The Pathological Effects of Temperature

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Of all those numerous sources from which disease originates, none are so prolific, nor so widely spread, as extremes of temperature and its alternations. From the tropic zone to the polar ocean, this effect not only impresses certain sytemal characteristics on the aspect of the country, and on its inhabitants, but it also exercises its influence, both in determining the nature of the prevailing diseases, and also the type which others shall assume, with the production of which it is wholly unconnected.

Seeing that this is so fertile a cause of diseased action, it might have been presumed, that its mode of operation would have been well understood, from the earliest times of the healing art, but so far from this being the case, although it has always been acknowledged the most common of all the exciting causes of disease, yet it is only within (it may be said) a few years back, that any successful investigations have been made into its influence upon health, and disease, the manner in which it operates in the production of most vital conditions of the system, and the laws by which its operation is governed.

Among the first, to turn his attention to this subject, was the celebrated Dr. Cullen, who had
in his "First lines," made some useful observations on the circumstances which either favour, or prevent the injurious action of cold on the system. Since his time, inquiries into this subject have been greatly facilitated by the rapid advance of science. The discovery of oxygen by Priestley, and the theory of combustion, first proposed by Lavoisier, with the subsequent application of it to explain the production of animal heat, which is so intimately connected with the effects of temperature on the body, and also the recent progress in anatomical and physiological research, have all paved the way for those successful investigations into its operation which have been lately made both in this country, and on the Continent. But, although our knowledge has been thus greatly increased, there are points upon which extreme diversity of opinion is still entertained.

Before proceeding to consider the modes of obtaining heat, and cold, in the production of disease, it will be necessary in the first place to make a few general observations on their physiological action on the living system. The range of external temperature under
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Which human life can be supported, is of very considerable extent, comprehending every variety of climate that is found on our globe. In tropical countries, during a great portion of the year, the thermometer rises as high as 110° Fahr. and in some parts of British India, to 120° and even as high as 130°.

On the other hand, in the Arctic regions, during the whole of their dreary winter, the thermometer seldom rises above 40° or 50° below zero. Yet, under these extremes, man is to be found, living, and enjoying life, modified, no doubt, by the circumstances under which he is situated; but disease is not necessarily produced, nor the natural term of their existence materially curtailed.

Formerly, before the subject was investigated, the human body was not supposed capable of sustaining a temperature higher than what occurs naturally on our globe; but, since the researches of Dr. Dr. Duhemel and Pilet in France, and subsequently, those of Lord John Clapham, and Dobson, in this country, it has been ascertained, that for a short time the body may be subjected to a degree of heat far exceeding any on the earth, without injury. In the experiments of Dr. Frodyce, and Sir Charles Clapham
which were made for the purpose of determining the degree of optimal temperature, which the body could bear, it was found that they could expose themselves to a temperature of 230° or 280° for a considerable time without much inconvenience. This is not however the highest degree capable of being borne: Sir F. Cheyne exposed himself for a short time to a heat of 321° in his own drying oven, but the highest degree of temperature ever known to be endured by any individual, was by Leblanc, who obtained the name of "Fire King" from his being accustomed to enter an oven heated to the almost incredible degree of 950°. The phenomena resulting from so great heat in these experiments, were extremely interesting and very different from what a priori might have been anticipated. The heart's action was considerably accelerated, and in many, the frequency of the pulse was nearly double; but the respiration was little affected, and the animal heat was scarcely in any degree increased, as ascertained by placing the thermometer under the tongue. While in the apartment in which these experiments were being performed, they found, that on breathing upon a thermometer, it sank several degrees, and the
breath on expiration felt cold to the touch; they also cooled their fingers by breathing upon them, and on applying their hands to their bodies they felt as cold as corpses. This wonderful power, which the body possesses of preserving its temperature from being materially raised, in a medium heated considerably above its own natural standard, was observed long ago by Dr. Franklin. He noticed on a very hot day in summer, the temperature of which was 100°, that his own body maintained a temperature 4° below it, but to what this faculty was owing he does not appear to have been aware.

This property is now generally admitted to be due almost entirely to the evaporation produced by evaporation from the surface of the respiratory secretion, the amount of which in health is increased or diminished according to the degree of external temperature. The powerful cooling effect of evaporation was shown by some of the experiments of Dr. Dibon. He found, that a vessel of water placed in the chamber, in which he himself was experimenting, the atmosphere of which was heated to a degree considerably above the boiling point, could not be brought to a state of ebullition, until a film
of oil was spread over the surface, so as to prevent evaporation, whereupon it commenced boiling immediately. It was found also, that the albumen in the interior of an egg could not be coagulated, but was merely dried up by transpiration through the pores in the shell, and on being cooked over with varnish it was quickly coagulated.

Although, in these experiments, the temperature of the body was not found much increased, yet it has been shown by M. M. Berger and Belascoche that long exposure to an elevated temperature does produce a considerable increase of animal heat. They ascertained, that after remaining in an atmosphere heated to 120° for seventeen minutes, the thermometer rose 6° higher, on being placed under the tongue, than it had done previous to entering. The highest degree of temperature, that can be acquired from exposure to excessive heat, cannot of course be ascertained experimentally upon man, but from the experiments of Berger and Belascoche, on the lower animals, it would appear, that an increase of 14° invariably proves fatal, and probably that that degree is not attained till after the death of the animal.

