

from, the same general cause—the condition of the blood, as hunger, thirst, want of respiration, etc.

6th. Sleep, or repose, is caused by the condition of the blood, and not damage done to the organs during exercise.

7th. Repair of tissue necessary to keep the organ in a capable condition, the necessity for which is the result of their functional action, takes place during action.

8th. Hence, sleep is not necessary for such repair after their exercise. In fact, they are not left in a deranged condition.

9th. Sleep and repose of all the voluntary organs are necessary to replenish the blood with the material for their support.

10th. The nutrition of increment takes place during repose, and is different from the nutrition of repair which occurs during action.

ART. VII.—*The Causes of Fever.* By ISAAC CASSELBERRY, M. D., of Evansville, Ind.

THE causes of fever are generally divided by pathologists into two kinds—the *predisposing* and the *exciting*. The former are all those external and internal causes which tend to lessen the power of organic resistance to the influence of morbid agents. The latter are those causes which produce actual disease by certain changes in the quality and quantity of the blood, and the alterations of the solids consequent thereon.<sup>1</sup> There exists, however, no absolute difference in the nature of these two kinds of morbid causes. The same agent may manifest its influence on the human organism either as a *predisposing* or an *exciting* cause of fever, according to the degree of intensity with which it acts, and the previous condition of the organism.

SECT. I. *Of Predisposition and Predisposing Causes.*—When, either from a general condition of the organism, or some inappreciable change in the elementary constituents of the blood, the organism is especially susceptible to the influence of morbid causes, a predisposition to disease is said to exist. This predisposition may be either *acquired* or *hereditary*.

As the human organism is continually under the influence of causes which have a tendency to change and terminate its actions, life would only be ephemeral in its duration, and oppressed by constant disease, if the human organism were not endowed with the automatic nervous power of resisting, to a certain degree, the influence of injurious causes.

It is by the aid of this resistance that man is enabled to live through a series of years amidst a multiplicity of causes which conspire unceasingly to

<sup>1</sup> Linton's Pathology, p. 23.

his destruction. In relation to the degree in which this power of resisting injurious forces is possessed by different individuals, there exists great diversity; and hence the various degrees of the altered condition of the blood which constitutes a predisposition to fever among different individuals. Thus, the prick of a pin in one individual will cause a manifest change in the elementary constituents of the blood in the tissue; in another, syncope; in a third, convulsions or tetanus; and in a fourth, scarcely any perceptible effects.

There exists an organic predisposition to disease in some individuals wholly independent of acquired causes. This organic aptitude to disease is induced by a peculiar conformation of the cellular arrangement of the component elements of the blood in the organism, by which they more easily assume diseased action in one individual than in another. It is well known that the most healthy and robust individuals, in appearance, are often the first victims to a febrile epidemic. The vigorous and healthy are often prostrated by the pernicious causes of the paludal forms of fever, while the feeble and valetudinarian enjoy an exemption. With regard to acquired predisposition to fever, observation furnishes us with an extended variety of facts.

Every cause capable of deranging the normal state of the organism, may, when acting with moderate force, produce an altered condition in the component elements of the blood in one or more tissues, and thereby produce a predisposition to fever in the organism, requiring only some further exciting cause to evolve febrile disease. The impression of every morbid cause, on whatever part of the automatic nervous system primarily made, is, in the first place, conveyed to some particular tissue or organ, according to the force of the impression and the automatic nervous condition of the various organs of the system. If this be correct, it is manifest that if the morbid impression, thus conveyed to an organ or structure, be too weak to establish a sufficient degree of morbid automatic nervous action to produce general derangement of the capillary functions, or a febrile paroxysm, the effect will only be a slight degree of insulated functional derangement, which, though not manifested by any feeling or appearance of ill health, is still an incipient link of disease, and wants only some additional disturbing force to enable it to put in motion a train of morbid actions. How greatly mere functional derangement of an important organ aids the cause of fever in developing disease, is often conspicuously illustrated by the influence of digestive derangement in the production of fever. Let but this citadel of the animal organism languish, and the enemies of human health will speedily attack the outposts, and make an easy conquest of the whole. Hence, of all the precautions which those who visit insalubrious climates may be required to adopt, the avoidance of everything which is calculated to derange the digestive function is perhaps the most important. By a well-known law of the animal organism, every agent, how deleterious soever it may be, gradually diminishes, and finally almost destroys the susceptibility of the automatic nervous system to its influence by long continued or repeated action. Hence, every agent will manifest its ope-

ration with a promptitude and intensity proportionate to the degree of previous immunity to its influence.

It is this state of the automatic nervous force which causes the difference of predisposition to endemial forms of fevers between the acclimated natives of insalubrious regions and strangers arriving from northern latitudes. This variety of predisposition depends in no degree on a want of organic vigour or general health, but on the degree of automatic nervous susceptibility. The robust and healthy are, in general, as much under its influence as the weak and infirm. By a gradual or habitual exposure to morbid agents, the human organism loses insensibly its automatic nervous susceptibility to their influence. When such a change is effected by the combined operation of climatic and endemial morbid agents, the system is said to be acclimated, and the individual, thus acclimated, enjoys a comparative immunity from the diseases of the climate.

High atmospheric temperature exercises a very powerful influence in the production of disease. Long continued exposure to an elevated degree of solar heat tends very considerably to produce a disturbance of the automatic nervous force, and, in consequence of this, a deranged action between the elementary constituents of the blood, and thereby diminish the force of their automatic nervous resistance to the disturbing force of morbid impressions.

It is a well established physiological fact, that atmospheric vicissitudes have a decided influence upon the circulation of the blood in the external capillaries. When the atmospheric temperature is low, the atmosphere is more dense and heavier, and by its pressure retards the capillary circulation; and when it is high, it is rarefied and lighter, and admits the blood to circulate more freely, because it offers less resistance by pressure to the introduction of the blood into the capillaries by nutritive affinity.

