

A treatise on tetanus : being the essay for which the Jacksonian Prize for the year 1834 was awarded by the Royal College of Surgeons in London / by Thomas Blizard Curling.

Contributors

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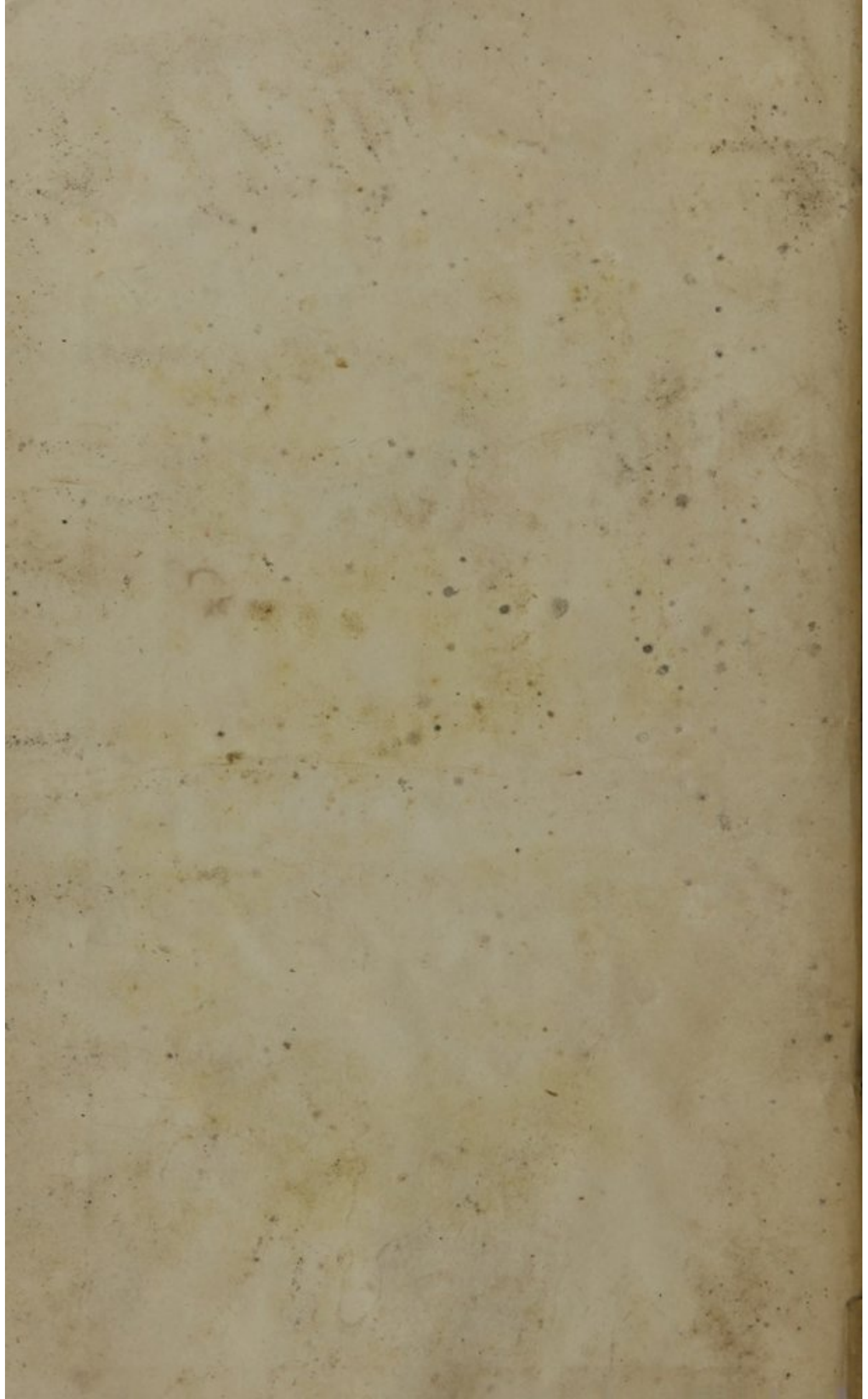


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A TREATISE

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T E T A N U S,

BEING

*Presented by
D. C. Peters*

THE ESSAY

FOR WHICH

THE JACKSONIAN PRIZE,

FOR THE YEAR 1834,

WAS AWARDED, BY THE ROYAL COLLEGE OF SURGEONS,
IN LONDON.

BY THOMAS BLIZARD CURLING,

ASSISTANT-SURGEON TO THE LONDON HOSPITAL, AND LECTURER ON MORBID
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PREFACE.

THE following Essay on Tetanus, one of a class of diseases but little understood, and exceedingly difficult of investigation, was not originally intended for publication. Having no novelties in treatment to recommend, I am induced to submit this imperfect performance to the notice of the profession in consequence of the desultory nature of the literature of this disease, conceiving that it may tend to place in a clearer light the knowledge already acquired, and that it may in some degree contribute to spare to others, whose attention may be directed to the subject, the labour which was incurred in collecting the materials upon which it was founded. The reader will bear in mind that it aims at nothing higher than to afford a fair and candid review of the inquiries of others, and to supply such additional matter as my own opportunities of observation have enabled me to furnish; together with such further and more exact information as may be readily gleaned from a collection and arrangement of facts.

When I was honoured with the Jacksonian Prize, Mr. Travers's second part on Constitutional Irritation had not appeared. It has been gratifying to me to find that, on many important points, especially in relation to treatment, I am sanctioned by the authority of this eloquent writer and philosophical observer.

Sept. 1836.

The first of these is the fact that the
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INTRODUCTION.

IN composing this Essay on a disease which has so frequently resisted the most powerful means that our art possesses, and in regard to the treatment of which so much difference of opinion exists, I have constantly kept in mind the instruction of the Jacksonian Committee, that the "number and importance of facts will be considered principal points of excellence." For in the study of a disease, the nature of which is as yet involved in obscurity, it is only by collecting and comparing facts that such legitimate deductions can be formed as will guide us to a knowledge of those principles by which its treatment should be regulated. I have also endeavoured to obtain from amongst the discrepant statements and conflicting opinions of different writers, those conclusions which their collective experience would appear to justify, and from amidst a host of remedies that have been employed, to trace to some general cause or mode of operation the salutary influence which they have been supposed to exert.

Brief and imperfect notices respecting Tetanus may be found as far back as in the writings of Hippocrates; yet but few authors, even at the present day, have treated of it in a systematic form, and the most instructive cases, and valuable information on record, are contained in the transactions of societies, or are scattered through various periodical journals.

In order to acquire more accurate knowledge respecting this disease, as well as to obtain data to reason from, 128 cases of traumatic Tetanus* have been carefully examined, analysed, and arranged in a table, distinguishing the sexes, and giving the ages of the patients, the nature of the injury, the time subsequent to the infliction of the wound at which the disease first showed itself, the result, and at what time after the appearance of symptoms, a general view of the treatment, and the sources from which the cases have been obtained. It would have been desirable to have added to these particulars an account of the trade or occupation of each patient, and of the state of the pulse; but as in most instances nothing is said in respect to these points, it is obvious that the

* Vide Appendix.

columns devoted to them must have been exceedingly imperfect. It will be seen that the cases composing this table are repeatedly alluded to in illustration of various phenomena, by which means what is stated is authenticated, and an opportunity afforded for further reference. This appeared the most convenient way of embodying in the essay the principal and most interesting matter derivable from so large a collection of cases, without the incumbrance of a voluminous extract of particulars.

It has been often lamented that cases only of successful practice are usually selected for publication, on which account great difficulty is experienced in obtaining a satisfactory estimate of the average fatality of diseases, and of the value of remedies. The observation applies with much force and justice to reports of cases of Tetanus. One hundred and twenty-eight examples have been taken indiscriminately from various sources; and although it is well known that by far the greater proportion of the subjects of this disease never recover, yet fifty-eight, or nearly one-half of them, are instances of cure. The inducements to report individual cases are generally to give publicity to remedies that have been found efficacious, and more rarely to put on record an account of unusual and remarkable phenomena, or interesting pathological appearances. It is evident, therefore, that an accurate and fair estimate of the actual rate of mortality in Tetanus, and of the value of the various means that have been employed in the treatment of it, cannot be obtained from this table. It affords, however, much useful information respecting the circumstances under which recovery takes place, the comparative value of different remedies, and other important particulars.

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TREATISE ON TETANUS.

CHAPTER I.

GENERAL ACCOUNT OF TETANUS.

§ 1. *Definition.* The term Tetanus, derived from the Greek verb *teino*, to stretch, is applied to a disease, characterized by permanent spasm or continued contraction of the muscles subservient to voluntary motion, called by Cullen *spastic rigidity*, with irregular intervals of partial but seldom of complete relaxation. These spasms are liable to sudden increase, in violent and painful paroxysms, which ceasing, leave the patient in a comparatively relaxed and easy state. In severe or aggravated cases, nearly all the muscles which are in any degree under the control of the will may become affected, comprehending the muscles which give motion to the head, trunk, and limbs, the muscles of the face, eyeballs, larynx, soft palate, and tongue, the diaphragm, levator and sphincter ani, and the compressor urethræ; whereas those muscles, which are uninfluenced by volition, appear to be exempt.

§ 2. *Forms and varieties of the disease.* Tetanus has been distinguished into two species, the *idiopathic*, including those cases where the disease appears to arise from some general cause, as exposure to damp or cold; and the *traumatic* or *symptomatic*, when it is a remote consequence of a local injury. A variety of the latter occurring in newly-born children is called *Trismus* or *Tetanus nascentium*. A distinction of more practical importance has been made into the *acute* and *chronic* forms, the symptoms of both being the same in kind but differing in degree and in the period of time which they take to run their course. *Idiopathic Tetanus* in this climate is usually chronic, rarely terminating fatally, and less active measures are necessary for subduing it. *Traumatic Tetanus* is most frequently acute, and, since the treatment of the acute disease, whether *idiopathic* or *symptomatic*, should be guided by the same

principles, and, as the remote cause and generally fatal result of the *traumatic* render it more interesting to the surgeon, my inquiries will be more particularly directed to this form of the disease.

§ 3. *Symptoms.* The symptoms of Tetanus, as manifested in a morbid action of the muscular system, have been distinguished by terms expressive of the posture or distortion of the body produced. Thus *trismus*, from *trizo*, to gnash, implies that the muscles which raise the lower jaw are in a state of spasm, keeping the teeth nearly or completely in contact. *Emprosthotonis*, from *emprosthēn*, forwards, and *teino*, is used when the body is bent forwards, by contraction of the abdominal muscles, and the head drawn towards the breast by the muscles of the neck. *Opisthotonos*, from *opisthēn*, backwards, and *teino*, expresses that the body is drawn backwards by the influence of the muscles at the posterior part of the neck and along the spine. *Plurosthotonos*, from *pleurosthēn*, sideways, or *pleurotonos*, from *pleuron*, the side, and *teino*, first described by Fernelius, and called by Sauvages *Tetanus lateralis*, are applied when the muscles situated on one side are more affected than those on the other, so that the body is bent laterally. The term *Tetanus* is sometimes restricted by authors to those cases in which the spasms are general.

