energetic, on account of the predisposition of the patient, from the associated toxæmia? The symptoms accorded equally with uræmic and narcotic poisoning; but, when no special treatment is adopted, the latter, I believe, seldom proves fatal after eighteen hours? Candour, however, demands the admission, that, whether the woman sank from disease alone, or the combined effects of disease and poison, must ever remain an equivocal question.

ON INHIBITORY INFLUENCE.

By C. HANDFIELD JONES, M.B., F.R.S., Physician to St. Mary's Hospital.

In the *Proceedings of the Royal Society*, p. 367, No. 32, there is an highly interesting communication from Mr. Joseph Lister respecting "the functions of the visceral nerves, with special reference to the so called inhibitory system." He takes up Pflüger's view, "that there is a certain set of nerve fibres whose sole function is to arrest or diminish action," and examines it fully with repeated testing by experiment. The result to which he arrives, as given at the end of his paper, is, that it may be regarded "as a fundamental truth not yet explained, that one and the same afferent nerve may, according as it is operating mildly or energetically, either exalt or depress the functions of the nervous centre upon which it acts. It is, I believe, upon this that all inhibitory influence depends, and I suspect that the principle will be found to admit of a very general application in physiology." Mr. Lister also foresees the bearing of this principle on pathology, and notices its probable concernment in the excitement of inflammation through the medium of the nervous system at a distance from the irritated part.

I am strongly inclined to believe that these views will prove to be of first rate importance in pathology, and will be found applicable to a multitude of common instances. However, I cannot but think that the principle, as propounded by Mr. Lister, requires some modification. What this is I will presently state, but will first detail some experiments illustrative of inhibitory influence.

The transmission of an interrupted current of galvanism through the lower dorsal region of the spine, when of a certain strength, caused complete relaxation and quiescence of the small intestines which had previously been in active motion, while the muscles of the limbs were thrown into spasmodic action, but on the discontinuance of the galvanism, the previous intestinal movement returned. A weaker current being now passed, the result was, that the action of the intestines was markedly *increased*. Violent struggling of the animal had the same effect as the strong electric current in producing a quiescent state of the intestines. 'This, as Mr. Lister remarks, goes to prove "that the inhibitory influence is certainly sometimes exerted in the natural actions of the animal, and is not merely the result of artificial stimulation." The following quotation from Bernard's *Leçons, système nerveux*, tom. ii, p. 392, shows the production of analogous phenomena in the cardiac and respiratory actions. "In a hound, the two nervi vagi were exposed, raised on a loop of thread, and galvanised both at once without cutting them. During the galvanisation, the contraction of the heart and the respiration were arrested, and the eyes became prominent, showing that there is, at the same time, centripetal and centrifugal action in the vagus. In another dog, the vagus being divided in the middle of the neck, the upper end and the lower were successively galvanised. The galvanisation of the lower end stopped the heart, and allowed the respiration to go on. The galvanisation of the upper end stopped the respiration, and let the circulation go on."*

The experiment performed by Weber, several years ago, of slowing or arresting the action of the heart by passing a galvanic current through the medulla oblongata, is quite to the same effect as the preceding. From the circumstance that direct irritation of an intestine lying relaxed under inhibiting influence, produces local contraction not propagated to the adjacent parts, Mr. Lister concludes that "the inhibitory influence does not operate directly upon the muscular tissue, but upon the nervous apparatus by which its contractions are, under ordinary circumstances, elicited."

* Previous experiments, however, show that the arrest of the respiration in these cases occurred from the violent stimulus keeping the inspiratory muscles tonically contracted, so that expiration could not take place. This I had overlooked, until the proof came into my hands.

Taking now as our basis the above cited experiments, I proceed to refer to various pathological facts which seem to me to receive explanation from the above views, and to confirm and modify them in their turn.

1. It is known (*vide Graves's Lectures*, p. 695,) that exposure to a blast of cold wind for some time has produced amaurosis, which was cured not by depletion or mercury, but by stimulation of the skin of the face and temples.

