Cold and Heat as Therapeutic Agents, their Practical Application and Value in some Pathological Conditions.

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Cold and Heat as Therapeutic Agents, Their Practical Application, and Value in Some Pathological Conditions.

The use of thermal remedies date back to the earliest ages, and the method of application and indication for their employment have been set forth by numerous observers throughout all medical literature of which we have any knowledge. Hippocrates in the 4th century mentions them frequently in his writings, and was evidently in the habit of employing them freely.

It is obvious how they first came into use, for nearly all acute and many chronic diseases are attended at some period by a sense of excessive heat or of cold and shivering, both of which could be relieved to some extent by application which favour the opposite sensation. Cold in some forms often readily relieves the discomfort attendant upon the hot dry skin of the febrile state, and being easily available would soon become of general application. The effects of heat on the other hand, although perhaps not so immediately apparent, were early appreciated, and almost universally, as is shown by the fact that all over the world hot springs have always been extremely popular.

NB: Degrees Fahrenheit are used throughout this treatise. A list of references is given at end.
as agents in the treatment of disease.

It would soon be observed that a moderate degree of heat is useful in allaying pain, and inducing diaphoresis. These measures then probably came into use in the alleviation of some of the discomforts of disease chiefly by instinct, and have always been recognised as more or less useful adjuncts to other methods of treatment.

Until the discovery of the thermometer by Galileo (1612) no exact observations could be recorded, and it was not until Fahrenheit invented the mercury thermometer (1720) that its instrument became of much practical value. But after that date, as the use of the new method of recording temperature became more general, many numerous experiments were made on the behaviour of the human organism under varying conditions of temperature both in health and in disease. Before the thermometer came into use the Cutaneous (F.C.)
Sensations were the sole guide as to the degree of heat or cold present, or to be administered. Hippocrates say, that "not so great an amount of heat as will burn the body, or of cold as will congeal it should be applied. He makes the observation too that "not better cool the body, for by the heat they evaporate the serum out of the body."

From the 4th century onwards, the practice of teaching of the "Fathers of Medicine" were more or less closely followed, and to some extent at least, thermal application have been used under every "system" of treatment and theory of disease. With the advent of exact methods of measuring the degree of heat or cold, employed a less empirical basis for their use could be established. In 1797 or 1798, Currie of Liverpool published his "Medical Reports on the Effects of Water, Cold or Warm, as a remedy in Fever and Febrile Disease. The experiments were originally made to endeavour to account for the fact that of several shipwrecked seamen, who were exposed on a partially submerged wreck, two of the strongest and apparently most healthy of the men, who were highest out of the
water, but were subject to frequent immersion, died of the cold exposure, while several of those who survived, although not strong men, were under the water most of the time. By means of these experiment, he says, "it seemed not unlikely that some light might be thrown on this curious subject by observing the effect of fresh and salt water of equal temperature upon the normal body heat." As a result of these experiments, Currie placed on record the first exact data respecting the reaction of the normal healthy body to the effects of cold, and incidentally also to the value of heat in restoration after long and severe exposure entailed by his experiment. A few years after Currie's publication a considerable literature of the subject appeared in France and Germany, chiefly perhaps in account of the attention excited at that time by the operation of Pisseny, a Silesian peasant, who professed to cure all diseases by means of water. Contzelen, Henry, later Liebermeister, took up the scientific investigation of the subject, and especially of the physiological effects of heat and
cold, and also the larger subject of the
maintenance of the body heat & the physiology
of heat production. The investigations of Meyr,
Roth & Zimny, Rubner etc. on the continent,
and Macalister, Pembrey, Hale White & others in
England have added much to our recent knowledge
of the physiology of the thermals processes,
while Boni Bande, Lumtitz, Hayem etc. have
gained us much information as to the clinical
application of these physiological facts.

The normal healthy body contains within itself
its necessary mechanism for the production of a
degree of heat which may be considerably above or
below that at its surrounding, and which remains
constant under all ordinary atmospheric conditions.
The variation has been shown to be less than
2°. Whether the body be exposed to the heat of the
tropics, or the extreme cold of arctic region,
so long as the body is properly clad and
supplied with suitable food. (16)

But thermal agent may be applied to the
body, in such a way as to materially alter the body-heat and influence the nervous centres, and so, indirectly, all the vital functions.

The chief source of animal heat is the chemical change produced by muscular activity, its resulting metabolism; the more rapidly this destructive process proceeds, the greater will be the heat production.

The main channels of heat loss are the skin, from which constant radiation and evaporation is taking place, the lungs, also by evaporation, and the other cavities through the loss of excretions heated by the body.

If these be far the largest share in heat loss is borne by the skin.

Many investigations have been made to ascertain how the heat regulating function is controlled, many assuming the existence of a 'heat centre' chiefly from the fact that damage to the brain's cortex often produces hyperemia out of proportion to the injury. Macleod states that thermolympia, thermogenesis, thermodila, are separate functions & prove thermogenesis to be distinct from the motor function in muscle.

It is a matter of common observation.
that when the body is exposed to a high temperature little or no discomfort is felt so soon as sensible perspiration begins.

And the same is true of physical exertion, the sudden and rapid increase in thermogenesis comes increased frequency of respiration and cardiac pulsation until the regulating mechanism comes slowly into action, and the moment presents "break out" relief is felt. On the other hand if the body be exposed to surroundings where the amount of heat loss is in excess of that produced by the body at rest there is an involuntary impulse to muscular movements to assert thermogenesis.

But this beautifully arranged compensatory mechanism will only act within narrow limits both of time and temperature. The mean body heat for twenty-four hours is about 98.12°F and a rise or fall of 7° or 8° above or below this point would rapidly prove fatal if maintained for any length of time, so that any external agency which will raise or depress the temperature of the blood up to or beyond this limit becomes a source of danger. It has been mentioned that the element of time.
is of importance, and all through thermal therapies it will be found that this is the case. Currie showed that by cold immersion in a bath at 44° the body heat could be lowered to 88°, and further to 73.2° or thereabouts, but after a period of time varying from 20 to 36 minutes of exposure to this degree of cold the symptoms induced were such as to call for speedy restoration. (It should be noted that the subjects of these experiments were confined to a restricted space, and at rest.)

On the other hand it is not easy to cause the temperature of the body above 104° by external heat with the body in health, for the profound diaphoresis that supervenes tends to lower the actual temperature rapidly, while if the external heat is very hot or continued for long there is a threatening of syncope which makes the continuance of the experiment risky.