These appellations, expressive only of certain variations in the symptoms, depending, for the most part, upon the partial or unequal operation of the disease upon the muscles moving and supporting the body, in a practical view are of little value, since the condition of the muscles often varies, at different periods, in the same case. For instance, at the commencement, trismus may be the only symptom, but, as the disease advances, opisthotonos or emprosthotonos may ensue. Besides, in acute and aggravated cases, nearly all the voluntary muscles are more or less in a state of permanent contraction, and the posture of the body does not depend so much upon a particular class being effected as upon the greater influence exerted by the more powerful muscles. Thus the numerous strong muscles arranged along the spine, destined to support the head and to sustain the erect position, although opposed in the paroxysms of Tetanus to the muscles of the abdomen, produce so rigid a curvature backwards that the body may sometimes be seen resting upon the bed only by the occiput and heels, forming a complete arch, and yet if the hand be placed at the same time upon the abdomen, the flexor muscles of the trunk will be found in a state of powerful contraction, feeling like a hard board.* In like manner, when the jaws are so completely closed, that not the slightest interval exists between the teeth, the muscles of the neck are often rigid and strongly affected with spasm. In case iv., the muscles of the back were much less affected than those of the abdomen, the spasms of the recti abdominis having been remarkably severe, yet emprosthotonos was not the result. This

* In opisthotonos the head is sometimes drawn so far backwards, that the sterno-cleido mastoidei, instead of acting as flexors, are rendered powerful extensors of the head.

state indeed is exceedingly rare, and I have only met with one case in which it remained constant during the progress of the disease. Pleurosthotonos is still more rare, and is considered by some writers as little better than an imaginary distinction, for, although it sometimes happens that the spasms are limited to the muscles on one side of the body, or are more severe on one side than on the other, yet it does appear that lateral distortion is necessarily the result.

At the commencement of an attack of Tetanus, the patient generally complains of stiffness or uneasiness about the muscles of the jaws, throat, or neck, which is frequently attributed by him to having caught cold, and described as a sore throat or a stiff neck. A difficulty is experienced next in rotating or moving the head, and in masticating and swallowing food, attempts to expand the jaws occasioning considerable distress, the nature of the disease often being first detected on requesting the patient to show his tongue. A painful traction or sense of tightness is soon felt about the cartilago ensiformis, passing backwards to the spine, and the muscles along the back and those of the abdomen become affected with spasms, which may afterwards extend to the limbs. The patient is bathed in a profuse perspiration, and suffers greatly from thirst, but the attempt to swallow often causes such a distressing paroxysm that there is complete inability to drink or to take any nourishment. The larynx becomes raised, the angles of the mouth drawn up, the alæ of the nose elevated, the nostrils expanded, the eyes fixed and prominent, the brows contracted, and the forehead wrinkled, giving to the countenance an expression of great distress and anxiety, and frequently a peculiar grin, called by the earlier writer *risus sardonicus*. The voice is sometimes altered, being harsh and disagreeable, and, in the violent paroxysm, the tongue, being forced between the teeth, frequently becomes severely lacerated and torn, rendering the mouth bloody, and adding very much to the frightful appearance of the countenance. The shoulders are drawn forwards, and the body, forced into different postures, according as one set of muscles is more strongly contracted than their antagonists, is sometimes, during the paroxysms, so violently thrown about as only to be protected from injury by the care of assistants. The pain at the præcordium increases, respiration is embarrassed and hurried, and the pulse becomes quick and irregular. As the disease advances, the highly painful and distressing paroxysm recur more frequently, being renewed every ten or fifteen minutes. They also become more violent and painful, and are induced by the most trivial circumstance as opening the door, a draught of air, or the least attempt to move or swallow. An agonizing sense of suffocation is experienced, the face appears livid, and in a state of violent convulsion life frequently terminates suddenly; or sometimes all the symptoms are abated just previous to death, and the patient afterwards sinks as if all the powers of the system were exhausted by the long and violent contractions of the muscles, and by the excess of pain and suffering.

This must be received rather as an enumeration of the order in

which the different symptoms, when present, generally appear, than as an accurate representation, or exact account of the usual progress of the disease. For there is every possible variety and irregularity in the symptoms, both in different cases and at various periods of the same case, and the only adequate description that can be given is in the narration of cases, several of which will be found in the following pages.

The expression of the countenance in Tetanus, although sufficiently uniform to be characteristic of the disease, is not invariably the same in every case. Aretæus observes, that distortion of the face is so great that patients are not recognized by their most intimate friends. A case of idiopathic tetanus is related by Dr. W. Farr, in the fourth volume of the Medical Observations and Inquiries, in which the spasms of the muscles of the face had so deeply impressed the marks of age on the countenance of the patient, who was only twenty-six years of age, as to induce all who saw him in that state to believe that he was at least sixty. I once observed the same circumstance in an equally remarkable degree. In case vi. the mouth was kept firmly closed by the action of the orbicularis oris.

The pain which is experienced generally varies according to the violence of the spasms, and some idea of its intensity may be formed by any one who has endured a severe cramp in the muscles of the extremities. The spasms are particularly painful, when occurring in muscles implicated in the wound, as in a stump after amputation, especially if in a state of inflammation. The continued spasm, or rigidity of the muscles, is often, however, unattended with pain, so that it is only during the paroxysms that any sense of uneasiness is experienced. Some remarkable instances have been described, in which there was complete immunity from suffering during the most acute paroxysms. Sir Gilbert Blane mentions, on the authority of a surgeon in the navy, an extraordinary case of Tetanus which proved fatal in four days, where the sensation, excited by the violent muscular contractions, was a sort of tingling of a pleasurable nature*. In case 81, in the table, no uneasiness was occasioned by the spasms of the muscles of the jaw and throat.

Pain at the præcordium has been called by Dr. Chalmers the *pathognomonic symptom of Tetanus*†; it is, indeed, rarely absent in acute Tetanus. Some writers have asserted, that when this symptom occurs Tetanus invariably proves fatal. This is erroneous, and many cases might be adduced from the table, in which, although this symptom was severe, the patients recovered. It is described by patients as a dragging sensation, or as a pain coming on suddenly and darting towards the back, the cause of it being generally attributed, and correctly, to spasm of the diaphragm. When this pain is very severe, there is usually considerable opisthotonos, which appears to be partly owing to the instinctive efforts of the patient to bend

* Observation on the Diseases of Seamen.

† Medical Observations and Inquiries, vol. i.

the body backwards, in order to relieve this painful traction. It is frequently one of the earliest symptoms, but sometimes occurs only at the termination of the disease. Respiration is laborious and hurried, being sometimes accompanied with a kind of catching of the breath.

Inability to swallow arises from spasmodic action of the muscles of the tongue and soft palate, and probably from contraction of the cardiac aperture of the diaphragm. In the attempt at deglutition, fluids are often rejected with force through the nose and from the mouth, and such distressing paroxysms are induced by the spasms excited in the muscles of the larynx, that there is sometimes a horror even of the sight of liquids. The same circumstance constitutes an effectual bar to the introduction of a flexible tube down the œsophagus from one of the nostrils.

The muscles of the eye are sometimes, but not generally, affected. When this occurs, as in case 27, the eyeball is fixed and drawn slightly inwards, the patient being unable to direct it towards particular objects. It more commonly happens, however, that these muscles are free, the eyelids being semi-closed, as in this case the contractions of the orbicularis palpebrarum are unopposed by spasm in the levator palpebræ.

Some authors describe the pupil to be contracted in Tetanus, others dilated. I have generally found it contracted.

The muscles of the extremities are less frequently the seat of spasm than those of the neck and trunk, and the wrists and hands are very seldom affected. The spasms sometimes commence in the limb which has been injured, as in cases 47, 85, 125, and 126. In a case of traumatic Tetanus, which occurred in the practice of Baron Dupuytren, the muscles of the injured limb were permanently and painfully contracted, when no other part of the body was effected. In case 5, I observed that the spasms were more severe in the limb which had been wounded than in the sound one.

It has been stated that the voluntary muscles only are thrown into spasms in Tetanus. Dr. C. H. Parry, however, in an interesting work on Tetanus and Hydrophobia, has attached great importance to the state of the heart, which organ, he imagines, becomes exhausted, and first loses its vital powers.* Dr. Currie remarks that "the patient, where the case terminates fatally, probably dies at last from spasmodic affection extending to the heart†." Mr. Travers is likewise of opinion that the disease travels ultimately to the heart and other viscera, a view which has been advocated by Mr. Howship, who has published a case‡, where the patient, in describing his sufferings, is reported to have said, that "he felt that his heart was at times ready to break with the distress of its pain." This organ, when examined eleven hours after death, the body being still warm, was found so much reduced in bulk as not to occupy a fourth

* Cases of Tetanus and Rabies Contagiosa, p. 18.

† Medical Reports, vol. i. p. 155.

‡ 79 in the Table.

part of the cavity of the pericardium, appearing to be very unnaturally shortened from the basis to the apex. The resistance upon pressing the muscular ventricles resembled that of a very firm and even horny substance rather than of a mere fleshy cavity. The substance of the heart felt in every part unnaturally firm, to a degree far beyond what can be well conceived. The auricles, as well as the ventricles, were greatly contracted. The sides of the left ventricle were found in the closest contact, so much so that when a section of the heart was made, the exact situation of the cavity was not immediately to be perceived. About half an ounce of blood still remained in the right ventricle. The auricle on the right side contained about an ounce of blood, that on the left a much less proportion. The heart was removed from the body, and upon being examined a few hours afterwards, it was found to have become completely relaxed, was much larger and softer, as well as very flaccid, having entirely lost that very peculiar and remarkable state of tone which it possessed at the time of its being first inspected. No other morbid appearance is described, and Mr. Howship concludes "that it was on every side clear, that the muscular structure of the heart had in this case become at length subject to the same affection which, during the earlier stages of the disease, was confined principally to those parts of the body subservient to voluntary motion*." The accuracy of this conclusion, however, cannot be very readily admitted. No importance should be attached to the circumstance of the man's ascribing the seat of pain to the heart, since many of the lower orders, especially the Irish, refer to it as the seat of all uneasy sensations about the chest. It is stated, that for a short time previous to death the pulse was extremely weak, and that the patient did not experience any sense of uneasiness in the heart. The severe pain which existed at the early disease in the situation of this organ, described "as running through the body," was most probably occasioned by spasmodic action of the diaphragm, and the seat of it would naturally enough be referred by the patient to his heart. Although I have never found this organ quite so firm as Mr. Howship has described it to have been in this case, still it may often be seen, when examined, within a few hours after death, exceedingly rigid and closely contracted in consequence of irritability remaining in the muscular fibre after life is extinct. Dr. Reid, after relating the morbid appearances in a case of Tetanus, observes, that "the difference of the ganglionic system from the spinal was well marked, by the influence of the disease not extending in a similar manner to the muscular organs of both systems. This is marked by the muscular parts of the heart and intestines being paler than natural, while the muscular organs belonging to the spinal system were remarkably florid and rigid."† It appears, therefore, that the heart is not uniformly found

* London Medical and Physical Journal, vol. xxii. p. 186.

† On the Nature and Treatment of Tetanus and Hydrophobia, &c. Dublin, 1817.

firmly contracted in the disease, nor is such a state of it peculiar to those who have died from Tetanus. That this organ participates in the spasms which attack the voluntary muscles is an opinion that, notwithstanding the high authorities to the contrary, has always appeared to me exceedingly problematical. That it can be an ordinary symptom of the disease is certainly impossible; for it must be obvious, that if such were the case, the action of the heart, instead of being accelerated, which is universally admitted to be its condition in Tetanus, must be greatly retarded, or even altogether arrested so long as the spasm lasts. Although the pulsations of the heart vary both in regularity and frequency, yet the longest period of intermission endures so short a time, that the organ can never be considered as remaining in a state of permanent spasm, which is the state of the voluntary muscles in Tetanus. Such a condition of this important organ is certainly incompatible with the continuance of life. Without, however, venturing to deny that the heart ever becomes affected with spasm, I consider that there is no evidence proving such to be the fact, or even rendering it probable, and that it is little better than a gratuitous assumption to account for the somewhat sudden manner in which the disease frequently terminates, in this way.

