stantly protruding; no splints could be kept on, and it was a question whether the arm should be taken off; but at a consultation of the surgeons it was decided not to amputate. At length, the patient regained a little consciousness, and I put the arm into a better position. From this time matters went on improving; the fracture united, and the limb became a perfectly sound one. Ultimately this man made a perfect recovery, and I lost sight of him for a number of years. About sixteen or eighteen years afterwards, when I was assistant-surgeon in the out-patient department, a man came into the room with a little girl. When I had done my work with the little girl, he said to me, "You don't seem to recollect me, sir?" I said I did not. He took off his coat and showed me his arm. There were the marks of the large wounds, and I at once recognised him as the man who had been perfectly insensible for a whole fortnight and yet recovered. Two years afterwards he again fell under my notice with a large aneurism involving the brachio-cephalic artery, and spreading to the aorta. I begged him to come into the hospital, where he remained for awhile and then went out. Some time afterwards, a man called at my house and asked me to go and see the same patient, who was dying in a mews, and who, knowing that I had been working at injuries of the head, had said that, if I liked to examine his head, he would give orders to his wife to have it done. With Mr. Holmes I subsequently went to examine the head, and his wife then told me that, if I wanted to illustrate anything, her husband's express wish was that I should have liberty to take away any part of it I chose, or any part of his body. That man was a brave and a large-minded man. Mr. Holmes and I examined the brain, and you will now find it in our museum. At the under part of both anterior lobes were evident traces of the injuries. You might have put a walnut into the part of the brain which had disappeared on the right side, the cavity being filled with loose areolar tissue. On the left side the destruction was not so great on the corresponding part, but you might have dropped a cobnut into the cavity. The brain-substance at the seat of the original injury had been quite absorbed, and these two large holes were left. It is not very likely that a patient living so long after such a severe injury will fall again under the notice of the surgeon who attended him, and that after the lapse of eighteen years the same surgeon should have the opportunity of examining the parts which had been injured.

In conclusion, Mr. Prescott Hewett stated that this patient, after recovering from the brain-injury, had become one of the best workmen in London. He was in after years a noted house-decorator, and especially employed by one of the largest firms wherever most refined work was to be done in painting and decorating drawing-rooms. And during this time he had been in the enjoyment of good health, and not more subject to headaches than his fellow-workmen.

NERVE-FORCE IN WASTE AND SUPPLY.*

By SAMUEL WOOD, Esq.,

Honorary Secretary of the Shropshire Scientific Branch of the British Medical Association.

GENTLEMEN,—In looking around for a subject on which to address you, I found, as usual on such occasions, that the difficulty which presented itself was not so much to find one as to choose one. Not merely the science and art of medicine, properly so called, teems with topics of interest—any one of which would tax far higher powers than my own to examine and illustrate it—but the sciences which are ancillary to medicine, and those on which the superstructure of professional knowledge is based, are replete with treasures which on all sides attract the searcher, any fragment of which, although polished by an unskilled hand, will assuredly in value and brilliancy well repay the labour.

The subject to which I determined at last to venture to invite your attention, attracted me to it both by its intrinsic interest and by the light which it is capable of throwing upon our daily work at the bedside. It is one which belongs to the chief of the natural sciences on which medicine rests: I mean the knowledge or science of the healthy animal organism—physiology.

My theme is Nerve-Force in Waste and Supply: in other words, the function of the nervous system—the part played by the great nervous centres, with their offshoots and tributaries, in the all-important processes of life—nutrition and disintegration.