But the thermotaxis mechanism will not stand the strain put upon it in either case for long, the actual time varying with the vitality and vigour of the subject thus exposed.

A state of consciousness essential to the
integrity of the thermic function, as is demonstrated by the rapidity with which the subjects of alcoholic stupor or those sleeping from fatigue approach the temperature of their surrounding, and thus obey the laws governing inanimate objects. Cases of frostbite and death from cold are more common under these conditions of unconsciousness than when the conscious subject is exposed to very much greater extremes of temperature. And the same may be said of heat, as is shown by the most infrequent accident of burning the skin by a hot water bottle during sleep, which while awake could have been borne with no ill effects whatever. The highest temperature I have ever noted as the result of a hot bath was in the case of a man who had gone to sleep in the Turkish bath chamber with the thermometer registering 160°, who as being aroused taken into a cooler atmosphere had all the symptoms of high pyrexia whose temperature in the mouth was 105.8. On another occasion a local hot air bath which had been borne at a similar temperature in several previous occasions with no discomfort whatever produced a severe "burn" owing to the patient having
failed + the amount of the cutaneous secretion being thereby diminished.

The general effect of cold upon the body.  

Carman's experiments in to the results of cold (40 to 44°) applied continuously up to 35 minutes by means of the ordinary baths may be briefly stated to have resulted in the determination of the following facts, viz: a rapid fall in the first few minutes, followed by a gradual rise up to about 20 minutes after immersion, and afterward a rapid fall. It is probable that the thermometers used by him were not so accurate as those now in use, for in the last of his 7 experiments he says that the temperature of the subject before taking the bath was 94° (in 5 minutes) and that after being first put into the bath it fell rapidly to 88°; then rising again slowly to 92° where it stood for 20 minutes; then fell to 85° (35 minutes from the commencement of the bath) at which period dangerous symptoms of collapse caused the further continuance of the experiment to be abandoned. Henry found the temperature units to 93.2 + 91.4 + Virchow record, a
temperature of 93.4. In one experiment upon myself it temperature fell as follows in a bath at 46°.

Temp. in mouth during bath 98.6°
5 mins after 96.8°
10 mins 94.8°.

At this period the skin was felt intensely vivid shivering supervened; the baths were left; vigorous movement resorted to; the heat then gradually rising and in 1/2 hour after leaving the bath the heat had raised to 99°. The whole body surface was in a glow. Annexed are pulse tracings taken at time of entering bath and at the end of 10 minutes immersion.*

In another instance after a short swim in water at 66° the mouth temperature was found to be 96.8°; and in a boy who had been some 20 minutes in cold water in the result of an accident the rectal temperature 10 minutes after recovery was 92°. He had supported himself by the edge of the ice and only suffered momentary total immersion; he recovered completely.

These every many similar observation by numerous writers prove beyond doubt that Currie's original observations were in the main correct.
The continuous application of cold to local areas.

Varying in degree with the amount of heat abstracted from the surface there will be a lowering of cutaneous sensibility, until at or near freezing point complete anæsthesia may be produced. The peripheral vessels are nearly emptied, as is evidenced by the pallor; by the fact that ice applied near the margin of a bleeding wound will check haemorrhage.

It has been noted by many observers, that remote effects are induced upon organs or regions of the body not under the immediate influence of cold. I have verified the fact observed by W. Edwards, that if one limb be exposed to cold the opposite one also falls in temperature though the general body heat may show a slight rise.

One hand was plunged into water at 38°. Temperature of the hand of opposite side at time of commencement of experiment 94.4°, and of rectum 98.6°. Ten minutes after immersion the hand not in the water registered 90.6°, the rectum 97.2°. Clinical thermometers were used.

In this experiment the rise in rectal temperature is more easy to account for than that of the hand.
In the former case this anaemia locally
induced will cause a hyperaemia in the rest
of the body, and as the temperature of any
given area is in some extent proportional to
the amount of contained blood, there should be
a general rise in all these parts not under the
direct influence of cold. Why the homolopous
limb should be excepted is not quite evident,
but there is obviously some connection through
the sympathetic and vasomotor nerve. It has
been shown too that the hand not exposed to
cold diminish in volume while the other one is
immersed in ice-cold water. If continued
for more than 30 minutes however these effects
are less marked, and I found that in 45 min.
the rectal temperature fell to 98.4°, showing that
a slight general cooling of the body was commencing.
Reduction of the general body heat by local heat
abstraction is however out of all proportion to
the general heating effect of hot applications applied
locally. (q.v.)

In connection with the remote effects of cold
some interesting experiments are recorded by
Chapman as to the influence of ice bags applied
to different areas of the body. There is a
well known relation for between cold
applied to the feet & leg, & the circulation in the
pelvic organ & with the intracranial circulation.
Cold to the feet is well known to check the menstrual
flow. There are few students who do not know
the value of a hot bath to the feet as a relief to the
headache & insomnia of intense cerebration.
The Effect of Heat upon the Body as a Whole.

Although with ordinary conditions of heat such as may be experienced in the tropics there is little or no influence upon the body heat this can be considerably affected by a heat above 148° as the following experiment will show.

In a Turkish Bath.

Temp. in minute. Pulse Resp. Temp. of Bath Duration.
98.6° 68. 18. 180° at commencement
115. minutes 101.6° 96. 24.
20. 101.0° 90. 24. Sweating profusely.
removal to room at 140°
140. minutes 100.8° 88. 26.

Some manoeuvres had been exercised in taking the temperature, viz., to avoid the effect of the high temperature of the bath upon the thermometer, but by conveying them to the subject of the experiment in cold water, that by its evaporation the same they were completely unfolded between the skin surfaces, the patient baking out momentarily to a cooler room in order to take the reading.

There was therefore a steady rise followed in the appearance of sensible perspiration, by a slight fall. Some hours after the bath the temperature
had fallen again to normal. Many observations were taken, but the above is typical of what happened in the majority of cases tested. In some there was little or no rise above normal throughout the bath, but there were almost invariably persons who began to perspire very early after entering the bath, even in robust health.

In the Russian or open air bath.