A certain degree of temperature is necessary to the normal performance of the organic processes in the cutaneous capillaries; and when it is increased, these processes are accelerated; and when it is diminished, they are retarded. Hence, when the temperature is increased to a certain degree, the cutaneous secretions are augmented, because there is more blood in the cutaneous capillaries, and its different component elements are more abundantly transformed. The capillary functions can be increased only to a definite limit, beyond which diseased transformation must ensue. So long as the automatic nervous force can maintain a normal relation between the elementary constituents of the blood in the capillaries, augmented normal transformation of these elements may transpire; but whenever this nervous force loses its controlling power over these elements, morbid transformation will be produced. Then the effete elements of the blood cannot be removed by a secretory action out of the organism in the form of perspiration, &c.; and the nutritive cannot be transformed and attracted to the different tissues of which they are designed to compose ultimate elements, because they are not free of effete constituents. Diseased action between the different elements of the blood is present. They

are no longer governed by the controlling influence of the automatic nervous force; their normal transformation cannot take place; they aggregate in the capillaries in obedience to the laws of chemical affinity. The cutaneous secretions may be increased, decreased, or prevented; the skin may be either hot and dry, or cool, and bathed in perspiration.

A low atmospheric temperature retards the functions of the cutaneous capillaries by diminishing the intensity of the automatic nervous force which exists between the different elements of the blood in the form of nutritive attraction and effete repulsion. The elements of the blood may be normally transformed; but this process takes place slowly. The quantity of blood circulated in these capillaries is consequently diminished in a proportionate degree to the state of the atmospheric temperature, and the quality of the blood. For the circulation of the blood in all the capillary vessels is produced by the automatic nervous force, and maintained more by the controlling power of this force over the transformations of the different elements of the blood than by the mechanical force of the muscular action of the heart. If this be true, when the transformations of the elements of the blood are slowly produced by the force of any disturbing cause, diminishing the normal influence of the automatic nervous force, the quantity of the blood circulated in the capillaries must always be diminished in a manner proportionate to this diminution. Many pathological facts may be adduced in support of this position.

SECT. II. *Of the Sources of Morbific Causes, and their General Character.*—A certain quantity of heat is indispensable to life throughout the whole range of organized beings. Every animated being possesses an organic power to generate heat, and to resist, to a certain degree, the physical laws of its distribution, and, in consequence, to maintain its peculiar temperature when placed in a medium either many degrees below or above its own temperature. The constant and rapid production of heat by the organic forces keeps up the natural temperature of the animal organism, although surrounded by a medium which abstracts its heat with great rapidity. Such, indeed, is the evolution of heat by the human organism, that an atmosphere of the temperature of 98° is generally oppressive and unpleasant by the feeling of warmth which it causes, although, at this temperature of the air, no heat can be communicated by the surrounding atmosphere to the organism. The temperature most grateful and most invigorating to the human organism, ranges from 60° to 65°. This degree of temperature abstracts the heat of the organism in about the same proportion in which it is generated in the healthy state of the organism; and this degree of temperature is, therefore, the most congenial; for it neither exhausts the organic forces, nor gives rise to unpleasant symptoms. There exists, however, considerable diversity in the human organism in relation to the power of supporting the extremes of temperature. This depends not only on the original vigour of the organism, but also, greatly, on the influence of habit and modes of living. An individual endowed with a vigorous organism and with habitual good health, will endure a degree of cold, without any un-

pleasant sensations, which, to one of an enfeebled and exhausted organism, will be a cause of painful sensations.

Habit, in relation to previous exposure, has a powerful influence in varying the effects of temperature on the human organism. The same temperature will cause sensations of cold or great warmth accordingly as the organism has been previously exposed to a high or low temperature. Whenever the surrounding medium abstracts the heat of the organism more rapidly than it is generated by the regular actions of the organism, the sensation of cold will be produced; and the intensity of this sensation will always be proportionate to the rapidity with which the heat is abstracted, and the feebleness of the heat-generating power of the organism.

*Physiological Effects of Cold.*—When the temperature of the human organism is so low as to give rise to the sensation of cold, its immediate effects are—

1. *Diminution of the functions of the cutaneous capillaries*—because the automatic nervous force which is manifested between the different elements of the blood in these vessels, in the forms of nutritive attraction, effete repulsion, animal heat, animal electricity, &c. is weakened, and the quantity of the blood circulating in these vessels is thereby diminished. Hence, the cutaneous surface often presents a pale, shrunken, dry aspect, by exposure to cold, even when no pathological condition is induced between the elements of the blood.

2. *Diminished force of the muscular action of the heart and arteries.*—This effect upon the heart and arteries must follow as a necessary consequence of the weakened force of the automatic nervous influence in diminishing the force of the nutritive attraction and effete repulsion between the elements contained in the cells of the blood. These cells do not undergo their normal mutations with the same rapidity as when the automatic nervous force acts upon them vigorously. Hence the diminished force of action of the heart and arteries is manifested by smallness, weakness, and slowness of the pulse.

4. *Diminished sensibility of the external parts, passing by degrees through the whole organism.*—This condition is produced by the influence of cold in the diminution of the organic processes. The growth of vegetables, and the maturations of their seeds, may be retarded or accelerated by the increase or diminution of the atmospheric temperature. The same is, to a certain degree, true in regard to the organic process in the animal organism. But these processes are not, however, as much influenced by the vicissitudes of temperature as the similar processes in the vegetable; because of the heat-generating force of the automatic nervous system in the human organism. Every sensation is produced by an impression made on the automatic nervous force of the tissue or organ impressed, by which this force is increased, decreased, or perverted, according to the force of the disturbing cause. Hence, the varied degrees of sensation excited by atmospheric vicissitudes, according to its duration and intensity, or its medium and mode of application. The

impression of cold may be weak, transient, and invigorating, or it may produce a torpor of all the organic processes, or a lesion of tissue.

5. *Cold often increases the force of the organic processes.*—In order to exercise this influence upon the human organism, it must not be either too intense or too moist. When the atmosphere is cold, it is more dense, and often almost wholly free from moisture. In this state it is invigorating to the human organism.

The reason is obvious. The lungs receive by absorption from the atmosphere more oxygen at each inspiration. This increased quantity of oxygen increases all the organic processes. An additional amount of food is required, and an increased quantity of the elements of the blood are elaborated. All the organic processes are more active. Hence the aphorism of Hippocrates, "*Hicme ventres calidiores sunt.*" The appetite increases, and the process of digestion is performed more rapidly in moderately cool and dry weather than in warm.

We are informed by Xenophon that the Greek soldiers, on their return from Asia, were exceedingly harassed by the most severe sensations of hunger, while passing the snow-covered mountains of Armenia, although they were allowed their ordinary rations of food. These facts are supported by the observations of travellers in northern latitudes.