In approaching this subject it is necessary to limit it. If we study the processes of nutrition under their most simple conditions, we find that they undoubtedly go on without the help of nerve-force; in fact, in the entire absence of a nervous system. Nerve-force is, therefore,

not a necessary element in nutrition. The whole vegetable kingdom is nourished by processes and organic contrivances so closely analogous to those which support the animal, that science has difficulty in drawing the line of demarcation between them; it clothes the earth with luxurious beauty, and gives directly or indirectly sustenance to all other living things, existing and perpetuating its existence by the assimilation of a few inorganic elements; yet it is, throughout its manifold orders, genera, and species, without a trace of a nervous system. The lowest and simplest forms of animal life, again, are produced, grow, reproduce their like, obtaining nourishment which they digest and assimilate into their own texture; and yet the minutest observation has failed to detect in them any nervous ganglion or filament. Nay, that nerve-force is not essential to nutrition, may be asserted from evidence drawn from man himself. The human embryo exists and grows, and acquires a specific organisation, before any trace of nervous cord or centre can be found in it; and even in the adult mammal, no lens has ever detected a nervous filament in healthy cartilage—a structure which, nevertheless, is subject to the same processes of renewal and decay as the other tissues of the body. We have, therefore, ample evidence that nerve-force is not essential to the process of nutrition.

What part, then, does the nervous system play in the reparation of the animal body and the removal of its retrograde products? In the first place, we may answer generally that the part played by the nervous system is one of *influence*. If we take the term "nutrition" in a wide sense, as including the processes of digestion, absorption, sanguification, as well as nutrition proper, or the repair of tissue, we shall find no lack of illustrations of the influence exercised by the nervous system over these processes. Healthy appetite is the prayer of the body for new *pabulum* to restore the loss which is constantly going on in the production of animal heat and in the waste of tissue. Appetite for food itself is a sensation which we owe to the nerves of organic life, and partly at least to the nerves supplying the stomach. But to what a high degree is appetite itself stimulated through the nerves of the special senses—through the smell, the taste, the eye, and the ear. Watch the hungry carnivore, with its ears erect, its excited eyes, and the saliva streaming from its jaws, as its olfactory nerves perceive afar the lump of carrion which its keeper is bearing. Even to philosophers the fragrance of dinner, the sight of a well-spread sideboard, and the pop of a champagne-flask, are appetising influences. On the other hand, how completely will shock to the nervous system, whether it be from some physical accident or some overpowering mental emotion—be it of a depressing or exhilarating kind, or some absorbing pursuit—for a time annihilate appetite. But these are trite and commonplace illustrations, which must at once occur to us all. Disease furnishes us with numerous and some of the best examples of the influence which the nervous system exerts over digestion. The complete loss of appetite and of digestive power which ushers in and accompanies acute hydrocephalus, the entire absence of the sensation of hunger and thirst exhibited by some patients suffering from melancholia, and the length of time during which persons in a state of catalepsy will support the entire deprivation of food and drink, are illustrations of this influence. Further evidence is supplied by physiological experiment. The old observations of Dr. Beaumont on St. Martin prove that digestion is delayed by mental emotion, and that, to insure the rapid and complete passage of food from the stomach, tranquillity of mind is a necessary condition. Again, it is well known that division of the pneumogastric nerves during digestion immediately, although temporarily, suspends the secretion of the gastric juice; the mucous membrane of the stomach, previously turgid with blood, becomes pale and ceases to secrete. Now it matters not whether this effect be due directly to the section of the pneumogastric nerves, or, as is more probable, to the shock of the operation; the disturbance of the process of digestion by a cause directly acting on and through the nervous supply of the stomach is equally illustrated.

There is another fluid, besides the gastric juice, which is directly concerned in the first stages of the process of digestion. How remarkably the secretion of the saliva is influenced by mental emotion—especially by emotion of a depressing kind, such as fear or grief—is an observation as old as the oldest records of humanity, wherein we read of the tongue cleaving to the roof the mouth, as the effect and evidence of grief.