Dr. Parry has, however, gone further, and has attempted to establish grounds for forming a probable conclusion as to the event of the disease by attending to the state of the pulse. He says, "If in an adult the pulse, by the fourth or fifth day, does not reach one hundred or perhaps one hundred and ten beats in a minute, I believe the patient almost always recovers. If, on the other hand, the pulse on the fourth day is one hundred and twenty or more in a minute, few instances will, I apprehend, be found in which he will not die."* The accuracy of a prognosis founded upon the state of the heart's action, was verified in six instances. I regret that the state of the pulse having been so rarely recorded in the reports of the cases composing the table, it is impossible to obtain any satisfactory data upon this point; but Dr. Parry's rule is not sustained by the testimony of other writers of experience. Dr. Morrison, who had ample opportunities for observation in Demerara, states that the pulse seldom exceeds eighty. In a boy, who fell a victim to the disease on the third day, in the absence of spasms the pulse was ninety-eight, but he has never remarked it higher than this†. Dr. Hennen found the pulse in the cases that he had met with, astonishingly unaffected‡, and the same was observed by Sir James Macgregor§. In cases 19, 33, 36, 55, 57, 60, 87, 90, 95, 115, and 125, although the pulse exceeded one hundred and ten beats, the patients recovered. In all those cases which I have witnessed, the action of the heart, as well as the respiratory movements,

* Lib. cit. p. 18.

† Treatise on Tetanus. Newry, 1816.

‡ Principles of Military Surgery, third edition, London, 1829.

§ Medico-chirurgical Transactions, vol. vi.

has been in some degree accelerated; and during the paroxysms there has generally been a further increase of about ten or twelve pulsations in the minute, whilst towards the close of the disease the pulse has been feeble, irregular, and sometimes intermittent. In case 113 the pulse was as much as one hundred and eighty during the paroxysms. This increased action is readily accounted for. For in any violent exertion of the muscles, as in running, the blood being precipitated with increased rapidity to the right side of the heart, the force and velocity of the circulation will necessarily be increased, and as a consequence respiration must also become accelerated. I conceive, therefore, that in Tetanus the frequency of the pulse and the hurried respiration must be, in a great degree, ascribed to the forcible contractions to which the muscles are excited, especially during the paroxysms. Yet the danger of the disease is not exactly proportionate to the intensity of the spasms, but is influenced, as will be shown hereafter, by the particular class of muscles affected. It is necessary also to notice, in an inquiry into the state of the pulse, that many of the remedies which are so often exhibited in large doses, may exert considerable influence in increasing the heart's action, as camphor, mercury, opium, and various stimulants. So that viewing all these circumstances, the condition of the pulse must be regarded as a very fallacious test of the severity or acuteness of the disease, and cannot therefore be depended upon as a guide in forming an accurate prognosis, Dr. Parry's rule being, in fact, neither sustained by experience, nor based upon any rational theory.

Not only has it been said that the heart becomes affected with spasm in Tetanus, but it has even been supposed that the middle coat of the arteries is not exempt from this affection. In case 64, in which amputation was performed by Mr. Liston, it appears that the vessels contracted so much that there was no hæmorrhage, and ligatures on the mouths of the divided vessels became unnecessary. We are scarcely justified, however, in grounding such an opinion upon the evidence afforded in this isolated case, for I am not aware that in any other of the instances in which this operation was performed a similar phenomenon was remarked. Not to mention that the middle coat of the arteries is by no means considered by anatomists in general to be muscular, we know that there is very great variety in their contractile powers; and although in the case alluded to, this property was evinced to a remarkable extent, yet I have witnessed it almost in an equal degree in an amputation performed upon a patient free from Tetanus. Besides, we should expect that if the vessels were affected with permanent contraction, their calibre would be so diminished throughout, that distant parts could be but very inadequately supplied with blood, whereas we find that in this disease there is no defect in the circulation until the powers are exhausted by the violent spasms.

In consequence of obstinate costiveness, which sometimes exists both previous to the development and during the progress of the

disease, Dr. Cullen* and other pathologists have imagined that the muscular structure of the intestinal canal also becomes affected with spasm. There is, however, no sufficient evidence to sustain such an opinion. Pain is not experienced in the bowels, as in colic, and constipation may be otherwise accounted for. When Tetanus is established, it is accompanied with certain conditions, which, independently of any derangement primarily existing in the alimentary canal, tend strongly to keep up or produce such a state of the bowels. Thus, in accordance with the close sympathy existing between the functions of the skin and of the mucous surface of the intestines, as a consequence of the excessive cutaneous transpiration generally attending the disease, absorption of the watery particles is more active, and the secretions poured into the alimentary canal are diminished; hence, the fæces being deprived of their proportion of the excrementitious fluids, become indurated and reduced in bulk. Again, the combined pressure of the diaphragm and of the abdominal muscles when permanently contracted, would tend to impede the peristaltic motion of the hollow viscera. This argument may be objected to on the ground that the movements continually going on in respiration are rather favourable to the peristaltic action of the intestines. There is, however, a great difference between the natural alternate motions, and the confinement and compression consequent upon spasmodic contraction of the abdominal muscles and diaphragm combined. Great difficulty in the expulsion of the fæces must likewise arise from the patient, during the spasms, losing the control over those muscles which so materially aid the performance of that function; and also, from closure of the anus by the spasmodic action of the sphincter ani, which muscle is sometimes so rigidly contracted as to prevent the introduction of a glyster pipe, as in case 35. Lastly, in addition to these causes of constipation arising from the nature of the disease itself, many of the remedies which are resorted to must assist greatly in inducing a torpid state of the bowels. Constipation does not, however, invariably attend the disease; but when it does occur, it may be accounted for without being necessarily attributed to spasm in the muscular fibres of the alimentary canal.

Retention of urine is sometime occasioned as in case 10, probably by spasm of the compressor urethræ, and great difficulty has thereby been experienced in the attempt to introduce a catheter for the purpose of evacuating the bladder. Mr. Morgan states that priapism occurs occasionally†. It must, however, be a rare symptom, and I have never witnessed it.

The muscles are observed to be relaxed during sleep, a striking example of which occurred to Mr. Mayo, in a boy who recovered from the disease. On visiting his patient before the symptoms were subdued, Mr. Mayo found him asleep, and remarked that he lay perfectly relaxed. The abdominal muscles were soft and yielding, and had not the least tension. The boy was awakened, and at the in-

* Practice of Physic, vol. iii.

† A Lecture on Tetanus, 1833, p. 14.

stant the full tension of the muscles returned. Not being further disturbed he fell asleep in a few minutes, when the muscles again became relaxed, and again, on his being awakened, resumed the state of spasm. I have, on several occasions, witnessed the same phenomenon. Whoever has been suddenly aroused from his rest by violent cramp in the extremities, will readily believe that it is almost impossible for a person to remain asleep during the paroxysms, or even the severer spasms of Tetanus. I have stated, however, that the continued spasm of the muscles, especially when mild, is occasionally unattended with pain; so that in chronic cases, or during the progress of recovery, and when the intervals between the paroxysms are considerable, sleep may ensue, and the muscles become relaxed. But in acute Tetanus, although sleep may sometimes occur as the result of exhaustion or of narcotic influence, yet its duration is but for a short period, lasting only until sufficient reaction is established to support the renewal of spasmodic contractions. Thus, when the patient awakes, as the circulation becomes more active, respiration more frequent, and temperature increased, the muscles return to the state of spasm and the paroxysms re-appear.

In violent muscular exertion the cutaneous secretion is increased. Such is observable in Tetanus, especially during the paroxysms, at which time the patient is bathed in perspiration, the secretion often possessing a pungent and peculiar smell. Baron Larrey has attached great importance to the cutaneous transpiration, which, when occurring over the chest and abdomen, he describes as critical*. His opinion is not borne out by the experience of other surgeons; and it is well known that a most profuse diaphoresis often takes place over the whole body, without being attended with the slightest amelioration in the symptoms of the disease. A miliary eruption frequently accompanies this excessive perspiration, occasioned probably by the active determination to the skin.

The skin usually feels hot, and it appears that the heat of the body is sometimes above the natural standard. M. Prévost, of Geneva, had a patient, a boy twelve years of age, affected with Tetanus, which was accompanied by an extraordinary development of heat. A thermometer, placed in the axilla, was raised to $110^{\circ} 75$ Fahr. Reckoning the original temperature at $98^{\circ} 2$, which is above the average for that age, there was an elevation of $12\frac{1}{2}^{\circ}$ Fahr†. In a case of traumatic Tetanus described by Dr. Bright, the temperature in the axilla on the third day was 105° ‡.

The urine is usually high coloured, and scanty in quantity, owing, no doubt, to the influence of the cutaneous secretion upon the renal; for in two instances in which I noticed that there was scarcely any increase in the perspiration, little alteration was observed either in the colour or quantity of the urine.

* Mémoires de Chirurgie Militaire et Campagnes de D. J. Larrey, 1812-17.

† Dr. Edwards on the Influence of Physical Agents on Life.

‡ Medical Reports, vol. ii. p. 564.

The tongue is generally moist at the commencement, but subsequently, when perspiration becomes profuse, and in cases attended with fever and inflammation, there is excessive thirst, accompanied with a dry state of the tongue. The appetite commonly remains, even when there is inability to swallow.

The functions of the brain and the organs of sense continue unimpaired, during even the most distressing paroxysms, and the mind is clear and occasionally cheerful. In some few instances delirium has occurred a short time previous to death. The remedies which have been exhibited, may possibly contribute to produce this derangement.

Traumatic Tetanus is generally unattended with fever; and Dr. Cullen*, Dr. Clephanet, Dr. Chalmers†, and many other authors, have remarked, that the blood very rarely possesses an inflammatory character. Mr. O'Beirne, of the artillery, states that he witnessed about two hundred cases of Tetanus; but he never saw one accompanied with fever§. It is true that in some instances even of the traumatic form of the disease, fever has been present, and the blood has been found cupped and buffed; but in nearly all such cases the symptoms of Tetanus are independent of those of inflammation, the latter sometimes co-existing with the former, but arising from distinct and often accidental causes, as in case 10, in which the wound was so severe as to occasion inflammation at the seat of injury; or as in case 89, where pleuritis supervened after the accession of spasm. It will however, be shown hereafter, that tetanic symptoms may result from inflammatory action in the medulla spinalis, which rarely occurs in the traumatic, but is occasionally the cause of the idiopathic disease. Inflammation and fever, therefore, when present, must not be viewed as the necessary effects of the spasmodic disease.

§ 4. *Mode of Termination.* Tetanus may terminate in resolution; that is to say, the symptoms may slowly subside, or it may prove destructive to life.

