turkish bath, the hot air bath, the Russian bath, the vapor bath, the incandescent light bath, the sand bath, the mud bath, the hot immersion bath, the hot blanket pack, and the dry pack.

Local thermic applications are made by limited applications of the above, and in addition the application of heated objects, such as jugs, bottles, or rubber bags filled with water, the cotton poultice, the electrotherm, dry compress containing metallic objects affording resistance through which a current is passed, thermophore, rubber bag

a
containing chemical solution capable of giving off heat for a long time during the process of crystallization.

The effect of a general or a local thermic application is essentially the same irrespective of the source of heat, the intensity of the effect depending upon the extent, duration, and the time of the application.

The dry bath. This is a very effective but rather inconvenient mode of bringing the body as a whole under the influence of heat. The patient is simply wrapped very warm in blankets with hot water bottles or bags to the feet and thighs. Care must be taken to tuck the covers in closely about the neck and to bring the wrapping closely in contact with the body everywhere so as to prevent the slightest movement of air in contact with the skin. This will prevent evaporation and the consequent cooling.

The source of heat is the body itself. If heat elimination is favored by the warm coverings, there is a gradual accumulation of body heat which after a time results in a sufficient increase in the body temperature to produce perspiration and all the other effects of general hot applications.

This measure is effective in accomplishing all that can be accomplished by any other sweating procedure. The chief inconvenience lies in the length of time required to produce vigorous perspiration, sometimes amounting to several hours, and a considerable degree of discomfort which the patient experiences during the period which elapses before perspiration begins, during which time heat is accumulating to a degree sufficient to induce activity of the cutaneous glands.

Therapeutic indications. The therapeutic uses of this procedure are the same as those of other general hot applications by which perspiration can be induced. The special uses of the dry pack are the induction of perspiration in cases where other general thermic applica-

tions are not readily available, especially when for any reason the application of water is not deemed advisable, as in certain cases of malarial infection, in most cases of surgical shock, and in certain cases of acute rheumatism.

Local applications of the dry pack are often required in surgical cases, in cases of paralysis of the limbs after the ligation of arteries, and threatened senile gangrene, and in neuralgic affections.

The counterindications are the same as for other general hot applicati ons.

The sand bath. This form of bath is less appreciated and employed in modern times than its merits deserve. It is the most effective means of inducing perspiration and may be employed either in a general or local way. There are a few European resorts where the sandbath is commonly used, especially in the treatment of rheumatism. It is not systematically employed in this country by others than myself. Experience with this bath in connection with the outdoor gymnasium has afforded most excellent results in cases of rheumatism, chronic sciatica, lumbago, uric acid diathesis, chronic dyspepsia, and various forms of chronic disorder.

In taking this bath, the patient either lies in a mass of sand exposed to the sun with his body except the head either patially or wholly buried in the heated sand. All the precautions should be taken which are indicated in relation to the sun bath and other general applications of heat.

The therapeutic indications and contraindications are essentially the same as for other general thermic applications.

The mud bath. This procedure which has been in vogue for hundreds of years at certain European resorts, has been in more recent years introduced into this country. It consists simply in immersing the

body in an ordinary bathtub filled with mud made by the mixture of an unctious alkaline earth with water to the consistency of a thin parridge. The attendant plasters the mud upon the patient's chest and rubs it well upon the surface everywhere until the patients begins to perspire freely. It is then removed and hot sprays administered until the mud is washed off, the application ending with a short cool or cold application.

The mud bath is thought to be especially efficacious in rheumatic affections. It is certainly an effecting method of elevating the body temperature and inducing perspiration, but it must be considered that it is doubtful whether any specific virtue resides in heat communicated to the body by moist earth, and there is little or no evidence to show that alkaline or any earth or any other substances are absorbed during the bath. Quite generally strong sulphurous odors are evolved by the moist heated earth, the inhalation of which may produce certain medicinal effects. This procedure has the disadvantage of being very inconvenient in use, and it is doubtful whether the advantages derived from its employment are to a sufficient degree superior to many other more convenient methods of applying heat afforded by thermotherapy to justify the special claims made for this procedure. It must be acknowledged, however, that many rheumatic patients express a special preference for this bath and entertain most profound faith in its special efficacy.

Directions for the application of the hot blanket pack, the hot immersion bath, the hot douche, and other general thermic applications in which water is the agent of heat communications, will be found in the section of this work devoted to hydrotherapy, to which section the reader is also referred for description of the fomentation, the localized dry pack, and other local thermic applications.

We will conclude this section with a brief statement of the anatomical and physiological facts and principles upon which the efficacy of localized thermic applications depend.

The effects of thermic applications to the surface depend (1) upon the elevation of the temperature of the parts to which the application is made, and (2) upon the effects induced in more or less remote parts from nervous reflex influence and through anatomically related blood vessels.

Effects depending upon reflex nervous action are the result of the association by means of different reflex arcs of the internal viscera with clearly defined cutaneous areas, each viscus having its own area through which most intense cutaneous reflexes are perceived, while at the same time more remotely related with all portions of the surface. These cutaneous reflex areas are for the most part located upon those portions of the body surface which overly the individual viscera. The accompanying cuts show diagramatically a number of these cutaneous areas which have been definitely worked out and which are clinically important.

Careful anatomical studies have shown that there is an equally intimate and more direct relation existing between the bloodvessels of deeply seated organs and overlying or adjacent cutaneous areas.

According to Woolsey (Text-book of Anatomy by American Authors. Gerrish), the vessels of the brain are freely connected with those of the scalp and the nose through the parietal foramen, the foramen cecum, the mastoid foramen, the posterior condylar foramen, the foramen of Vesalius, the foramen ovale, the foramen lacerum medium, the carotid canal, the anterior condylar foramen, and other openings as well as through the diploë of the cranial bones. The meningo-rachidian veins which form dense plexuses in the spinal canal, are freely associated with the cutaneous veins of the back and the dorsi-spinal veins

through the anastomosing veing which issue from the canal through the intervertebral foramina and unite with the intercostal, vertebral, lumbar and sacral veins. The blood supply of the eyeball, the eyelids and of the skin covering the eyebrows and adjacent portions of the forehead, is derived from collaterally related branches of the internal carotid. The circulation of the middle ear is collaterally related with the circulation of the skin of the face and head of the same side through the common carotid. The circulation of the internal ear on the other hand is associated with the skin of the organs of the back of the neck, being supplied by the vertebral arteries. The vessels of the nasal mucous memorane and of the pharynx are collaterally associated with those of the face and sides of the head through the common carotid. The circulation of the limbs is collaterally related to that of the overlying skin and the skin covering the arms and the upper part of the chest and back. The pericardium and the parietal pleura of the anterior portion of the chest is collaterally related to the skin covering the anterior portion of the chest wall through the internal mamary artery. The parietal pleura of the posterior portion of the chest and the visceral pleura are collaterally related with the intercostal vessels. A collateral relation also exists between the bronchial arteries, the nutrient arteries of the lungs, and the intercostals, especially those of the right side. The skin covering the arms is collaterally related with the pleura of the upper and anterior portion of the chest through the subclavian. The also exists a collateral relation between the nutrient vessels of the lungs and the vessels covering the anterior portion of the neck through the inferior thyroid arteries. The collateral relationship existing between the vessles of the skind and of the lungs is still further maintained by the connection of the bronchial viens with the azygos vein of the right

side, and with the superior intercostal or azygos vein of the left side. The kidneys are associated with the skin covering the loins through the renal branches of the lumbar arteries. The prostate in men, the uterus and ovaries in women, and the bladder in both sexes, are associated with the cutaneous vessels overlying the sacrum, the buttocks, the perineum, the external genitals, the groins, the inner surface of the thighs, the suprapubic region, chiefly through the internal iliac. These organs are also associated with the skin of the legs through the common iliac. The rectum is similarly associated with the skin covering the anal region and the perineum and that of the lower extremities.

There is a collateral relationship both venous and arterial between the stomach, liver, spleen, and intestines, even the pancreas, and the skin of the trunk which overlies those deeply seated organs. The portal circulation communicates with the systemic circulation, thus establishing a collateral relationship with the superficial vessels by half a dozen or more communications, especially the following: the hemorrhoidal plexus, the esophageal veins, the left renal vein, the phrenic veinat the surface of the liver, the epigastric veins at the umbilicus, the circumflex iliac (Treves, Schiff). In a similar way, it may be stated that the upper half of the body is collaterally related with the lower half, a fact of which constant use is made when the lower extremities are warmed and blood thus diverted from the head.

Understanding these interesting anatomical relations, it will be easy to see that the volume of blood in any internal viscus no matter how remote from the surface, may be diminished either by a general hot application to the surface whereby one-half of all the blood in the body may be diverted into the skin, or to a lesser degree by localized thermic applications. By means of hot applications suitably applied the vessels of different portions of the brain may be drained into the

communicating skin areas. The longitudinal sinus is drained by means of applications to the sides of the head. The lateral sinus may be drained by applications to the skin areas behind the ears; the cavernous sinus by applications over the face, ears, and side of the neck; the occipital sinus by applications to the back of the neck.

Congested spinal cord may be relieved by hot applications to the back from the base of the skull down. Congestion of the eyeball may be relieved by hot applications made over the eye and the forehead above it, not extending below the eye. Congestion of the middle ear is relieved by hot applications over the sides of the head and face; the internal ear by hot applications to the arms and legs; the nasal cavity and the pharynx by a hot application to the face and sides of the head. The larynx by a hot application to the front part of the neck, the arms, the back, the upper part of the chest, and the legs; the lungs by an application over the whole thoracic cage and the arms, an additional advantage being gained by a hot application to the legs; the kidneys by general hot applications to the whole surface or local hot applications over the lumbar region; the pelvic organs by hot applications to the hips and legs; the stomach and other viscera by hot applications over the interested part or better to the entire trunk.

As Treves very well remarks (Surgical Applied Anatomy, Page 371), these facts give "an anatomical demonstration of the value ..... of counter-irritants in inflammatory infections of certain of the viscera, and also a scientific basis to the ancient practice of poulticing the loin and the iliac region in nephritis and in inflammation about the caecum."

The fluxion effects produced by hot applications applied with scientific accuracy and the relief from pain and other therapeutic

effects which may be thereby secured, are among the most valuab le of all the resources of physiological and rational therapeutics. For efficiency in relieving pain, for example, the hot fomentations or an equivalent hot applications certainly stands next to opium and its derivatives, while it is incomparably superior to the drug by the fact that it relieves pain, but by hiding it, but by removing its cause. The accompanying figures clearly indicate to the eye how pain of a congested muscle may be relieved by the diversion of blood to the skin or the pain of a boil by spreading out the blood through dilatation of the vessles of the adjacent skin. When employed for the relief of pain, localized heating applications should be followed by a heating compress consisting of a towel wrung quite dry out of cold water, and well covered with flannel so as to pro mote reaction and retention of the heat, thus securing a prolonged poultice (?) effect. By this means, the blood is retained in the skin so that the effect of the hot applicationx is prolonged.

Deep-seated inflammations may be marvelously controlled by either general or localized applications to theproper cutaneous surfaces. This is well illustrated in pelvic inflammation, for example by the immediate relief afforded by the hot hip and leg or the hot hip pack, the general hot blanket pack, or the hot immersion bath or any other hot application. This use of heat may be said to be suggested by the natural instinct which leads one to protect any painful part such as an aching tooth, eye, or ear, by the application of the warm hand in the absence of more suitable ~~xxxxx~~ protection.

In deep-seated inflammations, a pain due to visceral congestion, is generally best relieved by simultaneous applications of heat and cold. The cold application should be intense but should cover but a small area, while the hot application should cover a very large area so located as to act derivatively. For example, in the case of

ovarian inflammation an ice-bag should be applied over the ovary simultaneously with the hot hip and leg pack. After the hot application is removed, the ice-bag should remain in plade, the limbs being kept warm by hot bags and wrappings. By the cold application the vessels of the inflamed part are made to contract from reflex action, while an exceedingly hot application acting derivatively empties the vessels of the part, thus securing the complete cooperation of two important therapeutic principles at one time and place. This principle is illustrated in the very common employment of the hot foot bath in association with the cold compress to the head for the relief of cerebral congestion. The same principle may be extended to the treatment of congestions and inflammations of any deep-seated organ. The modus operandi of this procedure, which the author believes he was the first to suggest, is graphically illustrated in the accompanying diagrams.

An interesting combined therapeutic application was suggested a few years ago by Dr. Wilhelm Winternitz. It consists in the application of the heating compress or wet girdle about the trunk while heat is applied over the stomach by means of the hot water coil. The writer has taken the liberty to name this measure the hot and cold trunk pack. The heat may be applied by means of rubber hot baths. (See Figure ..) The heat may be applied by means of the hot water bag instead of the hot water coil if more convenient. This derivative measure acts powerfully upon the visceral circulation, exercising a most remarkable sedative effect upon the stomach in irritable conditions of this organs. The writer has made use of this same principle for many years in the hot and cold head compress in which heat is applied to the back of the head or neck and cold applied to the face, or the opposite. The same principle may be applied

in the treatment of the spine, the chest, the intestines, the pelvic viscera and other parts of the body.

In conclusion, attention should be called to the fact that hot applications of all sorts whether general or local should almost without exception be concluded by a cool or cold hydriatic application so as to restore the tone of the surface vessels and to fix the blood in the skin, thus rendering ~~kkxxpxxmxxxxxxxxxxxxxxxx~~ permanent the temporary benefit derived from the hot application. When the hot application has been prolonged sufficiently to cause an elevation of the temperature, the cooling procedure should be at a moderate temperature ordinarily from 90° to 75°, and sufficiently prolonged to restore the thermic equilibrium of the body. The time required ordinarily would be one to three minutes. The duration should never be sufficient to produce chilliness, and the application should be made with sufficient vigor to maintain the dilatation of the surface vessels. When applications of hot have been limited to small areas or have been of short duration, the cooling application should be at a lower temperature and of short duration (60-45°, duration 3-15 seconds).

THERMOTHERAPY.

Anatomic basis.

Effects depend upon--

1. Elevation of temperature
   (a) of skin
   (b) of body

2. Reflex effects
   (a) in the skin
   (b) in reflexly related parts

Vascular connections

Vascular connections of brain and scalp
(a) Parietal foramen, foramen caecum, the mastoid foramen, posterior condyloid foramen, foramen Vesalius, foramen ovale, foramen lacerum, medium, carotid canal, the anterior condyloid foramen, as well as through the diploë of the cranial bones.

(b) The meningorachidian veins which form dense plexuses in the spinal canal are freely associated with the cutaneous veins of the back, and with the dorso-spinal veins through the anastomosing veins which issue from the canal through the intervertebral foramen, and unite with the intercostal, vertebral, lumbar and sacral veins.

Eyelids, eyeballs, through internal carotid

Face and head through common carotid

Internal ear and back of neck through vertebral arteries

Throat and nose with face and sides of heat through common carotic

Nose, arms, and chest (see Gray).

Pericardium, pleura with front of chest through internal mammary artery

Parietal pleura, skin of back through intercostal vessels

Bronchial arteries and intercostals and skin of neck through ~~thyro~~ thyroid arteries

Bronchial veins, azygos veins, connects with the renal branches of the urinary arteries

Vessels of the genito-urinary arteries with adjacent skin

Portal circulation six points

The hemorrhoidal plexus

The esophageal veins

The left renal vein

The phrenic vein at the surface of the liver

The epigastric veins at the umbilicus

The circumflex iliac vein

Longitudinal sinus, sides of head; lateral sinus, behind ears; cavernous sinus, face, ears, sides of neck and back of neck.

Show how to train the different vessels.

PRACTICE OF THERMOTHERAPY.

General exhausting effects

Exhaustion

Typhoid state

Autointoxication

Poisoning

Sweating

Cold

Rheumatism

Uric acid

Obesity

Diabetes

Fluxion effects

Chronic

Intensified cold effects

Simultaneous hot and cold

THERMOTHERAPY.

The employment of heat as a therapeutic agent technically includes applications at all temperatures and irrespective of the nature of the media through which the application is made. Properly speaking, hydriatic applications of all sorts, both hot and cold; vapor baths, hot and cold air baths, and even light baths, are thermic applications. The general plan of this series of volumes, however, requires that attention should be confined in this chapter to the consideration of such applications only as are capable of communicating heat to the body, hence excluding cold applications of all sorts. Vapor and Russian baths, which may be properly termed thermic applications, are also omitted from this chapter, having received proper consideration elsewhere.

Media of any sort having a temperature above that of the body are said to be "hot". Temperatures above 104° are termed "very hot". Temperatures near that of the skin are termed "warm". These terms with others relating to temperature are commonly used rather loosely. To secure accuracy in prescription it is better to indicate the exact temperature. When ordinary terms are employed they may be understood as expressing the following temperature values: Very cold, 32° to 55° F.; cold, 55° to 65° F.; cool, 65° to 80° F.; tepid, 80° to 92° F.; warm, 92° to 98° F.(neutral, 92° to 96° F.); hot, 98° to 104° F.; very hot, 104° F. and above.

For a full understanding of thermotherapy, it is essential that one should be familiar with the fundamental principles of hydrotherapy, a concise statement of which would be in place were it not that the subject is elsewhere considered at length in this series of volumes. The limitation of space will permit only a brief statement of the physiologi-

cal effects resulting from warm and hot applications, general and local, which ~~statement~~ will be followed by a description of the technique of hot applications and a summary of the therapeutic applications.

GENERAL PHYSIOLOGICAL EFFECTS.

The general effects of heat are those of an excitant or a physiological stimulant. Within physiological limits, the application of heat to living cells increases the activity of their protoplasm, an effect easily recognized in the quickened movements of the amoeba, leucocytes, and other minute animal forms, when placed upon a warming stage under the microscope. Heat is one of the most powerful of all vital stimulants It increases the activity of all tissues which it may be brought to bear upon,--glands, nerves, nerve-centers, etc.

The effects, however, are temporary, and are followed by secondary effects of an opposite character, depression, a sort of negative or atonic reaction after the withdrawal of the hot application. To these secondary depressant or atonic effects are attributable the weakening or exhausting effects of thermic applications when improperly managed or inappropriately applied.

The actual effects of a thermic application depend upon the temperature, duration and form of the application, and also upon the condition of the patient.

A prolonged application at a high temperature is at first excitant, then very decidedly depressant. The excitation is the natural result of the elevation of the temperature of the blood. The depressing effects appear to result from ~~the~~ the lowering of the nerve tone and the exhausting of nervous energy by over-stimulation.

A very short application at a high temperature is very strongly excitant, and the depressing effects which follow may be so slight as to be quite imperceptible.

A less intense, and moderately prolonged thermic application is excitant to a moderate degree at first, depressant effects appearing later, ~~with diminished tissue activity of all forms~~ after the conclusion of the application.

EFFECTS OF HEAT UPON THE SKIN:--

1. A very short and a very hot application produces a goose flesh appearance from contraction of the smooth muscular fibres of the skin.

2. Heat also contracts the yellow elastic tissue, but relaxes the white fibrous tissue which constitutes the chief element of ligaments and tendons.

3. Increased perspiration.

4. An increased activity of the respiratory function of the skin.

5. Increased tactile sensibility at 98° F., decreased at 113° F. Tactile sensibility disappears at a temperature of 130° F. when painful sensations are experienced.

6. Momentary pallor when the temperature is high (110° F. upwards), quickly followed by reaction with reddening of the skin from dilatation of the vessels. Lower temperatures produce immediate reddening of the skin with dilatation of the small blood vessels, especially the veins. Contraction of the cutaneous vessels, with pallor, occurs some little time after the withdrawal of heat, the result of atonic reaction and chilling of the surface from evaporation.

7. Increased heat elimination following a hot application is the result of the increased movement of blood through the skin, and the dilatation of the surface vessels, increased conductivity of the skin, and the increased evaporation occasioned by the largely increased amount

of moisture thrown upon the surface by the sweat glands.

EFFECTS OF HEAT UPON THE MUSCLES:--

1. The energy of the striated muscles is increased by short, hot applications from 98° to 104° F.

2. Prolonged warm or hot applications lessen the excitability and the energy of voluntary muscles. It is thus that heat becomes of service in relieving muscular cramp. Cold produces the opposite effect.

3. Very hot applications (104° to 130° F.) increase the excitability of the smooth or involuntary muscles.

EFFECTS UPON THE NERVOUS SYSTEM:--

1. Very short hot applications excite the brain, nerves and nerve centers through the impressions made upon the skin.

2. Prolonged general hot applications may give rise to pronounced exhaustion of the brain and spinal cord. Warm and hot applications lessen general nervous sensibility to a most remarkable degree. This is especially true of very hot applications. This effect may be due in part to the absorption of moisture by the terminal nerve filaments in the skin. It has also been suggested that this result may be brought about by the stimulation of the temperature nerves. It is well known that the skin is much more sensitive to thermic impressions than to any other form of stimulus which it is capable of recognizing.

3. Applications of heat to the skin generally produce an agreeable sense of comfort and well-being. When long continued, languor, lassitude and depression result.

4. Short very hot applications are, like short cold applications, exciting, both directly and reflexly.

EFFECTS OF HEAT UPON THE CIRCULATION:-

Heart:- 1. In general, heat applied over the heart tends to lessen the length of the systole while cold produces the opposite effect.

2. General hot applications at first slow the heart, then increase the pulse frequency. Cold produces exactly the opposite effect.

Blood Vessels:-- 1. Very hot applications at first contract, then relax the blood vessels.

2. Under the influence of heat the skin assumes a dusky red hue from slowing of the blood circulation in the skin due to the fact that the veins appear to be influenced by heat more than are the arteries. The vascular dilatation accompanying the reaction which follows a cold application influences the arteries especially, giving rise to a bright red hue. The vascular dilatation due to heat is passive, while that due to cold is active.

3. Large arterial trunks are dilated by hot applications when prolonged sufficiently to heat the intervening tissues or applied at points at which the vessels approach near the surface, as the groins, the axillae, the neck, the bend of the elbow and the knee.

4. The principle of fluxion or revulsion which furnishes the foundation for one of the most important therapeutic uses of heat depends upon the fact that when the vessels of one portion of the peripheral area to which blood is supplied by an arterial trunk are in a state of dilatation, ~~the result is~~ there is contraction of the vessels of the other portion of the same area and consequently a diversion of blood therefrom. In other words, the local hyperemia induced by an application of heat gives rise to a compensatory or collateral anemia in the area in vascular relation therewith. This explains the relief afforded by an application of heat about a rheumatic joint or over an inflamed or congested muscle. The same fact ~~This~~ likewise affords an explanation of the relief of visceral pain which results from a general hot application.

Blood Pressure:-/. Cold raises blood pressure while general hot applications lower blood pressure, though the blood vessels may be dilated in both cases.

2. The dilatation which accompanies the reaction following a cold application does not lower blood pressure because of the increased vigor of the heart action resulting from reflex stimulation, and the increased activity of the "peripheral heart." A very hot application may raise blood pressure by reflex excitation of the heart, producing a quick, strong pulse, but in general, hot applications lower blood pressure by dilatation of the cutaneous vessels, whereby peripheral resistance is lessened. The skin is capable of holding one-half to two-thirds of all the blood in the body. Hence a general hot application by dilating the surface vessels, and especially the veins of the skin, draws a large amount of blood from the internal circulation. The ventricles of the heart are not so well filled and the heart contractions are lessened in force.

3. A hot douche produces an elevation of blood pressure while at the same time dilating the surface vessels to the fullest degree by reason of the strong mechanical or percutient ~~effect~~ action characteristic of this form of bath, whereby the heart is stimulated.

EFFECTS OF HEAT UPON RESPIRATION:

1. ~~Hot, dry~~ Heat and dryness of the air hinders the gaseous exchanges in the lungs, and renders ~~the ease and frequency of~~ respiration more frequent and superficial.

2. ~~Air saturated with moisture~~ Hot moist air Heat and moisture to the extent of saturation, interferes with elimination through the lungs.

3. A general hot bath increases the rate and frequency of respiration. The depth of respiration is at first diminished but when the bath is continued sufficiently long to raise the temperature of the blood and increase CO_2 production, the depth of the respiratory movements is increased.

4. A frog breathes with its skin; a dog sweats with its lungs,; man not only sweats with his skin and breathes with his lungs, but like the frog to some extent breathes with his skin and like the dog sweats with his lungs. Hot baths not only promote the perspiratory activity of the skin but the elimination of moisture through the lungs, thus aiding in the escape of those toxic substances which, as Charrin has pointed out, are probably eliminated from the bronchial mucous membrane.

THE EFFECTS OF HEAT UPON BODY TEMPERATURE:—

1. A general application at a temperature above that of the body causes elevation of the temperature of the blood by interference with heat elimination. For example, in a series of experiments in the author's laboratory, the temperature of a young man weighing 108 pounds was increased 3.2°F. (1.8°C.) in thirty minutes, representing an accumulation of 88.2 calories. A bath at a temperature of the body (100°) caused an increase of 0.6°F. in temperature. Baths at a temperature of 92° to 96° F. (neutral) do not increase the body temperature. A Russian bath for twentyfive minutes increased the temperature 2.1°F. An increase of the same amount (2.1°F.) was observed as the result of an electric light bath for twenty three minutes. An increase of 1.7°F. resulted from a Turkish bath of one hour at 146° to 158°F.

The elevation of body temperature induced by prolonged hot baths is not wholly due to diminished heat elimination, since it has been shown that heat production is increased in dogs exposed to a temperature of 104°F. to three and one-half times the normal.

2. A short application of heat is followed by a fall of temperature, the result of increased heat elimination through dilatation of the surface vessels, and a diminution of heat production through the refelx influence of the thermic nerves upon the thermogenic processes.

THE EFFECTS OF HEAT UPON THE BLOOD:—

General hot applications decrease the blood count, notably diminishing the proportion of ~~leucocytes~~ red cells. ~~They~~ Heat also ~~diminish~~ lessens the alkalinity of the blood thus diminishing ~~the~~ vital resistance, as has been shown by Charrin. This fact emphasizes the importance of concluding every general hot application with a general cold application of some sort, cold having the effect to ~~restore~~ maintain the normal alkalinity of the blood and thus increase vital resistance. When profuse sweating is induced, the volume of the blood is diminished, unless the loss is made good by the ingestion of water.

THE GENERAL EFFECTS OF HEAT UPON THE ABDOMINAL VISCERA:—

As observed above, heat lowers the tone of voluntary muscles while cold raises it. In other words, heat relaxes muscles while cold contracts them. This effect is particularly marked where applications are made to the muscles of the abdominal wall, a fact which has long been taken advantage of in the treatment of strangulated hernia, and more recently in ~~the~~ examination of the pelvic and abdominal viscera while the patient lies in a hot bath.

The tension of the abdominal muscles is a matter of no small importance in relation to respiration and especially the blood movement in all the viscera lying below the diaphragm. With the relaxation of the abdominal muscles intraabdominal tension is diminished and the portal vessels become distended with blood. All the viscera are congested. The stomach and intestines become distended with gas, and stasis in the stomach and colon occurs, resulting in gastric indigestion, and constipation with fermentations and putrefactive processes which lead to autointoxication and various nutritive disturbances.

Cold, when applied to the abdominal wall, contracts not only the external voluntary muscles but the internal involuntary muscles of

the stomach and intestines, bladder, ~~xka~~ and gall bladder, together with the muscular structures found in the spleen and the liver, and the muscular walls of the blood vessels. Hot applications to the abdominal walls produce the opposite effect. It is apparent that hot applications of this sort are not therapeutically valuable except for the relief of conditions of muscular spasm, either in the external voluntary muscles or the internal involuntary muscular structures, as, for example, in intestinal or renal colic, or gall stones.

Long continued warm applications to the abdominal surface appear to lead to concentration of blood in the portal circulation, doubtless by relaxing the visceral vessels.

Very hot applications on the other hand appear to divert blood from the internal viscera by widely dilating the surface vessels. This effect is made possible by the anatomical connection which exists between the cutaneous vessels and those of the viscera which will be mentioned in detail a little later.

By the alternate application of heat and cold, the blood movement through any internal viscus may be very readily and perfectly controlled. Cold contracts the visceral vessels through reflex action of the thermic nerves while heat produces the opposite effect. By the alternation of these effects a veritable pumping action may be instituted whereby functional activity may be influenced and disease processes controlled.

Very hot ~~as well as very cold applications~~ waters when brought in direct contact with the gastric mucous membrane excite both motor and secretory activity, producing also a very decided stimulating effect upon the heart. Cold applications applied over the stomach as well as cold applications to the general surface increase the motility of the stomach and stimulate the secretion of the gastric juice. ~~Unless prolonged,~~ unless greatly prolonged, very hot applications, either general or local, produce similar effects.

It should be noted, however, that when the general hot application is prolonged until profuse perspiration is induced, the secretion of gastric juice is greatly diminished. Puschkin claims to have shown that the amount of the gastric juice and its digestive activity is greatly increased by the application of heat to the epigastrium after eating. The clinical results obtained by the writer in the use of this measure as a meas of promoting digestion ~~in the last twenty five~~ years, enables him to say that Puschkin's claims are fully corroborated by clinical experience. Applications to be beneficial in this way must be very hot. Warm applications doubtless tend to diminish the secretory activity of the stomach and to lessen motility.

THE EFFECTS OF HEAT ON THE LIVER AND THE SPLEEN: —

According to the exact observations of Kowalski, hot applications over the region of the liver followed by cold applications increase the secretion of bile. This effect is doubtless produced by the increased movement of blood through the organ induced by an application of this sort, as has been previously explained. The beneficial results obtained in hydriatic practice by the employment of fomentations ofer the liver followed by the heating compress, fully corroborate Kowalski's claims. For more than a hundred years this measure has been employed, largely empirically but nevertheless successfully, in the treatment of hepatic affections, so that it cannot be doubted that the liver may ~~not~~ ~~perfectly~~ powerfully influenced by this means.