But to pass from the earlier processes of digestion, and to trace the nutrient fluid through the different stages in which it is fitted to afford elements which repair tissue-change, or which, becoming oxidised in the circulation, afford the heat which is the form of force essential to animal existence, would afford us at every step of the process evidence of the influence which the nervous system exerts in controlling function and modifying and adjusting supply to meet demand. I would here remind you of one or two points which modern research has brought to light, in reference to the influence of the force in ques-

* Read at the annual meeting of the Shropshire Scientific Branch.

tion on the function of the two great glands which perform very important duties in the process of digestion—the pancreas and the liver. One part of the function of the pancreas, according to modern observers, is the production of a ferment for the digestion of albumen. It has been found by Schiff that the pancreas becomes charged with this ferment only during the absorption of peptogenic substances from the stomach. This act of absorption by the vessels of the stomach seems to be essential to the production of the digestive ferment by the pancreas. But the influence exerted by the process of absorption in the stomach on the pancreas is one of a reflex character; for Schiff found that, when the solar plexus was extirpated, or its connections with the spinal cord destroyed, the pancreas did not become charged with the ferment in question. The reflex change, according to Schiff, consists in the active dilatation of the vessels of the gland. If we turn to the liver, disease affords abundant proof that its chologenic functions are influenced by nerve-force. But I need not remind you that, besides the function of forming bile, that of forming grape-sugar has been attributed to that organ; and that, on the whole, the balance of physiological evidence seems to prove that the liver performs a glycogenic function—if not solely of the organs and tissues of the body, at least in a high degree. A distinguished American physician has recently advanced the theory that this glycogenesis may be increased by stimuli acting after a reflex manner. For instance, the large production of sugar in the blood during lactation, and the increase of that substance in the blood during pregnancy, which have been observed by Blot, are due to the liver being excited to an increased glycogenesis by a reflex nervous influence. Dr. Gouverneur Smith's theory is, that just as the flow of the gastric juice can be augmented by exciting the salivary secretion, so the glycogenic function of the liver is stimulated into activity by the changes which go on in the gravid uterus. Be this, however, as it may, we have the evidence both of physiological experiment and of pathological record, that direct irritation of a special part of the encephalon will produce an augmentation of sugar in the blood, and its consequent excretion by the kidneys. It is now sixteen years since Claude Bernard discovered that it was possible to produce glycosuria by irritation applied to the floor of the fourth ventricle, in the space comprised between the origin of the pneumogastrics and the auditory nerves. This experiment has met with remarkable clinical confirmation. Amongst other observers, Tardieu has recorded a case of diabetes mellitus which was connected with disease of the fourth ventricle. The medulla oblongata in its vicinity was injected, and of a dark grey colour. Symptoms of left hemiplegia were present during life.

Without attempting to unravel the mysteries which still shroud the process of sanguification, we may at least affirm that no physiological function is more clearly shown, by daily observation, to be under the influence of nerve-force. All of us recognise amongst the most common causes of anæmia mental affections, especially disappointed and hopeless passion. The chlorosis of the physician, and the green and yellow melancholy of the poet, have in a great number of instances the same cause, and are, in truth, identical.

"She never told her love,
But let concealment, like a worm i' the bud,
Feed on her damask cheek."

Whatever be the ultimate design of the red corpuscles, whatever the abstruse chemistry by which they attract to themselves iron and oxygen, whatever their relation to the mysterious amœboid leucocytes which are playing such an important rôle in modern pathological doctrine, we at least know that the quantity of this red currency may be diminished or increased by a dominant idea—an airy nothing, a psychical abstraction, thought—cerebration, if you prefer the modern phrase—exerting its influence through the marvellous nervous mechanism which connects and supplies the organs of organic life.

But it is time to inquire what is the exact nature of the part played by the nervous force in ultimate tissue-changes in waste and supply? The supply of blood to all parts of the body is regulated by the vaso-motor branches of the sympathetic, which supply the blood-vessels. It is well known that, if the sympathetic nerve be divided in the neck of an animal, the corresponding half of its head becomes excessively vascular, the vessels greatly dilated, the ear, the nasal membrane, the conjunctiva red and turgid with blood. The calibre of the blood-vessels and the consequent amount of nutrient fluid distributed to any organ are therefore directly under the influence of the sympathetic branches supplied to the blood-vessels. Divide the trunk of the nerve, and the regulating contractile power is no longer exercised; the blood-vessels dilate, and a condition of passive congestion is the result. It is difficult to foresee what may hereafter prove to be the value of this discovery to the healing art. Already some attempts have been made to utilise it in the actual treatment of disease. I refer to the influence which cold and heat applied to the spinal cord are believed by some to