A chamber about 2 ft. square with the thermometer registering 115° was used for this experiment.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Temperature (°F)</th>
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<tbody>
<tr>
<td>0</td>
<td>98.6</td>
</tr>
<tr>
<td>10</td>
<td>100.0</td>
</tr>
<tr>
<td>15</td>
<td>100.8</td>
</tr>
<tr>
<td>20</td>
<td>101.2</td>
</tr>
</tbody>
</table>

Came out feeling rather faint, respiration 37
pulse 120. Wrapped in cool sheet +

mouth temperature 10 min after bath 99.6°
30     98.0°
60     98.2°

Here a much lower degree of heat produced a similar result to the previous experiment, showing the difference in conductivity between dry + moist air. The effect upon retardation of heat loss is noted later (p.21).
The effect of a hot bath. A further experiment was made in follow, an ordinary house-bath being used.

Temp. 2 months 98.2° Temp of bath 111°
10 min 102.8° 110°
15 min 103.0° 110°

The pulse was rapid feeble & heat dispersion & impending syncope were noted. The subject of the experiment was removed from the bath, wrapped in a dry sheet & put to bed. Profuse diaphoresis followed, & the temperature rapidly fell to

10 min after bath 100.4°
15 min 99.6°
30 min 98.0°
40 min 97.8°
80 min 98.0°

Other observations were made, but the results were invariably similar, varying only a degree. A rapid rise, followed by (after leaving the bath) profuse diaphoresis & gradual lowering of the mercury till a slightly subnormal point is reached & then slow recovery to normal heat.
The effect of heat applied locally upon the body as a whole.

The apparatus used for these experiments was that known as "Dorson's Radiant Heat Bath," the source of heat being four large incandescent electric lamps enclosed in a copper chamber which is again covered in with asbestos cloth. The limb only was treated, usually a leg from foot to knee; the duration of the exposure to the intense heat produced was about 40 minutes.

As the use of local hot air chambers at very high temperatures is comparatively recent, the following short abstract of a few typical results may be recorded, collected from cases under my own observation.

In each case the limb was introduced into the chamber with thermometer registering about 120°. On tempting on the full heat of the lamps an atmosphere registering 350° to 400° was rapidly reached, which remained nearly constant for the remainder of the time occupied in the experiment. The heat produced is so intense that a thin covering of lint was usually interposed between the direct heat rays and the surface of the
Temperature taken in the mouth before and after the bath:

<table>
<thead>
<tr>
<th></th>
<th>before</th>
<th>after</th>
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<tbody>
<tr>
<td>1</td>
<td>99.0°</td>
<td>99.4°</td>
<td>99.8°</td>
</tr>
<tr>
<td>2</td>
<td>98.4°</td>
<td>99.6°</td>
<td>99.8°</td>
</tr>
<tr>
<td>3</td>
<td>98.0°</td>
<td>98.6°</td>
<td>99.4°</td>
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<tr>
<td>4</td>
<td>99.2°</td>
<td>99.6°</td>
<td>100.0°</td>
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<tr>
<td>5</td>
<td>97.2°</td>
<td>99.4°</td>
<td>100.4°</td>
</tr>
<tr>
<td>6</td>
<td>99.2°</td>
<td>99.6°</td>
<td>99.8°</td>
</tr>
<tr>
<td>7</td>
<td>98.0°</td>
<td>99.0°</td>
<td>102°</td>
</tr>
<tr>
<td>8</td>
<td>97.6°</td>
<td>98.8°</td>
<td>101°</td>
</tr>
</tbody>
</table>

Pulse and respiration increased relatively with the increase of temperature.

In some two hundred of these local hot air baths, this general rise of body heat was always present to some extent, at the time, but unnoted represent the extreme. I have never seen a total rise of more than 3.5°. Within two or at most three hours after the bath the temperature had regained normal or nearly so. About 15 to 20 minutes after the beginning of the bath, profuse perspiration takes place from the whole surface of the body, especially from the upper part of the head. There is always an increase in the pulse rate. Its enforcement
of the peripheral capillaries, relieving the heart and making it "race" to some extent. The accompanying polyphlogistic pulse tracings* are typical of others similarly taken. The converse of a pulse of fairly high tension to one of low pressure is well shown. One of the patients (B) was suffering from chronic rheumatism; the other was a strong robust subject the victim to a severe attack of pericardia. It is mentioned by some observers that the cardiac contractions become slower towards the end of the bath, but that has not been my experience.

All these applications of thermal agents, whether to the general surface of the body or only to limited areas, are attended by a common result, a disturbance of the heat equilibrium whereby the temperature of the body as a whole is raised.

In the bath of hot water there is a complete check to the surface loss over all the portions
of the body under water, and in addition the skin itself and subjacent tissues become better better conductors of heat from the periphery to the central organs because of the dilatation of the surface capillaries with the better conducting blood. By convection & physical carrying away of heated blood the whole of the body is gradually raised in temperature, & when it is remembered that about 27 cardiac pulsations are sufficient to complete the cycle of circulation it is easy to understand how the body can be so rapidly heated.

In the vapour or Russian bath the atmosphere is as charged & saturated with moisture that evaporation & cooling by sweating is difficult if not impossible, depending of course on the degree of saturation of the air of the bath. The rise of temperature in this bath is less rapid but still considerable.

In the dry air of the Turkish bath the rise of temperature is still less, for here every condition is present to stimulate evaporation & to keep the body cool by the activity of the skin as a heat regulator.

The remarkable rise in body heat from the
use of the local hot air chamber is only to be accounted for by the absorption, as it were, of large volumes of heat by the carrying and distributing agency of the blood, for even after profuse evaporation had been going on for some time the thermometer still recorded 100° to 101° in the mouth. Tuke, while pay, in connection with the heat rise which follows a hot bath, is due to stoppage of heat loss, that probably the hot water does not warm the body much because "the specific heat of the body is high," but the heat of the water etc. is not conveyed away by the solid tissue, but by the circulating blood, the specific heat of the blood is very nearly the same as that of water. Some interest, however, recently recorded by O.W. Brown, throw a further light upon this subject. The hind limb of a dog was subjected to "superheated" air (300°). At the beginning of the experiment both veins registered 96.2°. In 30 minutes the blood of the femoral outside was 97° while that inside the air chamber was 101.8°. It can hardly be doubted that the rapid rise of body heat nearly 2° is mainly due to the distribution of the blood coming away from the limb under experiment at a temperature 4° or 5° higher than it entered it.
The Effects of Brief and Sudden Thermal Stimuli.

We have now to consider another order of phenomena, connected with the exposure of the body surface to sudden brief or repeated application of cold or heat. For some degree the results are similar in either case.