The effect of thermic applications over the spleen, hot, cold, or alternate hot and cold, is clearly shown in the rapid diminution in size which may thus be secured in cases of splenic enlargement from malarial affection and allied conditions, when not involving structural changes in the organ.

THE EFFECTS OF HEAT UPON RENAL ACTIVITY:-

General hot baths promote renal activity and increase the amount of urine when the temperature is sufficiently high to increase blood pressure (104° to 110°F.). Renal secretion is diminished, however, when a general hot application is prolonged sufficiently to induce profuse perspiration. The powerful effects of general hot applications upon the kidneys is shown by the remarkable beneficial results obtained by the employment of the hot bath and ~~allied~~ other general hot applications in the treatment of acute nephritis.

THE EFFECTS OF HEAT UPON METABOLISM:-

1. General applications of heat, if sufficiently prolonged to elevate the temperature of the blood, increase CO_2 production, ~~and nitrogen oxidation~~. Nitrogen oxidation appears also to be particularly favored by ~~an~~ the elevation of temperature induced by a general hot application.

2. ~~The~~ Experiments also show that the elevation of temperature induced by general hot applications ~~appears to~~ aids the body in the formation of alexins and antitoxins. ~~It has been shown that~~ Animals suffering from infectious diseases live longer when subjected to the influence of heat. The recognition of this fact has led to the discovery that fever and the high elevation of temperature which occurs in connection with most acute infectious diseases is a remedial process. By reverse reasoning we are led to the conclusion that a fever artificially induced by a general hot application may be beneficial in aiding resistance to infection, Especially when followed by a short cold bath. ~~through its influence upon tissue activities.~~

Local applications of heat doubtless in many instances operate beneficially by concentrating the blood in a part and thus aiding leucocytosis, one of the most important of all forms of remedial activity.

The ANATOMICAL BASIS OF THERMOTHERAPY.—

The physiological effects of thermotherapy are determined experimentally. The therapeutic applications are suggested by inference or determined by clinical experience. For a full understanding of the rationale of both physiological and therapeutic effects, it is necessary to bear in mind a few anatomical facts of special interest in this connection. This is especially true in relation to local thermic applications.

The effects of thermic applications to the surface depend upon

1. The elevation of the temperature of the parts to which the application is made and of the general body temperature;

2. The effects induced in more or less remote parts through nervous reflex influence; and

3. The vascular relations existing between different bodily organs and regions.

The effects depending upon reflex nervous action are the result of the association, by means of reflex arcs, of the internal viscera with clearly defined cutaneous areas, each viscus having its own area from which the most intense reflex impressions are received while at the same time more remotely related with all portions of the surface. These cutaneous reflex areas for the most part overly the individual viscera. The accompanying cuts (Fig. 1. and 2.) show diagramatically the principal of these cutaneous areas which have been definitely worked out and which are clinically important.

Careful anatomical studies have shown that there is an equally intimate and more direct relation existing between the blood vessels of deeply seated organs and overlying or adjacent cutaneous areas.

According to Woolsey (Test-Book of Anatomy by American Authors.

Gerrish), the vessels of the brain are freely connected with those of the scalp and the nose through the parietal foramen, the foramen cecum, the mastoid foramen, the posterior condylar foramen, the foramen of Vesalius, the foramen ovale, the foramen lacerum medium, the carotid canal, the anterior condylar foramen, and other openings as well as through the diploë of the cranial bones.

The meningo-rachidian veins, which form dense plexuses in the spinal canal, are freely associated with the cutaneous veins of the back and the dorsi-spinal veins through the anastomosing veins which issue from the canal through the intervertebral foramina and unite with the intercostal, vertebral, lumbar and sacral veins.

The blood supply of the eye lids and of the skin covering the eye-brows and adjacent portions of the forehead is collaterally related with branches of the internal carotid which supply the eye ball.

The circulation of the middle ear is collaterally related with the circulation of the skin of the face, and head of the same side through the common carotid. The circulation of the internal ear, on the other hand, is associated with the skin of the back of the neck, being derived from the vertebral arteries.

The vessels of the ~~nasal~~ mucous membrane of the pharynx are ~~collat-~~ erally associated with those of the face and the sides of the head through the common carotid.

The circulation of the lungs is collaterally related to that of the skin covering the arms, the chest and the upper part of the back. The pericardium and the parietal pleura of the anterior portion of the chest is collaterally related to the skin covering the anterior portion of the chest wall through the internal mamary artery.

The parietal pleura of the posterior portion of the chest and the visceral pleura are collaterally related with the intercostal

visceral pleura are collaterally related with the intercostal vessels. A collateral relation also existsts between the bronchial arteries, the nutrient arteries of the lungs, and the intercostals, especially those of the right side. The skin covering the arms is collaterally related with the pleura of the upper and anterior portion of the chest through the subclavian. There also exists a collateral relation between the nutrient vessels of the lungs and the vessels covering the anterior portion of the neck through the inferior thyroid arteries. The collateral relationship existing between the vessels of the skin and of the lungs is still further ~~maintained~~ extended by the connection of the bronchial veins with the azygos vein of the right side, and with the superior intercostal or azygos vein of the left side. It is in the highest degree interesting to note the extensive communications between the pulmonary circulation and that of the cutaneous surface, all of which are of high physiological importance.

The kidneys are associated with the skin covering the loins through the renal branches of the lumbar arteries.

The vessels of the prostate in man, the uterus and ovaries in women, and the bladder in both sexes, are associated with the cutaneous vessels overlying the sacrum, the buttocks, the perineum, the external genitals, the groins, the inner surface of the thighs, and the supra-pubic region, chiefly through the internal iliac. These organs are also associated with the skin of the leg through the common iliac.

The rectum is similarly associated with the skin covering the anal region and the perineum and that of the lower extremities.

There is a collateral relationship both venous and arterial between the stomach, liver, spleen, intestines, and even the pancreas, and the skin of the trunk which overlies those deeply seated organs.

The portal circulation communicates with the systemic circulation,

thus establishing a collateral relationship with the cutaneous vessels at several points by half a dozen or more communications, especially the following: the hemorrhoidal plexus, the esophageal veins, the left renal vein, the phrenic vein at the surface of the liver, the epigastric veins at the umbilicus, the circumflex iliac (Treves, Schiff).

In a similar way, it may be stated that the upper half of the body is collaterally related with the lower half, a fact of which constant use is made when the lower extremities are warmed to divert blood from the head.

The cutaneous vascular areas connected with the several viscera are ~~diagrammatically~~ roughly indicated in the accompanying diagrams ~~cuts~~ (Fig. 3. and 4.). It should be remembered, however, that every portion of the cutaneous surfaceis remotely, at least, related vascularly to every internal part. It is also interesting to note that the vascular areas connected with the several internal viscera do not altogether correspond to the reflex cutaneous areas connected with the same parts, although in the main the reflex areas and vascular areas are practically identical. For example, the skin covering the front of the chest is of greatest importance as a means of reflexly influencing the pulmonary circulation, whereas the cutaneous vessels of the skin covering the back of the chest are more intimately related with the vessels of the lungs than are those of the anterior surface. A most important reflex relation exists between the skin covering the lower portion of the sternum and the kidneys, whereas the principal vascular relation exists between the kidneys and the skin covering the loins. The portion of the body below the umbilicus is collaterally related to the head, the arms, and the upper half of the trunk, and the legs are likewise in collateral relation with all parts of the body above them, especially those which occupy the pelvic cavity.

These relationships render it possible to employ the reflex and the fluxion methods at one and the same time, a cold application of small extent being applied over the center of greatest reflex activity while a hot application is made over the area which is in closest vascular relation with the interested part. When the vascular cutaneous areas and the reflex areas, ~~connected~~ concerned are identical, the cold application is made to the reflex area while the hot application is made to the feet, legs, ~~and~~ or lower half of the body, or even to the entire cutaneous surface ~~of the body~~ when the largest possible effect is desired.

Understanding these interesting anatomical relations, it is readily seen that the volume of blood in any internal viscus, no matter how remote from the surface, may be diminished either by a general hot application to the surface whereby one-half of all the blood in the body may be diverted into the skin, or to a lesser degree by localized applications. By means of hot applications suitably applied, the vessels of different portions of the brain may be drained into the communicating skin areas. The longitudinal sinus is drained by means of applications to the sides of the head; The lateral sinus may be drained by applications to the skin areas behind the ears; the cavernous sinus by applications over the face, ears, and side of the neck; the occipital sinus by applications to the back of the neck. Congestion of the spinal cord may be relieved by hot applications to the back from the base of the cranium down. Congestion of the eye ball may be relieved by hot applications made over the eye and the forehead above, not extending below the eye. Congestion of the middle ear is relieved by hot applications over the sides of the head and face; the internal ear by hot applications to the arms and legs; the nasal cavity and the pharynx by a hot application to the face and sides of the head,; the larynx by hot applications to the front of the neck, the arms, the back,

communicating skin areas. The longitudinal sinus is drained by means of applications to the sides of the head. The lateral sinus may be drained by applications to the skin areas behind the ears; the cavernous sinus by applications over the face, ears, and side of the neck; the occipital sinus by applications to the back of the neck.

Congested spinal cord may be relieved by hot applications to the back from the base of the ~~skull~~ cranium down. Congestion of the eyeball may be relieved by hot applications made over the eye and the forehead above it, not extending below the eye. Congestion of the middle ear is relieved ~~xxx~~ by hot applications over the sides of the head and face; The internal ear by hot applications to the arms and legs; the nasal cavity and the pharynx by a hot applicatiin to the face and sides of the head; The larynx by a hot application to the front part of the neck, the arms, the back, the upper part of the chest, and the legs; the lungs by an applicatiinn over the whole thoracic cage and the arms, an additional advantage being gained by a hot application to the legs; the kidneys by general hot applications to the whole surface or local hot applications over the lumbar region; the pelvic organs by hot applications to the hips and legs; the stomach and other viscera by hot applications over the interested part or better to the entire trunk, or trunk and legs.

As Treves very well remarks (Surgical Applied Anatomy, Page 371), these facts give "an anatomical demonstration of the value ... of counter-irritants in inflammatory ~~infections~~ affections of certain of the viscera, and also a scientific basis to the ancient practice of poulticing the loin and the iliac region in nephritis and in inflammation about the caecum."

Star page 10.18

As space will not permit a detailed discussion of all points pertaining to the therapeutic effects of heat, many of which have been ably considered by others in the discussion of hydrotherapy and allied subjects, we present merely a summary of the general principles involved.

** p. 18

The means ~~bases~~ employed in thermotherapy are for the most part exceedingly simple and such as every one is more or less familiar with. Yet it must not be supposed that the therapeutic use of the procedures ~~recognized in thermotherapy~~ is by any means a simple matter or that these agents can be used successfully without attention to the most minute details and the exercise of the greatest care to employ the measures appropriate to the case in hand. The successful practice of thermotherapy requires exactly as much painstaking accuracy and precision in diagnosis, in prescription making, in dosage and adaptation of means to individual conditions and idiosyncrasies as is necessary in the employment of powerful therapeutic measures of any other sort. Strychnia, morphia, and other powerful drugs may produce deadly effects when carelessly employed, but the effects resulting from the careless application of thermotherapy may be not less disastrous. It may be said, however, in favor of the physiological procedures of thermotherapy that they are to a remarkable degree self-adjusting and hence less likely to lead to injurious consequences than are powerful drugs. If this were not true, the extensive empirical and bungling employment of these agents by the laity would long ago have lead to their abandonment.

THERMOTHERAPY.

As is the case with all physiological therapeutic measures, the therapeutic effects of heat are clearly foreshadowed in the physiological effects of this agent. ~~These effects may be briefly summarized as follows:~~

(1) The general effects of heat render the highest service in most conditions of extreme exhaustion, as in surgical collapse, extreme fatigue from violent exertion, the collapse of typhoid and other infectious fevers, in certain cases of poisoning, and in acute autointoxication.

~~(2)~~ The general excitant effects of heat render service in all cases in which active diaphoresis is called for, as after taking a cold, acute rheumatism, certain forms of chronic rheumatism, some cases of pneumonia and other acute infectious febrile disorders, and as an alterative or spoliative measure in diathetic maladies.

~~(3) Short~~ General applications of heat serve an extremely useful purpose in modifying metabolism. Short applications lessen heat production and encourage heat elimination, while prolonged applications raise the body temperature by preventing heat elimination and also by communicating heat to the body.

~~(4)~~ The increase of oxidation which accompanies a prolonged hot bath renders applications of this sort of the highest value in cases of obesity, diabetes, and the uric acid diatheses. Cold applications to a marked degree increase the oxidation of carbohydrates, but a general application of heat administered in such a way as to cause a decided elevation of the body temperature is the most effective of all means of securing increased oxidation of proteid wastes and thus facilitates their removal from the body. This fact alone renders general hot applications of some sort almost indispensable in the treatment of most ~~forms of~~ chronic disorders, including cases of spinal sclerosis,

Star page 11.

...as the small vessels of the skin may be properly called.

locomotor ataxia, and many other disorders accompanied by organic changes, all of which probably have some form of autointoxication with accumulation of proteid wastes as their real etiological foundation.

(5) General hot applications are indicated in all forms of chronic visceral congestion, including chronic bronchial catarrh, chronic gastritis, instestinal catarrh, so-called chronic inflammation of the pelvic viscera, chronic cerebral congestion. The skin being capable of holding one-half to two-thirds of all the blood in the body, the filling of this immense vascular area, comprising a surface of more than ten thousand square feet, if we include the capillary network distributed in the walls of the tubules of the sweat glands, relieves visceral congestion by diverting the blood to the surface and accomplishes a therapeutic purpose which cannot be so satisfactorily obtained in any other way. The permanency of the effects thus obtained must be secured by following the hot application by a short cold application whereby strong reaction effects are produced with the accompanying dilitation of the small arteries and an increased rythmical activity of the peripheral heart.

(6) Still another important indication for general hot applications is the preparation of the skin for the cold douche, the shallow bath, wet sheet rub, wet sheet pack, or any other hydriatic application at a temperature below that of the body. This preparation is especially important in fever patients. It may be advantageously employed in all cases. ~~When employed for this purpose~~, the application should be of brief duration, ordinarily from three to five minutes, or only sufficiently long to thoroughly heat the skin, and the maximum desirable effect is obtained with the skin becomes slightly moistened by perspiration.

Thermotherapy)

(7) General hot applications are of service as a means of intensifying the effects of cold hydriatic applications. When employed for this purpose, the hot and the cold applications are made in alternation. A somewhat prolonged hot application of two or three minutes may be followed by a short cold application of five to twenty seconds. Such an application is purely excitant to the circulatory system and produces profound revulsive effects. Short application of equal duration, ten to twenty seconds, the so-called alternate applications, are powerfully excitant. Such applications are generally made by means of the alternating general douche for which the horizontal jet, the ring, or needle douche may be employed. The vapor douche and a cold air douche may be thus employed in alternation, or the patient may be exposed in alternation to hot air of the vapor bath, the electric light bath, or the hot air bath, and the refrigerant effects of the cold horizontal jet, the shower, or the plunge. Such applications produce exceedingly powerful effects, too powerful in fact for use except in extraordinary cases when it is important to rouse the sluggish functions by most powerful thermic stimulation. Applications of this sort may sometimes be advantageously employed in obesity and in fat diabetics.

(8) Finally, we may refer to the value of hot applications as a means of rendering tolerable cold applications which could not otherwise be borne, as the so-called simultaneous hot and cold application, a measure which the writer first introduced into therapeutics. Various combinations may be made, as for example, a hot shower bath combined with a cold douche to the spine, hepatic, gastric, lumbar, or hypogastric region, or the extremities, as may be desired; or a cold douche may be administered to any part of the body while the patient is enveloped in hot vapor in a Russian bath or warmed by means of the vapor douche. The ideal application of this sort is the combined cold douche and the

incandescent light bath. The patient sits in a recess surrounded on three sides by incandescent bights closely placed in front of a reflectig surface by which the skind is strongly heated, while at the same time the a jet of cold water is made to play upon any part of the surface which it is desired to impress in this way.

The purpose of a combination of this sort is to make a strong reflex effect upon some internal viscus while maintaining the highest degree of activity in the cutaneous surface. By this means we may prevent the general contraction of the surface vessels which very commonly follows the application of cold to a circumscribed area as well as when the general surface is acted upon. For example, a cold application over the stomach excites the peptic glands to activity while at the same time lessening the gastric congestion by causing contraction of the gastric vessels and also increases the motility by the stimulation of Auerbach's plexus. The application of a cold douche over the stomach gives rise to a general chilling of the surface, and the retrostasis of the blood resulting must necessarily increase the volume of blood in the gastric vessels so that the purpose of the gastric applicatien may in part be defeated; but by a simultaneous general hot application this undersirable retrostatic action may be prevented.

The same principle applies to localized cold applications made for the purpose of relieving congestion of the lungs, liver, splien, spi nal cord, pelvic viscera, or any other internal parts. This principle is put in operation whenever a cold compress is applied to the head, face or neck of a patient who is receiving a general hot bath, as a vapor, Russian or Turkish bath. A cold application upon the face and scalp by reflex action maintains contraction of the blood vessels of the brain and so prevents the occurence of congestion from

cardiac excitation and elevation of the blood temperature. In like manner very strong thermic ~~therapeutic~~ impressions may be made upon the stomach, liver, spine, and other internal viscera by the application of an ice-bag or an ice-compress to the cutaneous area reflexly associated with the particular viscus while the patient at the same time receives a general hot application by means of the Turkish, hot air, vapor, or Russian, ~~xxxx~~ or electric light bath, or in the absence of any of these, the general hot pack, the hot blanket pack, or the dry pack. An application of this sort gives almost magical relief from visceral pain ~~of all sorts when~~ due to congestion, as ovarian neuralgia, gastric pain of gastralgia, cancer, The dreadful pain following the operation of ovariotomy or hysterectomy which generally leads the patient to plead most earnestly for an opiate, rarely fails to yield ~~almost instantly~~ to the application of an ice-bag over the seat of pain in combination with the hot blanket pack applied to the whole body or ~~even~~ to the hips and legs ~~only~~. The convulsions of hysteria generally yield readily to the application of the spinal ice-bag with the hot blanket pack. The paroxysms of the epileptic state yield to the applications of ice to the head, neck and face, simultaneously with the hot blanket pack applied to the trunk and limbs.

General thermic applications are made by means of the Turkish bath, the hot air bath, the Russian bath, the vapor bath, the incandescent light bath, the sand bath, the mud bath, the hot immersion bath, the hot blanket pack, and the dry pack.

Local thermic applications are made by limited applications of the above, and in addition the application of heated objects, such as jugs, bottles, or rubber bags filled with water, the cotton poultice, the electrotherm, dry compress containing metallic objects affording resistance through which a current is passed, thermophore, rubber bag

containing a chemical solution capable of giving off heat for a long time during the process of crystallization.

The effect of a general or a local thermic application is essentially the same irrespective of the source of heat, the intensity of the effect depending upon the extent, duration, and the time of the application.

The fluxion effects produced by hot applications applied with scientific accuracy and the relief from pain and other therapeutic

Star page 16.3

... and in the drawing up of the legs when abdominal pain is present, an instinct which is possessed by the lower animals in common with man.

Double star page 16.3

... being confined to the area of most acute reflex activity.

effects which may be thereby secured, are among the most valuable of all the resources of physiological and rational therapeutics. For efficiency in relieving pain, for example, the hot fomentations or an equivalent hot applications certainly stands next to opium and its derivatives, while it is rendered incomparably superior to the drug by the fact that it relieves pain, not by hiding it, but by removing its cause. The accompanying figures (Figs 5, 6, 7, 8) clearly indicate to the eye how pain of a congested muscle may be relieved by the diversion of blood to the skin or the pain of a boil by spreading out the blood through dilatation of the vessles of the adjacent skin. When employed for the relief of pain, localized heating applications should be followed by a heating compress consisting of a towel wrung quite dry out of cold water, and well covered with flannel so as to promote reaction and retention of the heat, thus securing a prolonged poultice (?) effect. By this means, the blood is retained in the skin so that the effect of the hot applicationx is prolonged.

Deep-seated inflammations may be ~~marvelously~~ controlled by either general or localized applications to theproper cutaneous surfaces. This is well illustrated in pelvic inflammation, for example, by the great relief afforded by the hot hip and leg or the hot hip pack, the general hot blanket pack, or the hot immersion bath or any other hot application. This use of heat may be said to be suggested by the natural instinct which leads one to protect any painful part such as an aching tooth, eye, or ear, by the application of the warm hand in the absence of more suitable protection.

In deep-seated inflammations, pain due to visceral congestion, is generally best relieved by simultaneous applications of heat and cold. The cold application should be intense but should cover only a small surface, while the hot application should cover a very large area so located as to act derivatively. For example, in the case of

Star page 17. 25

Fig. 9. illustrates a combined hydriatic application for relief of a congested kidney. An icebag applied over the lower third of the sternum causes reflex contraction of the kdney vessels, as shown by Beni-Barde, while an application of heat made to the lumbar region relieves the congested organ by diverting blood from its arteries and veins into the overlying muscular structures.

In Fig. 10 and 11 is graphically illustrated the operation of a simultaneous hot and cold application for relief of congestion of the pelvic viscera. The icebag applied to the hypogastrium and the groins causes contraction of the branches of the internal iliac which supplies the uterus and ovaries, thus lessening the blood supplied to those parts, while the hot hip and leg pack by dilating the cutaneous vessels diverts a large volume of blood into the external branches of the internal iliac and the cutaneous branches of the external iliac.

ovarian inflammation an ice-bag should be applied over the ovary simultaneously with the hot hip and leg pack. After the hot application is removed, the ice-bag should remain in plade, the limbs being kept warm by hot bags and wrappings. By the cold application the vessels of the inflamed part ~~are~~ made to contract ~~from~~ reflex ~~action~~, while ~~an exceedingly~~ hot application, acting derivatively empties the vessels of the part, thus securing the complete cooperation of two important therapeutic principles at one time and place. This principle is illustrated in the very common employment of the hot foot bath in association with the cold compress to the head for the relief of cerebral congestion. The same principle may be extended to the treatment of congestions and inflammations of any deep-seated organ. The modus operandi of this procedure, ~~xxx~~ which the author believes he was the first to suggest, is graphically illustrated in the accompanying diagrams ~~(Figs 9, 10)~~

An interesting combined therapeutic application was suggested a few years ago by Dr. Wilhelm Winternitz. It consists in the application of the heating compress or wet girdle about the trunk while ~~heat~~ heat is applied over the stomach by means of the hot water coil. The writer has taken the liberty to name this ~~measure~~ the ~~hot~~ hot and cold trunk pack. The ~~heat~~ may be applied by means of ~~rubber~~ ~~bags~~ hot baths. ~~(See Figure #.)~~ The heat may be applied by means of the hot water bag instead of the hot water coil if more convenient. This derivative measure acts powerfully upon the visceral circulation, exercising a most remarkable sedative effect upon the stomach in irritable conditions of this organs. The writer has made use of ~~this same principle~~ for many years ~~in~~ the hot and cold head compress in which heat is applied to the back of the head or neck and cold applied to the face, or the opposite. The same principle ~~may be~~ applied

in the treatment of the spine, the lungs, ~~chest~~, the abdominal ~~intestines, the~~ and 18 pelvic viscera and other parts of the body.

In conclusion, attention should be called to the fact that hot applications of all sorts whether general or local should almost without exception be concluded by a cool or cold hydriatic application so as to restore the tone of the surface vessels and to fix the blood in the skin, thus rendering ~~xxxxxxxxxxxxxxxxxxxxxxxxxx~~ permanent the temporary benefit derived from the hot application. When the hot application has been prolonged sufficiently to cause an elevation of the temperature, the cooling procedure should be ~~at a~~ moderate, ~~temperature~~ ordinarily ~~from~~ 90° to 75°, and sufficiently prolonged to restore the thermic equilibrium of the body. The time required ordinarily would be one to three minutes. The duration should never be sufficient to produce chilliness, and the application should be made with sufficient vigor to maintain the dilatation of the surface vessels. When applications of ~~hot~~ heat have been limited to small areas or have been of short duration, the cooling application should be at a lower temperature and of short duration (60-45°F., ~~duration~~ 3-15 seconds).

THE TURKISH BATH.--

27 19

This very ~~interesting~~ ancient form of bath is a powerful means of influencing the bodily functions, and though likely to be largely superceeded by the electric light bath, must still be recognized as a measure of value and importance. The essential features of the Turkish bath are,-- a heated room in which the patient reclines until vigorous perspiration is induced, the

~~Thermotherapeutic Procedures~~ 27 276

47

shampoo, and a cooling spray or plunge. This bath, or its equivalent, has been used since very ancient times, as shown by the magnificient ~~remains~~ ruins and baths to be seen at the present day in Pompeii and Rome. The oldest existing Turkish bath was built in the time of Herod the Great, at Jersalem. While visiting Jerusalem a few years ago, the writer found this ancient establishment still in operation. This is probably the oldest bathing establishment in the world.

A scientifically arranged Turkish bath establishment consists of a series of rooms which provide, besides dressing rooms and a cooling room furnished with couches on which patients may recline after a bath, at least the following separate compartments: —

1. A room heated to a temperature of 110° to 130°, -- the "Tepidarium" of the ancients.

2. A hot room, heated to the temperature 150 to ~~120~~ 200°, -- the "Caldidarium" of the ancients. In some establishments another small room is provided in which a temperature of 230° to 300° may sometimes be observed.

3. A convenient adjacent room, furnished with marble slabs, and hot and cold water with other necessary paraphernalia, provides for the shampoo. Close at hand must be ~~provided~~ found a well arranged douche apparatus, and also a well eqipped establishment there will be found a plunge or swimming bath containing water at a temperature of 60 to 70°. Some European establishments ~~provide, in a plunge, water at a~~ the writer noted the little plunge temperature as low as 45°. ~~In~~ However, the writer's opinion a temperature of 65° is low enough to secure all essential therapeutic results, and is safer for the average patient than a lower temperature.

The ~~A~~ hot room ~~has been~~ may be heated by steam coils, or by hot air provided by a furnace or an indirect steam heater. ~~In rooms which are heated by~~ and direct radiation by steam pipes, the air is generally very impure, ~~as no~~ by reason of the absence of adequate provision ~~is made~~ for ventilation. When, however, ~~the~~ hot air system is employed, ventilating is employed. Any inferiority in effect desired may be attained by increasing the temperature of the bath

tion becomes essential as a means of maintaining the temperature of the room. This is secured by an outlet near the bottom of the room; this opening must communicate with the ventilating shaft. The opening for the inlet of warm air may be either at the floor or ceiling; it is perhaps best located at a point about two or three feet above the level of the floor.

TECHNIQUE: The patient disrobes, places a loin cloth about his body, drinks a glass of water, either hot or cold, enters the warm room and lies down upon a couch. Usually, by the end of ten to fifteen minutes, and sometimes, sooner, the skin becomes slightly moistened, and a little later the subject finds himself in a state of profuse perspiration. In cases in which perspiration does not promptly appear, the danger of the activity of the cutaneous glands may be encouraged by the gentle kneading of the patient, by superficial massage or friction of the skin by an attendant. The native shampooers of Cairo and Constantinople frequently rub the bather with mits made of course fabric somewhat resembling haircloth. A very hot foot-bath or a short, hot spray, or full bath, is also an effective means to encouraging perspiration. In patients who cannot drink freely, a hot enema (110°) administered just before the bath, will usually induce prompt perspiration. Hot water drinking is another important means of encouraging cutaneous activity. If the patient does not perspire either with or without the aid of the measures mentioned, he should not be allowed to remain in the bath for any considerable length of time, as serious injury may possibly result from a long exposure of the body to intense heat without the protecting influence of evaporation.

After the patient begins to perspire, he may, if he desires, enter the hot room to remain for a few minutes until very vigorous perspiration is induces; or if more moderate cutaneous activity is desired, he may remain

in the warm room. When the perspiration has been maintained as long as desirable, the patient is conducted to the shampoo room, where he is first rubbed with the bare hands or with Turkish mits, from head to foot, and in such a manner as to remove every particle of the superficial, deadly layers of skin which have been loosened by the profuse perspiration. The operator can readily determine when this waste material has been fully removed, by the smoothness of the skin. When the whole body has been gone over the patient is shampooed with good soap, the latter being applied and the skin thoroughly rubbed, either with a throughly aseptic brush, or a properly arranged mass of flax, manilla, or other fibrous material. Great care must be taken in the employment of the shampoo brushes to avoid conveying infection of any sort from one patient to anoter. The only safe precaution, when a common brush is used (a preactice which is certainly not to be commended) is, to drop the brush for two minutes into boiling water each time it is used, after thoroughly rinsing the soap suds out of it. There is an advantage in the use of manilla and other fibers in the fact that the cost of the material is so small thatit may be thrown away and a new supply provided for each patient and at each treatment.