Moist cool air does not have the same invigorating effect on the organism that cool dry air does; because the atmosphere is, when dry, a non-conductor of heat and electricity, while, when moist, it is a positive conductor of both. When it is brought into proximity with the cutaneous surface, which is endowed with animal electricity, which is negative, the positive electricity of moist air, being more abundant, attracts the negative animal electricity as fast as it is generated. The superiority of the attractive force of cool moist air, by increased quantity, over the force of animal heat and electricity, transmits this heat and electricity into mechanical force, by which the moist air is repelled from the cutaneous surface. The continued action of the superior force of the moist air, however, disturbs the organic processes of the cutaneous capillaries, because of the influence the abnormal state of the animal heat and electricity exercises over the other organic functions of these vessels. The secretions of carbonic acid by the lungs, and that of the azotized elements of the transformed tissues by the kidneys, is often increased by the action of cold on the cutaneous glands. There is less than a normal quantity of blood circulating in the external capillaries, and an increased quantity circulating in the capillaries of the lungs, kidneys, and liver; the blood is in a normal condition, the cells containing its elements are more abundant, and, being in a normal state, are normally transformed. Hence, the secretions from these glands are more abundant than before the derangement of the capillary circulation.

Cold diminishes the action of the organism; for, although, when moderately and transiently applied, it is generally followed by phenomena attribut-

able to a stimulating influence, yet these are not the immediate consequences of the low temperature; but they are caused by increased action of the organic functions of the tissue or organ after the temporary reduction of their activity by the cold. When an agreeable glow and an augmentation of the general vigour is experienced after leaving a cold bath, it arises not from the stimulus of the cold, but from the temporary depression which the cold water exercises upon the automatic nervous force of the cutaneous capillaries. As the quantity of blood in the capillaries always depends on the activity of the cellular mutations between its elementary constituents, so, when the influence of cold, in whatever mode applied, retards these changes, it must diminish the quantity of blood in the capillaries, and, as a necessary effect, all the organic functions. But the blood in the capillaries, though diminished in quantity, is normal in quality. As the influence of the cold upon the automatic nervous force is removed, this force gives to the diminished quantity of the blood in the cutaneous capillaries the same organizing force as when a normal quantity of blood is circulating in them. Hence, all the cellular mutations are produced with increased celerity, because of the normal state of this nervous force, and the normal but diminished quantity of the blood. The blood in the arterial extremities obtains admission to the capillaries in a quantity proportionate to the rapidity of the cellular mutations between its elements. As these changes are accelerated, an increased quantity of normal arterial blood, rich in nutritive elements, is attracted by nutritive affinity into the external capillaries; all the organic functions of these vessels manifest increased vigour and accelerated activity; the individual feels an agreeable glow over the surface, and an augmentation of the general vigour of the whole organism; he perspires more freely, breathes more comfortably, regards his avocation and associations more pleasantly; his physical functions are performed more perfectly, and his moral attributes glow more brilliantly.

6. *Cold as a morbid agent.*—Cold is the most common and frequent of all the causes of disease in the temperate latitudes. Its influence in the production of disease is much enhanced when conjoined with moisture, for a very dry and cold air is far less capable of abstracting the animal heat and electricity than low temperature united with humidity. But the most important condition which renders the impressions of low temperature prejudicial to the animal organism relates to the state of the blood. The morbid influence of cold is always efficient in proportion to the abnormal condition of the blood, especially when this condition is induced by high temperature. The most powerful of all the predisposing conditions of the human organism to the injurious effects of cold is a state of free perspiration from fatiguing or exhausting labour, or exercise, under the influence of high solar heat.

*Heat.*—High atmospheric temperature acts much more frequently as a predisposing cause than an exciting. The mode in which solar heat contributes to the production of disease is manifold. The heated atmosphere is rarefied, and offers less resistance to the introduction of blood from the arte-

rial extremities into the external capillaries, and affords less oxygen to the lungs at each inspiration. Between the glands of the skin and the liver there is an intimate relation of function, in consequence of which whatever excites the functions of the former generally produces an equal increase of the functions of the latter. This complementary relation of function always exists between these organs, when the lungs fail to perform the normal functions of respiration. Hence high atmospheric heat very generally produces an increased secretion of bile, by its influence upon the liver through the medium of the skin, whose functions it is so peculiarly adapted to augment. It is manifest that an inordinate activity of these two functions from the influence of heat must render them extremely liable to inactivity from the sudden effects of cold; and it is equally obvious that a sudden inactivity of these two important excretories cannot occur without an immediate injurious effect upon the whole organism. (*Johnson on Climate.*) As atmospheric resistance to the introduction of blood into the external capillaries is increased or diminished, according to the vicissitudes of temperature, it follows that when the temperature is high there is an augmented quantity of blood introduced into the external capillaries, by the increased force of the organic changes between the elements of the blood.

All the organic functions of these vessels are augmented and accelerated. An increased quantity of blood, which is normal in quality, is circulating in them. They are full, sometimes distended, and often present a reddened aspect. Cellular mutations are accelerated. The blood is introduced from the arterial extremities abounding in nutritive elements. These nutritive elements are appropriated with more rapidity and facility to the different tissues, which are identical with them in ultimate elementary arrangement and composition; while the effete elements are removed from the blood by a secretory process with equally increased rapidity.

The skin is bathed in perspiration. The augmented animal heat generated by the combustion of an increased quantity of oxygen and carbonic acid is transmuted into mechanical force, by which the aqueous elements of the perspiration are removed from the surface in the form of vapour.

The transmutation of animal heat into mechanical force is always sufficient to maintain the skin at a normal temperature, where the blood is in a normal condition. The increased animal electricity which is negative is attracted and transmuted into mechanical force by the positive electricity of the vapour of the perspiration, and repelled from the skin with the vapour. The sensitive nervous branches distributed to the external surface partake of the increased nutriment supplied to all the tissues by the augmented activity of the automatic functions. The automatic nervous force is communicated to the elementary constituents of the blood in the blood-cells of all the tissues in the form of nutritive attraction and effete repulsion; the sensitive and excito-motory nervous elements are therefore elaborated and appropriated to the coalesced tissues of these structures in an equally increased quantity.