2. Paralysis of the portio dura, from like exposure, is still more common. This has been attributed to effusion of lymph taking place around the facial nerve in the bony canal it traverses; but the supervention of the paralysis, as in some cases cited by Romberg from J. Frank (vol. ii, p. 282), is often too sudden to warrant our accepting this explanation as generally true. In a case alluded to by Dr. Graves, the two paralysees coexisted, vision and motor power were both impaired from exposure of one side of the face to cold.

3. Irritation of the bowels, as from worms, may cause amaurosis or deafness; or from enteritis, paralysis of the lower limbs.

4. M. Brown-Séquard cites several instances in which a neuralgia of a sensory nerve, to all appearance, produced paralysis of a motor.

5. Dr. Copland, article *Paralysis*, p. 21, mentions a case of "general palsy of the powers of voluntary motion immediately after prolonged exposure to cold and wet. The functions of the brain were unaffected, . . . and no evidence of inflammatory action, or of congestion in the spine could be detected." Sensibility of the surface was retained, and command over the sphincters. "He was treated at first on the supposition of either serous effusion or vascular congestion having taken place in the spinal canal, but without receiving any benefit. He ultimately quite recovered by having frequent recourse to warm baths containing stimulating substances."

6. Dr. Graves quotes a case from Dr. Hutton in his *Lecture on Paraplegia*, pp. 407, 408, in which a man had incomplete paraplegia after exposure to cold, wet, and fatigue, as well as a very close stricture. The latter was dilated, and "a very remarkable amendment took place in his back and lower extremities in a very few days after the first introduction of the instrument, in fact, it was almost sudden. Warm baths, friction to his limbs, etc., completed his cure." Dr. Graves comments thus: "you at once perceive the extreme importance of this case; it bears directly on the question before us, and proves that urethral irritation may, as well as inflammation of the kidneys, give rise to paraplegia." He had previously referred to Mr. Stanley's cases of paraplegia from renal disease which have evidently the same import.

7. The same eminent authority says (*vide* p. 407,) that he has recently met with a number of cases in which paraplegia was evidently brought on by exposure to cold and wet; and quotes a communication by Mr. Hunt to Mr. Stanley, to show that the same paralysis may result from uterine disease.

8. In his tenth Lecture, Dr. Brown-Séquard has the following remarks: "The sudden death which sometimes occurs when very cold water is drunk in a warm day, or in cases of a blow on the abdomen, of a sudden perforation of the stomach or intestine, of a wound of some abdominal viscus (without a notable hæmorrhage), etc., seems to be due to a reflex stopping of the heart's action. I have made a great many experiments which show positively that a sudden excitation of the abdominal sympathetic nerve kills, or diminishes the movements of the heart by a reflex action. The excitation goes up to the spinal cord chiefly along the great splanchnic nerve, and ascends the spinal cord until the place of origin of the paravagus, and through this pair of nerves it comes to the heart. This is proved by the fact, that a section of either the paravagus, or the spinal cord, or the splanchnic nerves, allows any kind of irritation to be made on the abdominal sympathetic without a stopping taking place in the heart. In some animals the influence of the irritation of the sympathetic in the abdomen is much more marked than in others; it is so, probably, in men. I have seen a gentleman drop down pulseless, in the most complete syncope, from a pain in the abdomen." In two experiments which I recently performed on cats, injecting half a drachm of citric acid dissolved in water into the peritoneum, death ensued very speedily, and the heart was found uncontracted, with its ventricular cavities full of dark blood on both sides. There was no other morbid appearance. I am, of course, aware of Dr. Gull's interesting observations of the state of the spinal cord in paralysis from renal disease, but I do not think his view is generally applicable. In one case of paralysis from exposure to cold and wet, where death oc-

occurred, I examined parts of the spinal cord without finding any trace of exudation.