Since the power of sustaining an elevated
Suppose the water level very efficiently
temperature, is principally to be ascribed to evaporation; it is evident that if this process be prevented by any means, the capacity will be destroyed. If the air therefore be saturated with moisture which has this effect, the degree of heat capable of being endured will be comparatively low. For example a vapour-bath can only be borne, at least by inhabitants of this country, at a temperature not higher than 117° or 121°, but habit seems to exert great influence on this, as on other things, since the Finns make use of it, as related by Aczel, in his journey to the North Cape, can remain half an hour, or more, in a vapour-bath the temperature of which ultimately rises to 138° and even to 167°.

The effect of heated air on the body is also greatly increased by its being in a state of motion, successive portions of it being thus constantly brought in contact with it, and in this manner preventing a cool stratum remaining nearest the body. This greater heating power of hot air in motion was well exemplified in one of the experiments of Lord de la Grange; although not exactly on living body, it illustrates this property very well. It was found that beefsteaks, which were being cooked by the same heated air which
they were requiring, could be prepared in less than
half the time they required when the air was at
rest, by directing a current over them by silently.
The sirocco, or hot wind which blows periodically in
Italy and Sicily, is also a striking example of the
effects of hot air in motion; for, although its actual tem-
perature, when the air is calm, is not very oppressive; yet
this wind is described as similar to a blast of burning
steam from the mouth of an oven. Descriptions are gi-
gen by travellers of the frightful effects of some of these
hot winds on the body. Thus, "Travers," in describing
the provinces of Persia, observes, that the deserts tra-
versed between Hormus and Brothoo "like
other in these countries, at all times perilous, are in
the hotter months frequently visitated by blasts of the
Siromon, which crack and thrash up the skin and
flesh, occasioning all the agony of scorching, while
from the gaping rents, the dark and incandescent
blood pours out in quantities that soon occasion
death. In some cases life seems at once dried up
while the corpse, changed to a putrid mass dotted
with little sausages and blisters, lies in this
condition without being touched."

Heat is a powerful stimulant to all organic
life. Its effects in this respect, both on the animal
for ever more

Washed in silver moon
The Greenland or Kittiwake
and vegetable kingdoms, are witnessed in early spring, when, under the invigorating influence of the solar rays, the trees resume their foliage, and the earth becomes covered with verdure; innumerable insects, emerging from the chrysalis condition, leave their winter retreat to sport in the balmy air, and by fertilizing quadrupeds, which have lain dormant during the rigor of the winter, become endowed from their vegetable existence, to again come forth to claim a place in the scale of animated beings. This property is also remarkably exemplified by the powerful influence it exercises on the dimensions both of plants and animals, as seen by comparing the gigantic elephant and buffalo, the palm, sequoia and larch vegetation of the tropics, with the diminutive animals, the chameleons, dwarf cats, and lichens, with the plants of the arctic regions. In man, this stimulating property is not so much displayed by an increase in size, as by rapidity of growth, and development of all the functions, as well as by augmented violence of the passions. The inhabitants of tropical countries are certainly larger than those of the arctic regions, but the most perfect development of the human species, both as regards intellectual and corporeal...
powers, is to be found in temperate climates, where the body is neither debilitated by prolonged nor intense cold, but strengthened and invigorated by continual alternations.

Since we do not possess the same power of producing an extremely low atmospheric temperature as we have of a high degree, we are wholly indebted to the explorers of Polar seas for the phenomena attending intense degree of cold, and whether therefore man could exist in a temperature much lower than any that prevails naturally, there are adopting means of ascertaining. The degree of cold frequently experienced by these Arctic voyagers, and quite endurable under proper precautions, is truly astonishing: by Capt. Parry the thermometer had been seen as low as -55° or 87° below the freezing point; by Sir John Franklin at -58°; and the lowest degree noticed was by least Back, where it fell to -70° or 132° below the freezing point.

Cold, in the first instance, acts as a depressing or sedative agent; but when moderate and of short duration it increases the activity of the vital powers by inducing re-action. A more intense, or longer continued cold produces shivering, shrinking,
of the skin, and elevation of the hair bulbs, causing the peculiar appearance of the skin, named cutis anserina; the bloodvessels of the surface are also contracted, producing paleness and diminished sensitiveness, with determination of blood to internal parts. When the degree of cold is excessive, or its application too prolonged, it causes torpor, irresistible tendency to sleep, which, it indolently, ends in complete coma and death. A remarkable and well-known instance of the overpowering tendency to sleep induced by cold, especially when combined with fatigue, occurred to Dr. Solander, and Dr. Joseph Banks, when on a distressing expedition on some of the mountains in Cerra del Fuego. Dr. Solander narrowly escaped reaching from yielding to its influence, and their two negro servants both died, it being impossible to rouse them from lethargic state into which they had fallen.

The power of sustaining life under great extremes of cold, must be attributed in some measure to the capacity which the human constitution possesses of adapting itself and the faculty of evolving a greater amount of heat when required, which man enjoys in a higher degree than any of the lower an-
imply; but his superiority over them is owing more to his mental than his physical power. Since by his command over food and artificial means of protection, he is enabled in a great measure to divest himself of temperature. This power of adaptation is perhaps as well marked in regard to the stomach as any other organ of the body. It is well known that the materials used as food differ widely in different climates; in hot countries consisting chiefly of farinaceous matters, fruits, &c., whereas in cold climates they are made up almost entirely of animal food containing a preponderance of fat or oil. Leibig's explanation of this is, that the farinaceous matter of the food being used entirely to keep the animal heat by a process similar to combustion, little of it is required by inhabitants of hot countries, where no great amount of heat is necessary to be generated. The inhabitants of these therefore look with loathing on fat articles of food, but it is found that on their going to colder countries, (that is is said to accommodate itself to the necessities of the system and a craving for food richer in farinaceous matter is produced; the same is noticed in temperate climates. In the
winter season, as compared with the summer.