The most marked example of this physiological effect produced by the means now under consideration is the familiar "hot achi" after the hand have been in ice water or snow. There is a period of intense pallor, coldness, and numbness, gradually giving place to a tingling, burning and ultimately redness of the surface, with bruit, and acute pain for some minutes. The cold contracts the superficial vessel, causing arterial anaemia. Acting directly upon the peripheral nerve endings it paralyses them. If the cold be now withdrawn vigorous movements of the parts, carried on a rebound or reaction takes place. The local vasomotor nerves, being paralysed, there is a loss of control of the vascular muscles of the blood vessel, and are over-stretched, severe pain resulting and in its turn helping to restore the balance by reflex action through the central nervous system.

The thermal reaction shown thus is an
exaggerated form is present more or less in all instances where the medium applied intermittently, suddenly, and for a short period, is above or below a neutral point, which may be said to be above 90° or below 80°. In either direction beyond these points, the resulting reaction is directly proportional to the distance from this neutral zone of the temperature of the medium used, provided it is not so low as the freezing point, or above 120°.

There is really no difference except in degree between this reaction to thermal stimuli and that to other irritants applied to the surface of the body, such as friction or mechanical or chemical "rubefacient." But in the use of thermal stimuli the results are well marked, easily controlled, and may be repeated frequently to produce an immediate effect upon the part under treatment and far reaching influence upon the organism as a whole. There is probably no other therapeutic procedure which will bring about such a rapid and general stimulation of the circulation by alternately filling and emptying large vascular areas at the periphery, thus using the skin as an expansile organ whereby the central viscera can be
deflected and relieved of hyperæmia. It is
of the highest value in this connection.
For obtaining the reactive effect cold
is better than heat, because when heat
is employed the net result is often a
slight rise in temperature, and a very
moderate reaction. The skin remains hyperæmic
and with accelerated cutaneous secretion some
time after its exposure to the form of stimulus.
If heat be used alternately with cold however
there is an enhanced reaction, which stimulates
the gland of the skin only moderately. The effect
upon the peripheral nerves is different too. The
cold produces a tonic condition as opposed to
the sedative influence of heat.
If necessary, that the applications either of heat
or cold for this purpose should be sudden. There-
more the nerve do not respond, as is demonstrated
by the well known effect of thermal stimuli in
physiological experiments upon the exposed portion
of a frog. Gradual warming induces no reaction.
Sudden heat or cold bring about a rapid and marked
crion of muscle.
Methods of Using Cold Externally.

These fall into three groups in accordance with the object in view.
1. For lowering the general temperature of the body
2. As local agents for the abstraction of heat
3. As contumacious stimulating measures for its
   reaction and tonic effect.

In the first group may be mentioned

I. Cold Affusion
   Gas Cold Baths
   Cold Cooling Pills
   Ice Cradle

In the second

II. Ice Poultice
    Ice Absorption
    Chapmoin's Ice Bag
    Ice Pillows
    Cold Water Beds
    Cold Compress
    Ordinary Poultice
    Evaporating Lotion
    Evaporating Salts, etc.
    Jeeal Inunction
The third group comprises:

**Ice massage**

Cold douche — stimulating stone measure.

Sprays — dependent for their value upon "reaction".

**Cold Affusion**

This is the earliest and most primitive method of applying cold to the body. It consists in pouring large volumes, about 4 or 5 gallons, of very cold water over the nude body, and was the system advocated by Creve, Jackson, and their predecessors for the treatment of fevers. It had been observed that patients in the delirium of fever had frequently rushed from their beds and plunged into a cold stream with immediate benefit. The body became cool, the delirium disappeared and the patient often obtained quiet and refreshing sleep after his somewhat heroic remedy.

It is probable that cold affusion acts in a different way to the cold baths or cold packs. All who have had experience with this method emphasize the fact that the best results are obtained by sudden, momentary affusion, that it should not be repeated many times, and that the water should be quite cold. The rapidity with which the body heat...
in reduced after effusion makes it certain that it is not due to physical cooling alone, but heat abstraction that is which takes place from the body to the mass of cold water. The whole thermotactic mechanism seems to be suddenly surprised into normal activity, and the paralysis of heat regulation which had followed the toxemia of disease to be suddenly removed in a manner analogous to the restoration of cardiac pulsation which is brought about by dashing cold water on the face or body during an attack of syncope. It is noteworthy that in most of the cases of hyperpyrexia recorded the skin was dry and quite free from sensible perspiration when the temperature got above 106°. It was the exposure of the body to cold by effusion or by cold baths, either this function, that it is only when the temperature falls to ordinary range again (102° or less) that perspiration appears.

Since men had occasion to use cold effusion in fever, and its disagreeable character, and obvious difficulty of performance in ordinary circumstances, render it a measure that should be reserved for emergency, the ordinary baths being more pleasant to use and causing less disturbance to the patient, etc.
As a stimulating tonic medicine in patients with normal temperature it ranks with the cold douche.

The Cold Bath.

This may be used in two ways: 1) as a bath at or about the heat of the body, cooled gradually by the addition of cold water; 2) as a cold bath at 50° to 70° into which the patient is lifted bodily. The first plan is undoubtedly the pleasantest, and cooling is satisfactorily attained by its means. In all ordinary cases of pyrexia it is sufficient. Where the temperature exceeds 105° or stupor or delirium are present it is better to use the cold bath; the shock is not disagreeable to the patient, rather the reverse, and it seems to have a peculiar effect to that produced by diffusion. The cooling is decidedly more rapid by the second form of bath than the first. In a case of intemperate fever with temperature of 105°, with stupor, tremor, and approaching collapse, I had the patient carried in a sheet & immersed in a cold bath, an ordinary house bath at 65°, consciousness was restored and all the previous symptoms abated. After 5 minutes the patient was lifted out, sponged with tepid water, wrapped in a dry sheet.
and covered with the blanket. He slept 6 hours and another bathed in perspiration, until exposed to the mouth of 99°.

A good substitute for the bath, if an ordaining one is not available, is constructed by placing the patient on a strong matress, with sheets and padding this up about 18 inches at the edges all round. Cold water may then be run in by a hose through the water tap, and overflow carried off by a siphon tube, the latter preferably with a tap also.

The Cooling Pack.