Recovery from Tetanus takes place very gradually. Of fifty-eight cases in the table, which terminated successfully, eight were cured in the course of a week; three in ten days; four in a fortnight; four recovered at the end of three weeks; fifteen at the end of a month; four after five weeks; eight after six weeks; three at the end of eight weeks; three after two months; and in two the symptoms were not removed till after three months. Even after the spasms have subsided, it is often a long time before the muscles can regain their tone and freedom of action. In cases 23 and 119, the muscles continued stiff for some length of time after recovery. In case 22, at the end of nine months after the patient first became affected, although enjoying good health, yet on catching cold he was still troubled with a stiffness about the jaws. In a case of recovery

* Lib. cit. vol. iii. p. 378.

† Medical Observations and Inquiries, vol. i.

‡ Lib. cit.

§ Dublin Hospital Reports, vol. iii.

from traumatic Tetanus, which I witnessed, rigidity of the muscles of the lower jaw continued for six months afterwards. In a case related by Dr. Currie, at the end of three years, it is stated that "his features retained the indelible impression of the disease*." Even after a slight cramp in the leg, some degree of stiffness in the muscles often remains for several days; but after such violent action as occurs in the paroxysms of Tetanus, by which muscular fibres are not unfrequently lacerated and vessels ruptured, a return to their former condition must necessarily be very gradual. The warm bath friction, and gentle exercise, are the means best adapted to restore the muscles to their original state.

The immediate cause of death from Tetanus is variously explained. The reasons for the opinion that it is attributable sometimes to a spasm seizing the heart have already been controverted. The ordinary causes are asphyxia, and exhaustion, and death is retarded or accelerated, according to the violence of the symptoms, the class of muscles principally affected, and the constitution of the patient. Asphyxia may be occasioned either by spasmodic closure of the glottis only, or by the spasms entirely suspending the regular action of the diaphragm, and of the other muscles concerned in increasing and diminishing the capacity of the thorax. When produced in the former way, death is somewhat sudden, occurring during a severe paroxysm, warning having perhaps been given by a sense of suffocation during a previous exacerbation. In the other case, death approaches slowly, the respiration being for several hours hurried, laborious, and irregular; the lungs become gradually congested, the motions of the chest being impeded, the expulsion of the inspired air, is prevented, and thus a fatal termination tardily ensues. Often, however, the two causes acting together speedily put an end to the patient's sufferings. When death takes place from exhaustion, violent spasms, attended with profuse perspiration, have perhaps been prolonged through many days, or even weeks, the patient during that time having been unable to swallow nutriment. At length the paroxysms become less acute and frequent, the pulse flags, the muscles relax, the eyes become dim, and he gradually sinks, the vital powers being at length worn out by the severe and painfully protracted spasms.

In a case of imminent danger from suffocation, it has been suggested that relief might be afforded by an opening made in the trachea. Such a proceeding can only be available when asphyxia is produced by spasm of the muscles of the glottis, in which case tracheotomy might probably afford an opportunity for the exhibition of remedies adapted to control the paroxysms. As these cases are generally very urgent, little more can be expected from the operation than postponement of a fatal issue for a short period; but it would certainly be justifiable as a *dernier resort*. I am not acquainted with any instance in which tracheotomy has been resorted to.

* Lib. cit. vol. i.

In affirming that spasmodic closure of the glottis, and not spasm of the heart, is the cause of the sudden death which so frequently happens in acute Tetanus, I am fully aware it may be objected, that we have no demonstrative proof of such being the fact. And yet the evidence would appear sufficiently strong, and as conclusive as any that can be adduced, to show that the dread of swallowing in hydrophobia is referrible to this cause; an opinion which I believe is not disputed. There is a sense of constriction at the throat, an apprehension of suffocation, and when the poroxysm ensues, all the outward signs of asphyxia. I have watched the tetanic patient in the sufferings of this dreadful moment—I have seen him tear away the coverings, grasp his throat, and with suffused eyes and livid countenance, and in all the agonies of impeded respiration, struggling for breath and for life. Now, having more than once witnessed the termination of a scene like this, I can scarcely bring my mind to believe that death is caused otherwise than by a sudden stoppage to respiration at the larynx. As anatomists, we know that this can only take place at the glottis; and since we have after death the pathological signs of asphyxia, and have no good evidence to enable us to account for this mode of termination in any other way, and bearing in mind the spasmodic nature of the disease, I think we are fully warranted in concluding that death is the result of spasm of the muscles which close the glottis.

In the artificial Tetanus produced by strychnine, death appears to be occasioned precisely in the same way as in this disease. In some instances life is suddenly cut short in a fit of spasm. In others, the cause of death seems to be a prolonged spasm of the muscles of respiration, those on the thorax feeling during the fits as hard almost as bone, and sometimes, but more rarely, the patient appears to die of the excessive exhaustion produced by the long continued and violent contractions*.

§ 5. *Statistics.* There are no data from which a correct estimate can be formed of the frequency of Tetanus in comparison with other diseases, of the probability of its occurrence after wounds, or of its mean rate of mortality, either in the traumatic form or in the idiopathic. Sir James Macgregor alludes to several hundred cases observed in the campaigns in Spain and Portugal, very few of which were cured†. Mr. O'Beirne mentions, that out of about two hundred cases which he witnessed in the Peninsular war, not one recovered, and on a rough calculation it was generally considered to attack in the proportion of one in two hundred wounded‡. Tetanus must occur oftener amongst an equal number of wounded after a battle than in civil life, in consequence of the men being more exposed to the predisposing causes of the disease; on which account, and from the greater severity of the injuries, the majority of them being inflicted by fire-arms, the probability of recovery must also be

* Vide Christison on Poisons, p. 799, third edition.

† Lib. cit.

‡ Lib. cit. p. 378.

much less. Mr. Howship has published the particulars of thirteen cases of Tetanus occurring after injuries of different severity, most of them being gun-shot wounds, of which ten were fatal*. Sir Gilbert Blane mentions, that the number of wounded in the actions of April 1782 in the West Indies, was eight hundred and ten, of whom twenty, or one in forty and a half, were attacked with Tetanus, seventeen of which number died†. Mr. Dickinson, surgeon at Grenada, met with thirteen cases of traumatic Tetanus; nine died and four were cured. He also witnessed ten cases of the idiopathic disease, of which six terminated fatally‡. In the table are included seventy fatal cases, from which it appears that the disease is equally fatal at every period of life, from the age of ten to forty-five. Idiopathic Tetanus is far less frequently fatal than traumatic, but mortality from the former is much greater in warm climates than in the more temperate regions.

Tetanus is both less frequent and less fatal in the female sex than in the male. Of the one hundred and twenty-eight cases in the table, sixteen were females, being to the males in the proportion of one to eight. Of these sixteen cases four only were fatal, whereas, out of the one hundred and twelve cases of males, sixty-six, or more than one-half, died. The comparative rarity of Tetanus in women is partly accounted for by their being less exposed, both to the predisposing and to the exciting causes of the disease; and since it is observed to occur more frequently in persons of a robust constitution and of great muscular strength, females are supposed to be less susceptible of it.

In most of the cases in the table, the patients were attacked between the ages of ten and fifty; four only having occurred after the fiftieth year, and three before the age of ten. The duration of the disease before its fatal termination varies considerably, being dependant upon those circumstances alluded to, when describing the immediate cause of death, and it is also often influenced by the extent of the original injury. Wepfer is said to have witnessed a case in which Tetanus proved fatal in thirty minutes, the patient having been an infant;§ but as sufficient time had not elapsed for the symptoms to show themselves in a well marked manner, it may be fairly questioned, whether this was a genuine case of the disease. Another rapidly fatal case is mentioned by the late professor Robison, of Edinburgh. A negro having scratched his thumb with a piece of broken china, was seized with Tetanus, and in a quarter of an hour after this slight injury he was dead.|| In case 102, related in the *Dictionnaire des Sciences Médicales*, the disease proved fatal in twelve hours. In case 62, the patient died in twenty hours; in case 94, in twenty-six hours; and in cases 15, 53, and 96, in forty hours.

* London Medical and Physical Journal, vols. xxi. and xxii.

† Diseases of Seamen.

‡ London Medicinal Repository, vol. i.

§ Encyclopédie Méthodique.—Tétanos.

|| Rees's Encyclopedia.—Tetanus.

Mr. Dickinson mentions an instance of a negro, twelve years of age, in which the disease ended fatally in twenty-two hours.* In the following case, for the particulars of which I am indebted to my friend and colleague Mr. Adams, who was called to the patient on the fifth day after the injury, the disease proved fatal in sixteen hours.

CASE I.

October 23, 1835.—A little boy, ten years of age, and of spare habit, accidentally received the contents of one barrel of a double-barrelled gun loaded with small shot in the lower part of the calf of the right leg, which carried away a large portion of skin, and exposed and lacerated the tendo Achillis. The wound was dressed by a surgeon at Old Ford, where the accident occurred, and during the first few days the patient appeared to be going on well, when on the evening of the fifth day after the injury (Oct. 28th) he complained of difficulty in swallowing, the pulse was accelerated, he had passed less urine than usual, and the bowels had not been relieved for two days—there was no rigidity about the muscles of the neck, and the wound was in a favourable condition. Decided symptoms of Tetanus appeared about three o'clock the following morning, and when seen at 11 A. M., he was labouring under rigid opisthotonos—the body representing a complete arch and immoveably fixed, except during occasional paroxysms, when the curvature was still further increased. The muscles of the abdomen and neck were extremely rigid, and the sterno-cleido mastoidei being thrown considerably behind the axis of motion, had become complete extensors of the head. The jaws were firmly clenched, and the peculiar expression of the eyes consequent upon a partially closed state of the lids, the angles being widely separated, was very striking. He was incapable of swallowing, the attempt inducing a sense of suffocation, and he experienced so much pain during the paroxysms as to cry aloud with agony. The bowels were relieved three times in the course of the day by means of castor oil, and an enema of the infusion of senna. Being placed in a warm bath medicated with a decoction of hops and a drachm of tartar emetic, he was seized with a paroxysm that nearly proved fatal; but being removed he rallied, and after an enema of ʒss of Tinct. Opii, which had been ordered every hour, was able to open his mouth and to swallow. He was attacked with another paroxysm about 7 P. M., in which he died suffocated, sixteen hours after the first appearance of decided tetanic symptoms, and the sixth day after the injury.

In the table, fifty-three cases were fatal within eight days after the appearance of symptoms; eleven by the following day; fifteen on the second day after, eight on the third, seven on the fourth, three on the fifth, four on the sixth, three on the seventh, and two on the

* Lib. cit.

eighth, but very few having lasted longer. In case forty-two, which is taken from Morgagni, the symptoms are related to have continued for upwards of twenty days before the patient was destroyed. The experience of Dr. Lionel Chalmers in acute Idiopathic Tetanus in South Carolina, accords very closely with the average duration of the traumatic disease, as estimated from the table. He states, that patients generally die in twenty-four, thirty-six, or forty-eight hours, and very rarely survive the third day, but when the disease is less acute, few are lost after the ninth or eleventh day.*

§ 6. *Causes.*—The influence and mode of operation of the various causes of Tetanus, will be more particularly investigated when considering the pathology of the disease. The traumatic, which is the most common form, is consequent upon every possible variety of injury, and attacks in every condition of the wound. It occurs after the slightest and most superficial abrasions, as also after the most complicated contusions, lacerations and fractures. In eleven cases in the table, it occurred after amputation, four being at the shoulder joint. Mr. Samuel Cooper,† and Sir Benjamin Brodie have seen it after amputation of the mamma, and the latter after the operation of tying the external iliac artery‡ Dazille records a case in which it followed the operation of securing the femoral artery for aneurism.§ It has happened several times after castration,|| and in case 116, it was caused by the operation of cupping. Andral mentions an instance of its occurrence after the application of a seton to the chest,¶ and it is related to have been induced by the extraction of a tooth,** and also by the injection of a hydrocele.†† It is said to occur most frequently after punctures and lacerations of fascious structures and of nerves, and after wounds of the hands and feet. It appears from the table, that in thirty-four instances the disease was occasioned by injuries, many of them very trivial, of the hands and fingers; and in thirty-five cases by injuries to the feet or toes. In sixty-four instances, the wounds were on some part of the lower extremities, in forty-six of the upper extremities. Mr. O'Beirne mentions, that he never witnessed the disease after an injury of the head, but in eleven cases in the table, the wounds were either on the face or scalp. Dr. Morrison notices three cases in negroes, where it originated from a severe flagellation. Baron Larrey has recorded an instance in which the disease was produced by a fishbone lodged in the fauces. Mr. Morgan witnessed two cases, consequent upon the blows inflicted by a schoolmaster with his cane,—they both termi-

* Lib. cit.