The same conditions of the atmosphere, as regards motion, or rest, and the quantity of moisture contained in it, which are found to increase the sensation of heat, have the same power in producing a greater sensation of cold. Cold air in motion acts in two ways—cooling both by contact and by producing evaporation; its power in this respect therefore is very great. Mr. Fisher, one of the surgeons in Capt. Parry's expedition to the Polar seas, relates, that they found a degree of cold adequate to freeze mercury, could be much more easily endured when the air was perfectly calm, than a temperature 10° higher, when a wind was blowing. The air in motion in this case therefore produced a sensation of cold, equal to a depression of 10° Fahr. The sedative and depressant influence of this agent is observed as we gradually approach the pole, by its effects on the organic functions, both of animals and plants, which become rare and diminished in life, and even man himself becomes degenerated, both physically, and morally.

Having now mentioned most of the principal
Physiological effects which extremes of heat and cold produce upon the living system, I shall in the next place proceed to consider the power which each of these agents both in originating and producing a tendency to diseased action.

In regard to heat it may be said, that this agent seldom acts directly, as an exciting cause of disease, more especially in temperate climates, but rather acts by predisposing the body to be operated on injuriously by the other exciting causes.

As a predisposing cause, it acts in two ways: indirectly, by so altering the atmosphere, as materially to interfere with the due arterialization of the blood, and the carbonaceous matter being thus not sufficiently eliminated, in the form of carbonic acid, from the lungs, a greater amount of labor is consequently thrown upon the various organs of the liver, which being thus unduly excited by a more abundant supply of blood than usual, and that also of a more stimulating quality, is very apt to assume diseased action, in preference to cold or any other exciting cause. The prevalence of hepatic complaints, among Europeans when they become residents in warm climates, is
owing principally to this cause, assisted in a great measure by want of sufficient exercise, and inducements in food not fitted for the climate. The influence of heat, inactivity, and excess of carbonaceous elements of the food in producing diseases of the liver is shown in the feats from which the livers are obtained for making the celebrated pâtés de foies gras prepared at Strasbourg and Toulon. The prevalence of cholera and diarrhoea in warm climates is also to be attributed to this cause. It acts directly by increasing the flow of blood to the surface and then by producing greater sensibility to subsequent applications of cold. The sensibility of the nerves depends entirely on the amount of blood with which they are supplied, and if this supply is by any means diminished, the sensibility to impressions will be diminished in the same rate. It is from this circumstance, that severe bruises may be received while bathing without knowing, but on emerging from the water they are felt deeply. The injurious effect of sleeping the surface too warm is evidently seen from this, and the equally beneficial results of an opposite custom by diminishing the determination to the surface is well known.
Long exposure of the face to high artificial temperature among cooks has been observed to produce a tendency to erysipelas on that part. If it be otherwise, there is reason to believe, heat when continued for a length of time, is at least one of the predisposing causes; but how it operates is not known.

Although heat in the first instance exercises powerful stimulating properties on all the organic functions, when continued for a length of time without the occasional invigorating influence of cold, it acts as a sedative on the nervous system and relaxes and diminishes the tone of the whole body. It increases the irritability and lowers the tonicity of the muscular and circulatory systems; the heart becomes feeble and each excited by motion or exertion, and from the different tone of the vessels, the circulation in the extremities becomes languid, producing coldness in these parts while there are congestions of internal organs. In this condition, the body is little able to resist the morbid agency of contusion or other exciting causes. These effects are best seen in warm countries, but even in this climate the debilitating and relaxing influence of excessive clothing and over-
sealed apartments are among the most frequent sources of disease.

As an exciting cause, heat, when applied to the body, according to its intensity, or the duration of its application, may produce all the stages of the inflammatory process from simple vascular excitement, up to the most intense inflammation and gangrene. If sufficiently strong, it will disorganize the flesh, as it would to any other organic substance, and convert it into an exudate.