The means employed in shampooing are not easily described. The movements administered with the bare hands, and which are of the highest importance, consist, for the most part, of alternate to and fro movements across the chest and up and down the body. This movement should not cover too great a territory at a time, and the work must be very thoroughly done. The hands should be frequently dipped in water at a temperature of about 90°; no part must be neglected.. The face, ears and neck should receive first attention; then the chest, abdomen, arms, and legs, and back (for which the patient turns over), and finally the feet.. After the patient has been very thoroughly gone over with the bare hands, a very strong lather is

-2-

made with a shampoo brush and soap rubbed together , and the patient's body is well covered over with the same. The brush, or mass of fiber or horse hair is then applied, at first to the upper part of the neck and chest, then the arms, then the lower parts of the body; no part should be neglected The shampooing and rubbing should be continued until the whole surface feels like polished marble. After the shampooing, the patient is conducted to the douche. If he is still quite warm, a cold douche may be administered at once. If he has become slightly chilled, he should be thoroughly warmed up before the cold application is made. This may be accomplished by means of a hot foot bath , or a warm shower bath. The bath should end with a douche of cold water at a temperature of 60° or less. If the patient is inclined to perspire freely after the bath , a shower at a temperature of 90° to 80° should be administered for from one to three minutes before the final application.

After the douche, which serves the double purpose of removing the soap with the shampoo, and counteracting any depressing effects from the prolonged exposure in the bath tub, the patient may enter the plunge or the swimming bath, or may wrap a sheet around him and lie down upon a couch until the skin becomes perfectly dry, and the pulse returns to its normal rate.

If the patient has a very dry skin, a little refined vaseline should be administered at the close of the bath. Massage, short movements, or joint movements , or both measures may be advantageously employed, which in many cases aid reaction and increase the value of the bath.

Note ~~to~~ be ~~added~~ to the ~~Turkish bath~~.

It is not usually necessary to apply cold to the head of the patient during the bath as perspiration of the face and scalp begins early and this prevents overheating of the head. For persons who are unaccustomed to the bath, the applications of a dry towel or napkin over the ~~face and~~ and forehead head will usually be sufficient. The distension of the surface vessels diverts the blood from the brain and thus obviates any danger from cerebral congestion. The only exceptions are those cases in which the heart is unduly excited and the brain congested ~~irritated~~ by the elevated temperature of the blood.

Physiological Effects:-- The physiological effects of the Turkish bath are essentially the same as those of other general hot applications. There are, however, certain characteristic differences which may be noted with advantage.

The exposure of the entire body to a superheated atmosphere, and especially the inhalation of ~~the~~ dry hot air, excites the pulmonary mucous membrane as well as the skin. The great extent of this membrane, about two thousand square feet, gives importance to this fact. The great dryness of the air and the excitation of the mucous surface with which it comes in contact unquestionably facilitate the elimination of those volatile toxins which find exit through the pulmonary mucous membrane (Charrin).

Shortly after the patient enters the bath, ~~his~~ the pulse ~~will be~~ is found considerably accelerated and tension increased. The higher the temperature of the bath, the more rapid ~~will be~~ the pulse. During this period of increased blood tension, the patient experiences a sense of fullness in the head, some respiratory distress, and general discomfort. As soon, however, as the skin becomes reddened and moistened with ~~xxxxxxx~~ perspiration, the pulse rate diminishes, tension is lowered, respirations becomes easy, and uncomfortable sensations disappear. The Breathing is ~~likely to be~~ usually thoracic in character.

The sudoriparous glands are powerfully stimulated. The amount of secretion may be increased from one and a half ounces per hour to fifteen or twenty times this amount. The writer has often seen patients lose two pounds or more in ~~sweat~~ weight as the result of an hour's ~~exposure~~ sweating in the hot room of ~~the~~ a Turkish bath. This ~~fact~~ rapid loss of water indicates ~~emphasizes~~ the importance of copious water drinking during the bath as the heart's action may be lessened in power and various other functions interfered with as the result of so considerable a reduction of the blood volume.

The large ~~amounts~~ of water discharged from the skin promoted absorption from the alimentary canal. As a result, ~~of this~~ patients who are taking Turkish baths daily are likely to suffer from constipation, unless this tendency is counteracted by copious water drinking.

The activity of the perspiratory glands excited during the bath continues in a modified degree for some hours after the bath as the result of the improved cutaneous circulation. Hence, water drinking must be practiced after as well as before and during the bath.

The intense congestion of the skin induced by the Turkish bath withdraws an enormous amount of blood from the liver, spleen, stomach, intestines, brain and other internal organs. The decongestion of these deep lying vascular areas is one of the most important results obtained by this procedure although one which seems to have been heretofore very little appreciated by those who have written upon this subject.

While it is not probable that any considerable amount of heat is communicated to the body from the heated atmosphere of the bath, heat production is increased to such a degree that a very decided elevation of temperature may generally be noted when the patient remains in the bath for half an hour or more. Experiments with the dog have shown that exposure to an atmosphere of a few degrees above the temperature of the body may increase heat production as much as 350%. At this rate, the heat production during ~~loss from~~ an hour's exposure in the Turkish bath might amount to nearly 400 calories or nearly ~~about~~ one-sixth the daily output of energy, representing three and a half ounces of fat or twice this quantity of carbohydrate. Heat elimination must be also greatly increased for the rise in body temperature is proportionately slight.

In the treatment of obese persons, it must be remembered that these patients have a much smaller skin surface in proportion to their weight than have smaller persons, and hence that heat elimination is greatly

hindered. For example, a person weighing ~~300~~ three hundred pounds has a skin area of only 13.2 square inches per pound, while a person weighing 120 pounds has a cooling cutaneous surface of 18 square inches for each pound of weight, or nearly fifty percent more. The obese person has a further disadvantage in that the surface vessels are in large part buried in fat, so that they do not come near the surface, whereas in a thin person the close approach of the ~~10,000~~ ten thousand square feet of capillary network to the surface secures a rapid cooling of ~~his~~ the blood.

~~For~~ To feeble subjects the Turkish bath should not be administered more than one to three times weekly. The ordinary patient may take a short Turkish bath daily, and when the bath is employed for reduction of weight, it may often be administered twice a day provided the exposure in the hot room is not more than thirty to forty minutes at each seance.

Therapeutic Applications:- Although the Turkish bath is perhaps not capable of inducing any therapeutic effect which cannot be otherwise secured, and while it is perhaps inferior to the light bath as a thermotherapeutic measure, it is nevertheless capable of producing excellent therapeutic effects in almost every form of chronic disease. It must not be supposed, however, that its chief advantages are the result of the profuse perspiration induced. As shown by Bouchard, the amount of toxic matter removed by sweating is very small. The elimination of water by the skin seems to serve chiefly as a means of regulation of the body temperature. Neverthreless, profuse perspiration is a most efficient alterative measure. General vital activity is accelerated by the large movement of fluid from the interior toward the periphery. Perspiration hence becomes an important means of promoting tissue activity in all chronic disorders accompanied by the

condition which Bouchard has termed "Ralentissment de Nutrition," a state in which all the vital processes are slowed, resulting in a general deterioration of the organism through impaired tissue formation and accumulation of waste. The Turkish bath, ~~hence,~~ thus may render valuable service in the treatment of obesity, fat diabetics, the chronic autointoxication so commonly present in chronic dyspeptics, the uric acid diathesis in all its forms, many cases of neurasthenia, hypochondria and melancholia. Most forms of chronic nervous disease, even cases of locomotor ataxia, chronic myelitis, ~~asteric sclerosis,~~ paresis, paralysis, neuritis and other equally obstinate maladies are materially helped by the judicious use of the Turkish bath, even though a radical cure may be in the majority of cases impossible.

As a hygienic measure, the Turkish bath has long justly held a high place in the confidence of the laity as well as of the profession. Simply the thorough skin cleanliness which it secures is an advantage of no small consideration, yet its highest value is due to the fact that the combined hot and cold procedures which it involves in the highest degree promote vital activity and the building up of the bodily resistance to the causes of disease, thus counteracting to some degree the evil consequences of the artificial conditions imposed by civilized life and affording a considerable degree of protection against the various infectious agents and other dangers to which most civilized human beings are exposed.

In all forms of anemia and Chlorosis, the Turkish bath is an admirable measure, promoting blood formation and relieving visceral congestion. Care must be taken, however, to avoid extreme temperatures and prolonged exposure in these cases on account of the degeneration of the blood vessels which is some times present in these affections,

(note) Just before Physiological Effects of Turkish Bath.

The Turkish bath affords an opportunity to secure the most pronounced effect possible upon the circulation of any internal viscus, it which may be desired to influence. For example, in ~~the~~ cases of chronic gastritis or chronic intestinal catarrh, chronic spinal congestion, cerebral hyperemia, or renal congestion, the general effect of the bath in relieving visceral congestion may be intensified by a suitably placed cold application consisting of an ice-bag, a cold compress, or a cooling coil. In cerebral congestion, an ice-bag may be applied to the head or an ice-collar may be fitted about the neck. A towel wrung out of ice water may be applied to the face and ears. In renal congestion, an ice-bag may be applied over the lower third of the sternum. In uterine and ovarian congestion, or the so-called chronic inflammation of these organs, an ice-bag may be applied to the groins and the hypogastrium. In chronic inflammation of the stomach or intestines, or congestion of the spleen, liver, or spine, ~~the~~ a cold application should be made over the parts indicated. The application of cold in the manner suggested, especially to the head, renders a higher temperature tolerable and may permit of a longer duration of the bath.

47

as pointed out by Bouchard.

Contraindications and Precautions:-- The Turkish bath is contra-indicated in cases of cardiac dilatation, tachycardia, arterio sclerosis, organic affections of the heart in which there is evidence of deficient of failing compensation, apoplectic subjects, irritable skin affections, and all febrile disorders. The bath must be used with great care in all forms of nephritis and is contraindicated in advanced stages of renal disorder, also in exophthalmic goiter.

The pulse should be carefully watched, especially during the first seances and the first few moments after the patient enters the bath. Undue cardiac ~~dx~~ excitation may generally be relieved by the application of an icebag over the heart. If the effect desired is not readily secured, the patient should be removed from the bath, and the incandescent electric light bath or some other heating procedure adopted.

To follow page 23.

THE HOT AIR BATH:-- This bath resembles the Turkish bath, the essential difference being that the head is excluded from contact with the heated air, so that the patient is able to breathe ~~atxr~~ air at the ordinary temperature, while the entire body, with the exception of the head, is exposed to dry ~~super~~-heated air.

Technique:-- The hot air cabinet may be a permanent structure of wood, zinc-lined, or it may consist of a portable cabinet of rubber, cloth, or other impervious material. In the absence of a specially constructed cabinet, a substitute can easily be improvised by placing the patient in a chair and covering him with a rubber blanket or with ordinary blankets between the folds of which newspapers have been placed.

Various sources of heat may be employed, as a small kerosene stove or ~~even~~ a large kerosene lamp or alcohol lamp, a small gas stove or even heated stones or bricks. For a permanent arrangement, a steam coil is most convenient. ~~The physiological and therapeutic effects are the same, however, no matter what the source of heat employed.~~

Fig. 1. shows a convenient arrangement for a hot air bath. When the patients are not able to sit erect, the bath may be administered in bed either by means of a special device or by an arrangement which may easily be improvised. It is only necessary to provide a space about the patient by means of a proper framework covered first with rubber cloth, then with ordinary blankets. Heat is supplied by means of a tin pipe which can be made by any tinner at a small expense, so arranged that one end can be slipped over the top of an ordinary lamp chimney while the other enters the enclosed space about the patient. Before entering the bath, the patient should take a glass of water, either hot or cold as he prefers. Perspiration may be promoted by repeated water drinking during the bath. The temperature may vary from 150° to 250° F.

THERMOTHERAPY.

The employment of heat as a therapeutic agent technically includes applications at all temperatures and irrespective of the nature of the media through which the application is made. Properly speaking, hydriatic applications of all sorts, both hot and cold, vapor baths, hot and cold air baths, and even light baths, are thermic applications. The general plan of this series of volumes, however, requires that attention should be confined in this chapter to the consideration of such applications only as are capable of communicating heat to the body, hence excluding cold applications of all sorts. Vapor and Russian baths, which may be properly termed thermic applications, are also omitted from this chapter, having received proper consideration elsewhere.

Media of any sort, having a temperature above that of the body are said to be "hot." Temperatures above 104° are termed "very hot". Temperatures near that of the skin are termed "warm". These terms with others relating to temperature are commonly used rather loosely. To secure accuracy in prescription, it is better to indicate the exact temperature. When ordinary terms are employed, they may be understood as expressing the following temperature values: Very cold, 32° to 55° F.; cold, 55° to 65° F.; cool, 65° to 80° F.; tepid, 80° to 92° F.; warm, 92° to 98° F.; (neutral, 92° to 96° F.); hot, 98° to 104° F.; very hot, 104° F. and above.

For a full understanding of thermotherapy, it is essential that one should be familiar with the fundamental principles of hydrotherapy, a concise statement of which would be in place were it not that the subject is elsewhere considered at length in this series of volumes. The limitation of space will permit only a brief statement of the physiological effects resulting from warm and hot applications, general and local, which will be followed by the description of the technique of hot applications and a summary of the therapeutic applications.

GENERAL PHYSIOLOGICAL EFFECTS.

The general effects of heat are those of an excitant or a physiological stimulant. Within physiological limits, the application of heat to living cells increases the activity of their protoplasm, an effect easily recognized in the quickened movements of the amoeba, leucocytes, and other minute animal forms, when placed upon a warming stage under the microscope. Heat is one of the most powerful of all vital stimulants. It increases the activity of all tissues which it may be brought to bear upon,--glands, nerves, nerve-centers, etc.

These effects, however, are temporary, and are followed by secondary effects of an opposite character, depression, a sort of negative or atonic reaction after the withdrawal of the hot application. To these secondary depressant or atonic effects are attributable the weakening or exhausting effects of thermic applications when improperly managed or inappropriately applied.

The actual effects of a thermic application depend upon the temperature, duration, and form of the application, and also upon the condition of the patient.

A prolonged application at a high temperature is at first excitant, then very decidedly depressant. The excitation is the natural result of the elevation of the temperature of the blood. The depressing effects appear to result from the lowering of the nerve-tone and the exhaustion of nervous energy by over-stimulation.

A very short application at a high temperature is very strongly excitant, and the depressing effects which follow may be so slight as to be quite imperceptible.

A less intense, and moderately prolonged thermic application is excitant to a moderate degree at first, depressant effects appearing later, after the conclusion of the application.

EFFECTS OF HEAT UPON THE SKIN.

1. A very short and a very hot application produces a goose flesh appearance from contraction of the smooth muscular fibres of the skin.

2. Heat also contracts the yellow elastic tissue, but relaxes the white fibrous tissue which constitutes the chief element of ligaments and tendons.

3. Increased perspiration.

4. An increased activity of the respiratory function of the skin.

5. Increased tactile sensibility at 98° F., decreased at 113°F. Tactile sensibility disappears at a temperature of 130° F. when painful sensations are experienced.

6. Momentary pallor when the temperature is high (110° F. upwards, quickly followed by reaction with reddening of the skin from dilatation of the vessels. Lower temperatures produce immediate reddening of the skin with dilatation of the small blood-vessels, especially the veins. Contraction of the cutaneous vessels, with pallor, occurs some little time after the withdrawal of heat, the result of atonic reaction and chilling of the surface from evaporation.

7. Increased heat elimination following a hot application is the result of the increased movement of blood through the skin, and the dilatation of the surface vessels, increased conductively of the skin, and the increased evaporation occasioned by the largely increased amount of moisture thrown upon the surface by the sweat glands.

EFFECT OF HEAT UPON THE MUSCLES.

1. The energy of the striated muscles is increased by short, hot applications from 98° to 104° F.

2. Prolonged warm or hot applications lessen the excitability and the energy of voluntary muscles. It is thus that heat becomes of service in relieving muscular cramp. Cold produces the opposite effect.

3. Very hot applications (104° to 130° F.) increase the excitability of the smooth or involuntary muscles.

EFFECTS UPON THE NERVOUS SYSTEM.

1. Very short, hot applications excite the brain, nerves and nerve-centers through the impressions made upon the skin.

2. Prolonged general hot applications may give rise to pronounced exhaustion of the brain and spinal cord. Warm and hot applications lessen general nervous sensibility to a most remarkable degree. This is especially true of very hot applications. This effect may be due in part to the absorption of moisture by the terminal nerve filaments in the skin. It has also been suggested that this result may be brought about by the stimulation of the temperature nerves. It is well known that the skin is much more sensitive to thermic impressions than to any other form of stimulus which it is capable of recognizing.

3. Applications of heat to the skin generally produce an agreeable sense of comfort and well-being. When long continued, languor, lassitude and depression result.

4. Short very hot applications are, like short cold applications, exciting, both directly and reflexly.

EFFECTS OF HEAT UPON THE CIRCULATION.

Heart: 1. In general, heat applied over the heart tends to lessen the length of the systole, while cold produces the opposite effect.

2. General hot applications at first slow the heart, then increase the pulse frequency. Cold produces exactly the opposite effect.

Blood Vessels: 1. Very hot applications at first contract, then relax the blood vessels.

2. Under the influence of heat, the skin assumes a dusky red hue from slowing of the blood circulation in the skin due to the fact that the veins appear to be influenced by heat more than are the arteries. The vascular dilatation accompanying the reaction which follows a cold application influences the arteries especially, giving rise to a bright red hue. The vascular dilatation due to heat is passive, while that due to cold is active.

3. Large arterial trunks are dilated by hot applications when prolonged sufficiently to heat the intervening tissues or applied at points at which the vessels approach near the surface, as the groins, the axillâe, the neck, the bend of the elbow, and the knee.

4. The principle of fluxion or revulsion which furnishes the foundation for one of the most important therapeutic uses of heat, depends upon the fact that when the vessels of one portion of the peripheral area to which blood is supplied by an arterial trunk are in a state of dilatation, there is contraction of the vessels of the other portion of the same area and consequently a diversion of blood therefrom. In other words, the local hyperemia induced by an application of heat gives rise to a compensatory or collateral anemia in the area in vascular relation therewith. This explains the relief afforded by an application of heat about a rheumatic joint or over an inflamed or congested muscle. The same fact likewise affords an explanation of the relief of visceral pain which results from a general hot application.

Blood Pressure: 1. Cold raises blood pressure while general hot applications lower blood pressure, though the blood vessels may be dilated in both cases.

2. The dilatation which accompanies the reaction following a cold application does not lower blodd pressure because of the increased vigor of the heart action resulting from reflex stimulation, and the increased activity of the "peripheral heart." A very hot application may raise blood pressure by reflex excitation of the heart, producing a quick, strong pulse, but in geheral hot applications lower blood pressure by dilatation of the cutaneous vessels, whereby peripheral resistance is lessened. The skin is capable of holding one-half to two-thirds of all the blood in the body. Hence a general hot application by dilating the surface vessels, and especially the veins of the skin, draws a large amount of blood from the internal circulation. The ventricles of the heart are not so well filled and the heart contractions are lessened in force.

3. A hot douche produces an elevation of blood pressure while at the same time dialting the surface vessels to the fullest degree by reason of the strong percutient or mechanical action characteristic of this form of bath, whereby the heart is stimulated.

EFFECTS OF HEAT UPON RESPIRATION.

1. Heat and dryness of the air hinder the gaseous exchanges in the lungs, and render respiration more frequent and superficial.

2. Heat and moisture to the extent of saturation interfere with elimination through the lungs.

3. A general hot bath increases the rate and frequency of respiration. The depth of respiration is at first diminished but when the bath is continued sufficiently long to raise the temperature of the blood and increase CO_2 production, the depth of the respiratory movements is increased.

4. A frog breathes with its skin; a dog sweats with its lungs; man not only sweats with his skin and breathes with his lungs, but like the frog to some extent breathes with his skin and like the dog sweats with his lungs. Hot baths not only promote the perspiratory activity of the skin, but the elimination of moisture through the lungs, thus aiding in the escape of those toxic substances which, as Charrin has pointed out, are probably eliminated from the bronchial mucous membrane.

EFFECTS OF HEAT UPON BODY TEMPERATURE.

1. A general application at a temperature above that of the body ca causes elevation of the temperature of the blood by interference with heat elimination. For example, in a series of experiments in the author's laboratory, the temperature of a young man weighing 108 pounds was increased 3.2° F. (1.8° C.) in thirty minutes, representing an accumulation of 88.2 calories. A bath at a temperature of the body (100°) caused an increase of 0.6° F. in temperature. Baths at a temperature of 92° to 96° F. (neutral) do not increase the body temperature. A Russian bath for twenty-five minutes ~~inc~~ increased the temperature 2.1° F. An increase of the same amount (2.1° F.) was observed as the result of an electric-light bath for twenty-three minutes. An increase of 1.7° F. resulted from a Turkish bath of one hour at 146° to 158° F. The elevation of body temperature induced by prolonged hot baths is not wholly due to diminished heat elimination, since it has been shown that heat production is increased in dogs exposed to a temperature of 104° F. to three and one-half times the normal.

2. A short application of heat is followed by a fall of temperature, the result of increased heat elimination through dilatation of the surface vessels, and a diminution of heat production through the reflex influence of the thermic nerves upon the thermogenic processes.

EFFECTS OF HEAT UPON THE BLOOD.

General hot applications decrease the blood count, notably diminishing the proportion of red cells. Heat also lessens the alkalinity of the blood, thus diminishing vital resistance, as has been shown by Charrin. This fact emphasizes the importance of concluding every general hot application with a general cold application of some sort, cold having the effect to maintain the normal alkalinity of the blood and thus increase vital resistance. When profuse sweating is induced, the volume of the blood is diminished, unless the loss is made good by the ingestion of water.

GENERAL EFFECTS OF HEAT UPON THE ABDOMINAL VISCERA.

As observed above, heat lowers the tone of voluntary muscles while cold raises it. In other words, heat relaxes muscles, while cold contracts them. This effect is particularly marked where applications are made to the muscles of the abdominal wall, a fact which has long been taken advantage of in the treatment of strangulated hernia, and more recently in examination of the pelvic and abdominal viscera while the patient lies in a hot bath.

The tension of the abdominal muscles is a matter of no small importance in relation to respiration and especially the blood movement in all the viscera lying below the diaphragm. With the relaxation of the abdominal muscles, intra-abdominal tension is diminished and the portal vessels become distended with blood. All the viscera are congested. The stomach and intestines become distended with gas, and stasis in the stomach and intestines occurs, resulting in gastric indigestion and constipation with ferments ations and putrefactive processes which lead to autointoxication and various nutritive disturbances.

Cold, when applied to the abdominal wall, contracts not only the external muscles but the internal involuntary muscles of the stomach and intestines, bladder, and gall bladder, together with the muscular structures found in the spleen and the liver, and the muscular walls of the blood vessels.

Hot applications to the abdominal walls produce the opposite effect. It is apparent that hot applications of this sort are not therapeutically valuable except for the relief of conditions of muscular spasm, either in the external voluntary muscles or the internal involuntary muscular structures, as for example in intestinal or renal colic, or gall-stones.

Long continued warm applications to the abdominal surface appear to lead to concentration of blood in the portal circulation, doubtless by relaxing the visceral vessels.

Very hot applications on the other hand appear to divert blood from the internal viscera by widely dilating the surface vessels. This effect is made possible by the anatomical connection which exists between the cutaneous vessels and those of the viscera which will be mentioned in detail a little later.

By the alternate application of heat and cold, the blood movement through any internal viscus may be very readily and perfectly controlled. Cold contracts the visceral vessels through reflex action of the thermic nerves, while heat produces the opposite effect. By the alternation of these these effects, a veritable pumping action may be instituted, whereby functional activity may be influenced and disease processes controlled.

Very hot water, when brought in direct contact with the gastric mucous membrane excite both motor and secretory activity, producing also a very decided stimulating effect upon the heart. Cold applications applied over the stomach as well as cold applications to the general surface increase the motility of the stomach and stimulate the secretion of the gastric juice. Very hot applications, either general or local, unless greatly prolonged, produce similar effects.

It should be noted, however, that when the general hot application is prolonged until profuse perspiration is induced, the secretion of gastric juice is greatly diminished. Fuchsin claims to have shown that the amount of the gastric juice and its digestive activity is greatly increased by the application of [illegible]

application of heat to the epigastrium after eating. The clinical results obtained by the writer during more than a score of years, in the large use of this measure as a means of promoting digestion, enables him to say that Huschkin's claims are fully corroborated by clinical experience. Applications to be beneficial in this way must be very hot. Warm applications doubtless tend to diminish the secretory activity of the stomach and to lessen motility.

EFFECTS OF HEAT ON THE LIVER AND THE SPLEEN.

According to the exact observations of Kowalski, hot applications over the region of the liver followed by cold applications increase the secretion of bile. This effect is doubtless produced by the increased movement of blood through the organ induced by an application of this sort, the rationale of which has been previously explained. The beneficial results obtained in hydriatic practice by the employment of fomentations over the liver followed by the heating compress, fully corroborate Kowalski's claims. For more than a hundred years this measure has been employed, largely empirically but nevertheless successfully, in the treatment of hepatic affections, so that it cannot be doubted that the liver may be powerfully influenced by this means.

The effects of thermic applications over the spleen, hot, cold, or alternate hot and cold, is clearly shown in the rapid diminution in size which may thus be secured in cases of splenic enlargement from malarial infection and allied conditions when not involving structural changes in the organ.

EFFECTS OF HEAT UPON RENAL ACTIVITY.

General hot baths promote renal activity and increase the amount of urine when the temperature is sufficiently high to increase blood pressure(104° to 110° F.). Renal secretion is diminished, however, when a general hot application is prolonged sufficiently to induce profuse perspiration. The powerful effects of general hot applications upon the kidneys is shown by the remarkably beneficial results obtained by the employment of the hot bath and other general hot applications in the treatment of acute nephritis.

EFFECTS OF HEAT UPON METABOLISM.

1. General applications of heat, if sufficiently prolonged to elevate the temperature of the blood, increase CO_2 production. Nitrogen oxidation appears also to be particularly favored by the elevation of temperature induced by a general hot application.

2. Experiments also show that the elevation of temperature induced by general hot applications aids the body in the formation of alexins and antitoxins. Animals suffering from infectious diseases live longer when subjected to the influence of heat. The recognition of this fact has led to the discovery that fever and the high elevation of temperature which occurs in connection with most acute infectious diseases is a remedial process. By reverse reasoning we are led to the conclusion that a fever artificially induced by a general hot application may be beneficial in aiding resistance to infection, especially when followed by a short, cold bath.

Local applications of heat doubtless in many instances operate beneficially by concentrating the blood in a part and thus aiding leucocytosis, one of the most important of all forms of ~~general~~ remedial activity.

THE ANATOMICAL BASIS OF THERMOTHERAPY.

The physiological effects of thermotherapy are determined experimentally. The therapeutic applications are suggested by inference or determined by clinical experience. For a full understanding of the rationale of both physiological and therapeutic effects, it is necessary to bear in mind a few anatomical facts of special interest in this connection. This is especially true in relation to local thermic applications.

The effects of thermic applications to the surface depend upon:

1. The elevation of the temperature of the parts to which the application is made and of the general body temperature;

2. The effects induced in more or less remote parts through nervous reflex influence; and

3. The vascular relations existing between different bodily organs and regions.

The effects depending upon reflex nervous action are the results of the association, by means of reflex arcs, of the internal viscera with clearly defined cutaneous areas, each viscus having its own area from which the most intense reflex impressions are received while at the same time more remotely related with all portions of the surface. These cutaneous reflex areas for the most part overlie the individual viscera. The accompanying cuts (Fig. 1 and 2) show diagrammatically the principal of these cutaneous areas which have been definitely worked out and which are clinically important.

Careful anatomical studies have shown that there is an equally intimate and more direct relation existing between the blood vessels of deeply seated organs and overlying or adjacent cutaneous areas.

According to Woolsey (Text-Book of Anatomy by American Authors, Gerrish), the vessels of the brain are freely connected with those of the scalp and the nose through the parietal foramen, the foramen cecum, the mastoid foramen, the posterior condylar foramen, the foramen of Vesalius, the fora-

men ovale, the foramen lacerum medium, the carotid canal, the anterior condylar foramen, and other openings as well as through the diploë of the cranial bones.

The meningo-rachidian veins, which form dense plexuses in the spind canal, are freely associated with the cutaneous veins of the back and with the dorsi-spinal veins through the anastomosing veins which issue from the canal through the intervertebral foramina and unite with the intercostal, vertebral, lumbar, and sacral veins.

The blood supply of the eyelids and of the skin covering the eyebrows and adjacent portions of the forehead is collaterally related with branches of the internal carotid which supply the eyeball.

The circulation of the middle ear is collaterally related with the circulation of the skin of the face, and head of the same side through the common carotid. The circulation of the internal ear, on the other hand, is associated with the skin of the back of the neck, being derived from the vertebral arteries.

The vessels of the mucous membrane of the nose and the pharynx are associated with those of the face and the sides of the head through the common carotid.

The circulation of the lungs is collaterally related to that of the skin covering the arms, the chest and the upper part of the back. The pericardium and the parietal pleura of the anterior portion of the chest is collaterally related to the skin covering the anterior portion of the chest wall through the internal mammary artery.

The parietal pleura of the posterior portion of the chest and the visceral pleura are collaterally related with the intercostal vessels. A collateral relation also exists between the bronchial arteries,--the nutrient arteries of the lungs,--and the intercostals, especially those of the right side. The skin covering the arms is collaterally related with the pleura of the upper and anterior portion of the chest through the subclavian.

There also exists a collateral relation between the nutrient vessels of the lungs and the vessels covering the anterior portion of the neck through the inferior thyroid arteries. The collateral relationship existing between the vessels of the skin and of the lungs is still further extended by the connection of the bronchial veins with the azygos veins of the right side, and with the superior intercostal ot the azygos veins of the left side. It is in the highest degree interesting to note these expensive communications between the pulmonary circulation and that of the cutaneous surface, all of which are of high therapeutic interest.

The kidneys are associated with the skin covering the loins through the renal branches of the lumbar arteries.

