

MEMOIRS
ON SOME
PRINCIPLES OF THE PATHOLOGY
OF THE
NERVOUS SYSTEM.

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MEMOIR II.

*On the Morbid Reflex and Retrograde Actions of the
Spinal Marrow.*

I PROCEED to fulfil my promise of the last session* to lay before the Society the result of my observations on the singular phenomena of the reflex and retrograde actions of the spinal marrow observed in various diseases. I shall first treat of

I. THE REFLEX ACTIONS.

I need scarcely recall to the attention of the members of this Society, the series of *experiments* related by Redi, Whytt, Legallois, Blane, Mr. Mayo, &c., or my own, relative to this interesting subject. But I must briefly advert to the principle of action,

* See the Transactions of this Society, vol. xxii, p. 217.

with its newly discovered laws, upon which these experimental phenomena depend, and to the extension of that principle to physiology—to the physiology of ingestion and egestion in the animal economy, which are the results of my own investigations.

In treating of certain muscular motions, produced by the irritation of muscular nerves, Haller distinctly speaks of two principles of those motions—the motive power residing in the nerve, which he designates the *vis nervosa*, and the moving power residing in the muscle, which he designates irritability or the *vis insita*.

Of the *vis nervosa*, Haller,* Bichat,† and Professor Müller,‡ all most distinctly state, that it acts in *one* direction only, viz., that *from* trunk *to* branch, or *from* the nervous centres *towards* those parts of the muscular system placed in relation with them.

It is obvious that, if this conclusion were well founded, there could be no *reflex* action of the *vis nervosa*, nor any application of this principle, to physiology,—a very improbable circumstance, *à priori*.

At the same time it appeared to me that, when I had established that the reflex actions did not depend upon sensation and volition, but upon some other principle of the animal œconomy, the only known principle which remained, and which could be the probable agent in these actions, was the *vis nervosa*. I resolved therefore to institute a new series of experiments in order to determine the ques-

* *Elementa Physiologiæ*, Lausanne, T. iv, p. 325.

† *Anatomie Générale*, 1801, T. iii, p. 277.

‡ *Handbuch der Physiologie*, 1834, i, p. 656.

tion, whether the *vis nervosa* were susceptible of other and unsuspected modes of action. To these experiments I will advert very briefly. They afforded the most satisfactory proof that my conjecture was correct, and in a word, that the motor principle of the reflex actions was discovered.

These experiments consist in denuding and stimulating the lateral nerves in the decapitated turtle. Contrary to the law laid down by Haller, Bichat, and Professor Müller, the *vis nervosa*, being excited, acted in an incident direction, that is, *from branch to trunk*, and both *upwards* and *downwards*, and, being *reflected* on the muscles, induced movements in both the anterior and posterior extremities.

It results from these and other experiments, relative to the *vis nervosa*,

1. That it acts in *direct* lines *along* the spinal marrow, and *from* the trunks *to* the branches of the nerves, and *to* the muscles they supply,—according to the law laid down by Haller, Bichat, and Professor Müller.

2. That it acts in *reflex* directions *to* and *from* the spinal marrow ; that is, *from* peripheral, cutaneous, and mucous surfaces, *through* the spinal marrow, and *to* the co-ordinated muscles, according to a newly discovered law ; and, as will be seen hereafter,

3. That it acts in a *retrograde* direction along the spinal marrow.

Such being the principle on which the reflex actions depend, the next question for this Society is,—in what circumstances are they most manifested in the human frame? From much investigation I

am enabled to state that in order that the *reflex* actions may be very apparent, it is essential

1. That the interference of *volition* should be removed ;

2. That the *vis nervosa* and the *vis muscularis* should be unimpaired, not to say augmented, and

3. That the *reflex nervous arcs* should be uninterrupted.

1. That volition interferes with some of the phenomena of the reflex function is obvious from some of the phenomena of sleep and of comatose and paralytic affections. This first principle I had long ago observed ; but it is to Mr. W. F. Barlow that the profession is indebted for its more complete development, in a lecture which he delivered during the last winter, to the students at Sydenham College. Several of Mr. Barlow's observations are extremely interesting ; he observes, " I gently passed my finger over the palm of the hand of a child who was fast asleep ; the fingers contracted and embraced it tightly, and I could draw the arm away or raise it up, so firm was the grasp. The child having awaked, I again touched its hand as before, but no closure of the fingers was induced." This simple experiment beautifully demonstrates the activity of the excitomotory function during sleep, and the counter influence of volition in the waking state. Mr. Barlow added, " I have remarked that spasmodic actions are induced in limbs paralysed as to voluntary motion, by stimuli which have no such effect on limbs still under cerebral influence."

It is on a similar principle that in cerebral paralysis the reflex actions are most observed in those cases in which the paralysis is most complete.*

2. The first effect of a violent experiment or accident seems to be to suspend the *vis nervosa*, the *vis muscularis*, or both. It is accordingly observed that *immediately* after the division of the spinal marrow, in an experiment, or *immediately* after injury sustained by the same organ in the human subject, by a fall or other accident, the reflex actions subsequently developed and manifested most clearly, are not observed.†

The nervous and muscular powers are gradually restored from this suspension, as the effect of shock, and, at a still more remote period, even acquire an anormal degree of intensity. The phenomena dependent on them are augmented proportionately. The same remark is still more true in regard to cases in which the *vis nervosa* is morbidly augmented by disease, as in tetanus, hydrophobia, certain affections of the spinal marrow, in the effects of strychnine, &c. In these latter cases the slightest cause of excitement is reflected with terrific energy upon the appropriate parts of the muscular system.

3. Lastly, it is essential that the reflex nervous arcs should be entire. It has been observed that in some cases of paraplegia the reflex actions are present, in others absent. A slight knowledge of

* See the Transactions of this Society, vol. xx.

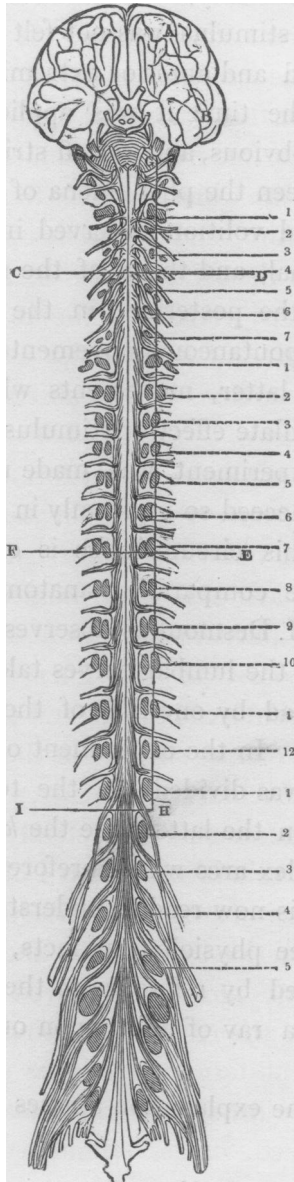
† Ibid. vol. xxii, p. 183.

the anatomy of the spinal column is sufficient to explain this apparent discrepancy. If the disease be seated within the *cervical* or *dorsal* vertebræ, the spinal marrow in this part is affected, but a portion *below* may remain free from the influence of the disease ; the reflex arc which involves this portion may, therefore, be entire, and the reflex actions will be observed. If, on the contrary, the disease be situated within the *lumbar* vertebræ, the cauda equina is affected, the centre of every reflex arc is excluded, and all the reflex actions will be absent.