When the heat has taken effect on a large surface producing an extensive blisters, a severe shock is frequently given to the nervous system; the heart's action becomes greatly depressed, and from this cause, especially from large blisters in children, death may take place by syncope. The patient having never rallied from the collapse produced by the first effect of the burn. In these cases the quantity of stimulants that can be borne by children is very remarkable, amounting to much more than would be fatal to them in ordinary circumstances. In warm countries, extreme heat acting upon the body frequently produces what has been termed coup de soleil or sun stroke.
This is produced in two different ways; most
frequently the intense acting on the nervous system
produces a condition similar to concussion, the
heart's action becoming affected through this means
but it appears also, that it may act primarily on the
vascular system, causing increased action of the
heart. When the excitement produced is extreme, the
circulation of the lungs seems to be chiefly affected,
a condition resembling pulmonary asphyxia be-
ing produced, the lungs in some instances being
drowned into bags of blood. Both these conditions
are well known in hot countries, especially among
troops in long marches; in the first case the remedi-
al measures found most useful are stimulants,
whereas in the latter, where the pulse is more full
than natural, opium, depletion and cold applica-
tions to the head are found most effectual. The
great prevalence of apoplectic attacks in hot wea-
thor must be attributed principally to this cause
and large fires, crowded rooms and warm baths
frequently cause it in those who have a tendency
to this disease. A remarkable instance is men-
tioned by Dr. Abercrombie, of encephalitis produced
by direct exposure to great heat of sun, in this
country, a circumstance that very rarely happens. A young man, aged 16, had bathed on 6th June 1878 in the river Tweed. After coming out the second time he lay down on the bank and fell asleep without his hat, and with his head exposed to the direct beams of the sun. On awaking he was speechless and walked home, and seemed otherwise in good health. He was put under treatment and recovered his speech, but lost it again at intervals, complained of pain in the head, and shortly after of squinting and double vision. He gradually sank into a state of coma and died. On examination there was found considerable softening and atrophy of the substance of the brain, and what afforded an explanation of the facility with which inflammation had been produced was the curious circumstance of a portion of the Cranium as large as a sixpence being nearly as thin as paper. Headaches, vertigo, nausea, and even Convulsions, are sometimes produced by application of considerable heat to the spinal cord, as in sitting with the back close to a large fire. From the skin being so situated as to be influenced by every change of external temperature
it is to be supposed that it will be very liable to
diseases produced by heat; and indeed many of
the cutaneous eruptions are due entirely to this
cause. Among these may be mentioned the Li-
chen tropicus or "quickly heat" which is frequently
among Europeans on their arrival in hot climates.
It is an eruption of vivid pimples not larger than
a pins head, the irritation proceeding from which
are is described as almost intolerable; the efp-
tration often disappearing when sitting quiet and
the skin cool, but immediately reappearing on
the least exertion, or from swallowing any warm
or stimulating liquid. A species of Deyema, cal-
led Deyema doloris or "heat spot" is frequently pro-
duced in this country by great heat of sun. A pa-
ular eruption having the same characters as Li-
chen simplex is said by Ray to be very common
among people much exposed to high artificial heat
as Boys, blacksmiths, founders &c. Affections
of stomach and bowels are frequently in a great mea-
sure owing to high temperature; and from this most
common class of diseases in hot climates, as dyspepsia,
Cholera, Dysentery and diarrhoea. Dysentery is probably
not entirely due to heat, but rather to exposure to cold
after great heat, but that high atmospheric temperature has a great part in its production is certain from the ravages which it commits in hot climates: Cholera and diaphaia are principally caused by the secretion of large quantities of bile rendered putrid and acid from influence of heat on the liver. In this country after a long tract of sultry weather, diaphiaia often prevails as if epidemically. A high atmosphere temperature when long continued seems also to produce a milder form of jaundice. Dr. Trask says he was struck with the frequency of this in a mild and manageable form, affecting chiefly young persons, chiefly females between ten and fifteen years of age old, in the autumn of 1846, after the prevalence of extremely hot weather.

Of yellow fever, it may be said to be a concurrent exciting cause, as it displays its greatest prevalence when the weather is excessively hot; and this is not strong entirely to its effect in producing a more concentrated form of malaria (since an intense heat rather warps and disperses malaria) but is rather owing to direct influence of heat on the constitution. This disease also commits the greatest havoc among those newly arrived from colder climates, where an active generation of heat is constantly required, and which takes some time
to become lowered to the amount necessary in warm climates. While this constitution is being formed, a considerable degree of febrile disturbance is produced which is called the Reaumur fever, which generally affects in a more or less degree people arriving in tropical countries. When blood is drawn from a vein in this febrile condition, it is found to be of nearly as bright a hue as that of the arteries, owing to the slight change produced in the Capillaries from the Capability of transmission. This constitution is lost again on a residence for some time in a colder climate, and the liability to yellow fever, which had been removed by this process of acclimatizing, becomes nearly as great as before. True yellow fever therefore rarely attacks the constant inhabitants of those countries where it prevails, unless in those where, at the same time that the summers are very hot, the winters are very cold as in some parts of America. The heat being sufficient for the production of the Arsene, while the coldness of the winter produces a type of constitution similar to that of more northern nations.

Solar heat may be said to act indirectly as an exciting cause, by its influence in the production of malaria and as this morbid influence has been
Hated to be more deleterious, and to curtail human life to a greater extent than any other single cause, it will be necessary to mention here, the known effect of heat in its production. All who have written on this subject, however, they may differ in opinion regarding the material or the nature of soil from which it emanates, agree in considering a certain degree of atmospheric heat essential for its production. That this is necessary at least in the malaria from which intermittent and remittent fevers are produced is evident from the fact that these never occur in the arctic regions nor in the cold season of temperate climates and rarely if ever beyond the 30° or 38° of North Latitude. The degree necessary for the development of intermitents is considered to be above 60° Fahr. Continued for some length of time, its virulence and abundance increase as we approach the tropics, intermitents being prevalent in temperate climates; as we proceed southward, the remittent begins to predominate and the same morbific agent under the influence of more intense heat, produces in the tropics fever of the continued form, and even as some depose the true yellow fever of those countries. That
The degree of heat principally determines the differences of these fevers is strengthened by the following circumstance, namely, that on the high grounds in the West Indies, where the temperature is not great, intermittenets may prevail as in temperate Countries; lower down as the temperature increases intermittent occur, while in the low grounds where the temperature is the highest they become of the continued type and may even assume as stated above the form of yellow fever. During the colt season in intertropical countries also fevers are few and of the intermittent character, which gradually merge into the remittent and continued form as the season becomes hotter. In regard to yellow fever, it appears that intense solar heat contributes powerfully to its development, the places where it chiefly prevails being situated between 10° South and 42° of North Latitude. Its frequency and virulence also seem in a great measure determined by the annual degree of heat, thus it has been 22 times epidemical in Martinique between the years 1669 and 1819, and 16 times in Charlestown between 1768 and 1819. The former is the hottest and driest of the Antilles and in the latter the thermometer rises in the
in the months of July and August to 92 and 93° in the shade; and in 1768 when the yellow fever prevailed in a very violent degree the thermometer varied from 97 to 98° in the shade.