exert over the vaso-motor system. But we may rest assured that much more remains to be done, before the full benefit of this discovery can be reaped by mankind. I may here notice that derangements of nutrition—inflammations, in fact—have been observed to occur in certain structures when the nerves supplying them have been divided, or paralysed. To these inflammations the name of neuro-paralytic inflammations has been applied. It was long ago observed that section of the fifth nerve caused inflammation of the conjunctiva and iris, and opacity and ulceration of the cornea. Now it is true that some experiments performed by Büttner and others tend to show, that this inflammatory process is the result of external irritants to which the eye is more exposed, owing to the loss of its sensibility. But other experiments by Samuel and Büttner demonstrate that irritation of the Gasserian ganglion is followed in twenty-four hours by violent irritation of the conjunctiva and cornea, ending in ulceration, when the utmost care is taken to exclude all external irritants. We have here, then, direct evidence that modification of a nutritive process may be produced by irritation of a nervous ganglion. But here, again, it is necessary to guard ourselves from error. The function of the vaso-motor nerves does not seem to be absolutely necessary to the nutritive process. The half of the head of a rabbit in which the cervical sympathetic has been divided, although its vessels are turgid with blood and its mucous membranes congested in a high degree, does not seem to suffer in nutrition. This condition may be maintained for weeks, or even months, and yet neither hypertrophy, nor atrophy, nor inflammation follows. Therefore, whilst the amount of supply of blood to a part is directly regulated by the nerve-force conveyed through the vaso-motor filaments to the contractile coats of the vessels, this nerve-force is not essential to the process of nutrition or disintegration.

But let us look at the matter from another point of view. The nutrition of a part depends upon its use. In organs which are unused, the processes of waste soon outstrip those of supply, and atrophy is the result. This is exemplified in every case of paralysis affecting voluntary muscles, in every accident or experiment where the motor nerve of a limb is divided. The nerves convey to the muscles the stimulus of volition and reflex stimuli, and thus the voluntary use of parts and the involuntary ceaseless action of the marvellous mechanism of the body are maintained. To natural action and to natural function, and to the maintenance of the equilibrium of supply and waste, which is the result of action and function, the nervous system is therefore essential.

It does not detract one iota from this truth that the nerve-force may be imitated by the electrical or galvanic stimulus; that, if a nerve of a limb of a frog be divided, it is possible to maintain the nutrition of its muscles by exercising them by a galvanic current passed through the cut extremity of the nerve. This fact, although it proves that it is the exercise and not the nerve-force which is necessary to nutrition, does not diminish the value of the physiological truth that the nerves are the conductors of the stimuli which are in the healthy condition essential to such exercise. Nay, it may be maintained that, by passing the galvanic stimulus through a nerve, that stimulus is converted into nerve-force. When the operation of dividing the sympathetic in the neck, already referred to, is performed, the dilatation of the vessels and the congestion of the mucous membranes may be made to disappear by passing a current of electricity through the part.

Nerve-force is, then, not an essential of nutrition, but it is the grand influencing and controlling agent which presides over the processes of waste and supply. Nerve-force, indeed, is the comprehensive term which includes all vital stimuli; whether they be psychical or reflex. All the stimuli derived from external agents—from the air we breathe, from the food we take, from the various forms of force, whether chemical force, or the force of light or heat, or electricity; all impressions, all stimuli, the behests of the will, the emotions of the affections,—all are conveyed through the ganglia and cords which ramify throughout the organism, and combine the wonderful apparatus into one harmonious and efficient whole.