In fact, the lines of *cerebral* and of *spinal* paralysis, drawn in the sketch given in my former memoir and reproduced here, have their application in the consideration of the question before us. In cerebral paralysis, we have reflex phenomena ; in spinal paralysis these phenomena are absent. Disease seated in the course of the lines A B, C D, E F, leaves the subjacent reflex arcs, and their functions entire ; whereas disease situated in the course of the lines G H, H I, excludes the centres of the reflex arcs and their phenomena respectively.

Very early in this investigation I observed that if the spinal marrow of a frog was divided between the anterior and posterior extremities, the head and the anterior extremities alone were moved spontaneously and with design, the respiration being performed as before ; but the posterior extremities were not paralysed : they were drawn up and remained perfectly motionless, indeed, unless stimulated ; but by the application of any stimulus, they were moved with

A B, C D, E F—lines of cerebral paralysis, with augmented irritability, and the presence of reflex actions.



G H, H I—lines of spinal paralysis, with diminished muscular irritability, and the absence of reflex actions.

energy, but once only, and in a manner perfectly peculiar. The stimulus was not felt by the animal because the head and anterior extremities remained motionless at the time it was applied. Nothing could be more obvious, and indeed striking, than the difference between the phenomena of the functions of sensation and volition observed in the anterior part of the animal, and those of the reflex function exclusively in the posterior ; in the former there were repeated spontaneous movements with obvious design ; in the latter, movements which were the mere and immediate effect of stimulus.

The same experiment was made upon the toad, but it did not succeed so uniformly in this animal as in the frog. This circumstance is explained by a reference to the comparative anatomy of the frog and toad. As M. Desmoulins observes, “ in the frog the insertion of the lumbar nerves takes place *lower* than in the toad by one fifth of the length of the spinal canal.”* In the experiment on the frog, the *spinal marrow* was divided ; in the toad it was the *cauda equina* ; in the latter case the *key stone* of the incident and reflex arcs was, therefore, excluded, the effect of which is now readily understood. Is it not interesting to see physiological facts, unintelligible, at first, explained by reference to the anatomy, and thus throwing a ray of light upon our pathological investigations ?

The very same explanation applies to the cases of

* Les Systèmes Nerveux, tome i, p. 787.

paraplegia, unattended by the phenomena of the reflex excito-motory action. The disease is seated *below* the termination of the spinal chord; it is, therefore, a disease of the *nerves*, and represented by the line HI. The influence of both nervous centres, of the cerebrum, and of the true spinal marrow, is removed, and there are both cerebral and spinal paralysis, and the absence of reflex phenomena.

When M. Magendie divided the fifth pair of nerves within the cranium, the *proof* that the division was complete, was obtained by observing that the eye-lids did not close when the eye-lashes were touched. In disease of the portio dura, the same phenomenon is observed. In experiments on the horse, detailed elsewhere,* the eye-lids lost their reflex action when the medulla oblongata was destroyed. In all these three cases the continuity of the reflex arc is severally interrupted, in its incident, central and reflex portion.

The same mode of reasoning applies to the other cases of paralysis, in which the reflex actions are absent.

The nervous arcs through which reflex actions may take place are shown in the following Table of the anatomy of the true spinal system :

* Memoirs, p. 61. § 67.

ANATOMY OF THE TRUE SPINAL SYSTEM.

I. The Incident Motor Branches.

1. The Trifacial, arising from—
 1. The Eye-lashes.
 2. The Alæ Nasi.
 3. The Nostrils.
 4. The Fauces.
 5. The Face.
2. The Pneumogastric, from
 1. The Pharynx.
 2. The Larynx.
 3. The Bronchia.
 4. The Cardia,—Kidney, and Liver.
3. The Posterior Spinal, arising from—
 1. The General Surface.
 2. The Glans Penis or Clitoris.
 3. The Anus.
 4. The Cervix Vesicæ.
 5. The Cervix Uteri.
 6. The Extremities.

III. The Reflex, Motor Branches.

1. The Trochlearis } Oculi.
2. The Abducens } Oculi.
3. The minor portion of the Fifth.
4. The Facial, distributed to
 1. The Orbicularis.
 2. The Levator Alæ Nasi.
5. The Pneumogastric or its Accessory.
 1. The Pharyngeal.
 2. The Œsophageal and Cardiac.
 3. The Laryngeal.
 4. The Bronchial, &c.
6. The Myo-glossal.
7. The Spinal, distributed to the
 1. Diaphragm, and to
 2. The Intercostal and } Muscles.
 3. The Abdominal }
8. The Sacral, distributed to
 1. The Sphincters.
 2. The Expulsors, the Ejaculators, the Fallopian Tubes, the Uterus, &c.
 3. The Extremities.

II. The True Medulla Oblongata and Medulla Spinalis, the Centre of the System.

I may here add the remark that the presence of the reflex actions coincides with that of augmented irritability of the muscular fibre, described in my former memoir, whilst their absence coincides with the diminution or annihilation of the muscular power.

Such being the principles which regulate the presence or absence of the reflex phenomena in disease, I shall now proceed to make some observations on the diseases themselves, in which these phenomena are displayed, and to give a series of cases in illustration, in the same sketchy manner as in my former memoir.

I. OF DISEASES OF THE HEAD.

In the coma of apoplexy, of epilepsy, and of hydrocephalus, we observe, according to the *degree* of the affection, the diminution of the cerebral, and of the cerebral and true spinal functions. The test is supplied by the eyelids. In the slighter forms of coma, the eyelids are frequently but partially closed, yet they close perfectly on touching the eye-lashes; in the severer forms of this affection, not only the cerebrum, but the medulla oblongata, has its powers impaired, and the eyelids do not close, although touched.

CASE I.

I carefully watched the progress of hydrocephaloid symptoms in the case of a little boy aged four. The eyelids closed imperfectly when he was undisturbed, but quite perfectly when the eye-lashes were touched with a pencil. This phenomenon ceased as the symptoms became aggravated, and returned as they were again mitigated.