It has also been remarked that at elevations of about 1000 feet above the level of the sea (in the West Indies) where the temperature is about 70°, yellow fever rarely if ever occurs. A continuance of temperature however above 75 or 80° does not in all places produce yellow fever; and on the contrary, it appears that it may prevail when the temperature is not at the highest point. It may therefore be supposed that although a temperature above 75° is required for its production, yet after that, such a degree is not necessary for its continuance after being produced for in the epidemic of 1793 at Philadelphia, although the temperature was above 80° at its commencement yet the greatest number of deaths occurred after it fell to 74° or 68°.

This high temperature is thus seen to be a frequent cause of disease, yet a temperature uniformly high, when there are none of the other circumstances present which favour the morbific agency of heat does not necessarily produce disease; thus it has been
observed that workmen in establishments where there is a constantly high temperature generally enjoy excellent health; and it stated by Sir James McGrigor "that during the march of the troops over the sandy desert of Chebys where the heat was uniform although the thermometer in the soldiers tents stood at 118° the health of the troops was equal to that, they had enjoyed at any former period in India."

The general effects of cold are in most respects the opposite of those of heat.

When it is not applied in an intense degree, or when intense only for a short time, so that the subsequent reaction may easily overcome it, it exerts a powerful tonic influence on the system. If however it be intense in degree or of long duration, it depresses the circulation and also the nervous energy of the part and if continued a certain time will destroy the vitality of that portion to which it is applied, producing what is termed frostbite, which generally occurs in those parts of the body where the circulation is most feeble, as in the extremities and tips of nose and ears. But not only local but general or somatic death may result from exposure to cold. A most intense
degree acts in the way of concussion, producing death by syncope; a less intense degree produces insensibility, stupor, drowsiness, and death in the way of coma. But when the cooling is still more gradual, and the loss of heat takes place equally throughout, the stagnation of the blood will be universal, and the cause of death not due to stoppage in the function of any one part. It is in this manner that death takes place from starvation; all the materials for generating heat becoming gradually exhausted.

This is the case as shown by the experiments of Lister. He found that animals whose death was impending from starvation, if subjected to artificial heat were almost invariably restored to a condition of activity, their temperature rose, and their muscular power returned; and if the artificial assistance was continued long enough, they in general recovered. It is probable that in many diseases attended with great exhaustion, death may occur from the same cause.

It is thus seen that cold may directly put a stop to all the vital powers when applied sufficiently long or intensely; but in general, death is rather and indirect result of the action of cold.
Formerly when the laws by which cold operates on the body were little understood, its morbid effects were supposed to come from sudden change from a high temperature, but since these have been more closely investigated, especially by Sir C. L. of Liverpool, this idea has been found incorrect; and that on the contrary a previously high temperature of the body, if its energies have not been exhausted by long continuance of the heat, is the most effective preventative of evil consequences from sudden exposure to cold. Among the inhabitants of Russia and Finland, and also among the North American Indians, it is a constant custom to rush from the vapour bath in violent perspiration and roll themselves naked amongst the snow or plunge into the adjacent river. And this practice is far from producing any bad results, on the contrary braces and invigorates them and counteracts the debilitating effects which so frequent use of it would otherwise produce. It is also related by Capt. Scoresby that although he was in the habit of going from the breakfast room of his vessel where the temperature was 35° or 40°, to the masthead where it was only 10° or below, and yet any
additional covering except a cap, yet he never experienced any ill consequences, and seldom any inconvenience from the uncommon transition. The community from injurious effects in these cases, is the same as stated above, to the heat of the body being steadily above the natural standard; and to whatever cause the increased temperature is owing, whether it be exercise, stimulants, liquor, or fertile excitement, sudden applications of cold will not be attended with any injurious consequence. It is not therefore to the circumstance of the body being in a high degree of heat, when the cold is applied, but as was explained by Dr. Burnie, when after being heated, it is beginning to cool again, which it does with great rapidity, especially if exhausted by fatigue and covered with perspiration, that its pernicious effects are to be attributed. Cold applied in these circumstances not unfrequently proves fatal. Alexander the Great is said by Quintus Curtius to have lost more of his soldiers from bathing in the river Bactra after a long and fatiguing march than he did in any of his battles, and on another occasion he himself narrowly escaped death from the same cause having fallen desperately into
The symptoms when covered with dust and sweat, and in other instances, are frequently caused by a sudden draught of water when the body is in a state of exhaustion from fatigue. A remarkable instance of this is mentioned by Dr. Burrie, "A young man after a most severe match at five and while sitting on the ground panting for breath and covered with perspiration, called to a servant to bring him a pitcher of cold water just drawn from a pump; he held it in his hand for some time till he recovered breath, and then drank a large quantity at once. He laid his hand on his stomach and bent forwards, his countenance became pale, his breath laboured, and in a few minutes he expired." Death in this case results from the action of cold on the solar plexus, situated close behind the stomach. In the above instances, a state of rest had succeeded the fatiguing exertion, and the body being also in a state of exhaustion, two powerful causes of cooling the body were in operation, the heat accumulated by exercise being easily dissipated, but while the "preneural" is sustained by continued exertion, cold water may be taken in considerable quantities without any injurious effects.
jects. This is well known to postilions, who always
make it a point to water their horses if possible a
mile or two before the end of their journeys.