But there is yet another point of view from which we may regard my subject. Life is constant, ceaseless change. The structure of our bodies is subjected to active processes of disintegration and decay on the one hand, and of active renewal on the other. For no two moments are we physically precisely the same. The human body is like a river, which, although to the eye, from month to month and year to year, it presents the same graceful meanderings, and reflects on its tranquil surface an unchanging landscape, is yet never the same water, but is ever losing by its onward course to the ocean and by evaporation into the blue ether, and is ever being supplied afresh from the rills of the cloud-capped mountains. Through the body of an adult man there passes each year at least a ton of material, some part of which is doubtless directly consumed in the generation of heat; but a large part becomes himself for the time being, replacing the effete material, in its

turn to be again replaced. All the structures and organs of the body undergo ceaseless destruction and ceaseless reparation; and the nervous system itself; the brain, the organ of thought and of volition; the cerebellum, the co-ordinator of muscular motion; the spinal cord; and the ganglia from which stimuli are conveyed to the digestive, circulatory, and secreting organs—all are in this constant condition of transition. Particle by particle they are all being removed; particle by particle they are all being restored. When we look at man from a psychical point of view, and remember the phenomena of memory, of trains of ideas, of consecutive reasoning, of recurring sensations, how marvellous is the character which this waste and repair of nerve-tissue assumes! Memory may be lost by a fragment of bone pressing on the cerebral convolutions, and recovered by removing the pressure. It is, therefore, exercised through cerebral matter, and is dependent for its exercise on the normal condition of that matter. But this cerebral matter is not the same at any two moments of our existence. The brain of yesterday is not the same as the brain of to-day, although the remembrances, the hopes, the fears, the disappointments, and the successes of half a century ago, may be recalled by the sight of a once familiar object, or by the sound of the voice of a long-lost friend. How marvellous, then, must be the balance of supply and demand—the adaptation of fresh particles to take the place of effete—in this wonderful storehouse of the mind! How exquisite must be the adaptation of the atoms which repair without a flaw the tablets of the memory!

We thus see that, in human life, the psychical and somatic functions are inextricably united. Both depend upon the pabulum assimilated by the organism for healthful activity, and fall into abeyance when the equilibrium between the forces of disintegration and renewal is disturbed. From these premisses, however, we should err if we argued their identity. The very facts which we have contemplated—the ceaseless transition, activity, decay, and repair, which are taking place in the grey and white matters of the human brain—offer an insurmountable obstacle to gross materialism. We know that we are ourselves, and that we are the same as when we played at our mother's knee, although no material particle of the child we once were remain to us.

I have thus endeavoured to illustrate my subject of nerve-force in waste and supply by calling to your recollection the true functions of the nervous system in controlling and influencing the processes of digestion and sanguification, the supply of nutrient fluid, and the process of nutrition properly so called; and, lastly, I have asked attention to the processes of waste and supply in relation to the nervous system itself, and especially to the great nervous centre, the enormous development of which is that which physically differentiates man from the animals.

The subject which I have sketched out, and very feebly, I fear, illustrated, teaches much both to the clinical physician and surgeon and to the sanitarian. To the surgeon, it tells of the necessity of treating the patient, and not merely the limb—of supplying the pabulum for that nervous force which must control the processes by which wounds are agglutinated and fractures consolidated. The lessons it gives to the physician are perhaps the most important that he has to learn. One of the most distinguished of our British physicians desired that the words "he fed fevers" should be engraved on his tomb, as sufficient to confer immortality on his name, and to hand it down to the gratitude of mankind. He was right. Health is the balance between waste and supply. In disease, the balance is no longer maintained; the processes are not equal; and, although in the onset supply may be in excess, before health is restored waste will assuredly overbalance supply. To replace effete material, new elements of nutrition—new germinal matter—is necessary; and for the generation of nerve-force, which is to influence and control the reparative process, a healthy supply of renewed blood must circulate through the nervous centres. The great end and aim of practical medicine is to enable the diseased to digest and assimilate the food which alone can repair worn-out tissue and supply the nerve-force which can restore to a healthy standard disordered function.

Lastly, this subject has its lessons for the sanitarian and the politician. We hear much of education in the present day; but what education or brain-work is possible or profitable in the case of children half starved, crowded in unhealthy dwellings, and poisoned with unwholesome water and impure air? To have the healthy active mind, we require the healthy active sensorium. Neither intellect nor virtue can be expected to flourish where squalid poverty stunts the growth, starves the brain, and nips the bud of natural affection.