CASE II.

I visited a patient affected with the deep stupor left by a violent epileptic attack. I dashed cold water in his face without inducing inspiration; I

touched the eyelid without inducing its closure ; a little water poured into the mouth excited cough and was swallowed with difficulty ; twenty ounces of blood were drawn from the arm, and the same experiments were made as before ; the patient sobbed when cold water was thrown upon his face ; the eye-lids closed on irritating their border, and deglutition was comparatively easy.

The condition of the larynx, of the pharynx, of the respiration, of the sphincters, is similarly affected ; and it may be remarked, in general, in regard to cerebral diseases, that they are less or more aggravated, according as the cerebral functions only, or the true spinal functions also, are affected. Impaired deglutition and respiration are, therefore, symptoms of the most serious import in cerebral diseases.

II. OF HEMIPLEGIA.

The reflex actions are not less observed in cases of hemiplegia than in cases of paraplegia ; but as they are, in general, more obvious the more complete the paralysis, and as the paralysis of hemiplegia is, in general, less complete than that of paraplegia, they have been less observed in the former affections.

CASE III.

In one case of hemiplegia so nearly complete that

the patient could only move the toe very slightly, forcible retractions of the foot and leg were produced by tickling the sole of the foot, or by applying a spoon, just taken out of hot or cold water, to the leg.

CASE IV.

In a case of hemiplegia, occurring in a child five years old, in which voluntary motion was entirely lost, sensation remaining, the following phenomena were noticed by Mr. Barlow :—“ When the paralytic arm or leg was pinched, it was convulsively retracted, and on the sole of the foot being tickled, the leg was bent with much energy, and at the same time the upper extremity of the hemiplegic side was thrown into spasmodic action. The application of heat and cold alike produced reflex actions. The hand was immersed in water at the temperature of 90°, 120°, and 140°. In the first case no muscular movement was perceived ; in the second there were forcible spasmodic actions ; in the last instance they were still more violent.

“ Dashing cold water on the face or chest, occasioned convulsive movements of the paralytic limbs. Nothing could be more marked and evident than the effect of emotion upon the paralysed extremities. On exposing the chest and dipping my hand into water, for the purpose of sprinkling some drops upon the skin, the child, inferring my intention from what had happened previously, cried violently,

and at this time there were movements of the arm and leg, similar to those which were excited by heat, cold, &c. The half of the body in which the power of the will was unimpaired, participated not in these actions, even when they were most violent."

I have already noticed the occurrence of reflex actions in hemiplegia (see the case given in my former Memoir, *Med. Chir. Trans.*, vol. xxii, p. 211), and in a case of hemiplegic loss of power of the hand, after severe attacks of epilepsy, of which I insert a brief outline here :—

CASE V.

W. W., aged twenty-one, had suffered a degree of loss of power of the left arm and leg, from repeated and protracted epileptic seizures ; he could not close the left hand firmly otherwise, but immediately grasped any object placed in the palm with considerable force.

CASE VI.

An interesting example of reflex actions in hemiplegia is given by Dr. Baly, in his translation of Professor Müller's *Physiology*, vol. i, p. 721, note :—

Dr. Baly observes, " The translator has now under his care, at the St. Pancras Infirmary, a woman aged fifty-three years, recently attacked with hemiplegia, (complete loss of sensation and motion

in the left upper and lower extremity,) in whom, nevertheless, pinching or even slightly touching the sole of the foot or ankle of the paralyzed leg, caused the limb to be retracted and the toes extended, the patient being unconscious both of the stimulus and of the movement. The phenomenon is here the more striking, as in the opposite leg, which possesses its full voluntary power, no spasmodic contraction is produced, although the slightest touch is felt."

CASE VII.

Another interesting fact of the same kind is given by Dr. Holland in his elegant "Medical Notes and Reflections," (p. 324, note.) "At this time," says Dr. Holland, "I am attending a patient who is scarcely able to raise his right arm to his chin, in effect of a hemiplegic attack three years ago; but in whom the dressing of a seton, near the lumbar vertebræ on the same side, often twitches the arm so forcibly as to raise it to a much higher level. In the same patient, when yawning, the fingers of the right hand become suddenly extended, though at other times bent closely and tightly inwards, without any power of opening them by voluntary effort."*

* It would be ungrateful in me not to express my obligations to Dr. Holland for the kind manner in which he has spoken of my labours in his elegant "Notes and Reflections," (see pp. 149, 323, 602, 606). I am not less indebted to Professor Sharpey, for the equally kind manner in which he has spoken of these investigations, in his Lectures at University College.

In cases of hemiplegia, the paralytic arm has been agitated in passing the urine or fæces.

CASE VIII.

Mr. F., aged about fifty-five, was seized, three months ago, with apoplectic symptoms, which left pretty complete hemiplegia. At first there was a little stertor and a little dysphagia ; but these symptoms ceased with the apoplectic state, the former at once, the latter a little more tardily. There was also slight enuresis for several days. On tickling the sole of the foot, or pinching the skin, or pulling a hair of the leg, and on applying a spoon just taken out of hot or cold water, there were distinct sudden movements of the leg. The same thing occurred in regard to the arm, but in a less marked degree. On first applying galvanism, the paralytic arm was least affected ; the effect, I suppose, of the shock of the disease ; afterwards the paralytic arm was most moved, as in other similar cases. On the same principle, the effect of emotion, as laughter, was at the first more observed on the healthy than on the paralytic side of the face ; more remotely, the equilibrium of the countenance, under the influence of laughter, was restored, or nearly so. At this time, the arm, and especially the hand, are paralysed to voluntary motion, but readily agitated by emotion, and sudden or energetic respiratory efforts, and constantly contracted, as by a spring, the arm towards the trunk of the body, the fingers towards

the palm of the hand ; and, lastly, more agitated by the influence of galvanism than the unaffected limb. The voluntary power of the arm is much less restored than that of the leg, in which the phenomena just enumerated are, comparatively, absent.

Sensation is far less affected than the power of voluntary motion.

The influence of certain acts of respiration, of emotion, of the principle of tone, &c., on hemiplegic limbs, though belonging to the spinal system generally, does not belong to the reflex actions, the more immediate object of this memoir. Briefly adverting to observations made in my former memoir, (Med. Chir. Trans., vol. xxii, pp. 207–208, 210–211,) therefore, I shall proceed to notice the case

III. OF PARAPLEGIA.

Under this head I shall very briefly adduce the various cases of reflex action which have been published, in the order in which they appeared. The phenomenon is now become familiar to every observer.