† Surgical Dictionary, article Tetanus.

‡ Medical Gazette, vol. ii. p. 345.

§ Observations sur le Tetanos, p. 232.

|| Tetanus is not uncommon in the horse after castration.

¶ Clinique Medicale, tom. iv. p. 445.

** Vide Review of Dr. Reid's Work on Tetanus, Edinburgh Med. Surg. Journal, vol. xv. and Mr. Maxwell's paper on Tetanus. Jamaica Physical Journal. 1834.

†† Travers, Lib. cit. part 2. p. 293.

nated fatally.* Dr. Rush, who had extensive opportunities for observation in the military hospitals of the United States, remarked that there was invariably an absence of inflammation in the wounds causing the disease.† In many of the cases in the table, the primary wound was completely healed and almost forgotten, when the symptoms of Tetanus appeared.

The interval between the infliction of the injury and the accession of tetanic symptoms varies considerably. In the case mentioned on the authority of Professor Robison, the disease appeared almost instantaneously. In case 114, only an hour elapsed. In case 102, symptoms were evinced within two hours after the injury; and in case 19, in eleven hours. In eighty-one instances, symptoms were first developed from the fourth to the fourteenth day after the wound; and in nineteen they were evinced on the tenth day. In thirteen cases, witnessed by Mr. Dickinson, at Grenada, the period varied from eight to fourteen days‡.

It has been noticed, that the longer the interval before the appearance of symptoms the more chronic is the disease, and the greater the probability of recovery. In thirteen cases, symptoms of Tetanus occurred about three weeks after the wound, but four only were fatal; and of seven cases, in which they did not make their appearance till after a month, only two ended fatally. In the returns made by Sir James Macgregor, the interval never exceeded three weeks, and in all the cases witnessed by Sir Benjamin Brodie, with one exception, the disease showed itself in the course of the second week after the reception of the wound. In that particular case, the symptoms were developed on the seventeenth day, but they were chronic, and the patient recovered||. Sir Gilbert Blane, who had numerous opportunities of observing the disease in the navy, states that he has known it to commence at all periods, from the second day to the end of the fourth week. In a case related by Mr. Ward, a surgeon at Manchester, symptoms did not appear till ten weeks after a burn in the axilla. This is the longest interval that I am acquainted with:—the patient was a female, and recovered, and it is questionable whether the disease should not be viewed as idiopathic§.

Tetanus is a disease which is met with in every part of the globe, but it occurs oftener in sultry than in temperate climates, and is observed to prevail more at the hot seasons, or during sudden changes from heat to cold, especially in a moist state of the atmosphere. Idiopathic Tetanus generally arises after exposure to damp and cold¶, and even in the traumatic form it has frequently happened

* Lib. cit. p. 6.

† American Philosophical Transactions, vol. ii.

‡ London Medical Repository, vol. i.

|| Medical Gazette, vol. ii. p. 345.

§ Facts establishing the efficacy of the opiate friction in Spasmodic and Febrile Diseases; also concerning Hydrophobia and Tetanus. 1809.

¶ The origin of Tetanus was ascribed to the influence of cold by many of the ancient authors, as Hippocrates, Aretæus, Celsus, and Cœlius Aurelianus.

that patients have caught cold previous to the accession of symptoms, as was remarked in case 13, 15, 19, 20, 22, 83, 86, 116, and 127. Dr. R. Huck, physician to the army in the last century, states, that of thirteen wounded men whom he had seen afflicted with locked jaw, nine received their wounds at the attack of the French lines at Ticonderoga, in the year 1758, and remained exposed to the cold air, the night after the action, in open boats upon Lake George*. M. François, of Auxerre, observes, that on board the Amazon frigate, before Charles Town, during the American war, after some stormy and very wet weather which had succeeded a continuance of dry, most of those wounded by fire-arms were attacked with Tetanus on the 14th day†. Dr. Heman states, that in almost all instances the patients had been exposed to a stream of air directly blowing upon them. He mentions, that many of the wounded were seized with it after the battle of El-Arich, and after the capture of Jaffa, when they were placed in tents on the wet ground exposed to constant rain‡. Baron Larrey noticed, that the disease was unfrequent during an equable temperature, but common when the wounded were exposed during the night to the immediate impression of cold and damp air. Dazille, Campet, and Dr. Rush have also given some striking illustrations of the predisposing influence of climate and atmospheric changes in exciting this disease. The imprudent use of a cold bath, and drinking cold water when heated by exercise, have been known to bring on an attack of idiopathic Tetanus. Dr. Chalmers relates, that a man chose to cut off his hair on a warm day in the month of March, and went to bed without a night-cap, but the weather changing, and becoming cold in the night, he was seized with Tetanus, and the next morning was found rigid with the disease||.

* Medical Observations and Inq. vol. iii.

† Dictionnaire des Sciences Medicales—Tetanus.

‡ Lib. cit. vol. i. p. 244.

|| Lib. cit. The same circumstances appear to operate unfavourably in animals. Hurtrel d'Arboval relates, that twenty-four horses were castrated on the same day at Bec, in the department de l'Eure. They were afterwards led four times in the day through a pond of water supplied from a very cold spring. Sixteen of them died between the tenth and fifteenth day after the operation. At Rennes, a horse after castration was exercised until he was covered with perspiration, and then suddenly plunged into the river. This was repeated three times, and the animal died tetanic*.

Tetanus is a disease by no means confined to the human species, being frequent in horses, and occurring sometimes in lambs, and according to Dr. Mason Good, in parrots. In horses it is rarely idiopathic, and the traumatic does not appear to be so fatal as in man. Mr. Sewell rates the average of recovery at three cases in five. In the admirable description of Tetanus in the horse, given by Mr. Youatt†, we find a striking analogy in its causes, symptoms, and pathology, to the disease in man, as shown by its appearance, when traumatic, after exposure to cold—by the universality of the spasms in acute cases, so that the animal is almost a complete fixture—by the position regulated rather by difference in the power of the flexors and extensors, than by the spasms being limited to particular muscles—by the anxious and haggard expression of the countenance, which

* Dictionnaire de Medecine, et de Chirurgie Veterinaire, tom iv. p. 263.

† Lectures in the Lancet.

Tetanus in every form is a common disease in the West Indies, and it has been noticed, that the negroes are more subject to it than the white population and Europeans. Dr. Anderson, who resided some years at the port of Trinidad, observes, that he does not recollect meeting with one case amongst the sailors, though he witnessed several amongst the blacks*. It is mentioned by Campet, that in Surinam, although the disease is common amongst the negroes, whites are very seldom attacked†; and Dazille states, that of an equal number of wounded whites and negroes, a far larger number of the latter would be seized with this disease‡. This has been attributed by some authors to the negro possessing a greater predisposition to the disease; by others, to his being more frequently subjected to its exciting causes, as exposure to the scorching rays of the sun, and to the night dews, to his working during the rainy seasons and in unhealthy situations, and to his being more liable to the reception of wounds, in consequence of the feet and other parts of the body being unprotected by clothing. To these may be added intestinal worms, and other disorders of the digestive organs, to which, from the nature of his food, he is more subject than the European. Of late years, however, the disease has become less frequent in the West Indian islands than formerly, which is justly ascribed to improvements in the treatment of wounds, in diet, cleanliness and ventilation—to the avoidance of exposure to damp, cold, and sudden vicissitudes of weather, and to greater attention being paid to the state of the bowels. Tetanus is also now much less common in the army and navy than in former years. Dr. Lind, who was physician to the fleet, about the middle of the last century, has recorded, that after amputation, five cases out of six generally proved fatal from an attack of lock jaw||; whereas, at the present day, in the practice of the army and navy, its occurrence after that operation is comparatively rare, which is attributed by Dr. Dickson to increased attention to the preservation of health, and to the treatment of the wounded§.

§ 7. *Prognosis.* It will be evident from what has been stated, that the prognosis in acute Tetanus must always be unfavourable. Some authors state that it is invariably fatal, but this I hold to be an error. Instances of cure will be alluded to in the following pages, and if in the progress of recovery the symptoms have assumed a

tells so plainly how much the animal suffers—and by the mode of termination when fatal, either by suffocation or by exhaustion. Amongst the peculiarities depending upon difference in conformation, may be mentioned, the protrusion of the membrana nictitans—the fixed position of the ears, which are erect, and directed forwards—and the hide-bound appearance or tucking up of the belly, produced by the violent contractions of the panniculus carnosus, and which is seen under no other circumstances.

* Edinburgh Medico-Chirurgical Transactions, vol. ii.

† *Traité Pratique des Maladies des Pays Chauds*, 1802, p. 43.

‡ *Lib cit.* p. 212.

|| An Essay on the most effectual means of preserving the health of seamen in the Royal Navy. 1757.

§ Medico-Chirurgical Transactions, vol. vii.

chronic character, we may fairly infer that the severity of the disease has been diminished, and the symptoms modified by the treatment pursued. In simple traumatic Tetanus, that is to say, in that which is without inflammation, as we more commonly meet with it, there are several circumstances to be taken into consideration—the climate, sex, state of the wound, duration of the interval between its occurrence and the appearance of tetanic symptoms, the progress of the disease, the class of muscles more particularly affected, the length of interval between the paroxysms, the relation which exists between the natural powers of the patient and the violence of the involuntary muscular contractions. The most important of all is the state of the respiratory muscles. If there be any disposition to spasm in the muscles of the larynx, there is not only imminent risk of suffocation, but the attempt to swallow is so liable to induce a paroxysm that we are utterly excluded from the opportunity of administering medicines internally, and of fulfilling one most important indication, supplying stimulants and nourishment. In the more chronic forms of Tetanus, in those cases in which the access is slow, the spasms by no means violent, the paroxysm slight and occurring at long intervals, and when the patient can obtain sleep, whether traumatic or not, we may generally anticipate a favourable result.