These nervous structures are endowed with augmented force. The sensitive functions are performed more nately, and the excito-motory more vigorously. An impression which would excite a sensation or motion in these tissues in this condition would not be recognized by them in an ordinary normal state. Hence they are much more influenced by any disturbing cause. This increased susceptibility of these nervous tissues to the force of a disturbing cause is often manifested in individuals in a high temperature by facilitating the production of sudden and dangerous local congestions or determinations of the blood.

When the atmosphere is rarefied, a less quantity of oxygen is absorbed by the lungs at each inspiration. The blood cannot, therefore, long continue to be normally oxygenated. It will soon contain an excess of the carbonaceous elements, unless their production be retarded; because they cannot be consumed by combination with the oxygen of the atmosphere, and manifested in the form of the different automatic nervous forces. The affinity of the different elements of the blood for each other is diminished by the diminution of the absorption of a normal quantity of oxygen at each inspiration. The force of all the organic processes is, therefore, retarded; because it is maintained by the normal cellular mutations between the elementary constituents of the blood, and whatever retards these changes diminishes this force. There is less desire to take nourishment; and if it is received into the stomach, it would not undergo chymification with normal facility and rapidity; and, therefore, it would cause a sensation of pain or fulness, more or less acute. Chylification and absorption are, in like proportion, decreased.

The nutritive elements in the absorbent system are not elaborated with the same energy; so that there is a less quantity of nutritive element received into the blood. The mechanical force of the action of the heart and arteries is diminished, because this force is maintained by the cellular mutations of the nutritive elements of the blood, at the termination of the muscular fibrillæ of the tissues, of which they are in part composed.

The increased activity of the external capillaries and diminished supply of the nutritive elements of the blood, by the decreased action of digestive processes, increase the deficiency of the nutritive constituents, while the *effete* elements are augmented by the excess of carbon retained in the blood. The elements of the blood begin to aggregate by chemical affinity in the capillaries, and an *appreciable* disease is manifested.

*Vicissitudes of Temperature.*—The sudden changes from a high temperature to a low, or from a low temperature to a high, especially when conjoined with all the sources from which febrile disease is most abundantly derived, are injurious in proportion to the state of the organism, the rapidity of the transition, and degree of the change. A very gradual change of atmospheric temperature seldom produces an *appreciable* disease, unless the blood is in an abnormal condition.

The mode in which high and low temperatures produce disease has already been explained.

It remains to explain the effects of the atmospheric vicissitudes upon the human organism, when they transpire with rapidity. When the cutaneous surface is in a state of free perspiration, under the influence of high solar heat, or from fatiguing and exhausting exercise or labour, the sudden application of cold to a large extent of surface, or to the stomach in the form of ice or cold water, will often suddenly produce the most alarming effects of extreme prostration, or an entire suspension of the organic functions.

The affinity of warm moist air for animal heat and electricity is much more intense than that for cool moist air. Hence, it is a much more powerful disturbing force. This is amply evinced by the deleterious effect of the atmospheric vicissitudes, when the air is loaded with warm, moist vapour, impregnated by pernicious gases evolved by vegetable and animal decomposition.

Both ancient and modern writers maintain that it is necessary to associate moisture with heat to generate malaria by the decomposition of vegetable matter. The ancients personified malaria under the emblem of a many-headed monster, whose devastating influence was so severely exercised over the luxuriant fields of Argolis, that it was made one of the labours of the potent son of Alcmena to rid the country of this dreaded source of pestilence. Hercules, therefore, drained the extensive Lernian marshes. The ancients were firmly impressed with the mysterious agency of all diseases; and hence they attributed the causes of fever to the mysterious agency of bad air, produced by vegetable decomposition in a moist atmosphere in high latitudes. This has ever continued to be the prevalent theory. Upon what is it supported?

The chemical and physical properties of malaria are unknown to us; the experiments which have been made to discover its existence have not been successful. The air collected above the marshes of Fort Fuentes was found by Gattoni as pure as that at the summit of Mount Leguone.

M. Desaye obtained, in the most confined marshes, as on the most exposed hills, 78 parts of azote, 21 parts of oxygen, and 1 of carbonic acid, from an analysis of the air. Carburetted hydrogen has been regarded as the poisonous element in marshes. (Thenard, Dupuytren.) The same causative effects have been attributed to sulphuretted hydrogen. (Daniel; Braithwaite, part xiv. art. 112. Gardner; Braithwaite, part viii. page 1.) Carbonic acid has been regarded as the cause, from its abundance in the blood and secretions. (Ficklin; *Transylvania Journ.*, vol. ii. art. 9.) M. Julia considers it a fermentative element deposited by the dews.

Malaria has been attributed to a great multiplicity of poisons. The strongest fact in favour of this position is the occasional prevalence of the continued febrile paroxysm, attended by the ejection of a peculiarly black matter and yellow aspect of the external surface; for example, in the same situation for months, almost entirely in the exclusion of the intermittent.

But as this occurs only under high temperatures, in which the dew-point is low, or, in other words, in which the atmosphere is loaded with moisture, I do not think it furnishes conclusive evidence that the cause is specifically different from that which produces the intermittent. On the contrary, it brilliantly illustrates the *unity* of the febrile cause; for, the disturbing force of the atmospheric vicissitudes is very intense, while the automatic nervous resistance of the organism is very feeble, from the augmented quantity and altered quality of the blood in the thoracic and abdominal viscera, produced by the frequent recurrence of a feebler force of these vicissitudes.

The vast majority of writers, both ancient and modern, have not assigned any definite element as the active agent of malaria. They all, however, seem to concur in attributing the production of malaria to the decomposition of vegetable and animal matter in a moist, warm atmosphere. (Blane, Lempriere, De Lisle, Baneroff, O'Halloran, Fellows, Johnson, Macculloch, Rush, Eberle, Cooke, Jackson, Fenner, and many others.)

All the facts, and many of the arguments adduced by these authors, in support of the malarious origin of fever, contribute, in the most conclusive manner, to illustrate the deleterious influence of the disturbing force of atmospheric vicissitudes in a warm, moist atmosphere.

In latitudes where the atmospheric temperature seldom rises above 60°, fever occurs but very rarely, and, perhaps, never in an epidemic form. The Lithuanian marshes of Russia do not render the surrounding districts insalubrious.