A sheet or convenient piece of cotton or linen cloth is wrung out of water and applied to the whole or any part of the body. It is best to have two or three thicknesses of cloth so as to retain more moisture. The wet cloth should be in close opposition to the skin, and kept in position by a thin layer of flannel which overlaps its edges, or, in the case of the full pack by a light blanket enclosing the whole body, with the exception of the head.
There are two methods of using the cooling pack: (1) as a direct agent for abating heat by conduction. For this purpose the pack is applied cold and kept cold by supercooling with a cooling pot (antiquated), or by its repeated renewal of ice cold cloths. Healing and Binger. Healing records the reduction of temperature in 5 hours from 108.6° to 99.5°, pulse from 140 to 72, and no subsequent rise. Binger said, "the assiduous application of cold cloths, wrung out of ice cold water, more almmost than the general cold bath." I have seen the temperature (by this means) reduced in two or three hours from 107° to 101° or even lower.

There is no doubt that by this method a steady reduction in body heat may be attained, but to be of any service the cloths require to be renewed every 15 minutes or so, and the disturbance to the patient's comfort and wetting of the bed linens merely entailed. So far to outweigh any beneficial effects.

(2) The alternative method of using the cooling pack is to apply it at or a little below ordinary body heat to leave it in situ for some hours, and to renew it only when nearly dry; in other words, to use up the superfluous febrile heat in the form of latent heat.
in the vapour formed by evaporating the water of the pack. The latent heat of water is 142°, and that of steam 966°, and in evaporating moisture from its surface the body gets rid insensibly of a very large amount of heat. The water in the pack takes the place of the natural sweat upon the cutaneous surface and by converting it into vapour the body gives up enough heat to raise the water to boiling point and to convert it into vapour. (The amount of heat abstracted to convert into vapour 1 gm of water is equivalent to that required to raise 5808 gm of water 1°.)

This form of cooling pack has no objectionable feature. It is pleasant and soothing, and may even be applied warm if desired, with equally good effect, for it quickly becomes of the same heat as the body.

It is essential in order to obtain the cooling action of the pack that it should be closely applied to the skin, and that only a thin layer of clothing should intervene between the outer covering of the pack and the skin of the room. The whole moisture of the wet cloth is insensibly evaporated through its covering, just as normal perspiration is carried off through our ordinary clothing.
Cooling packs are often suggested as a valuable method of treatment, but their application and rationale seem little understood, even the directions given for their use in many therapeutic works are somewhat ambiguous. The nurse often in her solicitude for the comfort of the patienthoots a cooling pack by police or blanket, or carefully covering with an eiderdown quilt. In the article on measles in Allbutt's "medicine" the following pack is advised: "If the depressing effect of the pack is likely to be excessive, it may be diminished by adding brandy to the water in which the cloths are wrung. It is difficult to see what decrease in depressing influence could be attained by adding brandy, though the rate of cooling may be accelerated by the addition of either brandy or Madeira.

I have used this second variety of cooling pack in all cases of pyrexia where a reduction of temperature seems called for, and with results which I was perfectly satisfied.
Cold or Depr. Sponging

Carried out in a warm room that is a refreshing and useful mode of treating pyrexia of moderate degree, where the patient cannot bear the more elaborate procedure. Evaporation from the surface and direct cooling may both come into play here. I have frequently observed the temperature before, and 15 to 20 minutes after cold general sponging, to show a difference of 2° lower.

The Ice Cradle

This is practically an arrangement for putting the patient in a cold air bath, or refrigerating chamber. Cans of ice are hung around a cradle within which the patient lies, covered only with muslin. It is in use in several hospitals, and good results are claimed for it. Barr of Liverpool has used a hollow metal half cylinder with double walls, in the space between which ice is placed. The patient lies under the arch thus formed and the heat of his body is radiated to the cold inner surface of the apparatus; he does not speak highly of its value. Cold is a negative quality and i:
not condensat, and the cooling effect of the ice-craddle or of cold air is dependent upon the amount of moisture in the atmosphere and the rate of motion of the atmosphere. The more moisture the better will the air conduct its heat away, and the more rapid the rate of movement of the air, the quicker the evaporation from the surface, and the desorption of heat by convection. Air being such a bad conductor dry (its thermal conductivity is 40 times less than that of water) and its use as an aid to escape convection entailing a "draught" it has not come into extensive use. In the apparatus as used the foot or so of still air intervening between the body surface and the ice-cold tube is a sufficient barrier to make this method of cooling of little effect. In the still dry air of the high Alps it limits the difficulty with which cooling takes place under those conditions, is well experienced, for with the thermometer recording many degrees below zero there is little difficulty in keeping warm, and very little sensation of cold. The ice-craddle cannot be recommended theoretically therefore, and in practice I have no experience of it.
This is a list of well-known devices for abstracting heat by conduction, or by rendering it latent in the vapour of water, ether, or alcohol. The ice pack is effective, but difficult to manage in practice and frequently produce more discomfort than benefit. For the continuous application of cold, Lister's coils are probably the most useful. The temperature of the water circulating through them being easily adjusted. Chapman's ice bags are also very convenient and efficient if carefully kept in opposition and two bags used, so that refilling may be effected without leaving the part unexposed to cold.

These ice bags were introduced by Chapman for the purpose of applying cold to limited areas of the skin, and he claimed for them that they could be made to influence different portions of the cord, paralyzing the controlling influence of the ganglia upon the vasomotor nerves, and thus allowing vascular dilatation of the area involved; by this mean a hyperaemia in any desired area could be produced. He records some very striking cases in support of this view, but the results I have obtained with them have not been satisfactory. The ice-pillow or cold-water bed explain themselves.
They are useful in some cases, for the sensation of cold is grateful in many instances, quite apart from any general cooling effect. The cold bed has the objection that only the surface is in contact with it; it is cooled, whereas is apt to result. Also a patient the subject of fever has usually a very varying temperature, with a sudden fall it is not easy to quickly alter the temperature of the bed.

The cold compresses moistened with camphorated spirit is a very effective method of abstracting heat by evaporation. The ordinary pox violets also serve the same purpose as a rule, though it is usually applied with the opposite end in view. After the first few minutes the heat of the pox violets is rapidly carried away by the blood circulating through the skin with which it is in contact. The innumerable pox violets tend rapidly to cool, and are thereafter kept warm itself by abstracting heat from the body, evaporation cooling on its outer surface being proportional to the permeability of its covering. Evaporating lotions are practically always used in the form of the cold compress; and its rapid evaporation of volatile substances for the production of local anaesthesia by intense cold.
The ice water enema has been used as a method of cooling, and as a local sedative to the lower bowel in typhoid and other fevers. One to two points of ice water are injected into the rectum. It is said that a reduction of ½ to 1° takes place in the general temperature; it is probable however that this fall is very transient.