I believe the first observation of this kind was made by Dr. Macartney of Dublin, and it was communicated by him to Sir Benjamin Brodie, and by this latter gentleman to this Society. To Dr. Macartney I am indebted for the following note :—

“ My dear Sir,

“ In reply to your letter I have to say, that Sir

Benjamin Brodie very accurately stated the fact as I had communicated it to him, respecting the priapism which is so apt to be produced by injuries of the spinal marrow. In the case to which he alluded, the man injured the spine by falling into a quarry. The erection of the penis was very violent immediately after the accident, and occurred at intervals, for several weeks afterwards, especially on the slightest friction of the glans penis, so as to create much inconvenience in the introduction of the catheter. He had no consciousness of what was going on, unless he put down his hand to the part, or looked at it.

“ I have seen similar cases of erections after injury to the spinal marrow, but not in so extreme a degree ; and I have observed a violent priapism in two men who were suffering death by hanging.

“ I am, very truly yours,

“ J. MACARTNEY.

“ Upper Merrion Street, Dublin,

“ March 29, 1838.

“ *To Dr. Marshall Hall.*”

Sir B. Brodie has confirmed this remark by his own observation. He observes, “ Priapism occurs even where the sensibility is entirely destroyed, and may be induced by the mechanical irritation caused by the introduction of the catheter, where the patient is entirely unconscious of the operation. This circumstance was pointed out to me, many years

ago, by Professor Macartney, of Trinity College, Dublin; and I have had many opportunities of verifying the correctness of the observation.”*

The next observation of this kind is by Mr. Mayo, who has observed, in his *Outlines of Pathology*, (1835, p. 154,)—"In some cases of privation of sense and motion in the legs, through disease affecting the middle of the spinal cord, I have seen so much independent power remain in them, that pricking or tickling the foot, which yet excited no sensation, and was unknown to the patient, was nevertheless followed by its retraction."

I believe we possessed no published facts of this kind before the attention of the profession was excited to them by my first publication on the subject of the Reflex Function of the Spinal Marrow, in 1832. Since that time, however, they have accumulated.

Mr. Barlow and Dr. W. Budd each communicated to me a case of reflex actions in paraplegia, about the same time, in 1836. I was indebted for a third to Dr. Elliot of Carlisle; a fourth I visited by the invitation of Mr. Liston, at University College Hospital, and a fifth on board the *Dreadnought*, with Mr. Busk. I have since seen a considerable number.

Mr. Barlow's case is the first observed, and published with a view of illustrating my investigations

* *Med. Chir. Trans.* vol. xx, for 1836, p. 140.

into the nervous system, and as it is, at the same time, the most complete, I shall give it in his own words :—

CASE IX.

“ John Bright, aged nineteen, on the first of October, climbed up a walnut tree, for the purpose of picking the fruit, and when he had attained a very considerable height, slipped, and was precipitated to the ground. He was soon afterwards found, in a cold and pulseless condition, with his lower extremities numb and motionless. These symptoms at first naturally led to the supposition, that there was a fracture of the spine, but examination gave no proof of it, and afforded no evidence of displacement: there was, however, a slight swelling in the situation of the two or three first dorsal vertebræ, and pressure there was attended by pain. He was much depressed by the violence of the shock, and his articulation was faint and indistinct. A few hours after, he had rallied, and complained of pain in his head, and giddiness, which were relieved by moderate depletion. There was obstinate costiveness of the bowels, which was overcome by strong purgatives; and retention of urine, which required the introduction of the catheter; and it was necessary to repeat this operation at proper times, for a month after the accident; subsequently to which, the bladder became incapable of retaining its contents. Although every attention has been

paid him, sloughs have formed in the integuments of the back.

“ The following is the present state of the patient, three months after the accident :—The lower half of his body and inferior extremities are entirely *devoid of sensation*, and they are *not*, in the slightest degree, *under the influence of* the will ; sometimes the patient has cold shiverings ; and whilst the muscles of that part of the body supplied with nervous energy from above the seat of injury are observed to shake, those deriving their nerves from below that spot are perfectly motionless. This has been often remarked by his mother, who waits upon him.

“ Notwithstanding the anæsthesia, and the patient’s inability to effect a single movement through the medium of volition, when the integuments of the legs are *pinched*, or more particularly when the sole of the foot is *tickled*, the extremities are retracted with considerable force. A little *cold water* dashed upon the surface has the same effect, though there is no feeling of coldness. The leg is constantly in the flexed position ; and if straightened, recovers it again. When the *catheter* is introduced, the penis is excited into a state of complete erection, and this is invariably consequent upon the gliding the instrument along the urethra : at the same time the legs are drawn up, and a twitching of their muscles is very obvious.

“ That the muscular contractions, so easily excited by various stimuli, are referable to the reflex

function of the medulla spinalis, cannot but be admitted. In this case, all communication between the *brain* and that part of the chord from which the lower half of the frame derives its nervous power is, so far as function is concerned, effectually cut off; therefore, to the agency of the *spinal marrow* are owing those movements of which the mind knows nothing, and which, at first sight, *seem* to denote the perception of an irritating cause, and the wish to avoid it; though, upon inquiry, it is found that no sensation whatever exists.

“The situation of the different portions of the fractured bones, and the condition of the spinal marrow within, observed on a post-mortem examination, show that the influence of the cerebrum must have been separated from the parts below the injury. The spinal marrow was nearly severed in the neck.”

Dr. W. Budd's case is already published at length in the Society's Transactions (see vol. xxii, p. 154), and need not, therefore, be reproduced here.

CASE X.

In the order of time, Dr. Carpenter's case must next be noticed. It was published in the Edinburgh Medical and Surgical Journal, No. 132. It was observed by Mr. Madden. Mr. Madden says,—“In the Autumn of 1834, I was in attendance upon a case of complete paraplegia, in which it was necessary to employ the catheter twice daily. On se-

veral occasions, when the point of the instrument was passing the prostatic portion of the canal, where a slight obstruction existed, I observed that the patient jerked his legs violently ; but upon inquiry he positively denied having experienced any sensation, being not even conscious of the presence of the instrument in the urethra. The disease appeared to have been originally induced by two severe injuries received a twelvemonth before. Upon dissection, the spinal cord in the lower part of the dorsal region, was found completely disorganized, being converted into a semi-fluid pulp. The preparation has been placed in the museum of the College of Surgeons."

Dr. Elliot's case is of great interest. It was one of spinal curvature, with a fluctuating swelling in the region from the fourth to the seventh *dorsal* vertebræ, with *paraplegia* and *rigid flexure* of the lower limbs.

The loss of sensation and of voluntary motion was complete, but "powerful involuntary movements were produced in various ways."

I am indebted to Dr. Elliot for the following interesting account of it.

CASE XI.