From a series of observations made by many authors, it appears that the atmospheric vicissitudes are not sufficient to develop fever when the temperature does not rise above 80°. The atmosphere must be both warm and moist. It is not, however, necessary that moisture should be present in great abundance, for the causation of fever. Hence, copious and continued rains, by inundating marshy soils, render such localities comparatively salubrious. (Rush, Cook, Daniell, Fergusson.) From his observations on this point, Fergusson was induced to think that the production of fever was wholly independent of the decomposition of vegetable and animal matter, and apparently without the agency of humidity.

In support of his position he says: "In the months of June and July, our army marched through the singularly dry, rocky, and elevated country on the confines of Portugal, the weather having been previously so hot for several weeks as to dry up the mountain streams. In some of the hilly ravines that had lately been watercourses, several regiments took up their bivouac, for the sake of being near the stagnant pools of water that were left among the rocks. Many men were seized with intermitting fever." (*Fergusson on the Nature of Marsh Poison*; Trans. Roy. Soc. Ed. 1821.) "Half dried ravines and stagnant pools of water" are surely no evidence of a want of atmospheric humidity, and when the surrounding atmosphere is hot and dry, constitute

an atmospheric condition the most favourable to the production of the most pernicious vicissitudes.

Water is a bad conductor; the heat of the sun is only imperfectly absorbed, and transmuted by the resistance offered to its absorption into mechanical force, by which the water in the form of vapour is conveyed into the atmosphere. As evening approaches, the atmosphere becomes more dense, until the vapour, in the evening and night, is deposited in the form of dew. The damp atmosphere is a conductor of heat and electricity, by which the animal heat and electricity is absorbed much faster than it is generated. The person exposed feels a sensation of chilliness. (*Willis on Fever*; Braithwaite, art. i. part 10.)

That a considerable degree of humidity is especially favourable and essential, is evident from the circumstance that marshes, stagnant pools, and the oozy shores of rivers and ravines have, in all ages and in all countries, been found the most insalubrious portions of the earth during the hot seasons.

The reason of this is obvious. Muddy water, or water which is impregnated with foreign elements, is a much better conductor of heat. Hence, the water in turbid and sluggish streams and stagnant pools absorbs more heat than pure water, before its resistance to absorption of heat transmutes the heat into mechanical force, by which it is conveyed into the atmosphere in the form of vapor.

The prevalence of fever in the vicinity of turbid and sluggish watercourses and stagnant pools, has long been observed and well authenticated. Soil has a considerable influence in the production of fever. (Rush.) A blue clay soil or an argillaceous one is the most favourable because it absorbs the heat of the sun, and in consequence retains its moisture, and thereby contributes to render the air in the vicinity moist. Let a person pass through a sandy soil over one of blue clay during a hot day, and he will feel sensibly the change.

The mixture of *fresh* and *salt* water in marshes, enhances the force of the atmospheric vicissitude. It is a singular fact, that the water of the sea is much more liable to go into putrefactive decomposition than fresh water. (*Eberle's Practice*, vol. i.) This, no doubt, depends on the great quantity of organic matter which it contains, and its consequent increased affinity for oxygen. The extensive pool of Valdec, in the south of France, and the large marshy plain in the vicinity of Luques, on the south of the Ligurian Apennines, may be cited as examples.

Those who advocate the existence of malaria maintain that it possesses a specific gravity greater than that of the atmosphere. (Rush, Caldwell, Cook, Eberle, Blane, Bancroft, De Lisle, Macculloch, and many others.) Hence they say, that persons sleeping in elevated chambers are much less apt to contract miasmatic diseases, than such as are lodged on the ground-floor. The ancient Romans appear to have been impressed with this idea, and they availed them-

selves of it by almost uniformly selecting very elevated positions or hills for the sites of their cities.

Many elevated localities, however, have been observed to be much more insalubrious than the low lands surrounding them. Morne-fortune, at St. Lucie, the Hospital and Richmond Hills at Grenada (Bancroft), Monjui, a hill 700 feet high, overlooking Barcelona (O'Halloran), may be cited as examples of this. Dr. Blanco and others relate similar facts.

The atmosphere immediately above the surface of the earth is warmer and much moister than that more elevated, and, therefore, has a greater specific gravity. Hence, the nearer the surface of the earth, the more intense will be the disturbing force of the atmospheric vicissitudes.

The insalubrity of some elevated localities may be explained by reference to their geological formation and vegetable growth, by which the atmosphere which has received its moisture from low lands surrounding them, are made warmer and moister, and of a greater specific gravity, than that over the low lands. Hence, from these causes, the atmospheric vicissitudes are, on these hills, more intense and pernicious. Writers upon malaria have observed its effect to be more deleterious during the first hours after the setting of the sun, and immediately before its rising. (Rush, Cook, Bancroft, Fellows, Johnson, and others.) These observations admit of an easy and philosophic explanation.

The atmospheric vicissitudes at these periods are the greatest, and the resistance of the organism to their disturbing force, the weakest.

The heat of the sun rarefies the atmosphere, and thereby diminishes the force of its presence; and in consequence of this, an augmented quantity of blood is introduced into the external capillaries, and all the organic functions in these vessels are performed with increased activity. There is a less quantity of oxygen absorbed, and food used, during the day. The resistance of the organism to the disturbing force of warm moist air, therefore, is diminished.

It is a well observed physiological fact, that the functions of the entaneous capillaries are augmented during sleep; and it is an equally well established physiological fact, that the degree of resistance to the force of disturbing causes and that of the activity of the functions of the organism, depend on the quality and quantity of nutriment received and normally assimilated. Hence, long abstinence from food, or even being without it during the night, especially when the organic functions of the entaneous capillaries are endowed with increased activity, as in sleeping, weakens the automatic nervous force and diminishes its power of resistance to the disturbing force of the atmospheric vicissitudes usually observed in high latitudes early in the morning. The pernicious effects of these vicissitudes in the evening and morning, have been often observed in this climate during the summer and early autumnal months.

Many authors maintain that the passage of malaria, like that of warm

moist air, may be prevented by mechanical obstruction. Thus, the interposition of a dense forest, of a high wall, a chain of elevated hills, or any other mechanical obstacle, has been known to protect the inhabitants of villages, of camps, of convents, and of single habitations from the pestiferous influence of neighbouring marshes. The pernicious gases are always more or less entangled and retained mechanically in the moist air, and often transformed into compounds less pernicious where the motion of the atmosphere is arrested or impeded. De Lisle relates several very remarkable facts illustrative of this observation. (Baneroff, Monfalcon.)