9. The depression, collapse, and visceral congestion resulting from burns, is known to be in relation to the extent of surface injured, rather than to the severity of the lesion. Mr. Erichsen says, "a person may have his foot completely charred and burnt off by a stream of melted iron running over it, with far less constitutional disturbance and danger than if the surface of the trunk and face be extensively scorched to the first and second degrees. The greater the extent of sensory surface injured, the greater will be the tendency to paralysis of the heart, and of the arteries of the viscera."

10. In cases of paraplegia occasioned by exposure to cold and wet, Dr. Graves observes, there is much less impairment of sensation than of motion, though the former may be sufficiently well marked. He attributes both phenomena "to the influence of cold acting on the nervous filaments of the cutaneous surface of the limbs, extending its morbid impression to the spine, and thence reacting on the nerves, so as to produce impairment of the power of motion and diminished sensation."

Now in all these instances, the one common thing that I observe is, that certain sensory or afferent nerves are affected by an *abnormal, injurious* impression, which being conveyed to the centre, spinal, or sympathetic, sets up a state there which is incompatible with the discharge of its function, whether that be connected with motion, or special, or common sensation. It can hardly, I think, be said that the causes of irritation and paralysis cited above induced *energetic* action of afferent nerves; they are almost all rather of a *depressing* kind, especially cold and wet, drinking cold water when heated, sudden perforation of a viscus, and burns. In fact a cure was obtained in some of the instances by appropriate stimulation of the originally affected sensory surface. Nor, indeed, do I think that in the experiments on animals before detailed it can quite safely be presumed that the stronger stimulus applied to the nerves, induced them to act more energetically. An interrupted galvanic current is not the normal stimulus to the nerves, and it is possible that the strong current may have been exhaustive and depressing. The case may perhaps be analogous to that of the moderate and excessive imbibition of a vinous stimulant. The former stimulates the brain and increases its vital activity; the latter depresses and disorders its action. It seems to me most probable that the same is true of galvanism as of heat and cold, respecting which agents Muller says, "heat and cold, when their action is not carried beyond a certain degree of intensity, nor continued beyond a certain time, are stimulants; but if their action be more violent and long continued, they have a contrary effect." It is only just to Mr. Lister to say that he has considered the question, as to the dependence of the inhibiting influence in his experiments on nervous exhaustion, and decides against that view, partly on account of "the very rapid recovery of the cardiac or intestinal actions when the inhibiting galvanic currents are discontinued."

I have cited the above mentioned actual occurrences as pathological experiments, so to speak, which as yet have hardly been interpreted, or their meaning been appreciated. They seem to me to afford tolerably conclusive evidence that impressions on afferent nerves may not only excite the nervous centres as in reflex action (the more common case), but *produce a directly opposite state of enfeeblement or depression*. It is a remarkable thing that this condition does not always, by any means, subside along with the cessation of the morbid impression, but continues more or less permanent, and is only removed by the excitement of a more healthy stimulus. This was the case in Dr. Graves's and Dr. Copland's patients. I now proceed to adduce some further instances, in which it appears to me eminently probable that the principle above enunciated is involved. The remarkable effect of hæmorrhage into one hemisphere of the cerebellum in producing paralysis of the opposite side of the body, seems to be explicable on this view, which, indeed, has been already proposed by Mr. Mayo for this particular case. The pons varolii contains much grey matter, through which the tract of motor fibres passes; if "a depressing influence or shock," using Mayo's words, be transmitted along the transverse fibres, it may so affect the dynamic matter, that motor impulses can no longer be transmitted along the channels of voluntary motion. In this view, the pons varolii is regarded as a centre connected by commissural fibres with those above.

The production of rheumatic pains by cold, and their cure by outward applications, may be better explained on this view

than on any other. The morbid influence, let us say in a case of stiff neck, strikes the afferent cutaneous nerves, and through them affects the spinal and sympathetic centres, producing in them some abiding alteration in their molecular constitution. This state is reflected outward on the vaso-motor nerves of the same side, occasioning their paralysis, and therewith inducing hyperæmia and disordered nutrition of the parts which they ordinarily influence, in fact a condition not remote from inflammation. At the same time, the motor nerves may be so stimulated, that tonic contraction of the muscles takes place. A stimulant and sedative liniment (hartshorn and laudanum) well rubbed on the skin, not unfrequently does away with the morbid state, by inducing healthy excitation of the afferent nerves, and so of the nervous centres.