The vessels of the prostate in man, the uterus and ovaries in women, and the bladder in both sexes, are associated with the cutaneous vessels overlying the sacrum, the buttocks, the perineum, the external genitals, the groins, the inner surface of the thighs, and the suprapubic region, chiefly through the internal iliac. These organs are also associated with the skin of the leg through the common iliac.

The rectum is similarly associated with the skin covering the anal region and the perineum and that of the lower extremities.

There is a collateral relationship both venous and arterial between the stomach, liver, spleen, intestines, and even the pancreas, and the skin of the trunk which overlies those deeply seated organs.

The portal circulation communicates with the systematic circulation, thus establishing a collateral relationship with the cutaneous vessels at half a dozen or more points, especially the following: The hemorroidal plexus, the esophageal veins, the left renal vein, the phrenic vein at the surface of the liver, the epigastric veins at the umbilicus, the circumflex iliac (Treves, Schiff).

In a similar way, it may be stated that the upper half of the body is collaterally related with the lower half, a fact of which constant use is

made when the lower extremities are warmed to divert blood from the head.

The cutaneous vascular areas connected with the several viscera are roughly indicated in the accompanying diagrams (Fig. 3 and 4). It should be remembered, however, that every portion of the cutaneous surface is remotely, at least, related vascularly to every internal part. It is also interesting to note that the vascular areas connected with the several internal viscera do not altogether correspond to the reflex cutaneous areas connected with the same parts, although in the main the reflex areas and vascular areas are practically identical. For example, the skin covering the front of the chest is of greatest importance as a means of reflexly influencing the pulmonary circulation, whereas the cutaneous vessels of the skin covering the back of the chest are more intimately related with the vessels of the lungs than are those of the anterior surface. A most important reflex relating exists between the kidneys and the skin covering the loins.

The portion of the body below the umbilicus is collaterally related to the head, the arms, and the upper half of the trunk, and the legs are likewise in collateral relation with all parts of the body above them, especially those which occupy the pelvic cavity.

These relationships render it possible to employ the reflex and the fluxion methods at the same time, a cold application of small extent being applied over the center of greatest reflex activity, while a hot application is made over the area which is in closest vascular relation with the interested part. When the vascular cutaneous areas and the reflex areas concerned are identical, the cold application is made to the reflex area, while the hot application is made to the feet, legs, or lower half of the body, or even to the entire cutaneous surface when the largest possible effect is desired.

Understanding these interesting anatomical relations, it is readily seen that the volume of blood in any internal viscus, no matter how remote from the surface, may be diminished either by a general hot application to the surface whereby one-half of all the blood in the body may be diverted into the skin, or to a lesser degree by localized applications. By means of hot applications suitably applied, the vessels of different portions of the brain may be drained into the communicating skin areas. The longitudinal sinus is drained by means of applications to the sides of the head; the lateral sinus may be drained by applications to the skin areas behind the ears; the cavernous sinus by applications over the face, ears, and side of the neck; the occipital sinus by applications to the back of the neck. Congestion of the spinal cord may be relieved by hot applications to the back from the base of the cranium down. Congestion of the eyeball may be relieved by hot applications made over the eye and the forehead above, not extending below the eye. Congestion of the middle ear is relieved by hot applications over the sides of the head and face; the internal ear by hot applications to the arms and legs; the nasal cavity and the pharynx by a hot application to the face and sides of the head; the larynx by hot applications to the front of the neck, the arms, the back, the upper part of the chest, and the legs; the lungs by an application over the whole thoracic cage and the arms, an additional advantage being gained by a hot application to the legs; the kidneys by general hot applications to the whole surface or local hot applications over the lumbar region; the pelvic organs by hot applications to the hips and legs; the stomach and other viscera by hot applications over the interested part or better to the entire trunk, or trunk and legs.

As Treves very well remarks (Surgical Applied Anatomy, Page 371), these facts give "an anatomical demonstration of the value of counter- irritants in inflammatory affections of certain of the viscera, and also a scientific basis to the ancient practice of poulticing the loin and the iliac region in nephritis and in inflammation about the cecum."

THE THERAPEUTIC EFFECTS OF HEAT.

The means employed in thermotherapy are for the most part exceeding ly simple and such as every one is more or less familiar with. Yet it must not be supposed that the therapeutic use of these procedures is by any means a simple matter, or that the most minute details and the exercise of the greatest care to employ the measures appropriate to the case in hand. The successful practice of thermotherapy requires exactly as much painstaking accuracy and precision in diagnosis, in prescription making, in dosage and adaptation of means to individual conditions and idiosyncrasies as is necessary in the employment of powerful therapeutic measures of any other sort. Strychnia, morphia, and other powerful drugs may produce deadly effects when carelessly employed, but the effects resulting from the careless application of thermotherapy may be not less disastrous. It may be said, however, in favor of the physiological procedures of thermotherapy that they are to a remarkable degree self-adjusting and hence less likely to lead to injurious consequences than are powerful drugs. If this were not true, the extensive empirical and bungling employment of these agents by the laity would long ago have lead to their abandonment.

As is the case with all physiological therapeutic measures, the therapeutic effects of heat are clearly foreshadowed in the physiological effects of this agent. As space will not permit a detailed discussion of all points pertaining to the therapeutic effects of heat, many of which have been ably considered by others in the discussion of hydrotherapy and allied sub-

jects, we present merely a summary of the general principles involved.

1. The general excitant effects of heat render highest service in m most conditions of extreme exhaustion, as in surgical collapse, extreme fati gue from violent exertion, the collapse of typhoid and other infectious fevers, in certain cases of poisoning, and in acute autointoxication.

2. The general excitant effects of heat render service in all cases in which active diaphoresis is called for, as after taking a cold, acute rhe matism, certain forms of chronic rheumatism, some cases of pneumonia and other acute infectious febrile disorders, and as an alterative or spo- liative measure in obesity and other diathetic maladies.

3. General applications of heat serve an extremely useful purpose in modifying metabolism. Short applications lessen heat production and oxid ation and encourage heat elimination, while prolonged applications raise the body temperature by preventing heat elimination and also by communicating heat to the body.

4. The increase of oxidation which accompanies a prolonged hot bath renders applications of this sort of the highest value in cases of obesity, diabetes, and the uric acid diathesis. Cold applications to a marked degre increase the oxidation of carbohydrates, but a general applications of heat administered in such a way as to cause a decided elevation of the body tem- perature is the most effective of all means of securing increased oxidation of proteid wastes and thus facilitates their removal from the body. This fact alone renders general hot applications of some sort almost indispensable in the treatment of most chronic disorders, including cases of spinal sclerosis, locomotor ataxia, and many other affections accompanied by organic change, all of which probably have some form of autointoxication with accumul ation of proteid wastes as their real etiological foundation.

4. General hot applications are indicated in all forms of chronic visceral congestion, including chronic bronchial catarrh, chronic gastritis, intestinal catarrh, so-called chronic inflammation of the pelvic viscera, and chronic cerebral congestion. The skin being capable of holding one-

half to two-thirds of all the blood ~~half~~ in the body, the filling of this immense vascular area, comprising a surface of more than ten thousand square feet, if we include the capillary network distributed in the walls of the tubules of the sweat glands, relieves visceral congestion by diverting the blcod to the surface and accomplishes a therapeutic purpose which cannot be so satisfactorily obtained in any other way. The permanency of the effects thus obtained must be secured by following the hot application by a short cold application whereby strong reaction effects are produced with the accompanying dilatation of the small arteries and an increased rhythmical activity of the "peripheral heart," as the small vessels of the skin may be properly called.

5. Still another important indication for general hot applications is the preparation of the skin for the cold douche, the shallow bath, wet sheet rub, wet sheet pack, or any other hydriatic application at a temperature below that of the body. This preparation is espedially important in feeble patients. It may be advantageously employed in all cases. The application should be of brief duration, ordinarily from three to five minutes, or only sufficiently long to thoroughly heat the skin. The maximum desirable effect is obtained when the skin becomes slightly moistened by perspiration.

6. General hot applications are of service as a means of intensifying the effects of cold hydriatic applications. When employed for this purpose, the hot and the cold applications are made in alternation. A somewhat prolonged hot application of two or three minutes may be followed by a short cold application of five to twenty seconds. Such an application is purely excitant to the circulatory system and produces profound revulsive effects. Short application of equal duration, ten to twenty seconds, the so-called alternate applications, are powerfully excitant. Such applications ~~of equal duration~~ are generally made by means of the alternating general douche for which the horizontal jet, the circle or needle douche may be employed. The

vapor douche and a cold air douche may be thus employed in alteration, or the patient may be exposed in alternation to the heat of the vapor bath, the electric light bath, or the hot air bath, and the refrigerant effects of the cold horizontal jet, the shower, or the plunge. Such applications produce exceedingly powerful effects, which may be utilized when it is important to rouse sluggish functions by the most powerful thermic stimulation possible. Applications of this sort may sometimes be resorted to with advantage in cases of obesity and in fat diabetics.

7. Finally, we may refer to the value of hot applications as a means of rendering tolerable cold applications which could not otherwise be borne, as in the simultaneous hot and cold bath, a measure which the writer first introduced into therapeutics. Various combinations may be made, as for example, a hot shower bath combined with a cold douche to the spine, hepatic, gastric, lumbar, or hypogastric region, or the extremities, as may be desired; or a cold douche may be administered to any part of the body while the patient is enveloped in hot vapor in a Russian bath or warmed by means of the vapor douche. The ideal application of this sort is the combined cold douche and incandescent light bath. The patient stands in a recess surrounded on three sides by incandescent lights closely placed in front of a reflecting surface by which the skin is strongly heated, while at the same time a jet of cold water is made to play upon any part of the surface which it is desired to impress in this way.

The purpose of a combination of this sort is to make a strong reflex effect upon an internal viscus while maintaining the highest degree of vascular activity in the general cutaneous surface. By this means we may prevent the general contraction of the surface vessels which very commonly follows the application of cold to a circumscribed area as well as when the general surface is acted upon.

This principle is put in operation whenever a cold compress is applied to the head, face, or neck of a patient who is receiving a general hot bath, as a vapor, Russian, or Turkish bath. A cold application upon the face and scalp by reflex action maintains contraction of the blood vessels of the brain and so prevents the occurence of congestion from cardiac excitation and elevation of the blood temperature. In like manner, very strong thermic impressions may be made upon the stomach, liver, spine, and other internal viscera by the application of an ice-bag or an ice-compress to the cutaneous area reflexly associated with the particular viscus while the patient at the same time receives a general hot pack, the hot blanket pack, or the dry pack. An application of this sort gives almost magical relief from visceral pain due to congestion, as in ovarian neuralgia, or gastritis, or gastric cancer. The dreadful pain following the operation of ovariotomy or hysperectomy which generally leads the patient to plead most earnestly for an opiate, rarely fails to yield to the application of an ice-bag over the seat of pain in combination with the hot blanket pack applied to the whole body or to the hips and legs.

General thermic applications are made by means of the Turkish bath, the hot air bath, the Russian bath, the vapor bath, the incandescent ~~electric~~ light bath, the sand bath, the mud bath, the hot immersion bath, the hot blanket pack, and the dry pack.

Local thermic applications are made by limited applications of the above, and in addition the application of heated objects, such as jugs, bottles, or rubber bags filled with water, the cotton poultice, the electrotherm,--a dry compress containing metallic objects affording resistance through which a current is passed,--or the thermophore,--a rubber bag containing a chemical solution capable of giving off heat for a long time during the process of crystallization.

The effect of an application, either general or local, is essentially the same, irrespective of the source of heat, the intensity of the effect

depending upon the extent, duration, and the time of the application. The fluxion effects produced by hot applications applied with scientific accuracy and the relief from pain, and other therapeutic effects which may be thereby secured, are among the most valuable of all the resources of physiological and rational therapeutics. For efficiency in relieving pain, for example, the hot fomentation or an equivalent hot application certainly stands next to ~~the~~ opium and its derivatives, while it is rendered incomparably superior to any drug by the fact that it relieves pain, not by hiding it, but by removing the cause. The accompanying figures (Figs. 5, 6, 7, 8) clearly indicate to the eye how pain of a congested muscle may be relieved by the diversion of blood through dilatation of the vessels of the adjacent skin.

Deep-seated inflammations may be controlled by either general or localized applications to the proper cutaneous surfaces. This is well illustrated in pelvic inflammation, for example, by the great relief of pain afforded by the hot hip and leg or the hot hip pack, the general hot blanket pack, or the hot immersion bath, or any other hot application. This use of heat may be said to be suggested by the natural instinct which leads one to protect any painful part, such as an aching tooth, eye, or ear, by the application of the warm hand in the absence of more suitable protection, and in the drawing up of the legs when abdominal pain is present, as instinct which is possessed by the lower animals in common with man.

Deep-seated inflammations and pain due to visceral congestion is generally best relieved by simultaneous applications of heat and cold. The cold application should be intense but should cover only a small surface, being confined to the area of most acute reflex activity, while the hot application should cover a very large area so located as to act derivatively. For example, in the case of ovarian inflammation, an ice-bag should be applied over the ovary simultaneously with the hot hip and leg pack. After the hot application is removed, the ice-bag should remain in place, the limbs being kept warm by hot bags and wrappings. By the cold application

the vessels of the inflamed part are made to contract reflexly while the hot application, acting derivatively, empties the vessels of the part, thus securing the complete co-operation of two important therapeutic principles at one ~~and the same~~ time, and place. This principle is illustrated in the very common employment of the hot foot bath in association with the cold compress to the head for the relief of cerebral congestion. The same principle may be extended to the treatment of congestions and inflammations of any deep-seated organ. The modus operandi of this procedure, which the author believes he was the first to suggest, is graphically illustrated in the accompanying diagrams.

Fig. 9 illustrates a combined hydriatic application for relief of a congested kidney. An ice-bag applied over the lower third of the sternum causes reflex contraction of the kidney vessels, as shown by Beni-Barde, while an application of heat made to the lumbar region relieves the congested organ by diverting blood from its arteries and veins into the overlying muscular structures.

In Figs. 10 and 11 is graphically illustrated the operation of a simultaneous hot and cold application for relief of congestion of the pelvic viscera. The ice-bag applied to the hypogastrium and the groins causes contraction of the branches of the internal iliac which supplied the uterus and ovaries, thus lessening the blood supplied to those parts, while the hot hip and leg pack by dilating the cutaneous vessels diverts ~~the~~ a large volume of blood into the external branches of the internal iliac and the cutaneous branches of the external iliac.

An interesting combined therapeutic application was suggested a few years ago by Dr. Wilhelm Winternitz. It consists in the application of the heating compress or wet girdle about the trunk while heat is applied over the stomach by means of the hot water coil. The heat may be applied by means of the hot water bag instead of the hot water coil if more convenient.

This derivative measure acts powerfully upon the visceral circulation, exercising a most remarkable sedative effect upon the stomach in irritable conditions of this organ.

The writer has for many years made use of the hot and cold compress in which heat is applied to the back of the head or neck and cold applied to the face, or the opposite. The same principle is also applied in the tr treatment of the spine, the lungs, the abdominal and pelvic viscera and other parts of the body.

In conclusion, attention should be called to the fact that hot applications of all sorts whether general or local, should almost without exception be concluded by a cool or cold hydriatic application so as to restore the tone of the surface vessels and to fix the blood in the skin, thus rendering permanent the temporary benefit derived from the hot application. When the hot application has been prolonged sufficiently to cause an elevation of the body temperature, the temperature of the cooling procedure should be moderate, ordinarily 90° to 75°, and sufficiently prolonged to restore the thermic equilibrium of the body. The time required ordinarily would be one to three minutes. The duration should never be sufficient to produce chilliness, and the application should be made with sufficient vigor to maintain the dilatation of the surface vessels. When applications of heat have been limited to small areas or have been of short duration, the cooling application should be at a lower temperature and of short duration (60° to 45° F., 3 to 15 seconds).

THE TURKISH BATH.

This very ancient form of bath is a powerful means of influenc int the bodily functions, and though likely to be largely superceeded by the electric-light bath, must still be recognized as a measure of value and importance. The essential features of the Turkish bath are,--a heated room in which the patient reclines until vigorous perspiration is induced, the shampoo, and a cooling spray or plunge. This bath, or its equivalent, has been used since very ancient times, as shown by the magnificent ruins of ancient baths to be seen at the present day in Rome and Pompeii. The oldest existing Turkish bath was built in the time of Herod the Great, at Jerusalem. While visiting Jerusalem a few years ago, the writer found this ancient establishment still in operation. This is probably the oldest bathing establishment in the world.

A scientifically arranged Turkish bath establishment consists of a series of rooms which provide, besides dressing rooms and a cooling room furnished with couches on which patients may recline after a bath, at least the following separate compartments:--

1. A room heated to a temperature of 110° to 130° F.,--the "Tepidarium" of the ancients. 2. A hot room, heated to the temperature 150° to 200° F.,--the "Calidarium" of the ancients. In some establishments another small room is provided in which a temperature of 230° to 300° F. may sometimes be observed. 3. A convenient adjacent room, furnished with marble slabs and hot and cold water with other necessary paraphernalia, provides for the shampoo. Close at hand must be found a well arranged douche apparatus, and in a well-equipped establishment there will be also found a plunge or swimming bath containing water at a temperature of 60° to 70° F. In some European establishments the writer noted the temperature of the plunge as low as 45° F. A temperature of 65° F. is low enough, however, to secure all essential therapeutic results, and is safer for the average patient than a lower temperature. Any intensity of effect desired may be at-

tained by increasing the duration of the bath.

The hot room may be heated by steam coils, or by hot air provided by a furnace or an indirect steam heater. When direct radiation by steam pipes is employed, the air is generally very impure by reason of the absence of adequate provision for ventilation. When, however, hot air heating is employed, the ventilation is easily made ample, air change being essential as a means of maintaining the temperature of the room. The foul air outlet must be near the bottom of the room, and must communicate with a ventilating shaft. The opening for the inlet of warm air may be either at the floor or the ceiling; it is perhaps best located at a point about two or three feet above the level of the floor.

TECHNIQUE: The patient disrobes, places a loin cloth about his body, drinks a glass of water, either hot or cold, enters the warm room and lies down upon a couch. Usually, by the end of ten to fifteen minutes, and sometimes sooner, the skin becomes slightly moistened, and a little later the subject finds himself in a stste of profuse perspiration. In cases in which perspiration does not promptly appear, the activity of the cutaneous glands may be encouraged by superficial massage or friction of the skin by an attendant. The native shampooers of Cairo and Constantinople rub the bather with mits made of coarse fabric somewhat resembling haircloth. A very hot foot-bath or a short, hot spray, or full bath, is also an effective means of encouraging perspiration. In the case of patients who cannot drink freely, a hot enema (110° F.) administered just before the bath, will aid in inducing prompt sweating. In extreme cases, the patient may be sponged with hot water. If he does not perspire either with or without the aid of the measures mentioned, he should not be allowed to remain in the bath for any considerable length of time, as serious injury may possibly result from a long exposure of the body to intense heat without the protecting influence of evaporation.

After the patient begins to perspire, he may, if he desires, enter

the second hot room to remain a few minutes until very vigorous perspiration is induced; or if more moderate cutaneous activity is desired, he may remain in the warm room.

When perspiration has been maintained as long as desirable, the patient is conducted to the shampoo room, where he is first rubbed with the bare hands or with Turkish mits, from head to foot, beginning with the head, and in such a manner as to remove every particle of the superficial layers of the epidermis which have been loosened by the profuse perspiration.

The movements employed in shampooing are not easily described. The first manipulations are administered with the bare hands, and consist, for the most part, of alternate to and fro short friction movements across the chest and up and down the trunk and the limbs. Small areas are dealt with in succession, the work must be very thoroughly done. The hands should be frequently dipped in water at a temperature of about 90° F. // No part should be neglected. The face, ears and neck, should receive first attention; then the chest, abdomen, arms, legs, back (for which the patient turns over), and finally the feet. After the patient has been very thoroughly gone over with the bare hands, he is rubbed in a similar manner with the hands covered by coarse cloth mitts.

Finally, the patient is shampooed with good soap, the lather being thoroughly rubbed upon the skin either by a thoroughly aseptic brush, or a properly arranged mass of flax, manilla, or other fibrous material. Great care must be taken in the employment of shampoo brushes to avoid conveying infection of any sort from one patient to another. The only safe precaution, when a common brush is used (a practice which is certainly not to be commend ed) is to drop the brush for two minutes into boiling water each time it is used, after thoroughly rinsing the soap suds out of it. There is an advant age in the use of manilla and other fibers in the fact that the cost of the material is so small that it may be thrown away and a new supply provided for each patient and at each treatment.

The brush, or mass of fiber or horse hair is applied at first to the upper part of the neck and chest, then the arms, then the lower parts of the body; The shampooing and rubbing should be continued until the whole surface feels like polished marble. After the shampooing, the patient is conducted to the douche. If he is still quite warm, a cold douche may be administered at once. If he has become slightly chilled, he should be thoroughly warmed up by a warm shower or rain douche before the application is made. The bath should end with a douche of cold water at a temperature of 60° or less. If the patient is inclined to perspire freely after the bath, a rain douche at a temperature of 80° to 75° F. should be given for one to three minutes before the final cold application.

After the douche, which serves the double purpose of removing the soap and counteracting any depressing effects from the prolonged exposure to heat, the patient may enter the plunge or the swimming bath, or may wrap a sheet around him and lie down upon a couch until the skin becomes perfectly dry, and the pulse returns to its normal rate.

If the patient's skin is very dry, a little refined vaseline should be applied with gentle friction at the close of the bath. If the skin remains moist from perspiration, give an alcohol rub (p. ..)

Massage, or joint movements, or both measures may be advantageously employed in many cases and aid reaction in feeble patients.

It is not usually necessary to apply cold to the head of the patient during the bath as perspiration of the face and scalp begins early and this prevents overheating of the head. For persons who are unaccustomed to the bath, the applications of a dry towel or napkin over the forehead and head will usually be sufficient. The distension of the surface vessels diverts blood from the brain and thus obviates any danger from cerebral congestion. The only exceptions are those cases in which the heart is unduly excited and the brain congested by the elevated temperature of the blood.

Physiological Effects:-- The physiological effects of the Turkish bath are essentially the same as those of other general hot applications. There are, however, certain characteristic differences which may be noted with advantage.

The exposure of the entire body to a superheated atmosphere, and especially the inhalation of dry hot air, excites the pulmonary mucous membrane as well as the skin. The great extent of this membrane, about two thousand square feet, gives importance to this fact. The great dryness of the air and the excitation of the mucous surface with which it comes in contact unquestionably facilitate the elimination of those volatile toxins which find exit through the pulmonary mucous membrane (Charrin).

Shortly after the patient enters the bath, the pulse is found considerably accelerated and tension increased. The higher the temperature of the bath, the more rapid the pulse. During this period of increased blood tension, the patient experiences a sense of fullness in the head, some respiratory distress, and general discomfort. As soon, however, as the skin becomes reddened and moistened with perspiration, the pulse rate diminishes, tension is powered, respiration becomes easy, and uncomfortable sensations disappear. The breathing is usually thoracic in character.

The sudoriparous glands are powerfully stimulated. The amount of secretion may be increased from one and one-half ounces per hour to fifteen or twenty times this amount. The writer has often seen patients lose two pounds or more in weight as a result of an hour's sweating in the hot room of a Turkish bath. This rapid loss of water indicates the importance of copious water drinking during the bath as the heart's action may be lessened in power and various other functions interfered with as the result of so considerable a reduction of the blood volume.

This large discharge of water from the skin promotes absorption from the alimentary canal. As a result, patients who are taking Turkish baths daily are likely to suffer from constipation, unless this tendency is

counteracted by copious water drinking. The activity of the perspiratory g glands excited during the bath continues in a modified degree for some hours after the bath as the result of the improved cutaneous circulation. Hence, water drinking must be practiced after as well as before and during the bath.

The intense congestion of the skin induced by the Turkish bath with-draws an enormous amount of blood from the liver, spleen, stomach, intestines, brain, and other internal organs. The decongestion of these deep lying ~~xxxxxx~~ vascular areas is one of the most important results obtained by this procedure although one which seems to have been heretofore very little appreciated by those who have written upon this subject.

While it is not probable that any considerable amount of heat is communicated to the body from the heated atmosphere of the bath, heat production is increased to such a degree that a very decided elevation of temperature may generally be noted when the patient remains in the bath for haf an hour or more. Experiments with the dog have shown that exposure to an atmosphere of a few degrees above the temperature of the body may increase heat production as much as 350. At this rate, the heat production during an hour's exposure in the Turkish bath might amount to nearly 400 calories or nearlyone-sixth of the daily output of energy, representing three and a half ounces of fat or twice this quantity of carbohydrates. Heat elimination must be also greatly increased for the rise in body temperature is proportionately slight.

In the treatment of obese persons, it must be remembered that these patients have a much smaller skin surface in proportion to their weight than have smaller persons, and hence that heat elimination is greatly hindered. For example, a person weighing three hundred pounds has a skin area of only 13.2 square inches per pound, while a person weighing 120 pounds has a cooling cutaneous surface of 18 square inches for each pound of weight, or nearly fifty per cent more. The obese person has a further disadvantage in that the surface vessels are in large part buried in fat, so that they do not

come near the surface, whereas in a thin person the close approach of the ten thousand square feet of capillary network to the surface secures a rapid cooling of the blood.

To feeble subjects the Turkish bath should not be administered more than one to three times weekly. The ordinary patient may take a short Turkish bath daily, and when the bath is employed for reduction of weight, it may often be administered twice a day provided the exposure in the hot room is not more than thirty to forty minutes at each seance.

Therapeutic Applications:-- Although the Turkish bath is perhaps not capable of inducing any therapeutic effect which cannot be otherwise secured, and while it is perhaps inferior to the light bath as a thermotherapeutic measure, it is nevertheless capable of producing excellent therapeutic effects in almost every form of chronic disease. It must be supposed, however, that its chief advantages are the result of the profuse perspiration induced. As shown by Bouchard, the amount of toxic matter removed by sweating is very small. The elimination of water by the skin seems to serve chiefly as a means of regulation of the body temperature. Nevertheless, profuse perspiration is a most efficient alterative measure. General vital activity is accelerated by the large movement of fluid from the interior toward the periphery. Perspiration hence becomes an important means of promoting tissue activity in all chronic disorders accompanied by the condition which Bouchard has termed "Ralentissment de Nutrition," a state in which all the vital processes are slowed, resulting in a general deterioration of the organism through impaired tissue formation and accumulation of waste. The Turkish bath may thus render valuable service in the treatment of obesity, fat diabetics, the chronic autointoxication so commonly present in chronic dyspeptics, the uric acid diathesis in all its forms, many cases of neurasthenis, hypochondria, and melancholia. Most forms of chronic nervous disease, even cases of locomotor ataxia, chronic myelitis, paresis, paralysis,

neuritis, and other equally obstinate maladies are materially helped by the judicious use of the Turkish bath, even though a radical cure may be in the majority of cases impossible.

As a hygienic measure, the Turkish bath has long justly held a high place in the confidence of the laity as well as of the profession. Simply t the thorough skin cleanliness which it securesis an advantage of no small consideration, yet its highest value is due to the fact that the combined hot and cold procedures which it involves in the highest degree promote vital activity and the building up of the bodily resistance to the causes of disease, thus counteracting to some degree the evil consequences the artificial conditions imposed by civilized life and affording a considerable degree of protection of the various infectious agents and other dangers to which most civilized human beings are exposed.

In all forms of anemia and chlorosis, the Turkish bath is an admirable measure, promoting blood formation and relieving visceral congestion. Care must be taken, however, to avoid extreme temperatures and prolonged exposure in these cases on account of the degeneration of the blood vessels which is sometimes present in these affections, as pointed out by Bouchard.

The Turkish bath affords an opportunity to secure the most pronounced effects possible upon the circulation of any internal viscus which it may be desired to influence. For example, in cases of chronic gastritis, or chronic intestinal chtarrh, chronic spinal congestion, cerebral hyperamia, or renal congestion, the general effect of the bath in relieving visceral congestion may be intensified by a suitably placed cold application consisting of an ice-bag, a cold compress, or a cooling coil. In cerebral congestion, an ice-bag may be applied to the head, or an ice-collar may be fitted about the neck. A towel wrung out of ice water may be applied to the face and ears. In renal congestion, an ice-bag may be applied over the lower third of the sternum. In uterine and ovarian congestion, or the so-called chronic inflammation of these organs, an ice-bag may be applied to the groins and

the hypogastrium. In chronic inflammation of the stomach, or intestines or congestion of the spleen, liver, and spine, a cold application should be made over the parts indicated. The application of cold in the manner suggested, especially to the head, renders a hi gher temperature tolerable and may permit of a longer duration of the bath.

Contraindications and precautions:-- The Turkish bath is contraindicated in eases of cardiac dilatation, tachycardia, arteriosclerosis, organic affections of the heart in which there is evidence of deficient or failing compensation, apoplectic ~~xxixxx~~ subjects, irritable skin affections, and all febrile disorders. The bath must be used with great care in all forms of nephritis, and is contraindicated in advanced stages of renal disorder, also in ~~exp~~ophthalmic goiter.

The pulse should be carefully watched, especially during the first seances and the first few moments after the patient enters the bath. Undue cardiac excitation may generally be relieved by the application of an ice-bag over the heart. If the effect desired is not readily secured, the patient should be removed from the bath, and the incandescent electric-light bath or some other heating procedure adopted.

THE HOT AIR BATH.

This bath resembles the Turkish bath, the essential difference being that the head is excluded from contact with the heated air, so that the patient is able to breathe air at the ordinary temperature, while the body, with the exception of the head, is exposed to dry, super-heated air.