A convent situated on Mount Argental, near the village of St. Stephano, was, for a long time, remarkable for its salubrity until the trees by which it was surrounded were cut down, when it became extremely sickly.

From mechanical resistance to the dissemination of warm moist air, contaminated by pernicious gases evolved by vegetable animal decomposition, many confined localities have been observed to be peculiarly insalubrious. Marshes surrounded by dense forests, in warm climates, have given unequivocal illustrations of this fact. The same effect has been observed in most low, marshy districts in high latitudes, or in hot seasons, in this climate, when environed by high hills or a dense forest. From these causes, some of the valleys in the mountainous regions of South America, are remarkably insalubrious, while the surrounding elevated localities are extremely salubrious. This is the condition of Acapulco, which, as Dr. Macculloch says, may be regarded as a striking instance "of the imprisonment of malaria by hills." This explains the wonderful intensity of the disturbing force of the atmospheric vicissitudes in jungles and swamps environed by dense forests.

A diversity of opinion has prevailed as to the distance to which warm moist air may be diffused from its source of emanation. In a quiescent state of the atmosphere, the sphere of the disturbing force of the vicissitudes is much more limited than has generally been supposed, because the atmosphere is not a conductor, and, therefore, offers mechanical resistance to the dissemination of vapour. The continued force of this resistance overcomes the mechanical force of the transmitted heat of the sun, by which a portion of the water is driven into the atmosphere in the form of aqueous vapour; because, the mechanical force derived from the transmitted heat of the sun diminishes in intensity in a direct ratio of equivalence of distance from its source of emanation. The force of atmospheric currents often conveys warm moist air, largely impregnated by noxious gases evolved by vegetable decomposition, several miles in a state of copiousness and concentration, fully adequate to the production of a disturbance of all the organic functions, and a fever or a diseased transformation of the tissues.

"In Italy," says Dr. Macculloch, "the poisonous exhalations of the Agnano reach as far as the Convent of Cimadoli, situated on a high hill at the distance of three miles. The account of thirty Roman noblemen, mentioned by Lancisi, is an interesting illustration. They were sailing near the

month of the Tiber. Twenty-nine out of the thirty were soon seized with the intermittent form of fever."

The effects, often truly frightful, of the *harmattan*, after becoming loaded with the pernicious gases of the swamps of Beain, afford a strong elucidation of this fact. Those who reside on the north or east side of marshes, stagnant pools, or sluggish streams in this climate, often suffer much more from the vicissitudes of warm moist air, contaminated with gases evolved by vegetable decomposition, than those who live on the south or west margin; because, the atmospheric currents, during the hot season, generally prevail from the south to the north, or from the west to the east. Late in the fall, when the currents of air usually reverse their course, the southern or western margins are more insalubrious. The cause of this difference manifestly consists in the course of the wind. Violent storms, and copious showers of rain, tend powerfully to produce an equilibrium in the different forms of the external force. Nothing is more common, therefore, than to observe febrile, diarrhoea, and dysenteric epidemics to remit immediately after copious floods of rain, or violent storms. (Rush, Eberle, Baacraft, and others.) Those who believe in the existence of malaria, maintain that there is a variety (*Mio-miasmata*) generated by the decomposition of the matter of perspiration and the other secretions of the body. It is chiefly during the cold season of winter that it is generated. Its effects are always strictly limited to the confined and crowded hovels of the poor, crowded jails, ships, hospitals, and wherever many individuals are confined in apartments not duly ventilated. In order to save fuel, and to compensate for deficient clothing, the external air is carefully excluded. The unhealthy condition of these habitations admits of physiological explanation without the supposition that this mysterious monster, *miasmata*, is here generated and present. The food the inmates use is impure in quality and deficient in quantity, and the air they breathe is deficient of oxygen and contaminated by an excess of carbonic acid by being often breathed by the same or different persons without any admixture of the external atmosphere. Want of cleanliness and appropriate exercise in the open air, decreases and perverts the organic functions of the external capillaries. The cutaneous glands do not depurate the blood of the appropriate effete elements. (Snow; *Braithwaite*, part xiii. p. 146.)

The abnormal secretion of the skin, and often other abnormal secretions which are not deposited in an appropriate receptacle, produce an evolution of pernicious gases, as the sulphuretted hydrogen, which tends powerfully to disturb the perfect equilibrium which should be maintained between the different forms of the automatic nervous force, and thereby produce a diseased transformation of the blood. The blood is not normally transformed, the automatic nervous force is enfeebled, and the effete elements, when not depurated, gradually transmute it into chemical action or force between the elementary constituents of the blood. All the organic functions now suffer. The cellular matations of the elements of the blood are abnormal.

The different forms of the automatic nervous force becomes more and more enfeebled, and more and more transmuted into chemical actions. The excess of motion or force thus abnormally generated is but feebly conveyed to the motor apparatus of the organism, by which it might be consumed. The continued generation of this excess of morbid motion by the transmuted automatic nervous force, and its equally continued conveyance to the motor apparatus, produced a continued febrile paroxysm, until the automatic nervous force is consumed, or transmuted into chemical action between the elements of the blood and transformed tissues.

Many authors have called the form of febrile paroxysm, thus produced, *typhoid* or *typhus*, according to the presence or absence of particular local lesions of nutrition. From the simple fact that persons similarly situated are liable to suffer of the same disease, this form of febrile paroxysm has been supposed by many authors to be generated by contagion. There is no more evidence, however, of its propagation by contagion, than that of intermittent febrile paroxysm.

The form of febrile paroxysm varies in accordance with the degree of intensity of the disturbing force of the atmospheric vicissitude and the degree of resistance offered to this disturbing force by the automatic nervous force. Hence, we observe the intermittent and continued febrile paroxysms.

The deleterious power of atmospheric vicissitudes is manifested not only by violent and fatal forms of febrile paroxysms, which they are known to produce so abundantly, but also by the more slow inroads they make on the physical and moral condition of those unfortunate individuals who are habitually exposed to their influence. The indigenous inhabitants of marshy districts in warm climates present an aspect of suffering and wretchedness from this cause which is well calculated to excite the commiseration of those who are more fortunately located. Continually exposed to the deleterious influences of the vicissitudes of warm and moist air loaded with pernicious gases, man in such situations exhibits a state of feebleness and early decrepitude strongly indicative of a broken-down constitution and deep irremedial chronic disease. So deep and pervading are these climatic effects on the human organism, that it never fails to debase in a remarkable degree both the physical and moral constitution of a people who, through successive generations, reside in localities of this character. Not only does the stature and symmetry of the body suffer conspicuous deterioration, but the mind becomes torpid, feeble, pusillanimous, and the moral sentiments debased. Intemperance, the greatest social curse and most degrading moral blight, is also much more prevalent in these localities.