To take another very humble instance: the great comfort of a "strengthening plaster" to aching loins or weak backs, is notorious; but what is its rationale? Surely this, that the surface is protected from all depressing influences, and, at the same time, mildly stimulated, and so the cutaneous nerves propagate to the centre more healthy impressions, which enable it to convey more vigorous impulses to the weak dorsal or lumbar muscles. I can testify, from personal experience, to the great advantage of chamois leather, worn over the præcordia during cold weather, in warding off a state of depression of the heart's action (otherwise healthy), which once issued in syncope. The beneficial effect produced was almost immediate. I suppose no one will imagine that the cold could directly affect the heart through the thoracic parietes; the results can only be explained on the view, that the inhibitory influence of cold on the cutaneous nerves had been propagated to the cardiac ganglia and nerves, enfeebling their action, and that on this morbid impression being removed, they resumed their healthy play.

Dr. Graves observes, towards the close of his *Lecture on Paraplegia*, "With respect to treatment, I may observe that I have never seen any benefit derived from applications to the spine" (blisters or issue). "I am in the habit of applying my local remedies to the legs and thighs, selecting those parts in which the greatest cutaneous sensibility exists. What I generally do is to keep up a succession of blisters along the inside of the legs, and over the anterior and inner parts of the thighs. The practice of medicine furnishes many proofs of the utility of stimulant applications to the nervous branches, in case of disease affecting the larger trunks. Thus, in sciatica, a blister applied over the ham or calf of the leg, where many of the ultimate ramifications of that nerve are superficial, will frequently produce a much more decided effect, than when applied over the origin of the nerve itself. Liniments of a stimulating kind, and blisters repeatedly applied, are the local means on which I chiefly rely in the treatment of this form of paraplegia." The practical experience of this eminent physician is evidently quite in accordance with the views we are considering. Stimulating application to the parts most endowed with sensibility, will convey powerful impressions to the spinal centre, by means of which, the previously existing morbid condition may be abolished.

That the neuralgic state is, in many cases, more or less of the nature of paralysis, is, I think, apparent from the very common coexistence of numbness with the pain; or, which is, perhaps, more frequent, the persistence of a state of anæsthesia in the intervals of paroxysms of pain; as well as from the circumstance, that neuralgia is aggravated by all causes of debility. It is well known that pain in a part may depend on some distant irritation, ceasing only when the latter is removed; *vide* two cases in Sir B. Brodie's work on *Local Nervous Affections*, pp. 12-13. Here the pain was evidently produced through the intermedium of the nervous centre. If now pain can be excited in this way, it is, at least, conceivable that it may be stilled in the same, by means of impressions of a different kind conveyed to the centre. With regard to the good effect of all external applications in neuralgia, it seems to me impossible to give any rational explanation except such as I have above indicated. It is inconceivable that they exert any notable influence, except on the cutaneous nerves, and if so, they must operate beneficially through the nervous centres. Indeed, if the pain is quite superficial, we may believe that a sedative application, say tincture of aconite, operates directly upon the disordered organs, and allays the irritation; but if the pain be deep-seated, as in sciatica, it is wholly impossible that an application to the cutaneous surface should directly affect the subjacent nerve. Moreover, in neuralgia it seems extremely difficult to have any absolute certainty as to the real seat of the pain-causing action; one can-