In considering the influence of cold on the system
the capacity of the individual must be taken into
consideration, since that is the chief means of coun-
tering its power.

This capacity is well known to exist in little
perfection in children, and that they are unable
to sustain their temperature unless by art heat from
without. Consequently, the prejudicial influence
of cold will be well marked in them. Ignorance
of this has been the occasion of many delicate chil-
dren being sacrificed to the erroneous notion of
hardening them against its effects. The influence
of cold on the mortality of infants is shown by a ta-
gle drawn up by Mr. Buckleb. The average mortality
of children a month old is, for the three summer months
Dec. 4, Feb., and March 125; and the average of July
is 110. This is confirmed by Fillebeeck and Blume Ed-
wards who not only ascertained that the greatest
number of deaths took place during the first three
months of the year, but also that the number varied ac-
cording to the severity of the Winter in the different
the provinces of France, in which these tables were drawn up. In old age also the power of generating heat becomes lessened, and hence old people become ill, and the average mortality which in prime of life was almost the same in winter as in summer, becomes after 70 nearly as great as in infancy, and gradually increases up to 90 when (as shown by the same statistical inquiries) the number of deaths is as high as 158 in Italy for every 100 in July and the average of the three winter months 145 while that of the three summer months is only 68, or less than a half.

Another circumstance that greatly influences the generation of heat, and therefore the power of withstanding cold, is the supply of materials for combustion. These consist chiefly of the non-sapidized articles of food, an abundant supply of which is indispensible in the cold regions of the globe, for sustaining the animal heat at the ordinary temperature. Accordingly it is seen that these regions abound in food of this description, and the quantities devoted to the Eskymans and other inhabitants of these countries is truly enormous, but at the same time quite necessary to enable them to support their temperature.

The experiments of Koselat show the dependence of
of animal heat on the supply of food. He found that ani-
imals deprived of food suffered a slight daily diminu-
tion of temperature, the loss increasing gradually to
the day of their death. This diminution was not shown
so much by a fall in their maximum heat, as by an
increase of the diurnal variation, which in health
amounts only to about a degree and a half, but un-
der starvation it was found to be as much as 8°, grad-
ually increasing as the animal became weaker. On the
last day of the life the power of generating heat rapidly
diminished, till their death, the whole loss of heat
on that day being 25°. He found also that young ani-
mal's, as might be expected, lost heat much more ra-
pidly than adults, and that they died sooner from
starvation. Generally in about 2 days, the grown up
animals living till the 13th or 14th day.

Among the circumstances that favor the ac-
tion of cold on the system, is the condition of sleep.
During this state respiration becomes slower and the
circulation weaker, and all the vital actions
that conduct to sustain the animal heat are to a
certain extent in abeyance. Hence the temperature
is diminished and the power of retaining heat is
also less. Dr. Davy found that the difference in heat
is about 1/3 in health; he also discovered that independently of condition of sleep, the temperature is lower than during the day, the maximum and minimum being about midday and midnight. This may explain partly the greater danger of the night air and it may be stated generally that everything that tends to weaken or debilitate the system, and to diminish its power of evolung heat, will favour the injurious action of cold. The principal of these enumerated by Bell, besides what have been already mentioned are, evolutions, a last night's drink, excess in heavy, long watching, much study and preceding disease.

The injurious action of cold in producing disease of internal parts is principally owing the impression made upon the nerves, producing a sensation of cold and according to the intensity and duration of this will be the resulting disease. The length of time during which the impression is continued is however of great importance than the intensity. Since a strong sensation of cold may be quite harmless when applied for a short time, whilst a much lighter one, which may occasion very little sensation of cold, if continued for a considerable time, will produce serious
consequences. Strong impressions also produce prompt reaction, whereas more slight ones are followed by feeble reaction, and the sensation is therefore prolonged. But besides the impression produced on the nerves, cold also acts by constricting the capillaries of the surface and impelling the blood to wards internal parts, producing in this way congestion of the liver, spleen and other organs. The climacteric condition resulting from long exposure to cold may also be explained in the same way. Constrictions are produced if they continue long or are frequently induced, injure the tone of the vessels, and may end in inflammation or other disorders. When there is a tendency to these congestions from weakness of the circulation, the great benefit derived from the shower bath is to be ascribed to the habit of re-acting against minor degrees of cold, which is thus produced. Since the prejudicial effects of cold are greater as the sensation it produces is more intense and permanent, those conditions of the atmosphere mentioned in a former part as increasing the sensation will consequently increase its modifying power. Cold winds therefore especially when supercharged with moisture are proverbially pernicious
and hence also the insalubrious character of cold humid climates. Galen says that "a cold, foggy condition of the atmosphere is far more productive of diseases of the chest and abdomen, than an equally cold one when the air is clear." Edwards on trying the comparative cooling properties of cold, moist, and of cold dry air upon animals, found the reduction of temperature was the same in both, but the absorption of cold was evidently greater in the moist atmosphere, from the thinner displayed by the animal in it. It may therefore be inferred that it has a peculiar effect on the nervous system independently of the mere abstraction of heat.