But, while such chronic and constitutional effects are wrought by the habitual endurance of these vicissitudes, the organism loses its susceptibility of being excited into those violent commotions of febrile action which they are so liable to produce in individuals less accustomed to their impressions. The natives of marshy districts are comparatively much more rarely affected



with the continued febrile paroxysms than those who are only occasionally brought within the sphere of these climatic vicissitudes; because in the former the disturbing agency of these vicissitudes is resisted by the inared automatic nervous force, while in the latter, who are not accustomed to its influence, its effects burst out in a raging and rapidly consuming flame.

There is no doubt that the disturbing force of atmospheric vicissitudes varies in the degree of intensity according to the various circumstances of locality, and the relative proportions of pernicious gases evolved by vegetable and animal decomposition. The febrile paroxysm of Batavia differs from that of Walcheren, that of Antigua from that of the Ganges, and all these differ from the plague of the Levant. (Dr. James Johnson.) That certain countries and localities have an especial tendency to generate one form of febrile paroxysm, while in other localities the other form almost exclusively prevails, is an observation founded on abundant testimony of unquestionable authority. In Germany, the intermittent febrile paroxysm assumes the tertian type; in Italy, the quotidian type greatly predominates; and in Hungary, fever is peculiarly liable to be attended with petechia. The febrile paroxysms of the Pontino mares are noted for the brevity of their intermissions, while in Holland they are equally noted for their protracted duration. In Spain, Africa, West Indies, and the southern parts of the United States, the febrile paroxysm is continuous, remarkably intense, and almost uniformly attended by the ejection from the stomach of a peculiarly black matter and yellow aspect of the external surfaces. In the Western States, the paroxysm is generally intermittent, but sometimes continuous.

As the morbid effects of the disturbing force of the vicissitudes of warm moist air produced on the functions of the organism depends on the resistance offered to its deleterious force by the automatic nervous force, so of a number of persons exposed for a certain time to this atmospheric vicissitude. Some may be affected with the intermittent, others with the continued: others may escape entirely.

The local manifestations of the diseased condition of the blood produced by the vicissitudes of warm moist air is by no means limited. The most simple form of general disease induced by this state of the blood is the intermittent febrile paroxysm as it usually prevails in the Western States. As the intensity of the disturbing force increases in power the automatic nervous force generally diminishes in resistance, and the febrile paroxysm increases in duration and malignancy. Then the febrile paroxysm almost always exhibits *appreciable* local manifestations of the general diseased condition of the tissues in the form of an inflammation or congestion. The diseased condition of the blood is often manifested in the form of dysentery, diarrhoea, pneumonia, hepatitis, neuralgia, &c.

The reason that many low, wet districts usually remain healthy in this climate is that the water remains nearly pure and, being a very imperfect conductor of heat, absorbs only a small quantity. This heat is, of course,

chiefly transmuted into mechanical force and driven into the atmosphere, carrying a portion of the water in the form of vapour. The vapour soon becomes so attenuated by the force of atmospheric resistance that it makes but a feeble impression on the organism.

The water of alluvial pools, bayous, sluggish streams, and their oozy alluvial shores is made impure by vegetable decomposition and mechanical retention of foreign elements. The affinity of the water of these localities for the heat of the sun is commensurate with its impurities; but the quantity of heat absorbed is more than equal to that transmuted into the mechanical force, by which a portion of the water is driven into the atmosphere in the form of vapour; because a portion of the absorbed heat is retained in the water, by which its temperature is made higher than that of pure water in the same locality. Another portion of the absorbed heat is transmuted into chemical affinity, by which impure water has a greater attraction for the oxygen of the atmosphere than pure water. Hence vegetable matter undergoes decomposition with much greater rapidity in impure water, and the gases of which the water and vegetable matter are composed are much more abundantly liberated. Some of these gases, which have no affinity for each other when completely evolved in the nascent state, readily combine and form new compounds.

This explains the formation of sulphuretted and carburetted hydrogen so abundantly evolved by vegetable and animal decomposition in a warm moist air, or in water impure from these decompositions. The pernicious effects of the respiration of these gases upon the human organism has been minutely described and well authenticated. (Daniell; *Braithwaite*, part iv., art. 112; Dr. Gardner; *Amer. Journ. Med.*, April, 1845; and others.) The production of fever has been ascribed to the presence of these gases by some of the same authors, but without sufficient evidence. They contribute to the formation of fever by disturbing the normal state of the automatic forces. This is the mode in which all gases evolved by vegetable and animal decomposition influence the human organism. They diminish the automatic nervous resistance to the disturbing force of atmospheric vicissitudes.

When the absorption of the animal heat from the cutaneous glands by moist air takes place with great rapidity, or when it is often repeated, all the organic functions performed in these glands must be decreased or perverted, according to duration or rapidity of the absorption, and the condition of the blood. For the force of nutritive attraction and effete repulsion between the elements of the blood is maintained by the automatic nervous force, which controls and regulates the organic functions and maintain a perfect equilibrium between it and the chemical action between these elements. Chemical action is always increased by transmutation of this force, by the force of a disturbing cause, when its intensity is not adequate to the resistance of the disturbing force, and this action which is maintained by transmuted automatic nervous force, and which takes place between the elements of the blood

and the oxygen of the atmosphere in the capillaries, perverts the transformation of the blood-cells, when it predominates over the automatic nervous force. The secretory processes by which the blood is freed of its effete elements, and the nutritive process by which the different tissues are maintained and repaired, are decreased or perverted, because the cells containing neither the effete elements nor the nutritive are normally transformed.

If, then, by cold produced, the absorption of animal heat by moist air, an elementary constituent, or constituents, be increased, decreased, or perverted by a lesion or diminution of the automatic nervous endowment, they will continue to maintain a morbid relation to the normal elements of the blood as long as the chemical action between the elements predominate over the automatic nervous force. Controlled by the laws of chemistry, they will aggregate in obedience to these laws; and, as superior quantity is equal to increased affinity, they will continue to augment by affinity.