Technique:-- The hot air cabinet may be a permanent structure of wood, zinc-lined, or it may consist of a portable cabinet of rubber cloth or other impervious material. In the absence of a specially constructed cabinet, a substitute can easily be improvised by placing the patient in a chair and covering him with a rubber blanket or with ordinary blankets between

the folds of which newspapers have been placed.

Various sources of heat may be employed, as a small kerosene stove or a large kerosene lamp or alcohol lamp, a small gas stove, or even heated stones or bricks. For a permanent arrangement, a steam coil is most convenient.

Fig.1 shows a convenient arrangement for a hot air bath. When the patient is not able to sit erect, the bath may be administered in bed either by means of a special device or by an arrangement which may be easily improvised. It is only necessary to provide a space about the patient by means of a proper framework covered first with rubber cloth, than with ordinary blankets. Heat is supplied by means of a tin pipe which can be made by any tinner at a small expense, so arranged that one end can be slipped over the top of an ordinary lamp chimney while the other enters the enclosed space about the patient.

Before entering the bath, the patient should take a glass of water, either hot or cold as he prefers. Perspiration may be promoted by repeated water drinking during the bath.

The temperature may vary from 150° F. to 250° F. A still higher t temperature may be borne if the air is perfectly dry, but offers no advantages.

The duration of the bath may be six minutes to an hour, according t to the effect desired. When administered to feeble persons, and when the purpose of the bath is simply to heat the skin in preparation for a cold application, the duration should be brief, not more than six to twelve minutes. When prolonged sweating is desired for eliminative effects, the duration may be twenty to sixty minutes. Ordinarily, however, the bath need not be employed for more than thirty to forty minutes to secure the maximum beneficial effects.

Before the patient enters the bath, the head or the face and neck, and in the case of men the scalp also, should be well cooled by bathing in water at 60° F. Towels should be applied about the neck in treating ladies

and to the head and face of men.

After the bath a cooling procedure of some sort should be employed. The rain douche, horizontal douche, wet sheet rub, shallow bath and pail douche are the most generally useful measures. In feeble cases, the cold towel rub and the cold mitten friction are preferable and should be employed at the beginning of a course of treatment. Later when the patient has, by proper hydriatic training, acquired greater ability to react, more vigorous measures may be employed. In certain cases, cooling of the skin is not desirable. This is especially the case with chronic rheumatics when suffering from acute exacerbation with more or less elevation of temperature and much pain and tenderness in the joints. In such cases, the patient, on removal from the bath cabinet, should be quickly wrapped with warm blankets. If it is desirable to continue the perspiration, the patient is warmly covered and made to drink freely. If, however, prolonged perspiration is not desirable, the patient is more lightly covered and the face is from time to time bathed with a little cool or tepid water until perspiration has ceased spontaneously and the usual pulse rate reestablished. The wrappings are then carefully removed uncovering small areas at a time, as an arm, the chest, or a leg, and an alcohol rub (See page .....) is administered.

Therapeutic Applications.--- The therapeutic applications of the hot air bath, and the contraindications therefor are essentially the same as those of the Turkish bath (See page...). It should be mentioned, however, that the hot air bath may be employed in cases in which the Turkish bath is inadmissible on account of the embarrassment experienced by the patient in the inhalation of hot dry air. In the writer's opinion, all the therapeutic advantages of the Turkish bath may be obtained by the proper employment of the hot air bath.

THE LOCAL HOT AIR BATH:---Hot air may be applied to any circumscribed portion of the body, either by means of a current of super-heated air directed upon the part, or by enclosing the part in a chamber the air of which is super-heated. The hot air douche was employed by the writer some eighteen years ago, but was not found to possess advantages over the simpler methods of making local applications of heat. Recently, various excellent devices have been offered for local applications of hot air, especially to the joints. There are none, however, which are greatly superior to a very simple device which can be easily constructed by any tinner. It consists simply of a tin box so arranged that it may be easily opened while the limb is being placed in position. The limb must be protected from contact with the metal portions of the box. This is easily accomplished by making the end pieces of wood. In use, the box is so placed that a large kerosene lamp may be placed beneath it with just sufficient space between the chimney and the bottom of the box to secure a clear flame. In a very short time, the air within the box will become sufficiently heated to secure the effect desired. With dry air, a temperature of 300° to 400° F. may be tolerated. The effect of this application is to produce powerful revulsion by dilatation of the surface vessels. It is possible that certain trophic effects may also be induced by the impression made upon the thermic nerves. ~~At the conclusion of the~~

At the conclusion of the application, the parts should be quickly rubbed with the hands dipped in cold water, or if the parts are painful, a towel wrung quite dry from cold water may be applied for ten or fifteen ~~xxxxxx~~ seconds. The parts are then quickly and carefully dried or bathed with alcohol and covered first with dry cotton, then with a mackintosh, and finally with flannel, so that the effect obtained by the application may be continued. In cases in which an active inflammation is present, as indicated by elevation of temperature and pain, the

heating compress should be applied instead of the cotton poultice. This consists of a single thickness of linen cloth, or three or four folds of cheese cloth, wrung quite dry out of water at 60°F., smoothly wrapped about the part and covered with flannel and mackintosh. The compress should warm up at once. If it remains cold, injury will result. Great care should be taken to extend the mackintosh sufficiently above and below the flannel wrappings to leave no opening through which air can enter or evaporation take place.

THE DRY PACK:-- This is a very effective but rather inconvenient mode of bringing the body as a whole under the influence of heat. The patient is closely wrapped in blankets (Fig.2) with hot water bottles or bags to the feet, thighs, and back. Care must be taken to tuck the covers in closely about the neck and to bring the wrappings closely in contact with the body everywhere so as to prevent the slightest movement of air about the body. This will prevent evaporation and consequent cooling.

In this procedure the source of heat is the body itself. Heat elimination is favored by the warm coverings so that there is a gradual accumulation of body heat which after a time results in a sufficient increase in the body temperature to produce perspiration and all the other effects of a general hot application.

This measure is effective in accomplishing all that can be accomplished by any other sweating procedure. The chief inconvenience lies in the length of time required to produce vigorous perspiration, which sometimes amounts to several hours, and the considerable degree of discomfort which the patient experiences during the heating period before perspiration begins.

THERAPEUTIC INDICATIONS.--- The therapeutic uses of this procedure are the same as those of other general hot applications by which

perspiration can be induced. The special uses of the dry pack are the induction of perspiration in cases where other general thermic applications are not readily available, especially when for any reason the application of water is not deemed advisable, as when a chill from malarial affection or pyemia is anticipated, in most cases of surgical shock, and in some cases of acute and chronic rheumatism.

Local applications of the dry pack are often required in surgical cases, in cases of paralysis of the limbs, after the ligation of arteries, in threatened senile gangrene, and in neuralgic affections.

The contraindications are the same as for other general hot applications.

THE SAND BATH:--- This form of bath (Fig.-)))) is less appreciated in recent times than its merits deserve. It is a most effective means of inducing perspiration and may be employed either as a general or a local measure. There are a few European resorts where the sand bath is still commonly used, especially in the treatment of rheumatism. The writer does not know that it has been systematically employed in this country by others than himself. Experience with this bath in connection with the outdoor gymnasium has afforded most excellent results in cases of rheumatism, chronic sciatica, lumbago, the uric acid diathesis, chronic dyspepsia, and various forms of chronic disorder.

In taking this bath, the patient lies exposed to the sun with his body, except the head, either partially or wholly buriedn in a mass of heated sand. All the precautions should be taken which are indicated in relation to the sun bath and other general applications of heat.

The therapeutic indications and contraindications are essentially the same as for other general thermotherapeutic measures.

THE MUD BATH:--- This procedure, which has been in vogue for hundreds of years at certain European resorts, has been in more recent

years introduced into this country. It consists simply in immersing the body in an ordinary bath tub filled with mud made by the mixture of an uncticus alkaline earth with water to the consistency of a thin porridge. The attendant plasters the mud upon the patient's chest and rubs it well upon the surface everywhere until the patient begins to perspire freely. It is then removed and a hot spray administered until the mud is washed off, the application ending with a short cool or cold application.

The mud bath is thought to be especially efficacious in rheumatic affections. It is certainly an effective method of elevating the body temperature and inducing perspiration, but it must be considered doubtful whether any specific virtue resides in heat communicated to the body by moist earth, and there is little or no evidence to show that alkalies or any other substances are absorbed during the bath. Quite generally strong sulphurous odors are evolved by the moist heated earth, the inhalation of which may produce certain medicinal effects.

The mud bath has the disadvantage of being very inconvenient in use, and it is questionable whether the advantages derived from its employment are sufficiently superior to those of many other more convenient methods of applying heat afforded by thermotherapy to justify the special claims made for this procedure. It must be acknowledged, however, that many rheumatic patients express a special preference for this bath and entertain most profound faith in its special efficacy.

Directions for the application of the hot blanket pack, the hot immersion bath, the hot douche, and other general thermic applications in which water is the agent of heat communications, will be found in works on Hydrotherapy, to which the reader is also referred for a description of the fomentation, the dry pack, and other hydriatic measures of applying heat.

OTHER LOCAL APPLICATIONS OF HEAT: ---The fomentation and the heating compress, perhaps the most useful of all the local measures known to thermotherapy, have been elsewhere described in connection with other hydriatic procedures.

Dry hot applications may be made by a variety of means, of which we need mention only a few. For example, the application of dry heat may be made by means of the hot water coil (Fig.-----) which is simply a coil of rubber or aluminum through which a stream of water at the required temperature is made to flow continuously. The temperature of the coil is easily regulated by a tube compressor which controls the outflow. A rubber bag with an opening at each end may be employed in place of the coil but is somewhat less convenient. To avoid the inconvenience of emptying the water which has passed through the coil and refilling the heating reservoir, the writer has arranged a heater on the plan of the ordinary range heater, consisting of a tank heated by a gas jet, from the top of which a pipe carries the water to the couch on which the patient lies while another pipe bringing back the water, enters the tank at the bottom. The coil is connected with the two metal pipes and forms a part of the system through which the water circulates. The rate at which the water flows is easily regulated by a stop cock in the pipe. Fig 4 is a diagram of this arrangement.

Rubber bags, bottles of jugs filled with hot water, heated sand bags, heated bricks, heated blocks of wood, and other heated objects may be employed as means of making localized applications of heat.

THERAPEUTIC APPLICATIONS:---Localized applications of heat are among the most useful of all means of relieving pain. The rationale of the effect produced differs in different cases. In neuralgia, for example, the relief may in some cases be due to the simple relaxation of the nutrient vessels of the nerve trunks. Du Bois-Raymond has shown that

the pain of neuralgia may be due to pressure upon the nerve filaments by spasm of their nutrient vessels as well as by compression of the nerve trunk by the overfilling of the blood vessels of contiguous parts. It is evident that in the latter case, the neuralgia pain may be relieved by simple revulsion or diversion of the blood to some other part adjacent or remote. It is important to bear in mind that the therapeutic effect desired can be obtained only by a long continuation of the improved condition secured by the application. An application lasting from ten to twenty seconds may, for example, give perfect relief for the time being, but as a rule the pain, unless due to some other transient cause, will return and often with very discouraging promptness. The disappointment thus occasioned frequently leads to resort to an opiate when a more skillful application would wholly obviate the necessity for an anodyne, of any sort. The writer is glad to say that though formerly frequently compelled to employ morphia and other anodynes in the treatment of pain, since becoming better acquainted with the analgesic properties of thermotherapy and the technique of the procedures whereby these powers may be brought into play, he finds cases extremely rare in which pain, even of a most excruciating sort, may not be very promptly relieved or at least mitigated to such a degree that tolerance is easily possible until the cause of the pain can be removed by natural or artificial means.

It would be an error to suppose that the best results are always to be obtained by very prolonged hot applications. If the object of the application is to withdraw the blood from a part to a very remote part, as when a hot application is made to the feet and legs for relief of the cerebral circulation or to aid in controlling a pleuritic pain, or an acute bronchitis, the application may be continued for an hour or even longer; but it should be remembered that the application of heat to so extended an area as the legs may after a time elevate the general tempera-

ture, especially when febrile activity is already present and the heat regulating power of the body lessened. In general, however, the hot applications should be at least briefly interrupted at the end of fifteen to twenty or at the longest thirty minutes. This is especially true when the heat is applied directly over the affected part, for the reason that a long continued hot application under such circumstances leads to an over-accumulation of heat in the part and dilatation of the deep lying vessels, as the result of which the derivative or revulsive action may be interfered with.

The derivative effect induced by the hot application and a continuation of the heating process may be secured by the application of a heating compress. This consists of a linen towel of one thickness, or a cheese cloth of three or four thicknesses, wrung dry out of water at 60° and applied over the same area to which the hot application has been made, the wet cloth being covered with mackintosh extending an inch beyond the moist cloth on all sides and all finally covered with several thicknesses of flannel, bound firmly in place so as to prevent access of air to the moist cloth. If air is admitted, evaporation will take place and chilling will result. The cold cloth should be applied the instant the hot application is removed, and should be warmed up within a few seconds. Prolonged chilling will counteract the beneficial effects of the hot application. The latter may be removed at the end of two or three hours or at shorter or longer intervals as may be required. By this means, the affected part may be kept continuously under the influence of the thermal agents employed, and definite results may be obtained. In many cases, the application of a cotton poultice consisting of dry cotton covered with mackintosh and flannel, affords the most convenient means of maintaining the effect obtained until another application is made.

Other therapeutic applications of localized heating measures have been elsewhere mentioned (See page ....).

615.84

(Chap. on Thermotherapy.)

THERMOTHERAPY.

The employment of heat as a therapeutic agent technically includes applications at all temperatures and irrespectiveof the nature of the medithrough which the application is made. Properly speaking, hydriatic applications of all sorts, both hot and cold, vapor baths, hot of cold air baths, and even light baths, are thermic applications. The general plan of this series of volumes, however, requires that attention should be confined in this chapter to the consideration of such applications only as are capable of communicatingheat to the body, hence excluding cold applications of all sorts. Vapor and Russian baths, which may be properly termed thermic applications, are also omitted from this chapter, having received proper consideration elsewhere.

Media of any sort, whatever the temperature above that of the body, are said to be "hot". Temperatures above 104° are termed "very hot".

For a full understanding of thermotherapy, it is essential that one should be familiar with the fundamental principles of hydrotherapy, a concise statement of which would be in place were it not that the subject is elsewhere condidered at length in this series of volumes. Space will permit only of a brief statement of the physiological effects resulting from hot applications, general and local, which statement will be followed by a description of the technique of hot applications and the therapeutic indications.

GENERAL,-- PHYSIOLOGICAL EFFECTS.-- The general effect of heat is that of an excitant or a physiological stimulant. Within physiological limits, the application of heat to living cells increases the activity of their protoplasm, an effedt easily recognized in the quickened movements of

the amoeba, leucocytes, and other minute animal forms, when placed upon a warming-stage under the microscope. Heat is one of the most powerful of all vital stimulants. It increases the activity of all the tissues with which it is brought in direct contact,-- the glands, nerves, nerve-centres etc.

Thes effects whowever, are temporary, and are followed by secondary effects of a opposite character.

Following this primary effect, afterthe withdawal of the hot application, secondary depressant or atonic effect appear, to which are attributable the weakening or exhausting effects of thermic applications when improperly managed or inappropiately applied.

The actual effects of a thermic application depend upon the temperature, duration and form of the application, and also upon the condition of the patient. A prolonged application of hat at a high temperature, is at first excitant, then very decidedly depressant, the excitation is the natural result of the elevation of the temperature of the blood. The depressing effects are the result of a lowering of the nerve tone and the exhausting of nervous energy from over-stimulation.

A very short application of heat at a very high temperature is very strongly excitant, and the depressing effects which follow may be so slight as to be quite imperceptible.

A less intense, and moderately prolonged thermic application is excitant to a moderate degree at first, depressant effects appearing later, with diminished tissue activity of all forms.

EFFECTS OF HEAT UPON THE SKIN:--

1. A very short and a very hot application produces a goose flesh appearance from contraction of the smooth, muscular fibres of the skin.

2. Heat also contacts the yellow elastic tissue, but relaxes the white fibrous tissue which constitute the chief element of ligaments and

tendons.

3. Increased perspiration.

4. An increased activity of the functions of the skin.

5. Tactile sensibility is increased at 98°, and decreased at 113°, and disappears at a temperature of 130° when painful sensations are dexperienced.

6. Reddening of the skin and dilitation of the small blood vessels, especially the veins.

7. Contraction ofthe cutaneous vessels, with pallor some little time after the withdrawal of heat, the result of atonic reaction and chilling of the surface from evaporation.

8. Increased heat elimination is the result of the increased movement of the blood through the skin, and the dilitation of the surface - vessels, increased conductivity of the skin, and the increased glandular activity resulting in the evaporation of an increased amount of moisture.

EFFECTS OF HEAT UPON THE MUSCLES:--

1. The energy of the striated muscles is increased by short, hot applications from 98° to 104°.

2. Very hot applications (104° to 130°) increase the excitability of the smooth or involuntary muscles.

Long, very hot applications (106° to 120°) lessen the excitabiltiy and the vigor of the voluntary muscles.

EFFECTS UPON THE NERVOUS SYSTEM:

1. The brain is unduly excited by very hot baths, and the result is nervousness, sleeplessness and exhaustion.

2. Very short hot applications excite the nerves and nerve centers through the impressions made upon the skin.

3. Long and very hot applications may give rise to most pronounced exhaustion of brain, and spinal cord, and may give rise to dangerous collapse,

EFFECTS UPON CIRCULATION:

1. The pulse rate is first slowed and then quickened. The pulse rate and tension diminish with the beginning of perspiration.

2. The surface vessels, especially the veins, are dilated by prolonged warm or hot applications, while very hot applications give rise to temporary contractions of the small vessels of the skin.

3. General hot applications induce an elevation of blood pressure when percussion or friction is administered at the same time.

EFFECT OF HEAT UPON RESPIRATION:

1. Applications of hot, dry air hinder gaseous exchanges in the lungs, and interfere with the respiration.

2. A general application of moist heat increases ease of respiration

3. General hot applications are followed by an increase in the rate and depth of respiration.

4. A temperature below 40^{o} increases CO_2 elimination; the same is also true of a temperature above 60^{o} to 70^{o}.

EFFECT UPON BODY TEMPERATURE:

1. A general application at a temperature above that of the body causes and elevation of the temperature of the blood by interference with heat elimination,-- for example, in a series of experiments in the author's physiological laboratory, the temperature of a young man was increased 3.2^{o} in thirty minutes, representing a gain of 345.6 heat units during the time named. A bath at a temperature of the body (100) showed an increased temperature of $.6^{o}$. The Russian bath for 25 minutes increases the rate of temperature 2.1^{o}. An increase of the same amount (2.1^{o}) was observed as the result of an electric light bath for 23 minutes, and increase of 1.7^{o} resulted from a Turkish bath of one hour at 140^{o} to 158^{o}.

2. Water applications at a temperature of 92^{o} to 96^{o} do not materi

ly affedt the body temperature, but exposure to air at a temperature above 60 to 70° increases heat production, while a temperature of 70 to 40°, more or less, has precisely the same effect. Careful experiments show that an increase offheat production in dogs exposed to a temperatre of 104° F, amounted to 350%.

3. A short application of heat is followed by a fall of temperature, the result of increased heat elimination through dilitation of the surface vessels, and a diminution of hent production through the impression made through the thermic nerves upon the thermogenetic centers.

EFFECTS UPON THE BLOOD:

General hot applications decrease the blood-count, notably diminishing the proportion of leucocytes and diminishing the alkalinity of the blood.

EFFECTS UPON THE FUNCTIONS OF THE ABDOMINAL VISCERA:

1. General hot applications diminish the secretion of hydrochloric acid.

2. General hot applications, and hot applications about the trunk of the body lessen the volume of blood in the liver and other abdominal viscera.

a.

EFFECTS UPON METABOLISM:

General applications of heat increase the CO_2 production and nitrogen oxidation.

THE TURKISH BATH.--

This very interesting form of bath is a powerful means of influencing the bodily functions, and though likely to be largely superceededby the electric light bath, must still be recognized as a measure of value and importance. The essential features of the Turkish bath are,-- a heated room in which the patient reclines until vigorous perspiration is induced, the

shampoo, and a cooling spray or plunge. This bath, or its equivalent, has been used since very ancient times, as shown by the magnificient remains of baths to be seen at the present day in Pompeii. The oldest existing Turkish bath was built in the time of Herod the Great, at Jersalem. While visiting Jerusalem a few years ago, the writer found this ancient establishment still in operation. This is probably the oldest bathing establishment in the world.

A scientifically arranged Turkish bath establishment consists of a series of rooms which provide, besides dressing rooms and a cooling room furnished with couches on which patients may recline after a bath, at least the following separate compartments.

1. A room heated to a temperature of 110 to 130°,-- the "Tepidarium" of the ancients.

2. A hot room, heated to the temperature 150 to 120°,-- the "Caldidarium" of the ancients. In some establishments another small room is provided in which a temperature of 230° to 300° may sometimes be observed.

3. A convenient adjacent room furnished with marble slabs, and hot and cold water with other necessary paraphernalia provides for the shampoo.

Close at hand must be provided a well arranged douche apparatus and a well eqipped establishment there will be found a plunge or swimming bath containing water at a temperature of 60 to 70°. Some European establishments provide, in a plunge, water at a temperature as low as 45°. In the writer's opinion a temperature of 65° is low enough to secure all essential therapeutic results, and is safer than a lower temperature.

A hot room has been heated by steam coils, or by hot air provided by a furnace or an indirect steam heater. In rooms which are heated by steam pipes the air is generally very impure, as no adequate provision is made for ventilation. When, however, the hot air system is employed ventila-

tion becomes essential as a means of maintaining the temperature of the room. This is secured by an outlet near the bottom of the room; this opening must communicate with the ventilating shaft. The opening for the inlet of warm air may be either at the floor or ceiling; it is perhaps best located at a point about two or three feet above the level of the floor.

TECHNIQUE: The patient disrobes, places a loin cloth about his body, drinks a glass of water, either hot or cold, enters the warm room and lies down upon a couch. Usually, by the end of ten to fifteen minutes, and sometimes, sooner, the skin becomes slightly moistened, and a little later the subject finds himself in a state of profuse perspiration. In cases in which perspiration does not promptly appear, the danger of the activity of the cutaneous glands may be encouraged by the gentle kneading of the patient, by superficial massage or friction of the skin by an attendant. The native shampooers of Cairo and Constantinople frequently rub the bather with mits made of course fabric somewhat resembling haircloth. A very hot foot-bath or a short, hot spray, or full bath, is also an effective means to encouraging perspiration. In patients who cannot drink freely, a hot enema (110°) administered just before the bath, will usually induce prompt perspiration.

Hot water drinking is another important means of encouraging cutaneous activity. If the patient does not perspire either with or without the aid of the measures mentioned, he should not be allowed to remain in the bath for any considerable length of time, as serious injury may possibly result from a long exposure of the body to intense heat without the protecting influence of evaporation.

After the patient begins to perspire, he may, if he desires, enter the hot room to remain for a few minutes until very vigorous perspiration is induces, or if more moderate cutaneous activity is desired, he may remain

in the warm room. When the perspiration has been maintained as long as desirable, the patient is conducted to the shampoo room, where he is first rubbed with the bare hands or with Turkish mits, from head to foot, and in such a manner as to remove every particle of the superficial, deadly layers of skin which have been loosened by the profuse perspiration. The operator can readily determine when this waste material has been fully removed, by the smoothness of the skin. When the whole body has been gone over the patient is shampooed with good soap, the latter being applied and the skin thoroughly rubbed, either with a throughly aseptic brush, or a properly arranged mass of flax, manilla, or other fibrous material. Great care must be taken in the employment of the shampoo brushes to avoid conveying infection of any sort from one patient to another. The only safe precaution, when a common brush is used (a preactice which is certainly not to be commended) is, to drop the brush for two minutes into boiling water each time it is used, after thoroughly rinsing the soap suds out of it. There is an advantage in the use of manilla and other fibers in the fact that the cost of the material is so small thatit may be thrown away and a new supply provided for each patient and at each treatment.

The means employed in shampooing are not easily described. The movements administered with the bare hands, and which are of the highest importance, consist, for the most part, of alternate to and fro movements across the chest and up and down the body. This movement should not cover too great a territory at a time, and the work must be very thoroughly done. The hands should be frequently dipped in water at a temperature of about 90°; no part must be neglected.. The face, ears and neck should receive first attention; then the chest, abdomen, arms and legs, and back (for which the patient turns over), and finally the feet.. After the patient has been very thoroughly gone over with the bare hands, a very strong lather is

made with the shampoo brush and soap rubbed together, and the patient's body is well covered over with the same. The brush, or mass of fiber or horse-hair is then applied, first to the upper part of the neck and chest, then the arms, then the lower parts of the body; no part should be neglected. The shampooing and rubbing should be continued until the whole surface feels like polished marble. After the shampooing, the patient is conducted to the douche. If he is still quite warm, a cold douche may be administered at once. If he has become slightly chilled, he should be thoroughly warmed up before the cold application is made. This may be accomplished by means of the hot foot-bath, or a warm shower-bath. The bath should end with the douche of cold water at a temperature of 60^{o} or less. If the patient is inclined to perspire freely after the bath, a shower at a temperature of 90^{o} to 80^{o} should be administered for from one to three minutes before the final application.

After the douche, which serves the double purpose of removing the soap with the shampoo, and counteracting any depressing effects from the prolonged exposure in the hot-bath, the patient may enter the plunge or the swimming bath, or may wrap a sheet around him and lie down upon a couch until the skin becomes perfectly dry and the pulse has returned to its normal rate.

If the patient has a very dry skin, a little refined vaseline should be administered at the close of the bath. Massage, short movements or joint-movements, or both measures may be advantageously employed, in many cases, which aid reaction, and increase the value of the bath.

615.84

THE DRY PACK.

This is a very effective, but rather inconvenient mode of bringing the body as a whole under the influence of heat. The patient is closely wrapped in blankets (Fig. 2) with hot-water bottles or bags to the feet, thighs and back. Care must be taken to tuck the covers in closely about the neck, and to bring the wrappings in closely in contact with the body everywhere, so as to prevent the slightest movement of air about the body. This will prevent evaporation and consequent cooling.

In this procedure the source of heat is the body itself. Heat elimination is favored by the warm coverings, so that there is a gradual accumulation of body heat, which after a time results in a sufficient increase in the body temperature to produce perspiration and all the other effects of a general hot application.

This measure is effective in accomplishing all that can be accomplished by any other sweating prodedure. The chief inconvenience lies in the length of time required to produce vigorous perspiration, which sometimes amounts to several hours, and the considerable degree of discomfort which the patient experiences during the heating period before perspiration begins.

Therapeutic Indications: The therapeutic uses of this procedure are the same as those of other general hot applications by which perspiration can be induced. The special uses of the dry pack are the induction of perspiration in cases where other general thermic applications are not readily available, especially when for any reason the application of water is not deemed advisable, as when a chill from malarial infection or pyemia is anticipated, in most cases of surgical shock, and in some cases of acute and chronic rheumatism.

Local applications of the dry pack are often required in surgical cases, in cases of paralysis of the limbs, after the ligation of arteries, and in threatened senile gangrene, and in neuralgic affections.

The contraindications are the same as for other general hot applications.

THE SAND BATH.

This form of bath (Fig_____) is less appreciated in recent times than its merit deserves. It is a most effective means of inducing perspiration, and may be employed either as a general or a local measure. There are a few European resorts where the sand bath is still commonly used, especially in the treatment of rheumatism. The writer does not know that it has been systematically employed in this country by others than himself. Experience with this bath, in connection with the outdoor gymnasium, has afforded most excellent results in cases of rheumatism, chronic sciatica, lumbago, the uric acid diathesis, chronic dyspepsia, and various forms of chronic disorder.

In taking this bath, the patient lies exposed to the sun, with his body, except the head, either partially or wholly buried in a mass of heated sand. All the precautions should be taken which are indicated in relation to the sun bath and other general applications of heat.

The therapeutic indications and contraindications are essentially the same as for other general therm therapeutic measures.

THE MUD BATH.

This procedure, which has been in vogue for hundreds of years at certain European resorts, has been in more recent years introduced into this country. It consists simply in immersing the body in an ordinary bath tub filled with mud made by the mixture of an unctious alkaline earth with water to the consistence of a thin porridge. The attendant plasters the mud upon the patient's chest, and rubs it well upon the surface everywhere until the patient begins to perspire freely. It is then removed, and a hot spray administered until the mud is washed off, the application ending with a short, cool, or cold application.

The mud bath is thought to be especially efficacious in rheumatic affections. It is certainly an effective method of elevating the body temperature and inducing perspiration, but it must be considered doubtful whether any specific virtue resides in heat communicated to the body by moist earth, and there is little or no evidence to show that alkaline or any other substances are absorbed during the bath. Quite generally strong sulphurous odors are involved by the moist heated earth, the inhalation of which may produce certain medicinal effects.

The mud bath has the disadvantage of being very inconvenient in use, and it is questionable whether the advantages derived from its employment are sufficiently superior to those of many other more convenient methods of applying heat afforded by thermotherapy to justify the special claims made for this prodedure. It must be acknowledged, however, that many rheumatic patients express a special preference for this bath, and entertain most profound faith in its special efficacy.

Directions for the application of the hot blanket pack, the hot immersion bath, the hot douche, and other general thermic applications in

which water is the agent of heat communications, will be found in works on hydrotherapy, to which the reader is also referred for a description of the fomentation, the dry pack, and other hydriatic measures of applying heat.

OTHER LOCAL APPLICATIONS OF HEAT.

The fomentation and the heating compress, perhaps the most useful of all the local measures known to thermotherapy, have been elsewhere described in connection with other hydriatic procedures.