III. Cold douche, affusion, etc.

In these methods of applying cold a quantity of water is projected upon the cutaneous surface in varying volumes, from the mass of water comprising the affusion to the fine spray of the needle bath, and they are used mainly for the induction of their secondary or reflex effect. In those applications the mechanical effect of impact has to be taken into account, increasing in its peripheral stimulation. They are valuable means of attaining this result in the more robust order of invalids, and may be varied in force and duration to suit differing degrees of reactive power in the patient. Ice drainage is employed for the utilisation.
of the intense reaction induced by rubbing
ice or snow on the skin. It has been advocated
for the relief of neuralgia and painful affections of
the lumbar and sacral nerves, and is applied
by taking a convenient block of ice and holding
it by two or three folds of flannel, rubbing it
gently over the painful area for some few
minutes. I have used it recently in two cases
of lumbago and one of sciatica, but with no
conspicuous good results. I do not think it
is so effective or permanent a method of relieving
pain as the application of direct heat, though
some temporary benefit was experienced in two
of the cases in which it was used.
Methods of Using Heat Externally.

These may be considered under two heads:
(1) for exciting diaphoresis;
(2) for the alleviation of pain.

In the first group:
I. Roman or Turkish Baths
   Russian, Berkelot, or Lapson
   Hot baths, including mud and seaweed baths.
   Sand
   Healing packs.

For a diaphoretic effect.

In the second:
II. Local hot air Baths
   Hot fomentations
   Liniment oil, etc., hot water
   Thermopan apparatus
   Hotfootbaths

For anodyne effect.

The Roman or Turkish Baths:

After being in use during the Roman occupation
in England, it disappeared for some centuries. It came
back to us through a Mr Urquhart, a chaplain in the diplomatic service at Constantinople, in 1860. In its modern form it consists of three rooms hot air chambers, ranging in temperature from 120° in the coolest to 200° in the hottest room. It is a convenient luxurious method of exciting delirium in the healthy and robust, but requires care in its use by the delicate. The bath usually concludes with a cold plunge or needle bath, after shampooing. The time required in getting the desired effect may be considerably curtailed by reversing the usual order and entering the hottest room first, the heat rapidly raising the temperature of the blood one or two degrees and inducing perspiration. After sensible perspiration is once started it can be maintained by a much lower degree of heat, and the cooler room may be used for the remainder of the bath. There are two periods in the time spent in the Turkish bath which should be thought of in prescribing them for weakly subjects; the first is at the end of the "dry stage" before sensible perspiration has begun. At this period the heart is pulsing rapidly, that salted high tension, after slight dyspnea is present; it rapidly pares off in the appearance of moisture on the surface; the second is
at a later stage when if the bath be unduly prolonged in some weakly individuals the activity of the skin becomes diminished owing probably to the greatly lowered blood pressure. At this stage the temperature is apt to rise 3 or 4 degrees, + fainting result. The point at which sensible perspiration will appear with the body at rest is about 90°F. and with the class of patients now under consideration adiaphoresis may be readily induced in an atmosphere of 72°F.

Even cases of cardiac dilatation or asthma will derive much benefit from a bath at this heat followed by cool sponging instead of a plunge bath + shampooing. The relief to the deep vessels, and to the heart itself by the determined flood of such a large mass of blood is often very marked, and this relief is often permanent, as evidenced by diminished oedema + less respiratory embarrassment or excretion.

A considerable excretion of nitrogenous waste takes place through the skin, leuvin also, fatty acids, + volatile drugs etc. + the disposal of these has doubtless a large share in the benefits of this as well as other diaphoretic measures.
Russian or Vapour Baths

In some form or other, the method of applying moist heat in almost universal in cold climates. Possibly the long period the body goes without ordinary ablution and the impermeable nature of the clothing worn may make this periodical thorough cleansing of the skin a necessity. In the Russian bath the whole body is subjected to the vapour, in the various forms of box baths including Bertchelots the head is protected from the heat by closing in the bath at the level of the neck. It is impossible to sustain a temperature in these baths for much over 112 to 115 for more than a few minutes. These baths should always be of short duration, as the body heat rapidly rises while in them and exhaustion results; they should always be followed by some cooler bath or spray. A modified and convenient form of this bath is made in an ordinary bed, by forming a tent with blanket, conveying steam beneath the covering from formed, the patient lying nude, with the head outside; they are not quite so satisfactory in effect however as those described above, unless the patient be slung in a net hammock, because the whole surface of the body upon which the patient
lies is excluded from the operation of the vapour. A better form is the "chair bath" constructed on similar principle, but allowing the patient to sit instead of lie.

The Hot Bath

Needs no description, its effects are noted page 17.

As a rule a temperature of 105° should not be exceeded if the bath is to be of more than a few minute duration. At 112° to 115° the heat is just tolerable. For inducing diaphoresis a bath at 102° to 14° for 15 to 20 minutes is usually sufficient, the result better than a hotter bath of shorter duration. It is common knowledge in the tropics that a hot bath has a cooling after-effect, which is doubtless due to the check to heat production & the profuse evaporation from the surface afterwards. In the healthy subject this effect is very transient however, the reaction to heat being much less intense & more brief than that to cold. The steamed & mud baths are merely modifications of the above.

Heating Packs.

These may be dry or wet and merely consist
in the taking of such precaution as will serve to stop the surface heat loss & to supply a greater or less amount of heat by conduction as possible. The most effective form is a blanket, hung out of hot water & applied as hot as can be borne & well covered with a blanket to the sheet; but a sufficient covering of any bad conductor of heat such as a blanket or eider down quilt is almost equally efficacious. In this aside stage of age much comfort seems to be derived from the hot pack.