§ 8. *Diagnosis.* Tetanus is a disease attended with such remarkable symptoms that it cannot very readily be confounded with any other affection. The peculiar expression of the countenance, the dragging sensation at the lower part of the sternum, and the sudden increase of the continued contraction at varying intervals, are at all times sufficiently diagnostic. The only disease for which it can be mistaken is hydrophobia. In addition to the symptoms just mentioned, it is distinguished from this still more formidable malady, by the normal state of the intellectual functions, and by the nature of the spasms. In hydrophobia there is more or less mental aberration, a restless and sometimes furious state of excitement, accompanied with a remarkable acuteness of the organs of sense, and an expression of countenance, and a manner so striking, that when once seen they are rarely forgotten. The spasms, too, are clonic, and of short duration, and are succeeded by a period of complete relaxation. It is only those cases of Tetanus where the guttural spasms are attended with a dread of fluids, and where liquids are forcibly rejected in the attempt to swallow, that can be mistaken for hydrophobia; but the circumstances already described, together with the difference in the mode of origin and period of access, are fully adequate to prevent these two diseases from being confounded. —The trismus occasioned by inflammation about the face and fauces, ulceration of the gums, diseased bone, rheumatic affections of the temporal and masseter muscles, or hysteria, are too easily discriminated from the spasmodic disease, to need any detail of the diagnostic marks.

CHAPTER II.

PATHOLOGY OF TETANUS.

SECTION I.—MORBID APPEARANCES.

NOTWITHSTANDING the labour and attention which have been assiduously directed to pathological investigations of late years, both in this country and on the continent, such researches have, as yet, effected little in elucidating the nature of Tetanus. Those writers who have recorded morbid appearances, in the inferences drawn from them, have for the most part taken but a partial and confined view, too often attributing the disease in general, to morbid action in such structure or organ, as in the particular case or cases, the subjects of their examination, happened to be in some degree deranged. In many instances, conclusions have been formed, when the inquiries have been much too limited; for not only is it essential to examine minutely the brain and spinal cord, but the investigation cannot be considered complete until the sympathetic system and the whole alimentary canal have been accurately inspected, and the nerves traced from the seat of injury to their apparent origin. The execution of this necessitates much time, and no slight degree of labour, and when the task is accomplished, the results can only be rightly estimated by one conversant with pathological pursuits.

Although the phenomena distinguishing Tetanus, are chiefly expressed in deranged action of the muscles, yet it is very generally admitted that some part of the nervous system is the source or actual seat of the disease.

I. LESIONS OF THE NERVOUS SYSTEM.

The consideration of the morbid changes observable in those parts of the nervous system which are supposed to be affected, may be referred to the three following heads:

1. The brain, spinal cord, and their investing membranes.
2. The sympathetic system.
3. The nerves immediately connected with the seat of injury.

1. *The Brain, Spinal Cord, and their investing membranes.*

The following appearances are often presented by the brain and its membranes, after death from Tetanus. Congestion of the sinuses; the vessels of the pia-mater filled with florid blood; more or less

increased vascularity of the cerebral substance; slight serous effusion between the membranes and in the ventricles.

Whatever vascular excitement may exist in these structures during life, the anatomical evidence of it is always extremely uncertain. Thus, although the blood in passing rapidly through the capillaries, dilating and injecting vessels which do not usually admit the red particles, by stagnating in them at the moment of dissolution, sometimes give rise to an appearance of increased vascularity; yet in many instances the vessels convey forwards their contents before stagnation can occur, in which case but slight, or even no trace of preternatural injection remains. In cases of Tetanus in which death has been occasioned by the spasms, producing asphyxia, I have noticed that the sinuses and larger veins are more particularly congested, and that the blood is of a darker colour than in other cases where the injection appears to occupy the small arteries, the networks formed by their extreme ramifications being so minutely filled with blood of a florid hue, as often to impart to the pia-mater an intensely bright red colour. And this corresponds with my observation of other affections of the nervous system, as delirium tremens, in which, as there is a determination of blood, and not a retarded circulation as in congestion, the chief seat of injection likewise appears to be the capillaries, the sinuses and larger veins being comparatively empty.

In some rare instances changes of a permanent nature have been observed. Bouillaud relates the case of a boy who had during life symptoms simulating Tetanus, in which a tubercle the size of a large egg, and five or six smaller ones were found after death in the substance of the right hemisphere*. In a fatal case of Tetanus, described by Dr. Bright in his Medical Reports, (case 39,) in which the symptoms appeared at the end of four weeks after a blow on the left side of the head, on examination after death, a collection of pus about the extent of a large nutmeg, was found in the substance of the brain about the middle of the middle lobe, close to the part where the blow had been received. This pus was contained in a firm cyst as thick as cartridge paper, exceedingly vascular, and almost made up of minute vessels: the cyst adhered to the dura mater, and seemed not improbably to be formed originally from a fold of the pia mater.

Serous effusion with increased vascularity is generally observed in the membranes investing the medulla spinalis, and also a turgid state of the blood-vessels about the origin of the nerves.

These appearances are not, however, invariably met with, for it is distinctly stated in many of the cases in the table, that the spinal marrow and its coverings were natural. Sir Benjamin Brodie mentions that he has never discovered any morbid changes in these structures in cases of Tetanus†. In some instances the substance of

* *Traité de clinique et physiologique de l'Encephalite, ou Inflammation du Cerveau, et de ses Suites, telles que le Ramollissement, la Suppuration, &c.*

† *Lib. cit.*

the medulla has appeared somewhat injected, and in case IV., related in a subsequent page, this seemed to be confined to the anterior columns of the cord. In an investigation of the cause of these lesions, the circumstance of position should not be overlooked. On examining the body of a man who died from the disease, which had been placed on its face immediately after death, I found that part of the pia mater covering the anterior columns of the medulla spinalis remarkably vascular: whereas in three other instances where the bodies were suffered to remain in the usual position, the vessels only on the posterior parts were observed to be turgid. Considerable ambiguity will always arise in consequence of the ready escape of serum from the cranium into the spinal canal. On inspecting the body of a man who had died of hydrophobia, I noticed that when the theca vertebralis was laid open no fluid was found; but afterwards, upon elevating the body, in order more conveniently to inspect the cranium, a large quantity of serum escaped from the vertebral canal, and in similar cases after the skull has been opened, upon lowering the head, several ounces of fluid may often be seen to run out of the spinal canal at the occipital foramen. Magendie, Ollivier, and Orfila, could not detect any perceptible lesion in the spinal cord of animals destroyed by the tetanic spasms produced artificially*.

As far as my observations enable me to judge, in cases of traumatic Tetanus, the appearances in the spinal canal which have been alluded to, are in most instances to be met with, but in the cranium they are less frequently present. Here then, a question of the utmost practical importance offers itself for consideration; are these appearances to be regarded as indicating that inflammatory action has existed in some part of the brain, spinal cord, or their investing membranes? Inflammation in these structures is viewed as the cause of Tetanus by many of the continental pathologists, amongst whom may be mentioned Broussais, Larrey, Magendie, Recamier, Professor Frank, and Brera; and by Dr. Reid, Dr. Kennedy, and other writers in England; and as this opinion must influence us very materially in determining the proper mode of treating the disease, it is necessary to examine well the grounds upon which it is founded.

Baron Larrey states, that in the numerous inspections of the bodies of the soldiers who died of Tetanus in the hospitals of Louvain after the battle of Waterloo, which were made with the greatest care, "he constantly discovered evident traces of inflammation on the spinal cord, with serous effusion more or less of a reddish colour within the sheath†." Mr. Castley, an army veterinary surgeon, observes, that in horses which have died of Tetanus, he has often found the medulla spinalis and investing membrane exhibiting "unequivocal marks of inflammation‡." It is to be regretted that the nature of these evident traces and marks of inflammation have not been

* *Encyclopédie Methodique*—Tétanos.

† *Clinique Chirurgicale*, tom. i. p. 88.

‡ *London Medical and Physical Journal*, vol. liv. p. 197.

stated with some precision : it may therefore be presumed that they were no more than a turgid state of the vessels accompanied with serous effusion. These appearances are undoubtedly a consequence of inflammatory action in the membranes of the brain and spinal cord, in its first or earliest stage, but they occur so frequently under other circumstances, that we are by no means justified in considering their presence as a decisive proof of such disturbance having existed. Thus, a congested state of the vessels with serous effusion, has frequently been seen after death from asphyxia, a state which it has been already observed, is often the immediate cause of a fatal termination in Tetanus. Similar lesions have been remarked in fatal cases of burn, where the shock was so great that no reaction took place, and the irritability of the vital organs was rapidly destroyed*. Dr. Kellie of Leith†, and Dr. Seeds‡, have shown that they are generally to be met with in animals bled to death, and they have been seen after uterine hæmorrhage, and after copious depletion for inflammation of the lungs or other viscera. Dr. Sims has given a Table containing fifty cases of persons who died of various diseases, not cerebral, and who manifested no symptoms referrible to the brain, but on dissection effusion of fluid and other morbid appearances were found in the brain or membranes§. I recollect finding a large quantity of serum between the cerebral membranes in a man with fracture of the ribs, who died rather suddenly after having been improperly bled nearly to the amount of a hundred ounces in twenty-four hours ; and I have frequently met with serous effusion, even large in quantity, the brain being sometimes in a state of anæmia, at other times congested, in cases which have afforded no evidence of cerebral derangement during life. These changes have likewise been observed in cases of death from cold, by Dr. Kellie||, Quelmalz¶, and Rosen**. They are also generally discovered after death from delirium tremens, hydrophobia, and epilepsy, affections certainly not proved to be inflammatory. Examples analogous to the above might indeed be greatly multiplied if necessary, but sufficient have been advanced to show that these lesions cannot be regarded as affording unequivocal evidence of the existence of inflammation. It constantly happens that nothing more than these triivial appearances, which are present alone in the earliest stage of acute inflammation, can be found in cases of Tetanus in which the symptoms have existed in their utmost violence for several days before death. On the other hand, M. Fournier Pescay found the cerebral membranes highly injected

* Travers's Inquiry into Constitutional Irritation, part i. p. 88.

† Edinburgh Medico-Chirurgical Transactions, vol. i.

‡ Medical Gazette, vol. v. p. 423 ; Medico-Chirurgical Review, 1816.

§ Medico-Chirurgical Transactions, vol. xix. p. 275.

|| Lib. cit. p. 84.

¶ Prog : quo frigoris acrioris in corpore effectus expedit, &c. in Halleri Disp. Med. vol. vi. 1758.

** Anat. p. 142.

in a remarkable case of Tetanus, already alluded to, which proved fatal in four hours after the injury, and in two from the access of symptoms, a period manifestly insufficient for inflammation to become established in a degree adequate to cause the violent spasms that distinguished this case*. And further it may be observed that a turgid state of the vessels of the brain, with serous effusion between the membranes, is commonly present in those who have been poisoned by opium, hydrocyanic acid†, and other powerful agents resorted to for the removal of Tetanus, the influence of which, although they may not have produced their full effects, should not be entirely overlooked in an investigation of the nature of these changes.

Now as the exact nature of the process termed inflammation is unknown to us, our conception of it being derived from observing the phenomena which are presented by it when seated in an external part, the only satisfactory proof of its having existed in the internal structures of the body, is afforded by the detection of those changes, such as thickening and unnatural adhesions and secretions, which we know to be the invariable results or products of a continuance of this morbid condition. If, therefore, it has been demonstrated, that certain appearances generally observable in the nervous centres in cases of Tetanus, are frequently met with under circumstances, and from causes anything but inflammatory; and that nothing expressive of such action is ordinarily remarked in the state of the pulse, of the blood, or of the secretions of persons affected with this disease: and moreover, if it appears that the morbid changes which are almost the constant results or terminations of active inflammatory disturbance in these important structures are altogether wanting in pure cases of the spasmodic disease, it must then be admitted that Tetanus is not entitled to be considered as an inflammatory affection. I say pure cases of the disease, because in coming to this conclusion it is not attempted to deny that Tetanus is ever attended with inflammatory symptoms or changes, but only, as will be more fully shown in the following pages, that the nature of the morbid action giving rise to it is essentially inflammatory.