Dry hot applications may be made by a variety of means, of which we need mention only a few. For example, the application of dry heat may be made by means of the hot-water coil (Fig. 3), which is simply a coil of rubber or aluminum through which a stream of water at the required temperature is made to flow continuously. The temperature of the coil is easily regulated by a tube compressor, which controls the outflow. A rubber bag, with an opening at each end, may be employed in place of the coil, but is somewhat less convenient. To avoid the inconvenience of emptying the water which is passed through the coil and refilling the heating reservoir, the writer has arranged a heater on the plan of the ordinary range heater, consisting of a tank heated by a gas jet, from the top of which a pipe carries the water to the couch on which the patient lies, while another pipe bringing back the water, enters the tank at the bottom. The coil is connected with the two metal pipes, and forms a part of the system through which the water circulates. The rate at which the water flows is easily regulated by a stop-cock in the pipe. Fig. 4 is a diagram of this arrangement.

Rubber bags, bottles or jugs filled with hot water, heated sand bags, heated bricks, heated blocks of wood, and other heated objects, may be employed as means of making localized applications of heat.

Therapeutic Applications: Localized applications of heat are among the most useful of all means of relieving pain. The rationale of the effect produced differs in different cases. In neuralgia, for example, the relief may in some cases be due to the simple relaxation of the

nutrient vessels of the nerve trunks. Du Bois-Raymond has shown that the pain of neuralgia may be due to pressure upon the nerve filaments by spasm of their nutrient vessels, as well as by compression of the nerve trunk by the over filling of the blood vessels of contiguous parts. It is evident that in the latter case the neuralgic pain may be relieved by simple revulsion or diversion of the blood to some other part adjacent or remote. It is important to bear in mind that the therapeutic effect desired can be obtained only by a long continuation of the improved conditions secured by the application. An application lasting from ~~10~~ ten to ~~20~~ twenty seconds may, for example, give perfect relief for the time being, but as a rule the pain, unless due to some transient cause, will return and often with very discouraging promptness. The disappointment thus occasioned frequently leads to resort to an opiate, when a more skilful application would wholly obviate the necessity for an anodyne of any sort. The writer is glad to say that, though formerly frequently compelled to employ morphia ~~and~~ and other anodynes in the treatment of pain, since becoming better acquainted with the analgesic properties of thermotherapy and the technique of the procedures whereby these powers may be brought into play, he finds cases extremely rare in which pain even of a most excrutiating sort may not be very promptly relieved, or, at least mitigated to such a degree that tolerance is easily possible until the cause of the pain can be removed by natural or artificial means.

It would be an error to suppose that the best results are always to be obtained by very prolonged hot applications. If the object of the application is to withdraw the blood from a part to a very remote part, as when a hot application is made to the feet and legs for ~~the~~ relief of the cerebral circulation, or to aid in controlling a pleuritic pain, or an acute bronchitis, the application may be continued for an hour, or

even longer; but it should be remembered that the application of heat to so extended an area as the legs may after a time elevate the general temperature, especially when febrile activity is already present, and the heat-regulating power of the body lessened. In general, however, the hot applications should be at least briefly interrupted at the end of fifteen to twenty, or, at the longest, thirty minutes. This is especially true when the heat is applied directly over the affected part, for the reason that a long-continued hot application under such circumstances leads to an over-accumulation of heat in the part, and dilatation of the deep-lying vessels, as the results of which the derivative or revulsive action may be interfered with.

The derivative effect induced by the hot application and a continuation of the heating process may be secured by the application of a heating compress. This consists of a linen towel of one thickness, or a cheese-cloth of three or four thicknesses, wrung dry out of water at 60°, and applied over the same area to which the hot application has been made, the wet cloth being covered with mackintosh extending an inch beyond the moist cloth on all sides, and all being finally covered by several thicknesses of flannel bound firmly in place so as to prevent access of air to the moist cloth. If air is admitted, evaporation will take place, and chilling will result. The cold cloth should be applied the instant the hot application is removed, and should be warmed up within a few seconds. Prolonged chilling will counteract the beneficial effects of the hot application. The latter may be renewed at the end of two or three hours, or at shorter or longer intervals, as may be reqired.
By this means, the affected part may be kept continuously under the influence of the thermal agents employed, and definite results may be obtained. In many cases, the application of a cotton poultice, consisting

of dry cotton covered with mackintosh and flannel, affords the most convenient means of maintaining the effect obtained, until another application is made.

Other therapeutic applications of localized heating measures have been elsewhere mentioned (See page____).

Cuts for Thermotherapy.

Fig. 1. Cutaneous areas reflexly related with the viscera, front view.

Fig. 2. Cutaneous ateas reflexly related with the viscera, back view.

Fig. 3. Cutaneous aresa the vessels of which are collaterally related with those of the viscera, front view.

Fig. 4. Cutaneous areas the vessels of which are collaterally related with those of the viscera, back veiw.

Fig. 5. Diagram illustrating the relationship existing between the skin and underlying the muscle or other structures .

Fig. 6. Diagram showing the effect of dilating the cutaneous vessels by a hot application in producing collateral anemia of the unerlying muscle or other structures.

Fig. 7. Diagram ilkustrating the congested state of the vessels of a boil or other circumscribed superficial inflamed part.

Fig. 8. Diagram showing the effect of a hot application and diminishing the amount of blood in the vessels of an inflamed part by dilating the vessels of the surrounding parts.

Fig. 9. Diagram illustrating the operation of a hot and cold compress when applied for relief of congestion of the kidneys.

Fig. 10. Diagram illustrating the distended condition of the blood vessels and inflammation of the uterus and the relation of these vessels to the internal and external arteries and their branches.

Fig. 11. Diagram showing the effect of an ice-bag to the hypogastrium, causing contraction of the vessels of the uterus, with a simultaneous dilitation of the external branches of the internal iliac and the internal iliac induced by a hot hip and leg pack.

Fig. 12. A hot air bath cabinet.

Fig. 13. A dry pack. Fig. (?) The sand bath

Fig. 14. The heating coil. Fig. 15. Hot water circulation for the heating coil.

THERMOTHERAPY.

The employment of heat as a therapeutic agent technically includes applications at all temperatures and irrespective of the nature of the media through which the application is made. Properly speaking, hydriatic applications of all sorts, both hot and cold; vapor baths, hot and cold air baths, and even light baths, are thermic applications. The general plan of this series of volumes, however, requires that attention should be confined in this chapter to the consideration of such applications only as are capable of communicating heat to the body, hence excluding cold applications of all sorts. Vapor and Russian baths, which may be properly termed thermic applications, are also omitted from this chapter, having received proper consideration elsewhere.

Media of any sort having a temperature above that of the body are said to be "hot". Temperatures above 104° are termed "very hot". Temperatures near that of the skin are termed "warm". These terms, with others relating to temperature, are commonly used rather loosely. To secure accuracy in prescription it is better to indicate the exact temperature. When ordinary terms are employed, they may be understood as expressing the following temperature values: Very cold, 32° to 55°F.; cold, 55° to 65°F.; cool, 65° to 80°F.; tepid, 80° to 92°F.; warm, 92° to 98°F. (neutral, 92° to 98°F.); hot, 98° to 104°F.; very hot, 104°F. and above.

For a full understanding of thermotherapy, it is essential that one should be familiar with the fundamental principles of hydrotherapy, a concise statement of which would be in place were it not that the subject is elsewhere considered at length in this series of volumes. The limitation of space will permit only a brief statement of the physiological effects resulting from warm and hot applications, general and local, which will be followed by a description of the technique of hot applications and a summary of the therapeutic applications.

GENERAL PHYSIOLOGICAL EFFECTS.

The general effects of heat are those of an excitant or a physiological stimulant. Within physiological limits, the application of heat to living cells increases the activity of their protoplasm, an effect easily recognized in the quickened movements of the amoeba, leucocytes, and other minute animal forms, when placed upon a warming stage under the microscope. Heat is one of the most powerful of all vital stimulants. It increases the activity of all tissues which it may be brought to bear upon, glands, nerves, nerve-centers, etc.

These effects, however, are temporary, and are followed by secondary effects of an opposite character, depression, a sort of negative or atonic reaction after the withdrawal of the hot application. To these secondary depressant or atonic effects are attributable the weakening or exhausting effects of thermic applications when improperly managed or inappropriately applied.

The actual effects of a thermic application depend upon the temperature, duration and form of the application, and also upon the condition of the patient.

A prolonged application at a high temperature is at first excitant, then very decidedly depressant. The excitation is the natural result of the elevation of the temperature of the blood. The depressing effects appear to result from the lowering of the nerve tone and the exhausting of nervous energy by over-stimulation.

A very short application at a high temperature is very strongly excitant, and the depressing effects which follow may be so slight as to be quite imperceptible.

A less intense, and moderately prolonged thermic application is

excitant to a moderate degree at first, depressant effects appearing later, after the conclusion of the application.

EFFECTS OF HEAT UPON THE SKIN.

1. A very short and a very hot application produces a goose flesh appearance from contraction of the smooth muscular fibres of the skin.

2. Heat also contracts the yellow elastic tissue, but relaxes the white fibrous tissue which constitutes the chief element of ligaments and tendons.

3. Increased perspiration.

4. An increased activity of the respiratory function of the skin.

5. Increased tactile sensibility at 98°F., decreased at 113°F. Tactile sensibility disappears at a temperature of 130°F. when painful sensations are experienced.

6. Momentary pallor when the temperature is high (110°F. upwards), quickly followed by reaction with reddening of the skin from dilatation of the vessels. Lower temperatures produce immediate reddening of the skin with dilatation of the small blood vessels, especially the veins. Contraction of the cutaneous vessels, with pallor, occurs some little time after the withdrawal of heat, the result of atonic reaction and chilling of the surface from evaporation.

7. Increased heat elimination following a hot application is the result of the increased movement of blood through the skin, and the dilatation of the surface vessels, increased conductivity of the skin, and the increased evaporation occasioned by the largely increased amount of moisture thrown upon the surface by the sweat glands.

EFFECTS OF HEAT UPON THE MUSCLES.

1. The energy of the striated muscles is increased by short, hot applications from 98° to 104°F.

2. Prolonged warm or hot applications lessen the excitability and the energy of voluntary muscles. It is thus that heat becomes of service in relieving muscular cramp. Cold produces the opposite effect.

3. Very hot applications (104° to 130°F.) increase the excitability of the smooth or involuntary muscles.

EFFECTS UPON THE NERVOUS SYSTEM.

1. Very short hot applications excite the brain, nerves, and nerve centers through the impressions made upon the skin.

2. Prolonged general hot applications may give rise to pronounced exhaustion of the brain and spinal cord. Warm and hot applications lessen general nervous sensibility to a most remarkable degree. This is especially true of very hot applications. This effect may be due in part to the absopption of moisture by the terminal nerve filaments in the skin. It has also been suggested that this result may be brought about by the stimulation of the temperature nerves. It is well known that the skin is much more sensitive to thermic impressions than to any other form of stimulus which it is capable of recognizing.

3. Applications of heat to the skin generally produce an agreeable sense of comfort and well-being. When long continued, languor, lassitude, and depression result.

4. Short very hot applications are, like short cold applications, exciting, both directly and ~~in~~reflexly.

full head

EFFECTS OF HEAT UPON THE CIRCULATION: **Heart:** 1. In general, heat applied over the heart tends to lessen the length of the systole, while cold produces the opposite effect.

2. General hot applications at first slow the heart, then increase the pulse frequency. Cold produces exactly the opposite effect.

Blood Vessels: 1. Very hot applications at first contract, then relax the blood vessels.

2. Under the influence of heat the skin assumes a dusky red hue from slowing of the blood circulation in the skin, due to the fact that the veins appear to be influenced by heat more than are the arteries. The vascular dilatation accompanying the reaction which follows a cold application influences the arteries especially, giving rise to a bright red hue. The vascular dilatation due to heat is passive, while that due to cold is active.

3. Large arterial trunks are dilated by hot applications when prolonged sufficiently to heat the intervening tissues, or applied at points at which the vessels approach near the surface, as the groins, the axillae, the neck, the bend of the elbow and the knee.

4. The principle of fluxion or revulsion which furnishes the foundation for one of the most important therapeutic uses of heat, depends upon the fact that, when the vessels of one portion of the peripheral area to which blood is supplied by an arterial trunk are in a state of dilatation, there is contraction of the vessels of the other portion of the same area, and consequently a diversion of blood therefrom. In other words, the local hyperemia induced by an application of heat gives rise to a compensatory or collateral anemia in the area in vascular relation therewith. This explains the relief afforded by an application of heat about a rheumatic joint, or over an inflamed or congested muscle. The same fact

likewise affords an explanation of the relief of visceral pain which results from a general hot application.

Blood Pressure: 1. Cold raises blood pressure, while general hot applications lower blood pressure, though the blood vessels may be dilated in both cases.

2. The dilatation which accompanies the reaction following a cold application, does not lower blood pressure because of the increased vigor of the heart action resulting from reflex stimulation and the increased activity of the "peripheral heart". A very hot application may raise blood pressure by reflex excitation of the heart, producing a quick, strong pulse, but in general, hot applications lower blood pressure by dilatation of the cutaneous vessels, whereby peripheral resistance is lessened. The skin is capable of holding one-half to two-thirds of all the blood in the body. Hence a general hot application by dilating the surface vessels, and especially the veins of the skin, draws a large amount of blood from the internal circulation. The ventricles of the heart are not so well filled, and the heart contractions are lessened in force.

3. A hot douche produces an elevation of blood pressure while at the same time dilating the surface vessels to the fullest degree by reason of the strong mechanical or percutient action characteristic of this form of bath, whereby the heart is stimulated.

EFFECTS OF HEAT UPON RESPIRATION: 1. Heat and dryness of the air hinder the gaseous exchanges in the lungs, and renders respiration more frequent and superficial.

2. Heat and moisture to the extent of saturation interfere with elimination through the lungs.

3. A general hot bath increases the rate and frequency of reppiration. The depth of respiration is at first diminished, but when the bath is continued sufficiently long to raise the temperature of the blood, and increase CO_2 production, the depth of the respiratory movements is increased.

4. A frog breathes with its skin; a dog sweats with its lungs; man not only sweats with his skin, and breathes with his lungs, but, like the frog, to some extent, breathes with his skin, and, like the dog, sweats with his lungs. Hot baths not only promote the perspiratory activity of the skin, but the elimination of moisture through the lungs, thus aiding in the escape of those toxic substances which, as Charrin has pointed out, are probably eliminated from the bronchial mucous membrane.

→ full head

THE EFFECTS OF HEAT UPON BODY TEMPERATURE: 1. A general application at a temperature above that of the body causes elevation of the temperature of the blood, by interference with heat elimination. For example, in a series of experiments in the author's laboratory, the temperature of a young man weighing 108 pounds was increased 3.2°F. (1.8°C.) in thirty minutes, representing an accumulation of 88.2 calories. A bath at a temperature of the body (100°) caused an increase of 0.6°F. in temperature. Baths at a temperature of 92°to 96°F. (neutral) do not increase the body temperature. A Russian bath for twenty-five minutes increased the temperature 2.1°F. An increase of the same amount (2.1°F.) was observed as the result of an electric light bath for twenty-three minutes. An increased of 1.7°F. resulted from a Turkish bath of one hour at 146° to 158°F. The elevation of body temperature induced by prolonged hot baths is not wholly due to diminished heat elimination, since it has been shown that heat production is increased in dogs exposed to a temperature of 104°F.

to three and one-half times the normal.

2. A short application of heat is followed by a fall of temperature, the result of increased heat elimination through dilatation of the surface vessels, and a diminution of heat production through the reflex influence of the thermic nerves upon the thermogenic processes.

→ full head

THE EFFECTS OF HEAT UPON THE BLOOD: General hot applications decrease the blood count, notably diminishing the proportion of red cells. Heat also lessens the alkalinity of the blood, thus diminishing vital resistance, as has been shown by Charrin. This fact emphasizes the importance of concluding every general hot application with a general cold application of some sort, cold having the effect to maintain the normal alkalinity of the blood, and thus increase vital resistance. When profuse sweating is induced, the volume of the blood is diminished, unless the loss is made good by the ingestion of water.

→ full head

THE GENERAL EFFECTS OF HEAT UPON THE ABDOMINAL VISCERA: As observed above, heat lowers the tone of voluntary muscles, while cold raises it. In other words, heat relaxes muscles, while cold contracts them. This effect is particularly marked where applications are made to the muscles of the abdominal wall, a fact which has long been taken advantage of in the treatment of strangulated hernia, and more recently in examination of the pelvic and abdominal viscera while the patient lies in a hot bath.

The tension of the abdominal muscles is a matter of no small importance in relation to respiration, and especially the blood movement in all the viscera lying below the diaphragm. With the relaxation of the abdominal muscles intra-abdominal tension is diminished, and the portal vessels become distended with blood. All the viscera are congested. The stomach

and intestines become distended with gas, and stasis in the stomach and colon occurs, resulting in gastric indigestion and constipation with fermentations and putrefactive processes which lead to autointoxication and various nutritive disturbances.

Cold, when applied to the abdominal wall, contracts not only the external voluntary muscles, but the internal involuntary muscles of the stomach and intestines, bladder and gall bladder, together with the muscular structures found in the spleen and the liver, and the muscular walls of the blood vessels. Hot applications to the abdominal walls produce the opposite effect. It is apparent that hot applications of this sort are not therapeutically valuable except for the relief of conditions of muscular spasm, either in the external voluntary muscles or the internal involuntary muscular structures, as, for example, in intestinal or renal colic, or gall stones.

Long-continued warm applications to the abdominal surface appear to lead to concentration of blood in the portal circulation, doubtless by relaxing the visceral vessels.

Very hot applications, on the other hand, appear to divert blood from the internal viscera by widely dilating the surface vessels. This effect is made possible by the anatomical connection which exists between the cutaneous vessels and those of the viscera, which will be mentioned in detail a little later.

By the alternate application of heat and cold, the blood movement though any internal viscus may be very readily and perfectly controlled/ Cold contracts the visceral vessels through reflex action of the thermic nerves, while heat produces the opposite effect. By the alternation of these effects a veritable pumping action may be instituted, whereby functional activity may be influenced, and disease processes controlled.

Very hot water, when brought in direct contact with the gastric mucious membrane, excites both motor and secretory activity, producing also a very decided stimulating effect upon the heart. Cold applications applied over the stomach, as well as cold applications to the general surface, increase the motility of the stomach, and stimulate the secretion of the gastric juice. Very hot applications, either general or local, unless greatly prolonged, produce similar effects.

It should be noted, however, that when the general hot application is prolonged until profuse perspiration is induced, the secretion of gastric juice is greatly diminished. Puschkin claims to have shown that the amount of the gastric juice and its digestive activity is greatly increased by the application of heat to the epigastrium after eating. The clinical results obtained by the writer during more than a score of years, in the large use of this measure as a means of promoting digestion, enables him to say that Puschkin's claims are fully corroborated by clinical experience. Applications to be beneficial in this way must be very hot. Warm applications doubtless tend to diminish the secretory activity of the stomach and to lessen motility.

THE EFFECTS OF HEAT ON THE LIVER AND THE SPLEEN. According to the exact observations of Kowalski, hot applications over the region of the liver, followed by cold applications, increase the secretion of bile. This effect is doubtless produced by the increased movement of blood through the organ, induced by an application of this sort, the rationale of which has been previously explained. The beneficial results obtained in hydriatic practice by the employment of fomentations over the liver, followed by the heating compress, fully corroborate Kowalski's claims. For more than a hundred years this measure has been employed, largely

empirically, but neverthless successfully, in the treatment of hepatic affections, so that it cannot be doubted that the liver may be powerfully influenced by this means .

The effect of thermic applications over the spleen, hot, cold, ot alternate hot and cold, is clearly shown in the rapid diminution in size which may thus be secured in cases of splenic enlargement from malarial infection and allied conditions, when not involving structural changes in the organ.

→ full head

THE EFFECTS OF HEAT UPON RENAL ACTIVITY:) General hot baths promote renal activity, and increase the amount of urine when the temperature is sufficiently high to increase blood pressure (104°to 110°F.). Renal secretion is diminished, however, when a general hot application is prolonged sufficiently to induce profuse perspiration. The powerful effects of general hot applications upon the kidneys is whown by the remarkably beneficial results obtained by the employment of the hot bath and other general hot applications in the treatment of acute nephritis.

→ full head

THE EFFECTS OF HEAT UPON METABOLISM:) 1. General applications of heat, if sufficiently prolonged to elevate the temperature of the blood, increase CO_2 production. Nitrogen oxidation appears also to be particularly favored by the elevation of temperature induced by a general hot application.

2. Experiments also show that the elevation of temperature induced by general hot applications, aids the body in the formation of alexins and antitoxins. Animals suffering from infectious diseases live longer when subjected to the influence of heat. The recognition of this fact has led to the discovery that fever and the high elevation of temperature which occurs in connection with most acute infectious diseases, is a remedial

process. By reverse reasoning we are led to the conclusion that a fever artificially induced by a general hot application may be beneficial in aiding resistance to infection, especially when followed by a short cold bath.

Local applications of heat doubtless in many instances operate beneficially by concentrating the blood in a part, and thus aiding leucocytosis, one of the most important of all forms of remedial activity.

THE ANATOMICAL BASIS OF THERMOTHERAPY. The physiological effects of thermotherapy are determined experimentally. The therapeutic applications are suggested by inference, or determined by clinical experience. For a full understanding of the rationale of both physiological and therapeutic effects, it is necessary to bear in mind a few anatomical facts of special interest in this connection. This is especially true in relation to local thermic applications.

The effects of thermic applications to the surface depend upon

1. The elevation of the temperature of the parts to which the application is made, and of the general body temperature;

2. The effects induced in more or less remote parts through nervous reflex influence; and

3. The vascular relations existing between different bodily organs and regions.

The effects depending upon reflex nervous action are the result of the association, by means of reflex arcs, of the internal viscera with clearly defined cutaneous areas, each viscus having its own area from which the most intense reflex impressions are received, while at the same time more remotely related with all portions of the surface. These cutaneous reflex areas, for the most part, overly the individual viscera.

The accompanying cuts (Figs. 1 and 2) show diagramatically the principal of these cutaneous areas which have been definitely worked out and which are clinically important.

Careful anatomical studies have shown that there is an equally intimate and more direct relaxation existing between the blood vessels of deeply seated organs and overlying or adjacent cutaneous areas.

According to Woolsey (Text-Book of Anatomy by American Authors, Gerrish), the vessels of the brain are freely connected with those of the scalp and the nose through the parietal foramen, the foramen cecum, the mastoid foramen, the posterier condylar foramen, the foramen of Vesalius, the foramen ovale, the foramen lacerum medium, the carotid canal, the anterior condylar foramen, and other openings as well as through the diploë of the cranial bones.

The meningo-rachidian veins, which form dense plexuses in the spinal canal, are freely associated with the cutaneous veins of the back, and with the dorsi-spinal veins through the anastomosing veins which issue from the canal through the intervertebral foramina, and unite with the intercostal, vertebral, lumbar, and sacral veins.

The blood supply of the eye lids and of the skin covering the eye brows and adjacent portions of the forehead, is collaterally related with branches of the internal carotid which supply the eye ball.

The circulation of the middle ear is collaterally related with the circulation of the skin of the face, and head of the same side through the common carotid. The circulation of the internal ear, on the other hand, is associated with the skin of the back of the neck, being derived from the vertebral arteries.

The vessels of the mucous membrane of the nose and pharynx are associated with those of the face and the sides of the head through the

common carotid.

The circulation of the lungs is collaterally related to that of the skin covering the arms, the shest and the upper part of the back. The pericardium and the parietal pleura of the anterior portion of the chest is collaterally related to the skin covering the anterior portiin of the chest wall, through the internal mamary artery.

The parietal pleura of the posterior portion of the chest and thhe visceral pleura are collaterally related with the intercostal vessels. A collateral relation also exists between the bronchial arteries,--the nutrient arteries of the lungs, and the intercostals, especially those of the right side. The skin covering the arms is collaterally related with the pleura of the upper and anterior portion of the chest through the subclavian. There also exists a collateral relation between the nutrient vessels of the lungs and the vessels covering the anterior portion of the neck through the inferior thyroid arteries. The collateral relationship existing between the vessels of the skin and of the lungs is still further extended by the connection of the bronchial veins with the azygos veins of the right side, and with the superior intercostal or the azygos veins of the left side. It is in the highest degree interesting to note these extensive communications between the pulmonary circulation and that of the cutaneous surface, all of which are of high therapeutic interest.

The kidneys are associated with the skin covering the loins through the renal branches of the lumbar arteries.

The vessels of the prostate in man, the uterus and ovaries in woman, and the bladder in both sexes, are associated with the cutaneous vessels overlying the sacrum, the buttocks, the perineum, the external genitals, the groins, the inner surface of the thighs, and the suprapubic region, chiefly through the internal iliac. These organs are also associated

with the skin of the leg through the common iliac.

The rectum is similarly associated with the skin covering the anal region and the perineum and that of the lower extremeties.

There is a collateral relationship, both venous and arterial, between the stomach, liver, spleen, intestines, and even the pancreas, and the skin of the trunk which overlies those deeply seated organs.

The portal circulation communicates with the systemic circulation, thus establishing a collateral relationship with the cutaneous vessels at half a dozen or more points, especially the following: the hemorrhoidal plexus, the esophageal veins, the left renal vein, the phrenic vein at the surface of the liver, the epigastric veins at the umbilicus, the circumflex iliac (Treves, Schiff).

In a similar way, it may be stated that the upper half of the body is collaterally related with the lower half, a fact of which constant use is made when the lower extremeties are warmed to divert blood from the head.

The cutaneous vascular areas connected with the several viscera are roughly indicated in the accompanying diagrams (Figs. 3 and 4). It should be remembered, however, that every portion of the cutaneous surface is remotely, at least, related vascularly to every internal part. It is also interesting to note that the vascular areas connected with the several internal viscera do not altogether correspond to the reflex cutaneous areas connected with the same parts, although in the main the reflex areas and vascular areas are practically identical. For example, the skin covering the front of the chest is of greatest importance as a means of reflexly influencing the pulmonary circulation; whereas, the cutaneous vessels of the skin covering the back of the chest are more intimately related with the vessels of the lungs than are those of the anterior

surface. A most important reflex relation exists between the skin covering the lower portion of the sternum and the kidneys, whereas the principal vascular relation exists between the kidneys and the skin covering the loins.

The portion of the body below the umbilicus is collaterally related to the head, the arms, and the upper half of the trunk; and the legs are likewise in collateral relation with all parts of the body above them, especially those which occupy the pelvic cavity.

These relationships render it possible to employ the reflex and the fluxion methods at one and the same time, a cold application of small extent being applied over the center of greatest reflex activity, while a hot application is made over the area which is in closest vascular relation with the interested part. When the vascular cutaneous areas and the reflex areas concerned are identical, the cold application is made to the reflex area, while the hot application is made to the feet, legs, or lower half of the body, or even to the entire cutaneous surface when the largest possible effect is desired.

Understanding these interesting anatomical relations, it is readily seen that the volume of blood in any internal viscus, no matter how remote from the surface, may be diminished either by a general hot application to the surface whereby one-half of all the blood in the body may be diverted into the skin, or to a lesser degree by localized applications. By means of hot applications suitably applied, the vessels of different portions of the brain may be drained into the communicating skin areas. The longitudinal sinus is drained by means of applications to the sides of the head; the lateral sinus may be drained by applications to the skin areas behind the ears; the cavernous sinus by applications over the face, ears, and side of the neck; the occipital sinus by applications to the

back of the neck. Congestion of the spinal cord may be relieved by hot applications to the back from the base of the cranium down. Congestion of the eye ball may be relieved by hot applications made over the eye and the ~~sides of the head and face; the internal ear~~ forehead above, not extending below the eye. Congestion of the middle ear is relieved by hot applications over the sides of the head and face; the internal ear by hot applications to the arms and legs; the nasal cavity and the pharynx by a hot application to the face and sides of the head; the larynx by hot applications to the front of the neck, the arms, the back, the upper part of the chest, and the legs; the lungs by an application over the whole thoracic cage and the arms, an additional advantage being gained by a hot application to the legs; the kidneys by general hot applications to the whole surface, or local hot applications over the lumbar region; the pelvic organs by hot applications to the hips and legs; the stomach and other viscera by hot applications over the interested part, or better, to the entire trunk, or trunk and legs.

As Treves very well remarks (Surgical Applied Anatomy, Page 371), these facts give "an anatomical demonstration of the value of counter-ifritants in inflammatory affections of certain of the viscera, and also a scientific basis to the ancient practice of poulticing the loin and the iliac region in nephritis and in inflammations about the caecum."

THE THERAPEUTIC EFFECTS OF HEAT.

The means employed in thermotherapy are, for the most part, exceedingly simple, and such as every one is more or less familiar with. Yet is must not be supposed that the therapeutic use of these procedures is by any means a simple matter, ot that these agents can be used successfully without attention to the most minute details, and the exercise of the greatest care to emplby measures appropriate to the case in hand. The successful practice of thermotherapy requires exactly as much painstaking accuracy and precision in diagnosis, in prescription making, in dosage, and adaptation of means to individual conditions and idiosyncrasies as is necessary in the employmant of powerful therapeutic measures of any other sort. Strychnia, morphia, and other powerful drugs may produce deadly effects when carelessly employed, but the effects resulting from the careless application of thermotherapy may be not less disastrous. It may be said, however, in favor of the physiological procedures of thermotherapy that they are to a remarkable degree self-adjusting, and hence less likely to lead to injurious consequences than are powerful drugs. If this were not true, the extensive empirical and bungling employment of these agents by the laity would long ago have lead to their abandonment.