not affirm that this may not be central, though it may appear to exist at some point of the peripheral course. Even if the pain-causing action be not centrally seated, it may be modified and stopped by impressions, altering the molecular condition of the centre. Of course, if there is any local cause of irritation, or neuritis, affecting the trunk of a nerve, the case is different. The experience of Duchenne, as quoted by Trousseau, in his work *On Therapeutics*, vol. i, p. 788, strongly corroborates the above remarks. He says, "there exists no special region of the cutaneous envelope, whose excitation enjoys the exclusive privilege of modifying sciatic neuralgia." He prefers, however, to operate "*loco dolenti*." "It is very necessary to dry the skin previously with an absorbing powder; for if the faradic excitation penetrates deeply, the neuralgia is aggravated instead of being calmed. How many facts I could bring forward in support of this opinion so opposed to M. Magendie's, who recommends, on the contrary, to conduct the electric excitant almost into the diseased nerve by the aid of electro-puncture." At p. 787 he states it as a capital fact, made out during a long discussion respecting the treatment of sciatica by cauterisation of the helix of the ear, that "a sharp and sudden pain produced at any part of the cutaneous surface, possesses the property of modifying effectually certain sciatic neuralgias." The columna nasi is a part of extreme sensibility, and electric excitation of this spot has caused the disappearance of sciatic neuralgia, after faradisation of the ear, had been tried in vain. It may be observed, that if a neuralgia be at all of old standing, it is much more difficult to remove it by surface applications. The morbid action in the centre becomes too firmly established to be easily superseded by the impressions subsequently excited. Although in the foregoing observations I have recognised the usually accepted law of eccentric nervous action, I must add that I do not at all see how many phenomena of neuralgic suffering can be explained in accordance with it. The pain is often so specially located in the track of the nerve, seems to run up and down along it so distinctly, that it is almost impossible to avoid speaking of it in such a way as to imply, that nerve fibres may have sensations referred to other points of their course besides the peripheral extremities.

The development of catarrh from the action of cold, appears to me most reasonably to be explained according to the theory of inhibition. The morbid impression made on some part of the cutaneous surface, is transmitted to the nervous centres, and there produces changes in the dynamic matter, which conditionate paralysis or paresis of the vaso-motor nerves of some mucous surface. This state, under predisposing circumstances, readily passes into actual inflammation. That the above view is not far from the truth, seems certainly probable, as well from the general nervous depression, pain in the limbs, and shivering felt when a person has taken cold; as from the instinctive practice adopted by all nations of protecting those regions which are liable to be affected by a chill. One can hardly help entertaining the idea, that certain parts of the cutaneous surface are more especially correlated with certain internal organs. In England, where bronchial catarrh is common, we are partial to chest protectors, bosom friends, etc. In India, where the abdominal viscera are especially prone to suffer, the khummerbund is indispensable. Not only catarrhal inflammation, but also parenchymatous, *e.g.*, hepatitis, may be, and often is, produced by exposure of the surface to cold. Here I think we can be sure that the morbid action must be set up through the intermedium of the nervous system. The heat of the climate increases the activity of the liver, and renders it predisposed to disorder. A "coup" of cold, a chill, strikes the surface of the abdomen, the cutaneous nerves transmit the morbid impression to the spinal cord, whence it travels to the solar plexus, and so to the hepatic, paralysing the nerves in the way of inhibition. This produces a state of active hyperæmia, which readily passes into inflammation. This view of the production of inflammation in one large class of cases, is identical with Henle's neuropathological theory, at least, in some chief particulars, but it rests on a basis which that theory wanted. This basis is supplied on the one hand by the demonstrated effects of vaso-motor nerve paralysis, which actually produces severe inflammation in states of debility; and on the other, by the facts on which the conception of inhibitory action is founded. It appears, indeed, that the impression of cold upon afferent nerves, may give rise to two forms of paralysis; viz., one of the musculo-motor nerves, which is comparatively rare; the other, of the vaso-motor nerves, which is common. It is exceedingly clear, from the frequency of inflammatory disease in the tropical, as compared with the arctic regions, that the

mere action of cold on the surface is, by no means, the most important cause in producing the result. The preëxisting state of the nerves, nervous centres, and tissues, their invisible vital qualities, are the truly efficient causes; without their action the operation of cold would be ineffectual.