"There appeared to be no *sensation* from a little above the crest of both ilia downwards, on pinching, rubbing, or scratching with a pin. Friction with the hand over those parts of the *abdomen* devoid of sensation, and over the ilium, on the right side,

produced, when the girl lay on the left side, powerful *extension* of the right leg and thigh, *i. e.*, the limb, if previously bent, became straight, and was forcibly moved backwards. Friction over the *sacrum* caused instant *flexion* of the knee and thigh; friction of the corresponding surfaces on the left side produced very irregular motions of the left lower limb."

An interesting case was communicated by Mr. Barron to Mr. Grainger, and published in the latter gentleman's work "On the Spinal Cord," (p. 94).

CASE XII.

"A girl, about fifteen years of age, who was a patient of Mr. Crosse, at the Norfolk and Norwich Hospital, a few years since, was affected with angular curvature of the spine, producing insensibility and paralysis of the lower extremities. On tickling the *soles of her feet*, which as an experiment was often done, the legs were immediately slightly retracted, although the patient said she felt nothing; it was further remarked that on touching the *other parts of the feet or the legs*, in the same manner, no effect was produced."

I am indebted for the following case to C. Slee, Esq., Middlesbro', Yorkshire.

CASE XIII.

"John Alderson, aged twelve, is a most intelli-

gent boy, of strumous habit. About six months ago a tumour was observed *between the scapulæ*, and a short time afterwards he became unable to walk without falling, even on a level floor. Soon after this he ceased to have the power of lifting his feet from the ground, when in the sitting posture. On pinching the feet and legs, I was astonished to find that each attempt caused violent involuntary startings of the limb, which were very painful. The sense of touch appeared to me to be even more acute than natural in every part of the lower extremities. I was informed that a current of cool air, on coming in contact with the limbs, frequently gave rise to the same phenomenon as that caused by pinching."

CASE XIV.

In a case read by Mr. Oubr , before the Royal Medical and Chirurgical Society, on March 17, 1840, of hemiplegia from tumour in the pons varolii, in a boy nine years of age, both the paralytic limbs, but especially the leg, were much agitated, and priapism excited by passing the catheter.

But I need not occupy the attention of the Society by any further detail of cases of this kind, especially as I have it in my power to remind them of the admirable and invaluable "Contributions to the Pathology of the Spinal Cord," published in the last volume of its Transactions, by Dr. William Budd.

IV. TETANUS ; HYDROPHOBIA ; EFFECTS OF STRYCHNINE.

As in cerebral paralysis we have augmented irritability of the muscular fibre, or of the *vis insita*, in tetanus and hydrophobia we have the *vis nervosa* morbidly augmented, but in an infinitely greater degree.

The slightest external stimulus is sufficient to excite reflex actions in their most terrific forms.

What is remarkable is, that it is precisely the functions of the orifices and sphincters, of the ingesters and egestors, which are most affected in these formidable diseases ; and, most of all, the larynx, the pharynx, the organs of respiration, and the rectum.

The remarks which have been made relative to the condition of the reflex function in tetanus and hydrophobia, apply equally to that artificial tetanus induced by strychnine. In a report of La Charité, of Berlin, drawn up by Dr. Köhler, it is observed that "in some individuals, the sensibility to external impressions, under the influence of strychnine, was so great, that they broke out into an almost uncontrollable fit of laughter on being touched with the finger." *

* *Lancet* for October 1836.

V. UNDUE EXCITABILITY.

Instead of paraplegia, and the other forms of paralysis, arising from disease of the spinal marrow, we have occasionally undue excitability. I think this subject has not been sufficiently treated of in medical writings. But I can only briefly notice it here in connection with the main subject of this paper. On another occasion, I may beg the attention of this Society to it more particularly. It is still a question how far the spinal marrow is primarily or organically affected in these cases; which I think quite distinct from those of common paraplegia.

CASE XV.

In one interesting case, (which was once seen by our President), there were movements of the fingers somewhat like those seen in chorea, whilst the muscles of the legs were spasmodically contracted; the patient was as incapacitated for muscular exertion as in paraplegia. The point to which I wish particularly to allude here is this,—the skin was so susceptible to impressions in certain parts of the surface, that the patient was affected with a sort of general emprosthotonic spasm, with a slight sob whenever the bedclothes, for instance, were drawn over his chest, and still more especially when the

penis was accidentally touched in a similar manner. Similar effects were observed on applying the pure potassa to establish an issue along the spine. The legs were drawn upwards whenever the sole of the foot first touched the cold floor on rising in the morning.

In another case, in which there was a peculiar dysphagia, which I propose to describe more particularly hereafter, together with inability to use the lower limbs, the susceptibility of the skin was such, that the touch of the left side of the thorax by a coarse towel produced the most painful and intolerable “*shudder*.”

VI. PECULIAR DYSPHAGIA.

I have met with three cases of the peculiar form of dysphagia to which I have just alluded. From an undue excito-motory action, the pharynx seizes some solid portion of what is attempted to be swallowed, and this is afterwards returned by a peculiar effort, for which I know of no designation but that of a forcible hawking. A pill, though taken with a large draught of water, is arrested at the upper part of the pharynx. A little of the core of apple, or of the gristle of meat, is seized and retained in the same manner, the rest being duly swallowed. Sometimes large portions of food are thus retained. When the pharynx is thus occupied by a portion of food, it is necessary to remove it either by swallowing

some fluid, or by the effort just described. It may not be without interest to add, that I am myself affected with this singular kind of dysphagia.

VII. MORBID ACTION OF THE RECTUM AND BLADDER,
AND OF THE SPHINCTERS.

There is a peculiar affection of the rectum and bladder in some nervous affections, of which the following experiment affords both the type and illustration: if, in a turtle, after the removal of the tail and the posterior extremities, with the rectum, and, of course, with a portion of the spinal marrow, water be forced into the intestine by means of Read's syringe, both the cloaca and the bladder are fully distended before any part of the fluid escapes through the sphincter; which it then does only on the use of much force, and *by jerks*. If, when the cloaca is distended, the integuments *over it* are stimulated, the water is propelled to a considerable distance.

When the rectum or bladder is distended, the patient feels a sudden call, and the action of the expulsors is so energetic, or the power of the sphincters is so diminished, that unless the call can be promptly obeyed the *fæces* or urine escapes.

In tenesmus and strangury, the sphincter of the rectum and of the bladder is excited to undue contraction respectively. A ligature applied to hæmorrhoids not uncommonly induces spasmodic action of the *cervix vesicæ* and retention of urine. In one case,

calculus of the bulb of the urethra induced spasmodic stricture of the sphincter ani. All examples of morbid reflex action.