To conclude: the lessons taught by a study of the relations between mind and body, from the physiologist's stand-point, have been supposed to favour a disbelief in the higher nature and destiny of man. Never was there a more profound misconception. We have seen that

physical life consists of ceaseless change. In this, the human organism is but akin to all nature, organic and inorganic. From the sun and stars, whose constitution the spectroscope has in recent years wonderfully revealed, to the grain of sand which is washed from the face of the surf-beaten rock to form again part of the bulwark of a distant shore—from the giant of the forest down to the tiny lichen hidden in the cleft of the wall—from the Leviathan of the deep down to the minutest monad—all are undergoing the same round of constant transition. Throughout the universe, as in the microcosm of man's body, the laws of disintegration and decay are balanced by the laws of reproduction and supply. Individuals, species, genera, all pass away, and are replaced by others. Man's brain, the highest organised machine, itself follows the universal law; but man himself is not thus mutable. The *ego* is one and the same, from the moment it first sprang into existence at the Divine behest. That it exists unchanged by the ceaseless changes of the physical organism to which it is linked, is surely evidence that it is independent of matter, and that it will exist when the present order of nature has passed and been succeeded by a phase higher and more glorious.

"The sun is but a spark of fire,
A transient meteor in the sky;
The soul, immortal as its sire,
Shall never die."

ON THE EMPLOYMENT OF NITRITE OF AMYL IN THE COLLAPSE OF CHOLERA.

By T. LAUDER BRUNTON, M.D., D.Sc.,

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In two papers which have recently appeared in this JOURNAL and in the *Practitioner*, Dr. Talfourd Jones very ably advocates the use of nitrite of amyl as a remedy in the collapsed stage of cholera. His proposal is, however, by no means a new one; for it was made by Dr. Chapman in 1866, as he mentions in a letter to this JOURNAL; and also by Dr. Gamgee about the same time. At the time that I mentioned the suggestion of the latter in a paper on the Action of Nitrite of Amyl in Angina Pectoris, in the *Lancet* for July 1867, I was unaware that this medicine had been already tried unsuccessfully by Drs. Hayden and Cruise of Dublin. Shortly after the publication of my paper, I obtained, through the kindness of those gentlemen, a copy of their Report of the Cholera Epidemic of 1866, as treated in the Mater Misericordiae Hospital, Dublin; and from this I now extract the following notices of the action of nitrite of amyl in that disease.

"When inhaled for a few minutes, he (Dr. Richardson) showed that it is capable of so exciting the circulation, that the face becomes flushed, accompanied by a thrilling sensation. It occurred to us that, in virtue of this remarkable property, the nitrite of amyl might be useful in re-establishing the circulation in the collapse of cholera. In one case, that of a man forty-two years of age, admitted in incipient collapse, the pulse rose from 102 to 114, and the temperature in the axilla rose from 95½° to 96½° F., after inhalation of the nitrite of amyl for three minutes. The inhalation appeared to aggravate his thirst. In another case, that of a woman aged 34, also in collapse, the pulse became perceptible after inhalation for a few minutes; and the patient seemed otherwise improved. Thirst seemed aggravated by the inhalation in this case also. A boy aged 4, in collapse, inhaled the amyl for a few minutes, after which there was a slight appearance of colour in the face. The boy strenuously resisted its further administration, owing to the obstruction to free respiration which it occasioned. In several other cases the amyl was tried; but although, when inhaled for a few minutes, it usually heightened in some degree the colour of the face and surface-temperature, the difficulty of inducing patients to continue the experiment for a sufficient length of time, owing to its interference with respiration and the increased thirst which it occasioned, caused it to be abandoned."

As the results of their trial of oxygen are very interesting, I subjoin them also.

"Inhalation of oxygen by means of Dr. Richardson's apparatus was also made trial of. In one case, that of a woman in collapse, the pulse became perceptible for a few minutes. A woman aged 44, in collapse, inhaled oxygen for eighteen minutes. The pulse, previously all but imperceptible, increased in strength; and the temperature of the surface was slightly elevated. In a third case, that of a girl aged 24, oxygen was administered on three several occasions. The temperature rose