The foregoing views respecting the production of inflammation, are strongly corroborated by the phenomena observed in cases of burns, especially as they have been elucidated by the experiments of Brown-Séquard. He quotes Mr. Long and Mr. Erichsen, to show the frequency of internal inflammations in such accidents. According to the latter, "the cerebral organs were diseased in thirty-three out of thirty-seven cases, the thoracic viscera in thirty out of forty, the abdominal viscera in thirty-one out of forty-two. Mr. Long concludes from his experience: "1st. That in almost every burn, indeed, in every burn, lesions of one or more of the viscera contained in the three great cavities exist, being, according to their frequency, as follows: abdomen, chest, head. 2nd. (Omitted.) 3rd. That the seat of internal inflammation corresponds sufficiently often with the external position of the burn; but that in a precisely equal number of instances, no such correspondence can be traced." Brown-Séquard himself (*vide Lecture x*, p. 546, *Lancet*), refers to his own experiments as proving, that division of the spinal cord about the third lumbar vertebra, prevents the development of inflammations in the abdomen, such as are found when an animal, not so treated, is killed two days after one of the legs has been scalded with boiling water. Division of the sciatic and crural nerves as high up as possible, had the same effect. He therefore believes "that it is, in a great measure, by a reflex action on the spinal cord, that burns produce their deadly influence on the viscera." It is quite clear that the impressions propagated to the spinal cord in such cases must be of a depressing kind, and that we cannot consider the afferent nerves as acting energetically.

The syncope which is produced by an over dose of digitalis, and the slowing of the heart's action from smaller quantities, have not hitherto been satisfactorily reconciled with its stimulant and tonic action upon the weak and flabby heart, its contracting influence upon the uterine fibre in menorrhagia, and its diuretic effect. The popular idea of digitalis is, that it reduces vascular action, which must mean, I suppose, that it quiets the excited movement of the heart. But it also has, as just shown, properties of a very different kind. Now, with our knowledge of the effect of excessive and abnormal stimulus of nerves, we can reconcile this discrepancy. Digitalis, when it lowers and arrests the heart's action, does so by overstimulating its primary action is always stimulant, as on the uterus and kidneys.

Syncope senilis, from irritation of the stomach by masses of undigested food, of which two instances are recorded by Mr. Higginbottom in the *Lancet*, 1856, p. 453, seems to be a good example of inhibitory influence. The usual effect would be vomiting, *i.e.*, a reflex contraction of muscles, but owing to debility, the impressions conveyed to the centres, produce such a state there, that the action of the heart is paralysed, of course, through the medium of its nerves. It is particularly interesting to note, that the administration of a more powerful and suitable stimulant; viz., ipecacuanha, produced vomiting, which the morbid material did not.

It is clear that this whole subject is of a highly practical nature, linking itself intimately with the etiology and treatment of disease. I cannot but return my sincere thanks to Mr. Lister, for having drawn the attention of observers to this novel and interesting conception.

TESTIMONIAL TO R. S. FOWLER, Esq. The presentation of a testimonial from the working men of Bath to Mr. R. S. Fowler, Physician's Assistant at the United Hospital, took place on the evening of January 18th, at the Guildhall of the above-named city. It was intended as a recognition of the eminent services rendered by Mr. Fowler during the prevalence of small-pox in that city. The testimonial consisted of a clock, silver inkstand, purse of twenty sovereigns, and a brass-bound oak chest. The clock and inkstand bore the following inscription: "This clock, with a silver inkstand and purse of gold, was presented at a public meeting at the Guildhall, by the working classes of the city of Bath, to Richard Sumner Fowler, Esq., M.R.C.S., of the United Hospital, for his skill and kind attention to the sick generally, and particularly during the epidemic of small-pox in the year 1858. January 18, 1859." The chest contained a statement of the origin of the testimonial, as well as other particulars respecting it, beautifully inscribed on vellum.