VIII. SINGULAR ACTION OF THE THORACIC AND ABDOMINAL MUSCLES.

CASE XVI.

In an interesting case it was observed that, whenever the rectum was more than usually fretted, the muscles of the thorax and abdomen were drawn into violent action, especially the serrati and the recti; the insertions of the former, and the division of the latter, were marked as we observe them in certain pictures and statues.

I now beg to draw the attention of this Society to another subject,—the localization of the effects of certain remedies, if I may use this expression.

The localization of certain remedies is highly worthy of observation: strychnine acts upon the glottis, cantharides on the neck of the bladder, aloes on the rectum, the secale cornutum on the uterus,—all organs specially under the influence of the excitatory power and reflex function of the spinal marrow.

I shall illustrate this subject, as before, by briefly adducing the particulars of two most interesting cases.

CASE XVII.

Strychnine.

A lady, being at Lausanne, in September 1836, consulted a foreign physician there, who prescribed the strychnine ; I do not know the dose ; I only know that it was afterwards *diminished* to one-tenth of a grain thrice a-day. Two pills were taken at bed-time, and three the next morning ; soon after which, the patient was taken with spasm of the muscles about the larynx, and those of one arm. She felt as if strangled. With much effort she mixed some *eau de Cologne* with water, “ snapped at it,” and so swallowed it. She was shortly relieved. The dose of strychnine was repeated between breakfast and noon. The same symptoms were renewed ; she *felt* and *looked* as if strangled. The muscles on each side of the larynx became tense, like cords ; she was again relieved by *eau de Cologne*, which she took hastily, as before. After this, the dose of strychnine was reduced, as I have stated, and was taken without any bad effect.

For the following interesting case I am indebted to Mr. Robarts, of Everett Street, Russell Square.

CASE XVIII.

Cantharides.

A young lady, aged 27, had a fatty tumour within the tenth and eleventh dorsal vertebræ ; it gradually,

but completely, severed the spinal marrow, and induced perfect paraplegia. The bladder lost its power of retention. The singular fact in this case was the following.—On giving a dose of tincture of cantharides the power of retaining the urine was always restored *for the time*. This power would cease, and again be restored, on suspending or repeating the medicine.

It is obvious that the cantharides acted through the segment of the excito-motory system, left below the division of the spinal marrow.

What strychnine effects in regard to the larynx and pharynx, cantharides effect in regard to the cervix vesicæ: the reflex function of these parts is notwithstanding augmented, and stimuli, which have no such effect naturally, induce morbid and even spasmodic actions. I need not illustrate the special and local action of aloes, or of the ergot, by any cases.

On the other hand, certain localities are more susceptible than others to the effects of the excito-motory stimulus: the sole of the foot is especially one of these; Dr. Little has published in his Thesis an interesting case of distortion of the foot, which only, but uniformly, occurred when it was placed upon the ground.

CASE XIX.

“Juvenis quidam si planta pedis humum attingebat, spasma tonico gastrocnemiorum afficiebatur,

quo calx sursum trahebatur. Sin æger sella sedebat vel supinus jacebat, pedem naturali modo undique movere et gastrocnemiis prorsus imperare potuit. Quoties vero digitis humum tangebatur, ut infra fusius retulero, gastrocnemii spasmodice contrahebantur."

Dr. Duffenbach met with a similar case.

The sides of the thorax are most susceptible to the singular effects of tickling, and to the augmented susceptibility or excitability of which I have briefly sketched two cases.

Having thus illustrated the subject of the morbid reflex actions, I must proceed to another object of this paper, viz., to point out the comparative effects of the different excitants of the reflex function.

THE EXCITANTS OF THE REFLEX ACTIONS.

The foetus in utero is so little exposed to the influence of stimulants or excitants applied to the cutaneous or mucous surfaces, that the excito-motory property is *comparatively*, little called into action in the form of the reflex function. The contact of the liquor amnii may preserve the lips or the larynx, and the sphincter ani, closed. In this manner the reflex function or the function of exclusion and of retention is in activity; but as the agent in ingestion and egestion, it is as if it did not exist.

It is on the expulsion of the foetus, and by the contact of the atmospheric air with the minute distributions of the incident nerves of the excito-motory

system, that the functions of ingestion and egestion first commence.

It is, doubtless, from the impression of the atmospheric air on the trifacial and spinal nerves, distributed upon the surface of the face and body, that the first inspiration is excited. My friend, Dr. Heming, in attendance on a case of labour, waited, after the delivery of the child, for the usual sign of respiration and crying. This did not take place ; and Dr. Heming began to feel a little anxiety for the infant's safety. On the point of proceeding to the use of some means of resuscitation, he raised the bed-clothes, and of course admitted the atmospheric air into contact with the infant's skin. Inspiration was instantly excited, and the little patient continued to breathe.

The influence of cold water dashed on the face, and the influence of the diffused contact of the cold bath, in exciting sudden sobbing acts of inspiration, are well known.

The same contact of cold air which excites the first inspiration, also excites the first acts of expulsion of the fæces and urine. This effect is also seen in the late periods of existence. The cold bath induces the same effect. I have observed animals, on being driven through a cold stream, invariably to evacuate the rectum and bladder. Cold water, injected into the rectum, is sometimes expelled with force. The same effect was produced in one of Dr. William Budd's patients,* on injecting cold wa-

* Medico-Chirurgical Transactions, vol. xxii, p. 182.

ter into the bladder. Might not this remedy be used with advantage in uterine hemorrhage?

Not only the bladder and rectum, but the uterus is subjected to the same influence. The catamenia are apt to be suddenly checked by the influence of cold. The uterus is excited to contraction and uterine hemorrhage is most distinctly arrested by an effectual douche of cold water.

I may here advert to the *diffused* influence of a mere *partial* application of cold upon the skin. The pores over an extensive surface are closed, and the perspiration arrested. Is this a *muscular* phenomenon, belonging to the reflex excito-motory system?

It is interesting to observe the salutary effects of a new exposure of a foetus at the precise moment when new functions are required. It is also interesting to observe the influence of the same cause at subsequent periods of life, and in certain cases of morbid affection. Of the latter, none are more remarkable than the phenomena observed in the coma of epilepsy and apoplexy. The medulla oblongata being compressed, together with the other contents of the cranium, the influence of dashing cold water on the face may be absolutely null: on taking off that pressure by blood-letting, the susceptibility to the influence is again restored: it becomes a measure, even, of the diminished compression.

There are other influences of cold, which must not be passed over unnoticed. Free exposure of the

face to the cold breeze is the most effectual remedy in sickness, and affords manifest relief in asthma.