The circumstances that diminish the tendency to suffer from effects of cold are "passions engaging close attention to one object." That state of body in which sensibility is greatly diminished as in maniacs" and the "power of habit." In regard to the first of these, it is a well known fact in physiology that when the mind is strongly directed on any one object, it is totally unconscious of impressions from other sources, and as the injurious effects of cold are owing chiefly to the sensation produced, the powerful direction of the attention into some other channel
while the cold is being applied, will have the effect of preventing this sensation, the injurious results of which will consequently not ensue. Thus, in a paroxism of spasmodic asthma, a person may remain for hours at an open window, when the temperature is below the freezing point, with nothing but his nightdress to shield him from the cold, without experiencing any evil effects from the prolonged exposure, his attention being so strongly occupied with the distress of breathing, that the impression is not perceived, and being not perceived is not followed by the usual results. And this insensibility is not owing to the temperature of the surface being kept up by the exertion necessary for breathing, since the temperature in this condition is generally much diminished, sometimes to the extent of 20°. The insensibility of maniacs to impressions of cold is strikingly illustrated in the following instance mentioned by Dr. Leunie. "I have known," he says, "a young woman once of the greatest delicacy of frame struck with madness, was lay all night on a cold floor, with hardly the covering which decency required, when the water beside her was frozen, and the milk which she was to feed on was a mass of ice. And of all the conditions of body, which enable it to
withstand the operation of cold, the power of habit is at once the most effectual and permanent. It is a general rule in regard to all sensations that their intensity is much affected by habit, being greatly diminished by frequent repetition. Provided the attention be not peculiarly directed towards them. The rule holds good in regard to cold, as manifested by its effects on individuals living in towns, and working in heated apartments, contrasted with people living in the country, and daily exposed to alternations of temperature. The influence of habit is not confined to the effects in modifying the degree of sensation, but it also accustoms the body to a more prompt reaction from the depressing power of cold upon the circulation, and likewise to a more powerful evolution of heat.

The most effectual means we possess therefore of inducing this habit of body and thus counteracting the morbid and susceptibility to cold, is the tone regimen generally and more especially the judicious application of cold; free and habitual exposure to fresh air and the use of the shower bath with moderate exercise. In order that the application be beneficial, it must be applied suddenly and only for a short time, so that its depressing effect be not
too great, nor in such a degree as produce any "limiting sense of chilliness." If applied in the proper manner, there should follow a pleasant glow all over the body, indicating the reaction which has taken place, and which is the principal object to be obtained. Those who have been debilitated from various causes, or who are so naturally, and in whom reaction is feeble, are rendered more capable of bearing it, and the subsequent reaction more strongly produced, by accelerating the circulation previous to the application of the shower bath, either by gentle exercise or a small quantity of wine or other stimulating liquor. In very feeble persons unable to sustain the shock of the shower bath, dousing the body every morning, at first with tepid water, and gradually coming to use it cold, is found a very efficient substitute. In both cases it is the safer plan to begin their use in summer, and continuing them throughout the year.

Having now gone over the principal physiological actions of cold and also the method by which its operation are regulated, I shall now proceed to enumerate as cursorily as possible the morbid conditions of body, which arise from sy-
future to its agency. Its importance may be estimated from the number of deaths attributable chiefly if not entirely to it, which comprehend a vast majority of diseases incident to humanity, and their frequent and universal prevalence, with the great amount of mortality arising from these as seen by statistics; and also from its influence in producing a more malignant type in other diseases, contributing greatly to increase the mortality from these. The influence of a low temperature on mortality is shown in the paper of Mr. Nebenius, comparing the number of deaths that occurred in London during the years 1795 and 1796 the former, the coldest and the latter, the mildest on record. In the month of January 1795 the thermometer, on an average, stood at 23° in the morning and at 24.4° in the afternoon, below the freezing point. During the same month of the following year, it stood at 43.5° in the morning and at 35°. In the five weeks beginning from 7th of January 1795 there were 2823 deaths; in the corresponding weeks of 1796 there were only 1471; the difference between the two being 1352.

Cold, in the same manner as heat, may act both as an exciting and a predisposing cause. When long continued without being counteracted
by sufficient clothing to exercise "by its sedative and debilitating, reducing all the vital properties of the system, it predisposes the body to be acted on by certain enabling causes of disease. Thus a healthy person may reside in a marshy district, without being affected with illness until he on some occasion become chilled by cold, and then, the body being thus debilitated, the malaria will take effect. The same is remarked in regard to many other contagious poisons. Of inflammation in the part to which it is directly applied, cold may be said to act only as a depressing cause, the subsequent reaction being the exciting. The vital properties of the part are lowered and therefore unable to withstand reaction of sudden and violent; inflammation is set up and that generally of the vesicular description, as chilblain blisters, lacerals and gangrene. To restore a part thus depressed by cold and at the same time to prevent this violent reaction, gentle friction with snow or ice are to be used. The friction arrests the sedative effect and induces reaction, the snow at the same time causing it to be gradual and such as the tender vitality of the part can bear. Many instances
are related in history of the disastrous effects of this "dry and violent reaction" being induced when the body was covered with clothes, as in the account of the retreat of the French from Russia, etc. When the sedative effects have been more general, so as to operate on the whole body, the same precautions are not necessary, since, the general circulation being restored, there is no danger from any partial injurious reaction; the patient may safely be brought into a warm apartment, and stimulants may be given together with more assiduous friction.