As is the case with all physiological therapeutic measures, the therapeutic effects of heat are clearly foreshadowed in the physiological effects of this agent. As space will not permit a detailed discussion of all points pertaining to the therapeutic effects of heat, many of which have been ably considered by others in the discussion of hydrotherapy and allied subjects, we present merely a summary of the general principles involved.

(1) The general excitant effects of heat render highest service in

most conditions of extreme exhaustion, as in surgical collapse, extreme fatigue from violent exertion, the collapse of typhoid and other infectious fevers, in certain cases of poisoning, and in acute autointoxication.

2. The general excitant effects of heat render service in all cases in which active diaphoresis is called for, as after taking a cold, acute rheumatism, certain forms of chronic rheumatism, some cases of pneumonia and other acute infectious febrile disorders, and as an alternative or spoliative measure in obesity and other diathetic maladies.

3. General applications of heat serve an extremely useful purpose in modifying metabolism. Short applications lessen heat production and oxidation, and encourage heat elimination, while prolonged application s raise the body temperature by preventing heat elimination, and also by communicating heat to the body. The increase of oxidation which accompanies a prolonged hot bath renders applications of this sort of the highest value in cases of obesity, diabetes, and the uric acid diathesis. Cold applications to a marked degree increase the oxidation of carbohydrates, but a general application of heat administered in such a way as to cause a decided elevation of the body temperature is the most effective of all means of securing increased oxidation of proteid wastes, and thus facilitates their removal from the body. This fact alone renders general hot applications of some sort almost indispensable in the treatment of most chronic disorders, including cases of spinal sclerosis, locomotor ataxia, and many other affections accompanied by organic changes, all of which probably have some form of autointoxication, with accumulation of proteid wastes as their real etiological foundation.

4. General hot applications are indicated in all forms of chronic visceral congestion, including chronic bronchial catarrh, chronic

gastritis, intestinal catarrh, so-called chronic inflammation of the pelvic viscera, and chronic cerebral congestion. The skin being capable of holding one-half to two-thirds of all the blood in the body, the filling of this immense vascular area, comprising a surface of more than ten thousand square feet, if we include the capillary network distributed in the walls of the tubules of the sweat glands, relieves visceral congestion by diverting the blood to the surface and accomplishes a therapeutic purpose which cannot be so satisfactorily obtained in any other way. The permanency of the effects thus obtained must be secured by following the hot application by a short cold application, whereby strong reaction effects are produced with the accompanying dilatation of the small arteries, and an increased rythmical activity of the "peripheral heart," as the small vessels of the skin may be properly called.

5. Still another important indication for general hot applications is the preparation of the skin for the cold douche, the shallow bath, wet-sheet rub, wet-sheet pack, or any other hydriatic application, at a temperature below that of the body. This preparation is especially important in feeble patients. It may be advantageously employed in all cases. The application should be of brief duration, ordinarily from three to five minutes, or only sufficiently long to thoroughly heat the skin. The maximum desirable effect is obtained when the skin becomes slightly moistened by perspiration.

6. General hot applications are of service as a means of intensifying the effects of cold hydriatic applications. When employed for this purpose, they hot and the cold applications are made in alternation. A somewhat prolonged hot application of two or three minutes may be followed by a short cold application of five to twenty seconds. Such an application is purely excitant to the circulatory system, and produces

profound revulsive effects. Short applications of equal duration, tend to twenty seconds, the so-called alternate applications, are powerfully excitant. Such applications are generally made by means of the alternating general douche, for which the horizontal jet, the circle or needle douche, may be employed. The vapor douche and a cold-air douche may be thus employed in alternation, or the patient may be exposed in alternation to the heat of the vapor bath, the electric-light bath, or the hot-air bath, and the refrigerant effects of the cold horizontal jet, the shower, or the plunge. Such applications produce exceedingly powerful effects, which may be utilized when it is important to rouse sluggish functions by the most powerful thermic stimulation possible. Applications of this sort may sometimes be resorted to with advantage in cases of obesity, and, in fact, diabetes.ics.

7. Finally, we may refer to the value of hot applications as a means of rendering tolerable cold applications which could not otherwise be borne, as in the simultaneous hot and cold bath, a measure which the writer first introduced into therapeutics. Various combinations may be made, as for example, a hot shower bath combined with a cold douche to the spine, hepatic, gastric, lumbar, or hypogastric region, or the extremeties, as may be desired; or a cold douche may be administered to any part of the body while the patient is enveloped in hot vapor in a Russian bath or warmed by means of the vapor douche. The ideal application of this sort is to combine cold douche and incandescent-light bath. The patient stands in a recess, surmounted round on three sides by incandescent lights, closely placed in front of a reflecting surface, by which the skin is strongly heated, while at the same time a jet of cold water is made to play upon any part of the surface which it is desired to impress in this way.

The purpose of a combination of this sort is to make a strong reflex effect upon an internal viscus while maintaining the highest degree of muscular activity in the general cutaneous surface. By this means we may prevent the general contraction of the surface vessels which very commonly follows the application of cold to a circumscribed area, as well as when the general surface is acted upon.

This principle is put in operation whenever a cold compress is applied to the head, face, or neck of a patient who is receiving a general hot bath, as a vapor, Russian, or Turkish bath. A cold application upon the face and scalp by reflex action maintains contraction of the blood vessels of the brain, and so prevents the occurrence of congestion from cardiac excitation and elevation of the blood temperature. In like manner, very strong thermic impressions may be made upon the stomach, liver, spine, and other internal viscera by the application of an ice-bag or an ice-compress to the cutaneous area reflexly associated with the particular viscus, while the patient at the same time receives a general hot application by means of the Turkish, hot-air, vapor, or Russian, or electric-light baths, or in the absence of any of these, the general hot pack, the hot blanket pack, or the dry pack. An application of this sort give almost magical relief from visceral pain due to congestion, as in ovarian neuralgia, gastritis, or gastric cancer. The dreadful pain following the operation of ovariotomy or hysterectomy, which generally leads the patient to plead most earnestly for an opiate, rarely fails to yield to the application of an ice-bag over the seat of pain, in combination with the hot blanket pack applied to the whole body, to the hips and legs.

General thermic applications are made by means of the Turkish bath, the hot-air bath, the Russian bath, the vapor bath, the incandescent-light

bath, the sand bath, the mud bath, the hot immersion bath, the hot blanket pack, and the dry pack.

Local thermic applications are made by limited applications of the above, and iin addition, the application of heated objects, such as jugs, bottles, or rubber bags filled with water, the cotton poultice, the electrotherm,-a dry compress containing metallic objects affording resistance, through which a current is passed,--or the thermophore,-- a rubber bag containing a chemical solution capable of ~~kaaki~~ giving off heat for a long time during the process of crystalization.

The effect of an application, either general or local, is essentially the same irrespective of the source of heat, the intensity of the effect depending upon the extent, duration, and the time of the application.

The fluxion effects produced by hot applications applied with scientific accuracy, and the relief from pain, and other therapeutic effects which may be thereby secured, are mong the most valuable of all the resources of physiological and rational therepeutics. For efficiency in relieving pain, for example, the hot fomentation or an equivalent hot application certainly stands next to opium and its derivatives, while it is rendered incomparably superior to any drug by the fact that it relieves pain, not by hiding it, but by removing its cause. The accompanying figures (Figs. 5, 6, 7, 8) clearly indicate to the eye how pain of a congested muscle may be relieved by the diversion of blood to the skin, or the pain of a boil by spreading out the blood through dilatation of the vessels of the adjacent skin.

Deep-seated inflammations may be controlled by either generalized or localized applications to the proper cutaneous surfaces. This is well illustrated in pelvic inflammation, for example, by the great relief of pain afforded by the hot hip-and-leg or the hot hip pack, the general

present, and instinct, such is processed by the lower animals in common with man.

hot blanket pack, or the hot immersion bath or any other hot application. This use of heat may be said to be suggested by the natural instinct which leads one to protect any painful part, such as an aching tooth, eye, or ear, by the application of the warm hand in the absence of more suitable protection, and in the drawing up of the legs when abdominal pain is

Deep-seated inflammations and pain due to visceral congestion, ~~and in the drawing up of the legs when abdominal pain is present, an instinct which is possed with the by the lower animals in general man,~~ is generally best relieved by simultaneous applications of heat and cold. The cold application should be intense, but should cover only a small surface, being confined to the area of most acute reflex activity, while the hot application should cover a very large area, so located as to act derivatively. For example, in the case of ovarian inflammation an ice-bag should be applied over the ovary simultaneously with the hot hip and leg pack. After the hot application is renewed, the ice-bag should remain in place, the limbs being kept warm by hot bags and wrappings. By the cold application the vessels of the inflamed part are made to contract reflexly, while the hot application, acting derivatively empties the vessels of the part, thus securing the complete co-operation of two important therapeutic principles at one time and place. This principle is illustrated in the very common employment of the very hot foot bath, in association with a cold compress to the head for the relief of cerebral congestion. The same principle may be extended to the treatment of congestions and inflammations of any deep-seated organ. The modus operandi of this procedure, which the author believes he was the first to suggest, is graphically illustrated in the accompanying diagrams.

Fig. 9 illustrates a combined hydriatic application for relief of a congested kidney. An ice-bag applied over the lower third of the ~~ster~~

sternum causes reflex contraction of the kidney vessels, as shown by Beni-Barde, while an applicatiin of heat made to the lumbar region relieves the congested organ by diverting blood from its arteries and veins into the overlying muscular structures.

In figs. 10 and 11 is graphically illustrated the operation of a simultaneous appliaction for relief of congestion of the pelvic viscera. The ice-bag applied to the hypogastrium and the groins causes contraction of the branches of the internal iliac, which supplied the uterus and ovaries, thus lessenging the blood supplied to those parts, while the hot hip and leg pack by dilating the cutaneous vessels, diverts a large volume of blood into the external branches of the internal iliac and the cutaneous branches of the external iliac.

An interesting combined therapeutic application was suggested a few years ago by Dr. Wilhelm Winternitz. It consists in the application of the heating compress or wet girdle about the trunk, while heat is applied over the stomach by means of the hot water coil. The heat may be applied by means of the hot water bag instead of the hot water coil, if more convenient. This derivative measure acts powerfully upon the visceral circulation, exercising a most remarkable sedative effect upon the stomach in irritable conditions of this organ.

The writer has for many years made use of the hot and cold head compress in which heat is applied to the back of the head or neck and cold applied to the face, or the opposite. The same principle is also spplied in the treatment of the spine, the lungs, the abdominal and pelvic viscera, and other parts of the body.

In conclusion, attention should be called to the fact that hot applications of all sorts, whether local or general, should ~~always~~ most without

exception, be concluded by a cool or cold hydriatic application, so as to restore the tone of the surface vessels and to fix the blood in the skin, thus rendering permanent the temporary benefit derived from the hot application. When the hot application has been prolonged sufficiently to cause an elevation of the body temperature, the temperature of the cooling procedure should be moderate, ordinarily 90°to 75°, and sufficiently prolonged to restore the thermic equilibrium of the body. The time required ordinarily would be one to three minutes. The duration should never be sufficient to produce chilliness, and the application should be made with sufficient vigor to maintain the dilatation of the surface vessels. When applications of heat have been limited to small areas or have been of short duration, the cooling application should be at a lower temperature and of short duration (60°to 45°F., 3-15 seconds).

THE TURKISH BATH.

This very ancient form of bath is a powerful means of influencing the bodily functions, and though likely to be largely superseded by the electric-light bath, must still be recognized as a measure of value and importance. The essential features of the Turkish bath are, - a heated room in which the patient reclines until vigorous perspiration is induced, the shampoo, and a cooling spray or plunge. This bath, or its equivalent, has been used since very ancient times, as shown by the magnificent ruins of ancient baths to be seen at the present day in Rome and Pompeii. The oldest existing Turkish bath was built in the time of Herod the Great, at Jerusalem. While visiting Jerusalem a few years ago, the writer found this ancient establishment still in operation. This is probably the oldest bathing establishment in the world.

A scientifically arranged Turkish bath establishment consists of a series of rooms which provide, besides dressing rooms and a cooling room furnished with couches on which patients may recline after a bath, at least the following separate compartments:-—

1. A room heated to a temperature of 110° to 130°F, the "Tepidarium" of the ancients. 2. A hot room, heated to the temperature of 150° to 200°,--the "Calidarium" of the ancients. In some establishments another small room is provided, in which a temperature of 230° to 300° may sometimes be observed. 3. A convenient adjacent room, furnished with marble slabs, and hot and cold water with other necessary paraphernalia, provides for the shampoo. Close at hand must be found a well-arranged douche apparatus, and in a well equipped establishment there will be also a plunge or swimming bath containing water at a temperature of 60° to 70°. In some European establishments the writer noted the temperature

of the plunge as low as 45°. A temperature of 65° is low enough, to secure all essential therapeutic results, and is safer for the average patient than a lower temperature. Any intensity of effect desired may be attained by increasing the duration of the bath.

The hot room may be heated by steam coils, or by hot air provided by a furnace, or an indirect steam heater. When direct radiation by steam pipes is employed, the air is generally very impure, by reason of the absence of adequate provision for ventilation. When, however, ~~the~~ hot air heating is employed, the ventilation is easily made ample, air change being essential as a means of maintaining the temperature of the room. The foul air outlet must be near the bottom of the room, and must communicate with a ventilating shaft. The opening for the inlet of warm air may be either at the floor or the ceiling; it is perhaps best located at a point about two or three feet above the level of the floor.

TECHNIQUE: The patient disrobes, places a loin cloth about his body, drinks a glass of water, either hot or cold, enters the warm room and lies down upon a couch. Usually, by the end of ~~10~~ ten to ~~15~~ fifteen minutes, and sometimes sooner, the skin becomes slightly moistened, and a little later the subject finds himself in a state of profuse perspiration. In cases in which perspiration does not promptly appear, the activity of the cutaneous glands may be encouraged by superficial massage, or friction of the skin, by an attendant. The native shapooers of Cairo and Constantinople rub the bather with mitts made of coarse fabric somewhat resembling haircloth. A very hot foot-bath or a short, hot spray, or full bath, is also an effective means of encouraging perspiration. In the case of patients who cannot drink freely, a hot anema (110°) administered just before the bath, will aid in inducing prompt sweating. In extreme cases, the patient may be ~~p~~ sponged with hot water.

If he does not perspire either with or without the aid of the measures mentioned, he should not be allowed to remain in the bath for any considerable length of time, as serious injury may possibly result from a long exposure of the body to ~~the~~ intense heat without the protecting influence of evaporation.

After the patient begins to perspire, he may, if he desires, enter the second hot room, to remain but a few minutes, until very vigorous perspiration is induced; or if more moderate cutaneous activity is desired, he may remain in the warm room.

When perspiration has been maintained as long as desirable, the patient is conducted to the shampoo room, where he is first rubbed with the bare hands or with Turkish Mitts from head to foot, beginning with the head, and in such a manner as to remove every particle of the superficial layers of the epidermis which have been loosened by the profuse perspiration.

The movements employed in shampooing are not easily described. The first manipulations are administered with the bare hands, and consist, for the most part, of alternate to-and-fro short friction movements across the chest, and up and down the trunk and the limbs. Small areas are dealt with in succession, and the work must be very thoroughly done. The hands should be frequently dipped in water at a temperature of about 90°. No part should be neglected. The face, ears, and neck should receive first attention; then the chest, abdomen, arms, legs, back (for which the patient turns over), and finally the feet. After the patient has been very thoroughly gone over with the bare hands, he is rubbed in a similar manner with the hands covered by coarse cloth mitts.

Finally the patient is shampooed with good soap, the lather being thoroughly rubbed upon the skin, either by a thoroughly aseptic brush,

or a properly arranged mass of flax, manilla, or other fibrous material. Great care must be taken in the employment of shampoo brushes, to avoid conveying infection of any sort from one patient to another. The only safe precaution, when a common brush is used (a practice which is certainly not to be commended) is to drop the brush for two minutes into boiling water each time it is used, after thoroughly rinsing the soapsuds out of it. There is an advantage in the use of manilla and other fibers, in the fact that the cost of the material is so small that it may be thrown away and a new supply provided for each patient, and at each treatment. The brush, or mass of fiber or horse hair is applied at first to the upper part of the neck and chest, then to the arms, then to the lower parts of the body. The shampooing and rubbing should be continued until the whole surface feels like polished marble. After the shampooing the patient is conducted to the douche. If he is still quite warm, a cold douche may be administered at once. If he has become slightly chilled, he should be thoroughly warmed up by a warm shower or rain douche before the cold application is made. The bath should end with a douche of cold water at a temperature of 60° or less. If the patient is inclined to perspire freely after the bath, a rain douche at a temperature of 80° to 75°F should be given for one to three minutes before the final cold application.

After the douche, which serves the double purpose of removing the soap and counteracting any depressing effects from the prolonged exposure to heat, the patient may enter the plunge or the swimming bath, or may wrap a sheet around him, and lie down upon a couch until the skin becomes perfectly dry, and the pulse returns to its normal rate.

If the patient's skin is very dry, a little refined vaseline should be applied with gentle friction at the close of the bath. If the skin

remains moist from perspiration, give an alcohol rub. (See page —)

Massage, or joint movements, or both measures, may be advantageously employed in many cases, and aid reaction in feeble patients.

See p. 33

It is not usually necessary to apply cold to the head of the patient during the bath, as perspiration of the face and scalp begins early, and this prevents overheating of the head. For persons who are unaccustomed to the bath, the application of a dry towel or napkin over the face and forehead will usually be sufficient. The distension of the surface vessels diverts the blood from the brain, and thus obviates any danger from cerebral congestion. The only exceptions are those cases in which the heart is unduly excited and the brain congested by the elevated temperature of the blood

PHYSIOLOGICAL EFFECTS : The physiological effects of the Turkish bath are essentially the same as those of other general applications. There are, however, certain characteristic differences which may be noted with advantage.

The exposure of the entire body to a superheated atmosphere, and especially the inhalation of dry hot air, excites the pulmonary mucous membrane, as well as the skin. The great extent of this membrane, about 2000 square feet, gives importance to this fact. The great dryness of the air and the excitation of the mucous surface with which it comes in contact, unquestionably facilitate the elimination of those volatile toxins which find exit through the pulmonary mucous membrane (Charrin).

Shortly after the patient enters the bath, the pulse is found ~~to be~~ considerably accelerated, and tension increased. The higher the temperature of the bath, the more rapid the pulse. During this period of increased blood tension, the patient experiences a sense of fullness in the head, some

respiratory distress, and general discomfort. As soon, however, as the skin becomes reddened and moistened with perspiration, the pulse rate diminishes, tension is lowered, respiration becomes easy, and uncomfortable sensation disappears. The breathing is usually thoracic in character.

The sudoriparous glands are ~~partly~~ powerfully stimulated. The amount of secretion may be increased from one and a half ounces per hour to fifteen or twenty times this amount. The writer has often seen patients lose two pounds or more in weight as the result of an hour's sweating in a hot room of a Turkish bath. This rapid loss of water indicates the importance of copious water drinking during the bath, as the hearts action may be lessened in power, and various other functions interfered with as the result of so considerable a reduction of the blood volume.

This large discharge of water from the skin promotes absorption from the alimentary canal. As a result, patients who are taking Turkish baths daily are likely to suffer from constipation, unless this tendency is counteracted by copious water drinking. The actitity of the perspiratory glands excited during the bath continues in a modified degree for some hours after the bath as the result of the improved cutaneous circulation. Hence, water drinking must be practiced after, as well as before and during the bath.

The intense congestion of the skin induced by the Turkish bath withdraws an enormous amount of blood from the liver, spleen, stomach, intestines, brain, and other internal organs. The decongestion of these deep-lying vascular areas is one of the most important results obtained by this procedure, although one which seems to have been heretofore very little appreciated by those who have written upon this subject.

While it is not probable that any considerable amount of heat is communicated to the body from the heated atmosphere of the bath, heat

production is increased to such a degree that a very decided elevation of temperature may generally be noted when the patient remains in the bath for half an hour or more. Experiments with the dog have shown that exposure to an atmosphere of a few degrees above the temperature of the body may increase heat production as much as 350 per cent. At this rate, the heat production during an hour's exposure in the Turkish bath might amount to nearly 400 calories, or nearly one-sixth the daily output of energy, representing three and a half ounces of fat, or twice the quantity of carbohydrate. Heat elimination must be also greatly increased, for the rise in body temperature is proportionately slight.

In the treatment of obese persons, it must be remembered that these patients have a much smaller skin surface in proportion to their weight than have smaller persons, and, hence that heat elimination is greatly hindered. For example, a person weighing three hundred pounds has a skin area of only .2 square inches per pound, while a person weighing 120 pounds has a cooling cutaneous surface of eighteen square inches for each pound of weight, or nearly fifty per cent more. The obese person has a further disadvantage in that the surface vessels are in large part buried in fat so that they do not come near the surface, whereas in a thin person a close approach of the ten thousand square feet of capillary net work to the surface secures a rapid cooling of the blood.

To feeble subjects the Turkish bath should not be administered more than one to three times weekly. The ordinary patient may take a short Turkish bath daily, and when the bath is employed for reduction of weight, it may often be administered twice a day, provided the exposure in the hot room is not more than thirty to forty minutes at each seance.

Therapeutic Applications: Although the Turkish bath is perhaps not

capable of inducing any therapeutic effect which cannot be otherwise secured, and while it is perhaps inferior to the light bath as a thermo-therapeutic measure, it is neverthless capable of producing excellent therapeutic effects in almost every form of chronic disease. It must not be supposed, however, that its chief advantages are the result of the profuse perspiration induced. As shown by Bouchard, the amount of toxic matter removed by sweating is very small. The elimination of water by the skin seems to serve chiefly as a means of regulation of the body temperature. Nevertheless, profuse perspiration is a most efficient alterative measure. General vital activity is accelerated by the large movement of fluid from the interior toward the periphery. Perspiration hence becomes an important means of promoting tissue activity in all chronic disorders accompanied by the condition which Bouchard has termed "Ralentissment de Nutrition", a state in which all the vital processes are slowed, resulting in a general deterioration of the organism through impaired tissue formation and accummulation of waste. The Turkish bath may thus render valuable service in the treatment of obesity, fat diabetics, the chronic autointoxication so commonly present in chronic dyspeptics. The uric acid diathesis, in all its forms, many cases of neurasthenia, hypocondria, and melancholia. Most forms of chronic nervous disease, even cases of locomotor ataxia, chronic myelitis, paresis, paralysis, neuritis, and other equally obstinate maladies are materially helped by the judicious use of the Turkish bath, even though a radical cure may be, in the majority of cases, impossible.

As a hygienic measure, the Turkish bath has long justly held a high place in the confidence of the laity, as well as of the profession. Simply the thorough skin cleanliness which it secures is an advantage of

of no small consideration, yet its highest value is due to the fact that the combined hot and cold procedures which it involves in the highest degree, promote vital activity, and the building up of the bodily resistance ~~of~~ to the causes of disease, thus counteracting to some degree the evil consequences of the artificial conditions imposed by civilized life, and affording a considerable degree of protection against the various infectious agents and other ~~agents~~ dangers to which most civilized human beings are exposed.

In all forms of anemia and chlorosis, the Turkish bath is an admirable measure, promoting blood formation and relieving visceral congestion. Care must be taken, however, to avoid extreme temperatures and prolonged exposure in these cases, on account of the degeneration of the blood vessels, which is sometimes ~~is~~ present in these affections, as pointed out by Bouchard.

The Turkish bath affords an opportunity to secure the most pronounced effect possible upon the circulation of any internal viscus which it may be desired to influence. For example, in cases of chronic gastritis or chronic intestinal catarrh, chronic spinal congestion, cerebral hyperemia, or renal congestion, the general effect of the bath in relieving visceral congestion may be intensified by a suitably placed cold application, consisting of an ice-bag, a cold compress, or a cooling coil. In cerebral congestion, an ice-bag may be applied to the head, or an ice collar may be fitted about the neck. A towel wrung out of ice water may be applied to the face and ears. In renal congestion, an ice-bag may be applied over the lower third of the sternum. In uterine and ovarian congestion, or the so-called chronic inflammation of these organs, an ice-bag may be applied to the groins and the hypogastrium. In chronic inflammation of

the stomach or intestines, or congestion of the spleen, liver, or spine, a cold application should be made over the parts indicated. The application of cold in the manner suggested, especially to the head, renders a higher temperature tolerable, and may permit of a longer dutation of the bath.

Contraindications and Precautions: The Turkish bath is contraindicated in cases of cardiac dilatation, tachycardia, arterial sclerosis, organic affections of the heart in which there is evidence of definient or failing compensation, apoplectic subjects, irritable skin affections, and all febrile disorders. The bath must be used with great care in all forms of nephritis, and is contraindicated in advanced stages of renal disorder, also in exophthalmic goiter.

The pulse should be carefully watched, especially during the first seances, and the first few moments after the patient enters the bath. Undue cardiac excitation may generally be relieved by the application of an ice-bag over the heart. If the effect desired is not readily secured, the patient should be removed from the bath, and the incandescent electric-light bath, or some other heating procedure adopted.

THE HOT AIR BATH. This bath resembles the Turkish bath, the essential difference being, that the head is excluded from contact with the heated air, so that the patient is able to breathe air at the ordinary temperature, while the entire body, with the exception of the head, is exposed to dry super-heated air.

Technique: The hot-air cabinet may be a permanent structure of wood, zinc-lined, or it may consist of a portable cabinet of rubber cloth, or other impervious material. In the absence of a especially constructed cabinet, a substitute can easily be improvised by placing the patient in

a chair, and covering him with a rubber blanket or with ordinary blankets, between the folds of which newspapers have been placed.

Various sources of heat may be employed, as a small kerosene stove, or a large kerosene lamp or alcohol lamp, a small gas stove, or even heated stones or bricks. For a permanent arrangement, a steam coil is most convenient.

Fig. 1. shows a convenient arrangement for a hot air bath. When the patient is not able to sit erect, the bath may be administered in bed, either by means of a special device or by an arrangement which may be easily improvised. It is only necessary to provide a space about the patient by means of a proper framework, covered, first with rubber cloth, then with ordinary blankets. Heat is supplied by means of a tin pipe, which can be made by any tinner at a small expense, so arranged that one end can be slipped over the top of an ordinary lamp chimney, while the other enters the enclosed space about the patient.

Before entering the bath, the patient should take a glass of water, either hot or cold as he prefers. Perspiration may be promoted by repeated water drinking during the bath.

The temperature may vary from 150°F to 250°F. A still higher temperature may be borne, if the air is perfectly dry, but offers no advantages.

The duration of the bath may be six minutes to an hour, according to the effect desired. When administered to feeble persons, and when the purpose of the bath is simply to heat the skin in preparation for a cold application, the duration should be brief, not more than six to twelve minutes. When prolonged sweating is desired for eliminative effects, the duration may be twenty to sixty minutes. Ordinarily, however, the bath need not be

employed for more than ~~30~~ thirty to ~~40~~ forty minutes to secure ~~the~~ the maximum beneficial effects.

Before the patient enters the bath, the head or the face and neck, and in the case of men, the scalp also, should be well cooled by bathing in water at 60°F. Towels should be applied ~~over~~ about the neck in treating ladies, and to the head and face of men.

After the bath a cooling procedure of some sort should be employed. The rain douche, horizontal douche, wet sheet rub, shallow bath, and pail douche are the most generally useful measures. In feeble cases, the cold towel rub and the cold mitten friction are preferable, and should be employed at the beginning of a course of treatment. Later when the patient has, by proper hydriatic training, acquired greater ability to react, more vigorous measures may be applied. In certain cases, cooling of the skin is not desirable. This is especially the case with chronic rheumatics when suffering from acute exacerbation, with more or less elevation of temperature, and much pain and tenderness in the joints. In such cases, the patient, on removal from the bath cabinet, should be quickly wrapped with warm blankets. If it is desirable to continue the perspiration, the patient is warmly covered, and made to drink freely. If, however, prolonged perspiration is not desirable, the patient is more lightly covered, and the face is from time to time bathed with a little cool or tepid water until perspiration has ceased spontaneously and the usual pulse rate reestablished. The wrappings are then carefully removed, uncovering small areas at a time, as an arm, the chest, or a leg, and an alcohol rub (See page____) is administered.

Therapeutic Applications: The therapeutic applications of the hot-air bath and the contraindications therefor are essentially the same as those of the Turkish bath (See page____). It should be mentioned,

however, that the hot-air bath may be employed in cases in which the Turkish bath is inadmissible, on account of the embarrassment experienced by the patient in the inhalation of hot, dry air. In the writer's opinion, all the therapeutic advantages of the Turkish bath may be obtained by the proper employment of the hot air bath, full head

THE LOCAL HOT AIR BATH.) Hot air may be applied to any circumscribed portion of the body, either by means of a current of super-heated air, directed upon the part, or by enclosing the part in a chamber, the air of which is super-heated. The hot-air douche was employed by the writer some eighteen years, but was not found to possess advantages over the simpler methods of making local applications of heat. Recently, various excellent devices have been offered for local applications of hot air, especially to the joints. There are none, however, which are greatly superior to a very simple device which can be easily constructed by any tinner. It consists simply of a tin box, so arranged that it may be easily opened while the limb is being placed in position. The limb must be protected from contact with the metal portions of the box. This is easily accomplished by making the end pieces of wood. In use, the box is so placed that a large kerosene lamp may be placed beneath it with just sufficient space between the chimney and the bottom of the box to secure a clear flame. In a short time, the air within the box will become sufficiently heated to secure the effect desired. With dry air, a temperature of 300° to 400°F may be tolerated. The effect of this application is to produce powerful revulsion or dilatation of the surface vessels. It is possible that certain trophic effects may also be induced by the impression made upon the thermic nerves.