As to other excitants of the reflex functions, we need only call to mind the simplest facts. The nipple or the finger, introduced between the lips of the new-born, or even the anencephalous, foetus, immediately excites the act of sucking: the mere introduction of the enema pipe into the rectum of an infant, equally excites the action of the rectum. The irritation of a few grains of common salt, applied to the border of the sphincter ani, will induce the premature expulsion of an egg in a common fowl.*

I need scarcely allude to food as the natural exciter of the pharynx, oesophagus, and cardia, or to the fæces and urine, as the equally natural exciters of the expulsors about the rectum, and of the bladder.

It will be observed that in *all* these cases the excitant is applied to *cutaneous* or *mucous* surfaces: these surfaces are, indeed, the only surfaces exposed to the action of external stimuli: some internal textures are, however, capable of transmitting the influence of excitants. I have seen the limbs of the decapitated turtle moved energetically on dividing internal tissues; and I have known spasmodic affections induced by disease of similar internal tissues; of which the cases published in the Transactions of this Society, in its twenty-second volume, p. 1, by Dr. R. Bright, may be examples.

* The same effect is said to have been produced by the *secale cornutum*, in an experiment performed by M. Velpeau.

It still remains for us to trace the influence of excitants of this function in some more hidden cases. It is almost certain that the gall-ducts, the ureters, and other excretory canals, are endowed both with incident and excitant, and with reflex and motor, nerves. The passage of a biliary or urinary calculus *excites* vomiting : exposure to cold, a loaded intestine, certain passions, and in infants mere dentition, will, on the other hand, arrest the flow of bile and induce icterus.

The influence of the excitants of this system of actions, considered as *remedies*, is little known. One of the most interesting examples of this kind is that of the application of cold to the face and to the general surface, in some cases of suspended animation. As a remedy in the cases of the still-born foetus and of drowning, the sudden contact of cold water is most important. I have already alluded to the use and influence of the cold water douche in cases of hemorrhage from inaction of the uterus.

Physiology is still in need of a series of experiments upon the comparative influence of the several excitants, especially cold, heat, and *mechanical irritation*.

It only remains for me to observe here what are the agents which most effectually excite the reflex actions in disease, and especially in the cases of cerebral paralysis. A metallic spoon, taken out of cold or hot water, and suddenly applied, the pulling of a hair, the prick of a needle, the titillation of a feather, are the means which most naturally

suggest themselves as tests of the excito-motory actions in cases of paraplegia.

The subject of tickling ought to be treated more at length, but I refrain from doing so for fear of wearying the attention of the Society.

II. RETROGRADE ACTION IN SPINAL DISEASE.

The subject to which I now venture to call the attention of the Society, is involved in the deepest obscurity.

It has been observed in certain experiments, which I shall detail very briefly, that an irritation of the middle part of the spinal marrow, below the origin of the brachial plexus, induces in some decapitated animals, and especially the cold-blooded and the very young of the warm-blooded, distinct movements of the anterior extremities.

I removed the head of a young turtle: on pinching and galvanizing the lower extremity of the medulla oblongata, there was an excited act of inspiration. The same event occurred on stimulating the nostril, the intra-maxillary or palatine fringes, and the internal part of the larynx.

I then laid bare the middle portion of the spinal marrow by removing part of the shell. On pinching or galvanizing this, *both* the *anterior* and *posterior* fins were moved.

I took a frog, separated the head, and divided the spinal marrow low in the back: I then stimu-

ated the lower end of the upper portion of the spinal marrow with the forceps ; the anterior extremities moved in the most remarkable manner :— they were gently raised, without being affected with the *twitchings* seen in the inferior extremities when the upper part of the lower half of the divided spinal marrow was stimulated.

I was next anxious to perform these experiments on an animal of warm blood. I chose for this purpose a rabbit of six days old.

I first removed the head. I then stimulated the lower end of the divided medulla. There was an immediate act of *gasping* ; I then divided the spine in the back, and stimulated the lower end of this middle portion of the spinal marrow ; the anterior extremities were immediately moved.*

In reference to the question, whether retrograde actions of the spinal marrow take place in disease, that is, whether spasmodic or other morbid action occurs in disease of the spinal marrow *above* the seat of the disease,— I must content myself by a brief reference to one or two English works, and by a brief extract from the “ *Memoirs* ” of M. Louis.

In Mr. Copland’s “ *Observations on diseased Spine*,” published in 1815, p. 47–50, there is a case in which disease seated in the lower part of the dorsal region affected the upper extremities.

* Similar experiments have been performed by M. Flourens and Prof. Müller ; but in these the *head* was not removed ; so that the effects might be complicated with the effects of sensation and volition.

This case is mentioned and confirmed by Sir B. Brodie in the *first* edition of his "Observations on Diseases of the Joints," in 1818; but the subject is omitted in the *third* edition of that work, in 1834; from which we may conclude that the author had subsequently learnt to doubt the accuracy of the observation.

In the "Memoirs" of M. Louis I find the following interesting observation, in relation to a case of caries of the third and fourth *dorsal* vertebræ;—"Les bras, déjà faibles dès l'entrée de la malade à l'hôpital, furent comme paralysés dans les trois derniers mois qu'elle y resta; ses mains étaient constamment fléchies, mais ses avant-bras jouissaient de quelques mouvemens: elle éprouvait des douleurs aux épaules, aux coudes et aux poignets; elle en eut de très-vives dans les deux derniers mois aux épaules, et peu après son arrivée à Saint-Germain, la tête s'inclina du côté gauche, et garda constamment depuis, la même position. L'appétit avait peu diminué, les selles avaient été plus rares que fréquentes, et dans les quinze jours qui précédèrent l'entrée de la malade à la Charité l'émission de l'urine fut difficile.

"Le 13 Novembre, tête inclinée à gauche, figure assez animée; paralysie des bras; douleurs dans toute l'étendue des avant-bras, et jusqu'à l'extrémité des doigts, lancinantes, augmentées par le mouvement." (See "Mémoires sur plusieurs Maladies.")

At p. 427, M. Louis adds, "Mais comme, dans les observations où règne le plus grand accord entre les symptômes et les causes auxquelles on doit les

rapporter, il n'est pas toujours possible de se rendre compte de tout, nous ne chercherons pas à expliquer pourquoi, dans le cas dont il s'agit, la douleur de l'épine n'a eu lieu que dans les trois derniers mois de l'affection ; ni comment le ramollissement de la moëlle existant au niveau des troisième et quatrième vertèbres dorsales, les bras étaient paralysés, tandis que les avant-bras jouissaient de quelques mouvements. Ces différens objets sont encore pour nous des anomalies ; et resteront peut-être tels, fort longtemps."

The only other observations which I shall adduce at present are taken from Mr. Stafford on the spine.

CASE XX.