But appearances in the medulla oblongata and spinalis, of a less equivocal character than those already described, are stated to have been found more particularly in cases of idiopathic Tetanus, or of traumatic, when occurring after injuries of the head or of the spine. In all those instances, however, in which we have any detail of the history and progress during life, it will be seen that they were clearly distinguished by symptoms sufficiently expressive of an inflammatory character. The prominent symptoms referrible to inflammation in the spinal cord and its membranes, according to Parent-Duchatelet and Martinet,‡ Ollivier,§ and Dr. Abercrombie,

* Dictionnaire des Sciences Médicales. Article Tetanos.

† Christison on Poisons.

‡ Recherches sur l'Inflammation de l'Arachnoïde Cérébrale et Spinale. 8 vo. Paris, 1821.

§ Traité de la Moëlle Epinière et de ses Maladies.

are, an acute pain extending in the direction of the spine—tetanic contractions of the muscles, especially of the back, and posterior part of the neck, sometimes producing complete opisthotonos—rigidity of the muscles of the extremities, and very frequently paralysis—febrile disturbance, with a quick pulse—restlessness, and occasionally high delirium, the patient often dying comatose.

But although inflammatory affections of the medulla and its membranes, are clearly distinguished from genuine Tetanus by some of its leading symptoms; yet the concurrence of permanent contraction of the muscles, especially in cases where the spasms are severe, and the inflammation is the consequence of external violence, has caused many of them to be mistaken for the latter disease. Thus Dr. Reese, of Baltimore, has published,* as an example of traumatic Tetanus successfully treated, the particulars of a case in which inflammation appears to have been consequent upon injury to the structure of the spinal cord itself; and as it possesses considerable interest, the account, slightly abridged, is here inserted.

Case.—A lad, aged fifteen, received a quantity of buck-shot in his back from the firing of a loaded gun. Two of the shot entered the spine, and the accident was immediately followed by total paralysis of the parts below. Next day some reaction having taken place, it was necessary to bleed, and also to employ the catheter, which last operation was afterwards required twice or thrice in the course of the day. Drastic purgatives produced little or no effect. In seven days symptoms of Tetanus came on in the form of opisthotonis. Laudanum was given in drachm doses every half hour during the night, and on the next day the caustic potash was applied along the whole length of the spine. At this time the patient's body was contracted to a semicircle, his feet distorted, and the toes drawn inwards, whilst he was suffering excruciating torture. In four hours after the application of the caustic there was a mitigation of the spasms. He fell into a sleep, which continued for six hours, and awoke free from tetanic symptoms, the paralysis of the bladder and lower extremities remaining. Sensation was, however, perfect. When the account was published, the boy had so far recovered as to be able to walk with a stick.

Strictly speaking, this was a case of traumatic tetanus, but it differed in many respects from ordinary cases of that form of the disease, the symptoms being obviously dependent upon inflammation excited by direct violence to the substance of the medulla spinalis. That the shot had penetrated so far as to injure this structure may be fairly inferred, since the paralysis was instantaneous; and, as sensation remained unimpaired, it may also be presumed, that the anterior columns were more particularly injured.

A case, in some respects similar to the preceding, but which terminated fatally, is recorded by Hippocrates in his fifth book, on

* American Medical Recorder, July 1825.

epidemics.* A man was struck on the back a little below the neck, by a dart, which was extracted, but, in a short time afterwards he was seized with opisthotonis and trismus, and every thing which he attempted to swallow was rejected through the nose. The symptoms became rapidly worse, and he died on the second day after the infliction of the wound.—As the tetanic symptoms supervened so rapidly it is very possible that the medulla spinalis itself was injured, although such is not stated to have been the case.

In case 11 it appears that a boy was struck on the back part of the neck by a shutter falling upon him, and was picked up insensible. On the following day symptoms of Tetanus showed themselves, accompanied with a hot and dry state of the skin, the bladder became paralysed, the fæces passed involuntarily, and he died on the fourth day after the accident.—On examining the body, it was found that the cervical portion of the spinal cord, to the extent of an inch, had undergone considerable softening, and that the membranes covering this portion were inflamed and much thickened.

Here, then, is another well marked case of inflammation of the structures within the spinal canal, consequent upon external violence, with symptoms of tetanus superadded; and it is remarkable, that out of seventy fatal cases, this and case 39 are, in fact, the only instances where changes in the nervous centres, unquestionably the result of inflammatory action, were discovered after death, which, as has been shown, can, in the present example, be accounted for by the nature of the injury and subsequent symptoms.† Somewhat analogous to these were, I have no doubt, the three cases of opisthotonos, following injuries of the head, witnessed by Sir Benjamin Brodie, in all of which matter was found on the medulla oblongata. Professor Frank has also recorded, as a case of “horrible tetanus,” an instance evidently of inflammation about the spinal cord, induced by a blow upon the spine, but he gives no account of the appearances on dissection.—The following is a case recorded by Dr. Michael Funk.

Case.—A man, aged 36, received a wound from a horse's foot upon the left temple. Three days after, he had slight symptoms of trismus and fever, with constipation, which were shortly followed by complete opisthotonos, and seven days after receiving the wound he died. He had been bled to two pounds, and the blood had the buffy coat. *Inspection.*—A small quantity of serum escaped from the dura mater when divided. There was a light-coloured extra-

* 'Ο πληγείς ὁξεῖ βέλει ἐς τοῦπισθεν μικρὸν κάτω τοῦ τραχήλου τὸ μὲν τρῶμα ἔλαβεν οὐκ ἄξιον λόγον εἰσιδεῖν, οὐ γὰρ ἐν βάθει ἐγένετο. Μετὰ δὲ οὐ πολλὸν χρόνον ἐξαιρεθέντος τοῦ βέλους ἐπταίνετο ἐς τοῦπισθεν ἐρυσθεὶς ὡς οἱ ὀπισθοτονικοὶ καὶ αἱ γεννέες ἐδίδεοντο, καὶ εἴ τι ὑγρὸν ἐς τὸ στόμα λάβοι καὶ τοῦτο ἐγχειροῖη καταπίνειν πάλιν ἀνέκυπτεν ἐς τὰς βίνας, καὶ τὰ λοιπὰ αὐτίκα ἐκακοῦτο, καὶ δευτέρῃ ἡμέρῃ ἔθανεν.—'Ιπποκράτους 'Επιδημίων τὸ πέμπτον. xx.

† Mr. Travers gives the case of a lad, æt. 16, who, on the third day after a blow on the cervical spine, was seized with violent spasms and fixed retraction of the head, and died at midnight. There was softening of the cervical portion of the spinal cord to the extent of an inch, and its membranes were inflamed and thickened. Lib. cit. part ii.

sation on the cord, and its vessels were very much injected. "This inflammation extended to the medulla oblongata;" it was most considerable in the region of the neck. Substance of the cord red, its cut surface presenting a good many bloody points; vessels of the brain enlarged, "though not to such a degree that one could pronounce it inflammation."*

In further confirmation of these views, as to the distinct character of inflammatory Tetanus, or rather of inflammation in the spinal cord accompanied with tetanic contractions in the muscles, two cases are selected, which have been published as examples of the idiopathic form of this disease.

1. Margaret P——, aged 56, was suddenly seized, without any apparent cause, with acute pain in the lumbar region and along the back, and shortly afterwards she was deprived of the power of moving the lower extremities. On the fifth day after the attack she was admitted into the Hôpital St. Antoine with the following symptoms. The jaws firmly closed—difficulty experienced in speaking—inability to stand—the fore arms half bent—deglutition difficult—respiration laborious—the face flushed—the intellect unaffected—and the pulse full and hard. She was bled to $\frac{2}{3}$ xij. On the sixth day, the symptoms were much the same as on the day before, and the blood which had been taken was buffed. Ordered to be cupped on the loins, opium internally, and opiate frictions. Towards the evening she became worse, breathing being more laborious, and before night she died. The body being examined, a great quantity of fluid was found in the theca vertebralis; the membranes enveloping the spinal marrow were of a rose colour, the minute vessels being turgid with blood. The anterior columns of the medulla were in a state of ramollissement, especially in the lumbar and cervical regions. Nothing unusual was observed in the different systems of nerves.†

2. Valentinis Pasqua, a washerwoman, 44 years of age, liable to rheumatic pains, was attacked after standing for some time in water, with stiffness of the jaw, neck, and limbs, in consequence of which she was compelled to confine herself to bed. On the third day afterwards she entered the hospital of Udina, under the care of Dr. Poggi. At that time the trunk was bent backwards in a state of opisthotonos, and the arms were stiffly extended and compressed against the chest. The breathing was frequent and feeble, the pulse strong and quick, the skin hot, the bowels constipated, the tongue dry, and on its edges red, thirst considerable, the urine passed with difficulty; but the intellectual faculties and sensibility were unimpaired. On the third day, the locked jaw, which never equalled the other spasmodic affections in severity, had not increased; but the spasms of the trunk and arms were more violent, the abdominal muscles

* Reports of Cases, translated from an inaugural dissertation in German, by Mr. Adams.—Glasgow Medical Journal, vol. iii. p. 141.

† This case is abridged from the Archives Gén. de Méd. Juin, 1831.

being exceedingly rigid. The febrile symptoms still remained the same, as also sensibility and the functions of the brain. On the fifth day she expired. *Inspection.*—The cerebrum, cerebellum, and medulla oblongata, were healthy. On the outside of the dura mater of the spinal cord there was some effusion of serum tinged with blood. The spinal arachnoid was unaltered. Immediately below the decussation of the corpora pyramidalia, the medulla spinalis presented, in its whole anterior, half a series of little spherical swellings underneath the pia-mater, which varied in size from that of a millet seed to that of a lentil. The whole anterior part of the cord was converted into a soft pulpy substance, confined, however, to the medullary structure, and of a dull white colour, with some red points in the centre, and on different parts of its anterior aspect. The posterior half of the spinal cord was, on the contrary, healthy in colour, form, and consistence. The anterior and posterior roots of the nerves presented quite a different appearance, the latter being quite healthy while the former were diminished in thickness, very soft, of a yellowish white tint, occupied by little elevations like the cord itself, and very easily torn away.*

In both these cases the symptoms expressive of their inflammatory nature were most clearly marked, as great febrile disturbance, and a full and hard pulse. In the first, there was the acute pain in the back, which is stated by Ollivier and Martinet to be a pathognomonic symptom of acute spinal meningitis; and also, loss of motion in the lower extremities. The morbid appearances were most satisfactory, and highly interesting, since they tend to confirm the present opinions of physiologists in regard to the distinct functions of the anterior and posterior columns of the spinal cord. But whether inflammation be the result of injury, or arises spontaneously, it is worthy of notice, that the spasms, although continued and severe, do not usually recur in such violent paroxysms as in proper traumatic Tetanus.

In some few instances blood has been found extravasated within the spinal sheath. This was noticed in a case of idiopathic Tetanus recorded by Dr. Funk. The effusion extended from the first dorsal vertebra to the lower part of the canal, being greatest in the lumbar region. It is stated, that the surface of the cord was rose red—the origins of the nerves swelled—and the cauda equina much reddened. In another case, of traumatic Tetanus in a female, mentioned by the same author, a similar appearance was observed.†

Other morbid changes, of an anomalous character, have been discovered on dissection, the causes of which, as well as their connection with the disease under consideration, are far less obvious than those already described. In a child, aged between three and four years, who died in the Hôpital des Enfants Trouvés at Paris, with

* *Annali Universali di Medicina* Febbraio e Marzo, 1823. Also, *Archives Gén. de Méd.* vol. xviii. p. 406.