This is abundantly manifested by the progress of any disease. In the forming stage of an inflammation there is only a slight increase of the protein compounds, and protein excess, by the superior affinity of an increased quantity, in accordance with chemical laws, continues to augment, and soon constitutes the prominent character of diseased action.

In the incipient state of fever, there is only a minute excess of carbonaceous compounds retained in the blood by a suspension of the secretory process by which they are eliminated. The retained carbon produces chemical action between the elements of the blood, and thereby makes less intense the force of the nutritive attraction and effete repulsion between them. It disturbs that perfect equilibrium which should be maintained between the organic nervous force and the chemical action, and, in consequence of this disturbance, many of the cells containing elementary constituents of the blood are not normally transformed. A greater or less lesion of the organic function must supervene. The lesion of the capillary circulation will be commensurate with the duration or intensity of the disturbing force upon the automatic nervous force. The carbon in the blood-cells which are not normally transformed, will not combine with the oxygen of the atmosphere, or contribute to the formation of elementary compounds, or evolve heat and be removed from the blood in the form of carbonic acid by a secretory process. A limited quantity only of carbon combines by cellular mutation with an equivalent of oxygen; hence, only a portion of the carbon of the blood is consumed by combination with oxygen, while another portion is transmuted into chemical force.

The lesion of the capillary circulation will be commensurate with the duration or intensity of the disturbing cause. The action of the heart and arteries will become more and more enfeebled by the augmented quantity and altered quality of the blood retained in them by capillary lesion. For, although the muscular contractions of the heart and arteries may be increased in rapidity, yet they are diminished in intensity; because the force of these contractions,

which is derived from cellular mutations at the ultimate terminations of the fibrillæ of which their muscular tissue is composed, is decreased or perverted according to the quality and quantity of the blood circulating in their capillaries. Any disturbing force will, therefore, produce a diminution of the muscular force of the action of the arteries and heart, where it is of sufficient intensity to retard the cellular mutations in cardiac or arterial capillaries either by direct lesion of their automatic nervous force or by indirect lesion of this force through the medium of the altered quality of the blood, in which the chemical action predominates.

Eafeehled action of the heart and arteries *always* precedes a febrile paroxysm, and is always present during that period. A *febrile paroxysm* is produced when the automatic nervous force communicates the excess of the chemical action or force to the sensitive and excito-motory nervous systems. As the phenomena of motion in the animal organism are dependent on the change of matter, so the increase of the change of matter in any organ or tissue is followed by an increase of all the motions. When a great excess of force is produced by a change of matter, the force, since it can only be consumed by motion, is extended by the organic nervous force to the apparatus of the sensitive and excito-motory systems. (*Liebig's Animal Chemistry*, p. 75.) This is an explanation of the aspect and condition of the organism usually present during a febrile paroxysm. An accelerated state of the circulation in a febrile paroxysm must always be preceded by an increased cellular mutation of the elements of the blood in the capillaries, because these are the agents which the automatic nervous force employs to control, maintain, increase, or diminish the force of the circulation.

A resumption of the organic functions in the external capillaries must always precede an increased force of the circulation. This is manifested by an increased heat of the skin, a suffusion of the surface, often a throbbing of the external arteries, and always an incipient perspiration. Then an increased quantity of blood and of oxygen is conveyed into the capillaries. Copious perspiration follows; an increased secretion of urine and of bile ensues; and respiration is free and more tranquil. The oxygen absorbed from the atmosphere is conveyed to the whole organism, combines with the excess of carbon in the blood, and evolves heat, while the azotized elements of the transformed tissues are left free to combine with hydrogen, and be removed by secretory processes.

When the organic functions in the capillaries are performed with abnormal rapidity, an increased quantity of arterial blood, rich in nutritive elements, is introduced from the arterial extremities into the capillaries by the increased affinity of superior quantity. The accelerated force of the augmented quantity of the blood, and the increased rapidity of the muscular action of the heart and arteries promotes the combination of the oxygen of the atmosphere with the retained carbon in the blood; and if lesion of capillary circulation is not produced by the excess of chemical action between the elements of the

blood in any organ, the increased combination and combustion of the abnormal excess of carbon will continue uniform until it is neutralized and removed from the blood by secretion, by which the blood will be depurated of effete elements, and left in a normal condition. But when lesion of the capillary circulation is produced by excess of chemical action in any organ, the elements of the blood in the capillaries in that organ will aggregate by chemical laws, and the oxygen of the atmosphere will not only combine with the aggregated elements of the blood in the diseased capillaries, but also combine with the elements of the adjacent tissues, for which it has an affinity, because their automatic nervous force has not sufficient intensity to produce the cellular mutations by which the oxygen could combine and consume the retained carbon in obedience to the laws of the organism. The force of the oxygen which does not combine with the excess of carbon in the aggregated elements is spent upon the adjacent tissues; diseased action augments; a lesion of solid tissue is produced. This lesion will be commensurate with the abnormal condition of the aggregated elements and the degree of resistance offered to the diseased action by the automatic nervous force.

ART. VIII.—*Diffuse Aneurism of the Femoral Artery, following a wound; Ligation of the External Iliac Artery, &c.; Recovery.* By A. H. AGARD, M. D., of Western Starr, Summit County, Ohio.

A. P. M. aged 27, a muscular, hardy man, of a sanguine-bilious temperament, received a stab in the upper and front part of the thigh, on the night of December 7, 1854, with the blade of a small dirk-knife. Profuse hemorrhage followed, from which he fainted in a few minutes. The blood was said to have been dark coloured, and to have flowed without any arterial jet. He was not seen by a physician, however, until after syncope had taken place. The amount of blood lost was reported by the bystanders to have been quite large. Vomiting and recurring syncope followed for a few hours, when reaction came on, and he was thought to be comfortable and doing well.

The wound, which was found near the inner border of the sartorius muscle, about one and a half inches above the point where the border of the muscle passes over the femoral artery, consequently a little to the outer side of the artery, was dressed by a compress and roller by Dr. Chapman. No hemorrhage followed. The surface wound healed in two or three days, and the patient so far recruited that he was taken home, a distance of three miles. Meantime a large, painful tumour appeared in the region of the injury, which gave the friends some anxiety, and Dr. McNeil, the family physician, was called in December 11, four days after the receipt of the injury. What the