"October 1831.—A man fell from the top of a waggon-load of hay ; he had struck his back upon the *second, third and fourth* lumbar vertebræ, which were considerably displaced laterally, the body leaning to the right side, leaving but little doubt that the spine at that part had suffered fracture. He was perfectly paralysed below the injury ; the fæces escaped involuntarily, and the bladder could not expel its contents ; the arms likewise were partially paralysed, in both the powers of feeling and motion. His present state is as follows :—the muscles of the right arm are so *contracted* that it is closely fixed to the side ; the fore-arm, from the same cause, rests upon the humeral part ; the wrist is bent on the fore-arm, and the fingers are firmly clenched in the palm of the hand ; the sense of feeling is partially lost ; the

left arm is affected in the same manner, but not in so great a degree ; the right leg has both the power of motion and feeling ; the left leg has the power of feeling, but not that of motion ; the sphincter muscle of the rectum remains paralysed, the *fæces* still escaping involuntarily, and the bladder only expelling half its contents.

“ The various symptoms just related are certainly very extraordinary, and had it not been for the discoveries of modern physiologists, they could not have been accounted for ; and even as it is, some of them are still involved in great obscurity. For example, how can we for certain explain why, in one case, the arms alone should be paralysed ; in another only the bladder and rectum, and one leg partially ; and in a third, that the parts above the place where the blow was received, should suffer as well as those below ? Such phenomena cannot be satisfactorily accounted for, and the only attempt at elucidation we can offer is, that the origins of those nerves, or that particular part of the substance of the medulla with which they are connected, supplying the parts affected, have more particularly suffered.”

It is obvious that the question agitated in this place is one of great moment in the diagnosis of diseases of the spine ; for if there be in disease or accident, retrograde influences of the spinal marrow, we must not always conclude that the disease or injury is situated *above* the origin of the nerves affected. It is equally obvious that the whole subject needs new and accurate observation.

I trust that one advantage will arise from the brief remarks which have been made in this communication, viz., that in every case of cerebral or spinal disease, and disease of the nerves in their course, the condition of the reflex actions, and of the retrograde influences of the spinal marrow and nerves, will henceforth be carefully examined. The first of these subjects has already made great progress; the second has scarcely been touched upon in medical writings. I will venture to suggest that cases of caries of the vertebræ appear to afford the most probable example of diseases *limited* to a given region of the spinal marrow, and therefore the best for the latter kind of inquiry. They afford examples of *irritation* before morbid processes have induced *disorganization*. The questions to be considered are two. 1. Is there paralysis? 2. Is there spasmodic action, in parts receiving their nerves from portions of the spinal marrow *above* the seat of the disease?

The time is already arrived when it is impossible to examine a case of cerebral or spinal disease without a distinct reference to the sentient and voluntary and the excito-motory phenomena. The cases taken and recorded before this distinction was clearly pointed out, are already felt to be inadequate to fulfil the demands of observation. The subject must be resumed: observations must be made anew, with constant reference to the distinctions which I have established, before all the evidence which they afford can be said to be derived from them.

Inferences.

I will conclude this paper by submitting to the Society the following propositions or inferences.

1. It is proved by the series of facts which have been observed in the human subject, that the excito-motory reflex actions are independent of sensation and volition, however they may be accompanied by sensation, or influenced by volition, in the perfect animal.

2. It is proved as a consequence, that the reflex actions are dependent on another principle of the nervous system ; and it is proved by a series of experiments, that this principle is the *vis nervosa* of Haller, acting according to a new reflex law.

3. The phenomena of the excito-motory reflex actions are obvious in cases of paralysis, in proportion as that paralysis is more complete ; they are therefore, more observable in paraplegia, than in hemiplegia, in general, but in each of these according to their intensity ; they are therefore not only independent of sensation and volition, but inversely as these, frequently disappearing as these return.

4. In accidents, as in experiments, the excited reflex actions are not immediately observed, but are manifested only after the lapse of certain intervals of time ; it is plain therefore, that the first influence of shock, is to diminish the excito-motory power ; and this may remain until the patient falls a prey to

the accident ; as in the case noticed in Dr. W. Budd's paper.*

5. It is observed that at a subsequent period, in more favourable cases, the excito-motory power is not only restored to its normal condition, but morbidly augmented.

6. This is especially observed in certain diseases, as tetanus, the effects of strychnine, &c.

7. The reflex arcs of the nervous system will be imperfect in cases of disease or injury of the lumbar or other regions, as in the case noticed in Dr. W. Budd's paper,† and the reflex actions will consequently be absent ; a fact which affords, in its turn, an important source of diagnosis, as to the seat of the disease.

8. In certain cerebral affections attended by coma, the presence or absence of reflex actions, in the eyelids especially, gives us an index of the degree of severity of the disease.

9. Certain diseases, as hydrophobia, epilepsy, hysteria, and certain remedies, as strychnine, cantharides, &c., not only induce augmented excitability, but manifest their effects precisely upon the organs which are, physiologically, under the influence and dominion of the excito-motory power.

10. There are new forms of disease of the true spinal functions, not hitherto described, such as the dysphagia, the peculiar action of the rectum, &c., which have been briefly noticed.

* *Medico-Chirurgical Transactions*, vol. xxii, p. 185.

† *Ibid.*

11. Certain parts, as the sides of the thorax, the soles of the feet, &c., are more susceptible of the excitement in question than others.

12. Dr. W. Budd has very justly observed, that in many cases of violent reflex, and even convulsive actions, there was no sense of fatigue, and little emaciation of the muscles. In fact, fatigue is a cerebral state, and cannot be expected to occur in the cases in which the reflex actions are most observed; and emaciation is most obvious in spinal paralysis, in which the reflex arcs being interrupted, the reflex actions are also precluded from taking place. Fatigue *is felt* severely after violent attacks of epilepsy and other spasmodic diseases, in which the cerebral functions are afterwards restored.

I beg to observe in conclusion that, lengthy as this communication may appear, I have done my utmost to curtail it, and have omitted much that I should otherwise have inserted. On some future occasion, I trust I may be allowed to explain, more particularly than I could do on this, *the plan of observation of diseases of the nervous system*, to which I have briefly adverted, p. 163. The importance of this view of the subject will be at once apparent on reading the valuable works of M. Lallemand and M. Andral, whose cases, indeed, would require to be observed anew, with a distinct reference to these recent views of the nervous system. Scarcely a case of cerebral or spinal disease occurs in which it is not necessary, at the bed-side, to advert to the

distinctions which I have pointed out, in reference both to the diagnosis and treatment. Such is the *practical* application and value of this investigation.

It is necessary to advert to another important topic—the influence of *emotion* in diseases of the nervous system. This I propose doing in a third memoir.