The depressing influence of cold on the vital powers is frequently shown towards the end of severe winters, by the prevalence of the most malignant forms of epidemic fevers of this country, at that period, and any disease recurring at that time, very often assume a typhoid type. This is chiefly observed among the lower orders in this country, who are unable to protect themselves sufficiently from the rigours of the weather, and it has also been remarked by travellers, that among the Eskimos and other inhabitants of Polar regions, diseases generally assume the asthmatic form.

As heat by increasing the functional activity
of the lung produces a predisposition to disease in that organ; he also, cold in the same way may be said to predispose the lungs and air passages to disease, by increasing their activity. It is seen therefore, that as in autumn, after a succession of sultry weather, the liver and bowels are deranged, so in spring after the protracted cold of winter, the respiratory organs are the most frequent seat of disease. Cold also as mentioned previously predisposes the body to be acted on injuriously, the warm climates, from the greater evaporation of heat induced.

The most numerous and important class of disease, however, produced by cold, are those on which it operates as an exciting cause. The chief of these are inflammations of internal parts, of which it is by far the most frequent exciting cause, and to enumerate which would be superfluous.

Of Acute Rheumatism it is probably the only exciting cause, the predisposing being, as is supposed, lactic acid in undue quantity in the blood. This explains the danger resulting from cold applied, while the body is in a state of perspiration, which contains this acid in abundance, especially after exercise, from transformation of muscular.
It is the principal channel through which it is eliminated from the body. If the perspiration therefore be checked while in this condition, the lactic acid will be retained in the blood and produce its morbid effects. Among the numerous circumstances that combine to produce scrofula it may be said to be one of the principal, especially if combined with moisture; hence it prevails chiefly among the poor, who are necessarily exposed to its influence in a greater degree than the higher order, and it rarely breaks out in summer, when the weather is mild and dry, but generally in the cold damp weather of winter and spring, and is a disease almost exclusively confined to cold humid countries. That it is not due chiefly to cold is shown by the circumstance of its being of rare occurrence in the northern and colder countries of Europe, Russia, Sweden, and Norway. But on the other hand it is also seldom seen in warm climates; and also, when it has shown itself, trivial removal to a warmer climate will often cause its complete disappearance; it is evident therefore that it requires a certain degree of cold, at all events, for its production. It is a disease also which may be produced at pleasure.
in animals, by confining them in cold damp places and giving them insufficient nourishment; and the several cases known where young men, to all appearance in a healthy condition, became affected with it, on being impressed, and placed under nearly the same circumstances as the animals subjected to experiment. Inhabitants of warm climates, and animals also from the tropics, are observed frequently to fall victims to it, after their arrival in this country, the cold taking more effect upon them. Dypsy is also frequently produced by application of cold while the body is in a state of perspiration or after an attack of scarlet fever. Of the obscure causes of Diabetes, this has also been mentioned as one, and there is a case mentioned by Dr. Christie in which seems to confirm this. It was in the case of a fisherman, who after prolonged exposure in a boat one stormy night, found his urine greatly increased in quantity, and on examination it was discovered to be loaded with sugar; the man died 18 months after. Cold is also a very frequent cause of many disorders of the nervous system as apoplexy, palsy, &c. In those who possess a tendency to apoplexy, it is a most powerful agent in the production of it, as an examination of the mortality bills
there, the number of deaths from it, being always in proportion to the severity of the winter, in some of which when the temperature is very low, it prevails like an epidemic. In producing it, cold may operate in two ways—by repellent the blood from the surface to wards internal parts, and also indirectly by both producing and aggravating diseases of the lungs, which being attended with dyspnea, and coughing, impede the return of blood from the head, and in this way produce cerebral congestion. The peculiar form of partial paralysis, called Facial palsy is more more frequently owing to cold than to any other cause. Dr. Powell mentions three cases, in each of which the affection was produced by exposure of the side of the head to a current of cold air for a considerable time; and there are also two instances of it from the same cause noticed by Dr. Watson. How cold operates in its production, is not well understood: it has been supposed to cause swelling of the soft parts around the Petrie aura, compressing it where it is situated in the petrous portion of the temporal bone.

There is still another diseased condition of the nervous system, which is occasionally due to this cause, namely, Vertigo. This most frequently arises from Transactions of the College of Physicians

*Transactions of the College of Physicians
after an injury, but in some cases it can be traced
to nothing else than exposure to cold. Seemingly from
this cause alone is rarely met with in this country, as
it appears to require a high atmospheric temperature
to produce a predisposition, but there is a well marked
case mentioned by Dr Hall of Broadford, where it
could be traced to no other cause, than exposure while the
body was in a state of profuse perspiration, one sultry
day; and he states that complete rigor was produc
dually, by the accidental exhibition of a very large dose of


Calm, besides the idiopathic form of it. This
cold scene sometimes to have a considerable share
in the production of the traumatic form of the
disease, acting as a concurrent exciting or
determining cause, when injuries have been inflict
ed. Thus it is stated, that of the French troops,
wounded in the battle of Hussen, which was
fought during excessively hot weather, very few
became affected with that disease, while, after
the battle of Frieden, which occurred in the cold
damp weather, immediately succeeding a very
hot season, it prevailed to a frightful extent
not even sparing those who underwent immediate
amputation. Of the manner in which cold operates
in its production and the changes effected in the
re-nerved system, nothing is absolutely known.