II. The Local Hot-air Bath.

This forms a sort of connecting link between the general & local heating applications, for dry heat or from the whole surface is induced as well as from the parts under immediate treatment. There have lately been introduced several forms of apparatus for submitting portion of the body to the influence of very hot dry air. The first was known as the Fullerman Hot-air Bath and was practically a copper cylindrical oven in which the limbs or part under operation could be introduced. The source of heat was a series
of Bunsen gas jets which gave a heat inside the cylinder of 250° to 300°. This apparatus has been superseded by others in which the source of heat is electric, and these are more easily controlled and their heat concentrated to the point of application; the heated atmosphere, unpurged with carbonic oxide from the Bunsen burners is also objectionable, and this is entirely obviated by the new source of heat. There are two forms now in use, one (Frenville) in which the heat is provided by the resistance to the current of long coils of platinum wire, the wire remaining dull but a very large volume of heat being evolved; the other (Dowsing) obtains its heat from large incandescent electric lamps. In both of them a temperature of 400° to 450°, or even higher, can be very quickly reached by employing the heat-generating apparatus in narrow limits. This is a very convenient method of applying intense heat to a limited area where electricity is available. It is claimed that the light rays will induce diaphoresis at a lower degree of heat than the dull heat, but there is no sufficient evidence of the truth of this.

Some of the physiological effects of the salt lamps.
already been mentioned. Its chief value is its portability; the whole apparatus for a bath forming a convenient box-shaped chamber which can be used in the patient's bedroom, with the facility with which very high degrees of heat dry air can be obtained for local treatment for the relief of pain. It is a very useful method too of giving to weakly patients, who require it, all the benefit of a Turkish bath, with the minimum of movement and fatigue. It is mainly for its anodyne properties that this bath has a place in therapeutics, for an equally profound leucocytosis can be induced by a simple hot bath at the feet plus at about 112°. It has also been suggested that the heat has a solvency action, leading to the re-solution of deposits of sodium bicarbonate from the tissues, and there seems a good deal of presumptive evidence in favour of this.
Hot fomentations, lint, oil, with hot water, hot water bags, the Thermogen, and other methods for locally applying heat are too well known to need much consideration; their value is well proved by their general use through all ages as an antidote to pain. A marble tablet in the temple of Aesculapius in Rome records that the donor was cured of a pleurisy by the application to his side of a mixture of wine and hot ashes from the altar of the god; and at the present day there are few cases of pleurisy that have not been treated either before or after they come into the hands of the medical practitioner with a similar application from a less sacred source.

To induce an anaesthetic effect the particular agent used must be applied as hot as the patient can bear it, and renewed or kept supplied with heat as it cools.

In local inflammations affecting heat relief pain by its direct sedative effect upon the cutaneous nerves; it also reduces pressure effects and stasis by its stimulant action upon the cutaneous secretion and local circulation.

For their remote effect upon deep organs the
hot local applications have always held a high place, and that they do have such an effect is undoubted, for the extreme hyperaemia reduced locally must mean a distal anaemia relief of passing congested areas.
Some Pathological Conditions in Which Cold is Indicated

Pyrexia

By far the most important therapeutic application of cold is in the treatment of fever. We have seen cold as cold, a potent factor in lowering the body heat in health, but it is still more powerful in reducing the temperature in disease, in restoring to healthy action the thermostatic mechanism disturbed by the pathological condition.

In 1786 Dr. Wright of Edinburg gave an account of the success of cold ablation in the treatment of fever. Currie mentions that Johann Breslau first brought it prominently into action in Europe in 1797. After Currie's treatment the use of cold in pyrexia became extensive, especially in the treatment of measles. Since the success in typhus and later in cholera inoculation results in hyperpyrexia again attracted attention, but, and since then many observers have confirmed and verified their results. In 1894 at the Meeting of the Brit. Med. Assoc., a paper was presented by Hale stating renewed pyrexia with treatment a

heat p 209.
of external cold, a conclusion which was
endorsed by the majority of those taking part
in the subsequent discussion. In a more
recent paper Mr. Hale White questioned the advisability
of treating pyrexia as a symptom to be attacked,
and suggests, as others have done, to probable
protective mechanism, or the possible value of
encouraging instead of attacking it. But so
far as the patient's comfort, feeling, are concerned,
there can be little doubt that if the skin is
inactive & the temperature above 102° some
method of cooling is called for, to very painful.
The reduction in mortality in such fevers as
Malaria shows that there is material advantage
in the attack upon the disease itself by thus
lowering the body heat. The contrary methods of
treatment by hot hot baths has been advocated,
but the experience with them has not been large
& the result, not encouraging.

An ordinary pyrexia I have for some years
been in the habit of using hot cold or cooling
external applications in all cases,
where any interference seemed necessary, and
this whether the thermometer registered
100° or 106°. It is useless to wait until the
fever proceeds the higher points; for the relief that follows even at the lower temperatures is often immediate and considerable. The chief guide to its employment should be the condition of the skin; if that is harsh, dry, hot, and the application of cooling agents externally can do nothing but good, if carried out secondum artes. If the skin, though it reflect as 105° be moist no cooling measure are needed, for the appearance of sensible perspiration is always the harbinger of a fall in the body heat. If external cold will reduce a high fever it will do the same for a more moderate degree of pyrexia, and although, as in every other remedy, it is not easy to say that the methods employed have been directly instrumental in bringing about a pure result and the results I have obtained have been absolutely convincing to myself. Both by personal experience and observation of its value in my practice it has proved to be the by far the pleasantest, most certain and safest means we have of reducing body heat and restoring a healthy activity of the skin.
In hyperpyrexia,

The cold bath was first used by Fox, who later adapted its graduated method, from 98°
106°. Ord, Macalister & Harper have recorded
satisfactory results, both with the cold and the
graduated bath.

For the Pyrexia of Typhoid,

Seven separate methods of using cold for
this form of pyrexia have been advocated,
cold affluxion, the cold bath, the graduated bath,
the ice-bath, cold packs, cold sponging, and the
cold air-bath or ice-cradle.

Buchta & Pierre advocated cold affluxion. Bland
from 1862 to 1870. At 61° to 68° with complete
immersion of the body for temperature of 102°
Kempson 68° to 72°. Zierinen & Zonneveld 93° to 66°
88 to 78° eido: 92. The other methods
are all variations of this method.

In my own experience I have found the
cold pack combined with tepid sponging
the most convenient and most satisfactory, in all
but extreme cases of pyrexia in typhoid. Its
advantages in practice are obvious. In January
of this year I had an attack of typhoid
fever myself, and was treated throughout by this plan with excellent results. As every occasion upon which the temperature exceeded 101° the base was dry the pack was applied and the response was always marked and rapid. Sparging of the surface night and morning was also methodically carried out. The absence of disagreeable shock and minimum of disturbance are great advantages of this method.