At the conclusion of the application, the parts should be quickly rubbed with the hands dipped in cold water, or, if the parts are painful, a

towel wrung quite dry from cold water may be applied for ~~10~~ ten fifteen or ~~15~~ seconds. The parts are then quickly and carefully dried, or bathed with alcohol and covered, first with dry cotton, then with a mackintosh, and finally with flannel, so that the effect obtained by the application may be continued. In cases in which an active inflammation is present, as indicated by elevation of temperature and pain, the heating compress should be applied instead of ~~a~~ the cotton poultice. This consists of a single thickness of linen cloth, or three or four folds of cheese-cloth, wrung quite dry out of water at 60°F, smoothly wrapped about the part, and covered with flannel and mackintosh. The compress should warm up at once. If it remains cold, injury will result. Great care should be taken to extend the mackintosh sufficiently above and below the flannel wrappings to leave no openings through which air can enter, or evaporation take place.

Star, page 40:

The Tallerman-Sheffield Local Hot Air Bath consists of a cylinder of copper, of shape and size adapted to the part to be enclosed. One end of this cylinder is closed by a cap connected with the cylinder in such a way that it may cover the opening completely or partially. The limb to be treated is introduced at the other end, air being excluded by means of a rubber sleeve, one end of which is attached to the cylinder, the other being gathered closely to the limb. Several openings on the upper side of the cylinder provide for ventilation in connection with the adjustable cap, thus avoiding the accumulation of moisture. The cylinder is heated by gas burners placed beneath. The temperature is determined by one end of which enters the cylinder at the upper side.

The apparatus of Lentz is an improvement upon that of Tallerman-Sheffield. It consists of a copper cylinder of similar construction, to the bottom of which is attached a fire box of Russian iron in which is placed a Bunsen burner, consisting of two tubes each of which there is a row of small flames similar to those employed in heating ordinary gas ovens. The cylinder is lined with sheet asbestos, the lower third of the lining being separated from the cylinder a distance of one- and one-half inches, supported by iron bars running the whole length of the cylinder. On the cradle of this frame rests a thick piece of magnesium an excellent non-conducting material. This forms a safe and suitable bed upon which the limb may rest without danger of burning. The remaining arrangements are practically the same as those in the Tallerman-Sheffield apparatus.

The temperature employed in the Tallerman-Sheffield apparatus is 240 to 260°. The Lentz apparatus produces a higher temperature, ranging from 300 to 350° in ten to fifteen minutes after the limb is introduced. temperaturemay be controlled by the cap or door at the closed end of

the apparatus. On opening this, the temperature very quickly falls. By regulating the size of the opening, the amount of air passing through the apparatus may be regulated and thus the temperature adapted to any individual case.

The duration of the treatment may be from twenty to forty minutes, or even longer. The effect of the apparatus is to produce the most powerful diaphoresis and intense cutaneous congestion. If the application is continued for some time, general diaphoresis is also produced. This effect renders necessary some general cooling procedure at the conclusion of the application as well as the local cooling which has before been referred to. It should be remembered that it produces relaxation and lowered tone of the vessels and tissues and parts brought under its influence. A short local cold application is necessary to produce a tonic reaction by which the blood is fixed in the skin and the activity and tone of the surface vessels increased. This will prevent subsequent injury by slow cooling by evaporation. A general cooling application is necessary for the same purpose. If this is neglected, the patient is liable to be chilled by the evaporation of moisture from the skin and all the possible good effects of the application will thereby be neutralized and the disease may possibly be aggravated. Local and general thermic and hydriatic applications are often brought into discredit by a neglect to employ the proper means to prevent these untoward effects of hot applications. The best general applications ~~xxx xxx~~ for most cases are, the cold mitten friction, the cold towel rub, and the alcohol rub. The latter is especially indicated in feeble persons and those whose joints are much affected and are the seat of much pain and tenderness.

In order that the patient may readily receive this general treatment and prevent moistening of the clothing, all the clothing should be

removed, including the underclothing, in preparation for the local treatment, although the part to be treated may be only a single joint, as the wrist, elbow, or ankle. This precaution involves some little trouble and inconvenience, but its observance is necessary to secure uniformly satisfactory results. Great care must be taken to avoid burning the patient, not only because of immediate ill effects, but because burns are very slow to heal in chronic rheumatics and thus necessarily interrupt treatment for a considerable length of time.

The flame should always be lighted for a few minutes before the limb is introduced so that the instrument may be warmed and also to avoid the possibility of injury to the patient from explosion of gas if too large an amount should escape before the application of the match in lighting. If for any reason the flame should go out during the application, the limb should be removed while the burner is being relighted.

This procedure has proven of most extraordinary service in cases of sub-acute and chronic ~~xxhxxxxxsx~~ articular rheumatism, gout, traumatic arthritis, synovitis, teno-synovitis, fibrous ankylosis, rheumatoid arthritis, chronic ulcer of the leg, joint tuberculosis, and sprain. Decided benefit has also been derived in cases of acute gout and rheumatism, although the method is less readily applicable in these cases because of the great pain involved in moving the limb. Local hot air baths have been found especially beneficial in removing the stiffness, swelling, and pain left behind as a result of gonorrheal and other infectious forms of rheumatism. Experience has s own that the benefit derived from these applications are in part due to the general heating effect of the application as well as the heating of the affected parts. This is demonstrated by the fact that when applications have been confined to a single joint in cases where a number of joints have been affected, all the joints have been effected and the general benefit was evidently the result of the general heating effects whereby increased oxidation of uric acid and allied waste elements is secured as in the general hot air and vapor baths.

(Star for Proof 14 W:

The safer method for those whose powers of reaction are not strong, and which most patients find most agreeable, is to wrap the patient in a Turkish sheet as he emerges from the water, putting him to bed with the sheets brought closely in contact with every part of his body, and well covered with woolen blankets. This prevents any possibility of chilling by slow evaporation.

J. H. K.)

(Star, 15 W: As many persons have conscientious scruples against the use of alcohol, it is well to bear in mind that the tendency to chill may be effectively combated by a glass full of hot ~~water~~ lemonade, or even hot water, and especially by a short preliminary hot bath or vigorous friction of the surface just before the patient enters the cold bath. J. H. K.)

(Double star, 15 W: In this country and in England the full bath is administered in an ordinary full bath tub. The patient cools the head thoroughly before entering the bath, then steps into the bath quickly and lies down in it until the body is submerged to the neck, rubbing the chest and sides with vigor while lying, and rising to rub the hips and legs at the end of ten or fifteen ~~xxxxxxx~~ seconds. When it is desired that the bath should be prolonged, these processes are repeated once, twice, or more times if desired. The patient may assist in the rubbing.

J. H. K.)

Star, page 16:

It should be remembered, however, that in cases of tubercular disease, the cold full bath should never be administered until after the petient has had long and careful training by means of less severe procedures such as the cold hand rub, cold towel rub, wet sheet rub, and the shallow or half bath. This bath is indicated in diabetes only in cases where the patients are vigorous and fleshy, showing no indication of renal disease.

(Corrections for
Int. Syst. Therapeutics.)

(Star Page 89.)

Since the above was written an excellent apparatus for the application of high tension currents for therapeutic purposes has been perfected by Graeff and has been extensively used by Apostoli and others in the treatment of various chronic affections and with promising results. The physiological effects pointed out by d'Arsonval have been confirmed by various other observers, and it has been clearly shown that this form of electrical current whilepossessing very slight sensory effects is capable of very powerfully influencing nutrition in a variety of ways. Its most marked effect is to increase metabolic change, as shown by the decided increase of CO_2 elimination. The therapeutics of high tension currents is as yet in its infancy, but it is the writer's opinion that the future will prove this form of electrical stimulation to be an exceedingly valuable therapeutic agent.

A NEW RATIONALE OF THE THERAPEUTIC EFFECTS OF PERCUTIENT ELECTRICAL APPLICATIONS UPON VISCERAL OR OTHER DEEPLY SEATED STRUCTURES.

--- oOo ----

The therapeutic application of electric currents to nerves and muscles unquestionably rests upon a sound scientific foundation laid by the physiological experiments of Duchenne, DuBois-Raymond, Erb, and numerous other scientific investigators. But this statement can scarcely be made with the same assurance in relation to percutient applications of electricity made for the purpose of relieving pain and various other morbid conditions in the viscera and various other deeply seated structures. For example, it is known empirically that gastric, ovarian, uterine and various other internal congestions may be relieved by percutaneous electrical applications. But how is this relief obtained? The writer believes the answer is to be found in a study of the effects of irritants of various sorts. Pflüger showed long ago that the so-called electrotonic state produced by applications of electricity to the skin obeys the same laws as the excitation produced by other forms of irritation. For exampl there is produced in the vininity of the anode, at first a diminution of sensibility, which is followed by aslight exaggeration of sensibility, after the anode is removed, then by a return to the normal state. Intense applications of cold produce similar effects, as do other irritants. Naumann, 1867, Röhrig, 1873, Wintermitz, and other investigators, have shown that irritants of various sorts both reflex and mechanical, including friction, follow essentially the same law. The effects of the application of friction, for example, may be briefly suggested as follows:

Light centripétal friction applied to the surface accelerates the circulation, causing rise of blood pressure, increases the force and frequency of the pulse, and lessens the frequency of respiration.

Very light friction continued for some time gives rise to contraction of the small bloodvessels, which may persist for several hours. There is also a slight rise of temperature, due to a small increase of heat production and a slight diminution of heat elimination.

Energetic friction causes first very marked contraction of the blood vessels, which is quickly followed by dilatation of the vessels, arteries, veins, capillaries and lymphatics, with great acceleration of the blood current.

The increase of heat elimination reduces the temperature several tenths of a degree.

Very vigorous friction, or violent irritation of the skin, produces almost instant and very marked dilatation of the cutaneous vessels, the preliminary period of contraction being so brief as to be practically imperceptible.

The heart's action is slowed, as is also the respiration.

Heat elimination is increased nearly fifty per cent, (Wintermitz, Pospischil) and the temperature may fall as much as 1^{o} or 2^{o} F., (Mantegazza).

Examination of the products of respiration show marked increase of CO_2 (Pflüger), which would indicate increased heat production, notwithstanding the lowered temperature, showing that the increase of heat elimination is much greater in proportion than that of heat production.

There is, also, according to Pflüger, a marked increase in the production of urea, showing that there is a general increase of catabolism, since both nitrogenous and carbonaceous wastes are augmented.

Very violent friction or irritation produces marked weakness of the heart, dyspnoea, and in rabbits, albumin in the urine (Walkenstein), in which again we see an effect identical with that which follows an ex-

cessively severe cold applications. All the functions of the skin are stimulated by friction.

Any one who is at all familiar with hydriatic applications must have observed the remarkable similarity between its method of effecting results and that of electricity. The most important results of each are attained through their influence upon the nervous system, as the ther a- peutic effects of water, as well as those of electricity, are based upon its physiological effects.

The researches ofSchuller, Vinaj, Winternitz, and others, have shown that prolonged moderately cold applications to the surface produce prolonged contraction and congestion of internal vascular areas reflexly connected with the cutaneous areas acted upon. Local cold ap lications in this respect differ from general cold applications, which cause dilatation of the visceral and cerebral vessels by mechanical displacement of the blood resulting from the contraction of the surface vessels.

Warm applications, that is, a temperature of 92 to 98°, on the other hand, cause immediate contraction of the vessels of the interior of the body corresponding with dilatation of the cutaneous vessels.

Every portion of the cutaneous surface is reflexly associated with some internal area, the conditions of which may be controlled by the application to the associated cutaneous area of thermic or other agents capable of producing vascular changes; for example, any agent which causes contraction of the cutaneous vessels will cause a corresponding contraction of the~~xcorrespondingxvisxsarx~~ associated visceral vascular area, this being also true respecting vaso-dilatation.

From clinical observations which I have made and from the study of practic~~xhydrxthx~~ electrotherapy in connection with hydriatry, or rational hydrotherapy, I am fully convinced that many of the effects of percutaneous applications of electricity are produced by the same means that many

hydriatic effects are obtained; viz., through sensory impulses propagated from the skin to the spinal cord through the sensory nerves and sent out from the spine as motor influences, carried along through the nonmedulated vaso-constricting fibers of the sympathetic and the medulated inhibitory fibers which pass directly from the vasomotor centers of the cord to their distribution in the vessels. In other words, I believe that the condition of established in the skin under the influence of electrical stimulation is propagated through the reflex arc and referred to the associated internal vascular area. It seems to me that this view alone affords a rational explanation of the influence of percutaneous applications of galvanism upon internal congestions. We know that uterine congestion may be relieved by electrical applications of various sorts. A galvanic current of twenty to forty milliamperes, applied, the cathodal electrode over the epigastric region, the anode over the lumbar region, produces decided effects in relieving uterine and ovarian congestion. Yet the location of these organs is such as to bring them practically at the neutral point between the two poles, and hence outside the sphere of influence of either the cathode or the anode. It is true, that by increasing the strength of the current that the neutral point may be moved nearer to the anode, while decreasing the current moves the neutral point nearer the cathode, thus bringing in either case a larger area under the influence of the opposite pole, and knowing this fact and taking advantage of it, we may bring under the influence of either pole desired, structures not too far removed from the surface. But in the case of organs located approximately in the center of the body or far beneath the surface, as in the case of the uterus, the ovaries, the abdominal viscera in general, and the spinal cord, it is evident that we are powerless to produce in them an electro-tonic condition of any considerable degree of intensity. In the case of the pelvic organs, likewise in the case of the stomach, we are able to produce either an anelectrotonus or catelectrotonus, as

we may desire, by means of suitable electrodes; but in the case of the spinal cord, the sympathetic ganglia, most of the abdominal viscera, ad and indeed we may say nearly all the deeply seated structures of the body, we are unable to produce electrotonic states, for the reason that the action of the electrical currents when applied to the body is chiefly always confined to the immediate vicinity of the electrodes. As the current leaves the electrode, it spreads out, utilizing the whole body as a conductor, instead of passing directly from one electrode to the other, as might be supposed by one not familiar with the laws of electro-physics.

These and other considerations have fully persuaded me that in explaining the effects of percutaneous applications of electricity, we must keep in mind the interesting anatomical and physiological relationships which form the basis of a large share of the applications of water in rational hydrotherapy.

The researches of Brown-Sequard, Charcot, Wintermitz, Beni-Barde Fleury, and other hydriatrists have established a distinct reflex relation-ship between the following-named external and internal regions respectively-

Scalp and skin covering the neck, upper part of back, and face, with the brain.

The precordial region, with the heart.

The skin covering the chest, with the lungs.

The middle dorsal region and epigastric region, with the stomach.

The lower third of the sternum and lumbar region, with the kid-neys.

Skin overlying the liver and spleen, with these organs.

The umbilical region, with the intestines and sympathetic ganglia.

The epigastric, the lower lumbar and sacral region, the inner

surface of the thighs, and the feet, with the uterus and ovaries.

In general, the skin overlying an internal organ is reflexly associated with it. This is the reason why percutaneous applications of electricity made over an organ usually influence it, and not altogether because the electrical current is passed through the organ.

For nearly twenty years I have made use of this principle in the application of electricity, especially in the treatment of genito-urinary diseases, and have seen excellent results from the application. For example in applications intended to influence the genital glands and associated organs,-- the uterus, ovaries, and tubes in women, the testicles and prostate in men,--I have found it distinctly advantageous to make application to the inner surfaces of the thighs and perineum as well as to the epigastric and lumbar regions. I was first led to do this because of the anatomical relations of the nerve supply of these regions, before the reflex relationship between cutaneous and visceral vascular areas was so thoroughly understood as at present. I have also for many years utilized anodic applications of the galvanic current to the face as a means of relieving coryza, and have often seen the patient relieved of headache, presumably congestive in character, by applications of this current.

Granting the truth of the above statements respecting the mode of action of percutaneous applications of electricity upon visceral circles, it needs no length argument to show the great advantage of combining electrical and hydriatric applications in a great variety of morbid conditions.

According to my personal experience, two general rules may be established for applications of this sort:--

1. Increased movement of blood and accelerated functional activity of an internal organ, may be induced by a short vigorous cold appli-

ation in combination with a cathodic application of the galvanic current. his electrical application may be either simultaneous or may immediately ollow the cold application. Bipolar, faradic, or sinusoidal currents ay also be applied with advantage, but the effect is less distinct han that of the galvanic current. The electrical application should e as strong as the patient can bear without pain, and should be given ith large electrodes.

2. The movement of the blood, congestion, and undue functional ctivity of an internal organ, may be diminished by a prolonged moderately ol application, (60-70° from thirty minutes to several hours,) combined anodic
ith the simultaneous application of the galvanic current of moderate trength.

By the application of these principles results which appear really marvelous to one not familiar with applications of this sort may be obtained in cases of congestion of the brain, lungs, liver uterus ovaries, likewise in atonic conditions of the stomach bowels, in amenorrhoea and hypopepsia.

In applications for the relief of pain, in which electricity so often renders most valuable service, the association of heat is an exceedingly valuable measure. When the pain is neuralgic in character, a strong application of the sinusoidal or faradic current, combined with the fomentation at a temprature high enough to produce slight pain when first applied, continued for fifteen or twenty minutes, gives very positive and gratifying results. The current should be as strong as the patient will bear. When the pain is due to congestion or inflammation, an anodic application of the galvanic current should be employed instead of an induction current. The application should be prolonged and not so strong as to produce decided sensation.

Anodic galvanic applications may likewise be associated with col as an analgesic measure.

In cases of cardiac insufficiency in which the application of electricity may y be thought a useful measure, advantage may be obtained by the application two or three times daily of a cold compress for forty to sixty minutes over the anterior surface of the chest. Slowing of the pulse and an increase in arterial tension as indicated by sphygmographic tracing will indicate at once the therapeutic power of this simple application.

Cases of atony of the bladder and inactivity of the bowels, due to dilatation of the colon, the cold douche to the feet and over the lumbar, umbilical, and hypogastric regions, in combination with faradic and sinusoidal applications to the rectum and abdominal wall, achieved prompt success in many most obstinate cases which have failed to yield to other measures. Cold douches applied to the parts named may also be used to advantage in combination with the galvanic current applied simultaneously with the abdominal and lumbar. The strength of the current should be 60 to 80 milliamperes, the application being made by means of a smoothly fitting electrode.

In cases of apepsia and hypopepsia in which hydrochloric acid is absent or greatly deficient in quantity, most excellent results may be obtained by the application of the cathodic galvanic or the sinusoidal currents applied to the epigastrium in combination with the ice bag for half an hour before each meal.

Painful congestion is relieved by very hot fomentations applied for half an hour after a meal in combination with the faradic or sinusoidal current of moderate strength.

Very short, very hot applications over the liver (130 to 140° for five to eight minutes), combined with prolonged anodic galvanic applications,

act powerfully in relieving hepatic congestion.

A very hot fomentation over the lumbar region, combined with anodic galvanic application to the same parts and to the lower third of the sternum, is indicated in renal congestion.

The haemostatic effects obtainable by hydriatric applications in combination with the galvanic current I have found of invaluable service in hemorrhage due to ovarian congestion, intra-uterine vegetations, and intra-uterine and sub-mucous and intestinal fibroids of the uterus. In cases in which persistent hemorrhage follows the employment of electrolysis the cold pelvic pack and the hot vaginal douche in many cases render continuation of the treatment possible when otherwise its interruption would be necessary.

In amenorrhoea the effects of cathodic, and anodic or sinusoidal applications to the uterus are greatly increased by short cold applications to the lumbar regions, the inner surface of the thighs, and the feet.

In applications of electricity to paralyzed and paretic muscles the effects of the electrical application may be greatly increased by the previous application of cold water in the form of the ordinary cold douche, the percussion douche, the Scotch douche, or cold friction, or by the heating compress. The marked increase of muscular irritability produced by hydriatric applications of this sort increases the susceptibility of muscles to the influence of the electrical current, whether the galvanic, faradic, or sinusoidal current be employed.

For the relief of pain in neuralgic joints, hot applications accompanied or followed by the sinusoidal or the galvanic current are a most useful measure in cases in which joints are not painful or stiffened or thickened by inflammatory products. The alternate hot and cold douche

and other exciting hydriatic measures may with much advantage be employed in connection with cataphoresis. I have found this combination exceedingly useful in treating many cases of this sort.

In chronic congestion of the pelvic and abdominal viscera, the good effects obtained from local electrical applications, either internal or percutaneous, may be continued or intensified by the use of the heating compress, consisting of a towel wrung dry out of very cold water, placed over the parts and covered with several thicknesses of flannel sufficient to maintain the heat produced by reaction, but without excessive accumulation of heat.

Faradic, sinudoidal, and cathodic galvanic applications may be employed in connection with the revulsive douche and other revulsive applic tions in all cases in which pain is not a marked feature, but in which the purpose is to produce strong circulatory reaction. When pain is present, the faradic or sinusoidal current should not be employed, and the anode of the galvanic current should be employed instead of the cathode.

The form of revulsive applications referred to consists of a prolonged hot application followed by an exceedingly short cold application. The respective kimmsxof times of the application may be: Hot, five to fifteen minutes; cold fifteen to thirty seconds. If compresses are employed, three to five minutes for the hot douche, followed by a cold douche of four to ten seconds.

For general hypnotic effects applicable to nearly all cases of insomnia, a neutral bath, that is a bath at a temperature of 92-96° for thirty to forty minutes, or a douche with little pressure at the same temperature, with a duration of one to five minutes, almost invariably succeeds in securing sound sleep without the use of hypnotic druys of any

ort, especially when combined with the static insulation and breeze to he head and spine, or a galvanic application to the inferior cervical sympathetic and solar plexuses, the anode being placed at the neck. This application rarely fails to secure sleep, provided proper attention is given to the diet and other matters of hygiene.

The neutral full bath combined with the galvanic, faradic or sinusoidal current, is perhaps the most powerful of all hypnotic measures. I have employed this bath with success for nearly twenty-five years, and it has rendered valuable service, not only in relieving insomnia, but in helping patients through the trying hours which immediately follow the withdrawal of opium, cocaine and other drugs, in the treatment of various forms of drug addiction.

The faradic, sinusoidal and static of high frequency currents, are all of a tonic character, stimulating metabolism, arousing the nerve centers, and directly exciting the brain and all portions of the central nervous system.

Short applications of cold water, especially when accompanied by strong mechanical effects, as in the cold douche, are the most powerful of all known tonics. By combination of the cold douche withthe faradic and sinusoidal electrical currents, the tonic effects of each measure are intensified. The electrical application should bemade immediately after the douche or soon after the douche, when reaction is well established.

The most powerful of all tonic applications of water is the percussion douche. Applyito the spine especially, this powerful hydriatic procedure awakens the whole nervous system in a most remarkable manner, and prepares it to receive the greatest possible benefit from applications of electricity which may follow, such as general faradization, general applications of the sinusoidal current, the

615.84

Hermotherapy Stars.

Star, page 16:

It should be remembered, however, that in cases of tubercular disease, the cold full bath should never be administered until after the patient has had long and careful training by means of less severe procedures such as the cold hand rub, cold towel rub, wet sheet rub, and the shallow or half bath. This bath is indicated in diabetes only in cases where the patients are vigorous and fleshy, showing no indication of renal disease.

(Double Star, 15 W: In this country and in England the full bath is administered in an ordinary full bath tub. The patient cools the head thoroughly before entering the bath, then steps into the bath quickly and lies down in it until the body is submerged to the neck, rubbing the chest and sides with vigor while lying, and rising to rub the hips and legs at the end of ten or fifteen seconds. When it is desired that the bath should be prolonged, these processes are repeated once, twice, or more times if desired. The patient may assist in the rubbing.

J. H. K.)

(Star, 15 W: As many persons have conscientious scruples against the use of alcohol, it is well to bear in mind that the tendency to chill may be effectively combated by a glass full of hot lemonade, or even hot water, and especially by a short preliminary hot bath or vigorous friction of the surface just before the patient enters the cold bath. J. H. K.)

(Star for Proof 14 W:

The safer method for those whose powers of reaction are not strong, and which most patients find most agreeable, is to wrap the patient in a Turkish sheet as he emerges from the water, putting him to bed with the sheets brought closely in contact with every part of his body, and well covered with woolen blankets. This prevents any possibility of chilling by slow evaporation.

J. H. K.)

Star, page 3, manuscript.

A very complete statement of the physiologic effects of thermic applications upon the various bodily organs and functions has been given elsewhere in this volume, by Winternitz (See pages ------) in a discoussion of Hydrotherapy. As the principles of Thermotherapy rest upon the same foundation, it will benecessary to discuss here only such points an relate specifically to Thermotherapy, and especially those which require somewhat fuller elucidation.

Star, page 8:

Local applications of heat, either m@ist or dry, produce a very marked increase in the number of leukocytes, although reducing in number the red cells.

Star, page 6:

The small vessels termed by some writers the "skin heart" but to which I have applied the name of the "peripheral heart" for the reason that the small vessels of the muscles and various internal organs are influenced as well as those of the skin.

4. The tension of the tissues, as well as the vascular tension, is diminished by heat as the result of the mechanical influence of heat upon the connective tissue and muscular elements which form the framework of the tissues, as well as upon the involuntary muscular tissues which are found in the skin and in most of the viscera.

Star, page 12:

----- by increasing the blood supply of the affected parts as well as by greatly increasing the preparation of leukocytes, as shown by Winternitz.

Star, page 38:

Greatest care must be taken to avoid burning the patient. Cases have been reported in which patients have lost their lives by carelessness in this regard. When an alcohol lamp is used as the source of heat, it should be placed in a vessel of water. The lamp should be lighted before the patient enters the bath. If the flame goes out, the patient should be removed from the bath before it is relighted. The same precaution should be taken if gasoline or kerosene is used as the means of heating.

Double Star, page 38:

I" preparation for the bath, the patient should remove all his clothing in a warm room, should be wrapped in a Turkish sheet or woolen blanket while passing from the dressing room to the bath cabinet. The patient should drink a glass of water, either hot or cold as preferred, or lemonade, before entering the bath. It is also important that before the patient enters -----

static charge, etc.

It requires but a cursory review of these physiological effects to note the remarkable parallelism between the effects of hydriatic applications and the effects produced by electricity. With equal readiness it may be seen how by the simultaneous or successive use of electricity and water, if applied with scientific precision, these two potent agents may be able to render mutual aid in a great variety of conditions.

Special note may be made of the following points in which such a useful association is suggested: Water moistens the skin, and thus increases conductivity. Hot applications cause immediate dilatation of the bloodvessels, increasing the vascularity of the skin, and thus also increasing its electrical conductivity, while cold water causes at first a contraction of the small vessels, lessening the blood supply of the skin, diminishing its conductivity for both heat and electricity. In the reaction which follows, however, the amount of blood in the skin is greatly increased, thereby lessening its resistance. Both very cold and very hot applications to the skin diminish nerve sensibility, and thereby increase the tolerance to the electrical current. Anaemia of the skin, on the other hand, increases sensibility, while saturation of the skin with moisture diminishes irritability and nerve sensibility.

Steiner showed that temperatures below 59° and above 77° lessened the velocity with which nerve impulses are conducted, while Hermann has shown that the application of cold diminishes notably the phenomena of electrotonus. Heat, being primarily excitant, produces effects analogous to the cathode, while cold, being primarily sedative, produces effects anodic in character. Neutral applications are likewise sedative, thus resembling the anode in their effect. Short cold applications, because of the reactionary excitation produced, occasion effects resembling the cathode's influence of the galvanic current or the excitation of the

aradic, while the atonic reaction which follows a prolonged hot application esults in sedative effects similar to those of the anode.

I might enlarge at considerable length upon the subject I have ntroduced, but have, I think, described a sufficient number of applications to illustrate the principles which it was my purpose and object to et forth.

I have had constructed electrodes of various shapes by means of which it is possible to combine conveniently thermic applications with electrical applications. In general, these electrodes consist of a rubber or metallic chamber to one side of which the electrode is attached. Any one who has once seen the almost magic effect of the combination of hydriatic and electrical applications in relieving deeply seated pains will appreciate their value over any other form of treatment.

THE THERAPEUTIC APPLICATION OF THE ELECTRIC LIGHT.

The electric light, especially when derived from the rays of the electric arc, resemble in every particular the light rays received from the sun. Like the sun's rays thermic rays are divisible into three classes, heat rays, luminous rays and chemical or actinic rays. The luminous rays are again divisible into red, green and violet. The therapeutic effects of light depend upon the heat rays and actinic or chemical rays. The actinic rays are found present in larger proportion in the arc light than in the sunlight. These rays may be readily separated by means of glasses of various colors. For example, red glass filters out all except red rays. The phenomena of solar erythema or sun-burn which has been shown to be due to the chemical or actinic rays of the sun, affords an illustration of the effects of the chemical rays of sunlight upon tissues not properly protected by pigment or other artificial covering. White cows, for example, like white men, are subject to sunburn, whereas black cows and negroes are exempt from this inconvenience. The chemical rays of light are also destructive to various bacteria, especially pathogenic bacteria such as the typhoid bacillus, the bacillus anthracis, and the bacillus tuberculosis.

Upon the discovery of the electric light and practical methods of producing it, numerous experiments were undertaken for the purpose of ascertaining whether this excellent artificial substitute for sunlight possessed the property of stimulating the vital processes of plant life in a manner analogous to the action of sunlight. An interesting paper by Wm. Siemens, published in March, 1880, contained a detailed account of experiments made for the purpose of determining the influence of the electric light upon vegetation, with the following conclusions:--