White thinks, that it is not alone as a direct antipyretic that the cold bath sparging to act, but by aiding elimination of toxins. No one knows the enormous elimination of toxic products during the cold bath treat- 1

Here is Brown's record, nearly fifty per cent reduction in the mortality from typhoid in a series of nearly 2000 cases treated by baths — against a similar number treated in the ordinary way, 1 and other pain, purulent results.
In the Exanthematous

The application of cooling agents is often called for at some period or other. There is a popular expression that a cold application is the form of fever where a rash makes its appearance are harmful, "don't catch it in." Whether this is so, or not, is not easy to ascertain, but is probably without foundation, with the exception of small pox. I have treated the pyrexia of all the eruptive fevers by the administration of cold packs, wet body packs, and cool sponge-bathing after bathing. I have never had occasion to give an antipyretic by mouth since adopting this plan. Almost all authorities are agreed as to the value of the wet packs in the high fever of delirium of a bad case of scarlet fever, but it is equally useful in the earlier stages of the disease when the fever is a source of discomfort.

In Pneumonia

The cooling application has been advised by F. Weber, F. B. Burt, T. J. Utens, et al., and in doubtful cases, where the pyrexia is high, but I have found these applications over the affected lung more agreeable. It has not been shown that local cold has any specific action in shortening the natural course of the disease.
As a "Nerve Tonic" & Stimulant to Metabolism.

The cases where cold is indicated as an exaltant to "reaction" are generally all those in which there is a moderate degree of debility. If the asthma is below a certain point, the external shock of cold fails to elicit that response as a reflex effect in cutaneous vaso-dilatation which is its chief value in this connection, and instead of a tonic it becomes a depressant.

Among other conditions where it is of value may be mentioned advanced convalescence, anaemia, malnutrition, hysteria, & all functional neuroses. Its action as a stimulant to the nerve centres & general metabolism is well merited. An increase in red blood cells has been noted.
Some Pathological Conditions in which Heat is Indicated.

As a dermatotic in chronic nephritis, the cutaneous secretion being to some extent vicarious for the renal its increased activity often relieves a damaged incompetent kidney; the position cold occupy in the etiology of nephritis, points to the necessity of keeping the skin warm and active where there is any threatening of this disease. The Turkish bath or some form of vapour bath is best in these cases, though any local application of heat above 100° to about 1/4 of the cutaneous surface or less will often be sufficient.

The local hot air bath with "superheated dry air" has been recommended in these cases, but care requires, the increased where oedema is present to any extent. In one case of this kind under my care the skin blistered rapidly in the hot air chamber at a temperature of 300°. It seemed to me probable that, although some ordinary evaporation took place from the skin, the saturation of the cutaneous tissues with watery fluid prevented its true secretion of sweat; the water near the
surface was then rapidly raised to boiling
point and the skin scalded in consequence.
I have seen no record of similar accidents
however.

In Rheumatic and joint affections of the
chronic type, and in Rheumatoid Arthritis,
heat has perhaps had the greatest recognition
for its soothing anaesthetic action in these painful
affection it is beyond question. It has been
prescribed in all forms, from simple exposure
to the sun to hot sand, mud, steamed water
steam, & artificially heated dry air. In acute
rheumatics much relief may be obtained by
bandaging the swollen, painful joint with a
flannel bandage over cotton wool. The high
temperature of the body is thus utilised in forming
a heating pack over the joint, the wool preventing
radiation & conduction & so raising the heat of the
part thus heated relatively to the rest of the body.
Later when the face has subsided the joint
remain stiff & painful repeated hot fomentations
or some form of local hot air or vaporous baths
is most effective in aiding recovery.

In Rheumatoid Arthritis & Chronic joint joints
heat in one form or other is the one form of treatment which is found by all astrologers to be of any real service in allaying local symptoms. And it seem probable that not only the local condition is relieved by the soothing & paralyzing effect upon the autonomic peripheral nerve endings, but that the cause of the painful condition may be also removed by the solvent action of heat on the morbid product deposited in the tissues in these diseases. In short at all events, it has been proved that a deposit of bismuth, if done, takes place in the affected structures, and the bismuth is soluble in direct proportion to the heat of the solvent.

In many cases of rheumatic arthritis, I have found a remarkable improvement to result from the judicious application of heat. Having tried or seen in use all the various methods of applying it, I have no doubt that the best results are achieved by the modern form of hot-air bath of very high temperature. The anodyne effect is of the immediate, and of the cases treated recently there was considerable
improvement in 28, and some degree of relief in all. I have seen no case permanently the worse for these hot applications, while it is more than can be said for the ordinary hot baths. In patients who are greatly debilitated or of advanced age a lower temperature in the chamber is admirable, otherwise the general rise of body heat which attends the use of the higher temperatures seems the most attended with risk. I have noticed that the heat balance is always more unstable in the case of patients and the more advanced the case the more rapid is the rise. The baths therefore should be shorter, for the early stage is earlier, and the heat only sufficient to relieve the pain.

In Sciatica + Lumbago

Heat is very useful here in getting rid of the products of inflammation. The bloating + stasis of lymph in the nerve sheath is opposed by stimulation of local circulation in the lymphatic + blood vessels. The anodyne effect of heat is also of service. Hot fomentations, general or local baths are all valuable in their affection.
Sphygmographic Pulse Tracings.

Effect of Cold Bath.

1.

Before immersion in cold water. Pressure 70s
(ouster's).

2.

Ten minutes, immersion in cold water at 46°.
Slowing + increased tension.
The Pulse tracings during the local hot air bath.

At commencement of bath. Temperature in bath 91°.

20 min from beginning of bath. Sleeping profuse.
Temperature in chamber 30°.

At end of bath. 40 min from commencement.

Temp. in bath. 42°.

The right thigh, from hip to knee only was exposed to the influence of heat. Patient was quite comfortable, complained of no cardiac discomfort, but was bathed in perspiration. The lowering of blood pressure in the radial artery is well marked in 2 & 3.
A 2nd case in local hot-air bath (feet alone)

Before bath. Pressure 20\textsubscript{2}. Temp. 168\textsuperscript{0}

5 min after exposure sheet. Temp. 245\textsuperscript{0}

10 min. Temp. 300\textsuperscript{0}

20 min. Temp. 320\textsuperscript{0}

40 min. Temp. 380\textsuperscript{0}
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