† *Lib. cit.* p. 140.

symptoms of opisthotonos trismus, difficult deglutition, and coma, Ollivier discovered deposition of a red and very consistent fluid in the cellular texture between the dura mater of the cord and the bony canal of the spine in the dorsal region, serous effusion within the membranes and the arachnoid of the medulla, covered with an albuminous concretion for four inches.* Burserius relates the case of a man who died of Tetanus induced by exposure to cold after intoxication, in which, on dissection, a large quantity of viscid yellow serum was found under the outer covering of the spinal cord. In the museum of St. Thomas's Hospital there are two preparations of bony and cartilaginous deposits beneath the arachnoid covering the medulla spinalis, in the dorsal and lumbar regions, distinct, small in size, and of the thinness of paper, which are described as having been taken from the bodies of patients who had died of Tetanus;† and in case 94, in addition to increased vascularity of the spinal marrow with considerable effusion, a number of small bony patches were observed on the pia mater covering the cord. In case 96, also, three small laminæ of bone were found on the dorsal division of the chord. Mr. Travers states, that in the cases which have come under his notice, some morbid deposition of this kind was discovered in the substance of the arachnoid tunic covering the medulla in five out of eight.‡ I have examined the spine with care in at least a dozen instances of Tetanus, but have never met with it. It is clear that these osseous deposits, which are not unfrequently discovered in the bodies of persons who have died of other diseases, could not have been recent productions, and were not, therefore, the immediate cause of the disease; but whether their presence predisposes to the development of Tetanus, and like bony spicula within the cranium in epileptic cases, under circumstances of inordinate excitement or unusual action of the arterial system, determine its access, are questions which, however inclined we may be to settle them in the affirmative, cannot very readily be decided.

2. *The Sympathetic System.*

Attention has been directed to the state of the ganglia of the sympathetic system in an Essay on Tetanus, by Mr. Swan. The morbid changes observed, were, a preternaturally injected state of the minute vessels supplying the ganglia, especially the cervical and semilunar. Similar appearances had been previously noticed by Dr. Aronssohn of Strasbourg, and by Andral§. In case 18 it is stated, that the superior cervical ganglion was injected; and on two occasions I have

* Lib. cit. vol. ii. p. 585.

† I understand, that in the dissection of a woman who died of hydrophobia in the same hospital, a distinct cartilaginous deposit, about the size of a sixpenny piece, was discovered on the dorsal division of the medulla. Dr. Bright has described a fatal case of chorea, in which the same lesion was observed.

‡ Lib. cit. part ii. p. 321.

§ Clinique Médicale, tom. i. p. 419.

myself found the cervical ganglia of the sympathetic unusually vascular, whereas, in a third instance, they were natural.

M. Dupuy states, that he has frequently discovered inflammation and disorganization of these ganglia, and of other nervous trunks in horses that have died of Tetanus*.

Mr. Swan has also shown that the ganglia of the sympathetic nerves are rendered unusually vascular in animals poisoned with gamboge, arsenic, strychnine, and mercury, and he has met with these appearances in cases where great constitutional irritation has followed severe injuries.

In Ploucquet's *Literatura Medica Digesta* there is a reference to a case in Meyer, in which Tetanus is supposed to have been induced by an ossification of the pleura irritating the splanchnic nerve. In the same work there is likewise an allusion to a case from Vetter, in which irritation of the par vagum, from the sharp point of an ossified gland in the vicinity of the trachea, was supposed to have given rise to the disease.

3. *The Nerves immediately connected with the Seat of Injury.*

The nerves have, in several instances, been found injured and inflamed at the seat of the original wound. In case 5, on examining the wound at the back part of the thigh, which was inflicted by a spike that had penetrated deeply into the semitendinosus muscle, driving a piece of wadding before it, I found the sciatic nerve, which passed close to the bottom of the wound, highly injected with blood. In case 4, I traced the internal plantar nerve to the wound, which was occasioned by a compound dislocation of the great toe, where it appeared thickened, and its neurilema unusually vascular. In the dissection of a patient of Mr. Ewbank, who had died of Tetanus after a wound of the leg by a pitchfork, the prong was found to have penetrated to the peroneal nerve, which was bruised, and implicated in the inflammation set up in the part†. In case 64, after a laceration of the hand, which was amputated by Mr. Liston as soon as the tetanic symptoms made their appearance, the branch of the median nerve, going to supply the thumb, was found torn two-thirds across, and its extremity inflamed and thickened for nearly an inch. On dissecting the stump of a young officer, who died of Tetanus after the amputation of his arm, Baron Larrey and M. Ribes found the median nerve included in the ligature upon the artery, and its extremity swollen and red‡. In another case, mentioned by Larrey, the disease was consequent upon a wound by a bullet, which had passed through the internal and posterior part of the arm of a French general, cutting across the radial and internal cutaneous nerves and a portion of the biceps§. Baron Dupuytren discovered, in the arm of

* Encyclopédie Méthodique—Tétanos.

† Medical Gazette, vol. ii. p. 346.

‡ Lib. cit. vol. iii. p. 287.

§ Ibid. vol. i. p. 269.

a boy who died of Tetanus, a few days after being struck by a coachman, a portion of a whip enveloped in the very substance of the cubital nerve*. In case 89, the internal plantar nerve, before it divided into the two branches which supply the great toe and the toe next to it, was completely torn through, and each extremity of the nerve was bulbous and vascular: every other part of the nerve appeared perfectly healthy. In case 13, the plantar branch of the tibial nerve was involved in the wound. Dr. Hennen mentions that in one case he found the radial nerve, connected with the injury, thickened, and a spiculum of bone sticking in it†. Mr. Morgan found, on dissecting the thumb, in a case of Tetanus, two pieces of splintered teak, imbedded in the abductor muscle, and resting upon a branch of the radial nerve, without any appearance of inflammation in the part‡. In another case the sheath of the nerves supplying the injured part was highly inflamed. Dr. Murray has related a case, (case 20 in the table) where the wound, giving rise to the disease, was a severe laceration of the integuments of the leg, with fracture of the tibia and fibula. When examined after death, the sheath of the popliteal nerve was highly injected with blood, and from the ham downwards, the nerve was remarkably red in all its ramifications in the directions of the fracture, some of them being enlarged. It is mentioned that the integuments over the popliteal space were lacerated and bruised, and the parts in the vicinity of the fracture inflamed, and injected with extravasated blood. This latter statement is very important, since in this case, and probably in several of the others, the nerves only shared in that inflammatory action which was common to all the other textures connected with the seat of injury. In order to obtain something more satisfactory upon this point, I dissected out the nerves of a leg that had been amputated on account of a compound fracture, followed by excessive suppuration: and also those in the arm of a man who died from phlegmonous erysipelas of the limb terminating in gangrene. In the first case, the branches of the popliteal nerve were unusually vascular; and in the arm, the median, ulnar, spiral, and external cutaneous nerves presented a similar appearance through nearly the whole of their course. I was present again at the examination of a case of Tetanus, in which the nerves were carefully traced to a wound at the back of the hand that was nearly healed, but nothing remarkable was observed. The same has also been noticed in other cases§.

In some instances the appearances which have been described were not merely confined to the nerves at the seat of the wound, but were observed in different parts of their course as far as their origin

* Medical Gazette, vol. v. p. 574.

† Lib. cit. p. 251.

‡ Lib. cit. p. 7.

§ In a case of hydrophobia, in which I traced the nerves proceeding to a cicatrix on the wrist consequent upon the bite, the posterior branch of the ulnar, and all the nerves at the inner part of the arm, together with the axillary plexus, appeared abnormally injected; but, on dissecting out the same nerves on the other arm, which was uninjured, they were found still more vascular.

from the spinal marrow. M. le Pelletier, chief surgeon at the Hospital at Mans, has communicated to the Royal Academy at Paris*, a Memoir in which he has attempted to show, that in all cases Tetanus originates in inflammation extending from the neurilema of the nerves of the part injured to the membranes or substance of the medulla spinalis. In a case where Tetanus occurred, after a compound fracture of the humerus, he found the neurilema of the cubital and median nerves red and inflamed, as also the envelops of the brain and spinal marrow; and it was remarkable, that the appearances of inflammatory action were confined to the left side of these membranes, being the side corresponding with the arm that was fractured†. In another case, in which the disease appeared on the seventh day after an incision made into a carbuncle on the inner part of the left leg, on dissection forty hours after death, the membranes of the spinal cord were found to be unusually vascular, and the cord itself, from the fourth cervical to the fourth or fifth dorsal vertebra, red and very soft. The branch of the sciatic nerve, distributed to the site of the carbuncle, was encircled by a vascular net work. M. Pelletier has also communicated to the Academy of Medicine the particulars of a third case of fatal Tetanus supervening on amputation of the leg‡. A lad, fifteen years of age, and of a feeble constitution, had his left leg removed in consequence of a malignant affection of the heel. He went on very well for three days, and the wound partly healed by the first intention, when he experienced considerable tenderness in the stump, with convulsive twitchings of the muscles. On the sixth day the patient was attacked with trismus, the respiratory muscles shortly became affected, and, notwithstanding he was largely bled, the disease proved fatal on the eighth day after the amputation. On dissection, a small depôt of purulent matter was discovered in the stump at the head of the fibula, the parts around being inflamed. The sciatic nerve at this place was found softened in structure, and of a violet hue, being much injected with blood, and this appearance was continued for eight or ten inches to the hip, being also observable in some of the branches of the nerve. For some days previous to the accession of tetanic symptoms, the patient had complained of pain in the track of this nerve when it was pressed upon. The pia-mater of the medulla spinalis, at the part corresponding with the origin of those nerves supplying the muscles affected with spasm, was highly injected, reddish effusion was found under the membranes, and the spinal marrow itself, in the middle of the dorsal region, was in a state of ramollissement. In the case of a female, 19 years of age, who died of Tetanus consequent upon a wound in one of her fingers from a splinter of wood, which inflamed, and was followed by the formation of an abscess, it is stated, that on inspection of the body by Dr. Hesselbach, "in some

* Séance, Oct. 12, 1826.

† *Révue Médicale*, 1827, tom. iv. p. 183.

‡ *Journal de Progres*, 1828. Also *Archives Générales de Médecine*, tom. ii. Second series.

places the nerve of the arm was remarkably inflamed," and that "between the dura-mater and arachnoid was contained a pretty large quantity of bloody serum, the vessels being much injected, with extravasation of blood throughout the whole course of the spine.*"

In case '92 it appears that a boy was scorched on both legs. After death the nerves were accurately examined. "The cutaneous nerves of both legs, particularly the communis tibialis and the communicating branches of the peroneal nerve with the tibialis communis, were inflamed at the seat of the injury; tracing them upwards, above this point, they were perfectly healthy, except that portion of the peroneal which turns over the head of the fibula, there it was again distinctly very vascular, thus leaving an intermediate portion perfectly free from the appearances of inflammation. The vascularity seemed to be confined to the sheath of each nerve; the deep-seated branches appeared to be quite natural." In case 93, the patient had the ring and middle fingers of the right hand much lacerated and injured by machinery, and the last phalanx of the middle finger being adherent to the second only by a small slip of skin, it was removed accordingly. It was discovered, on dissection after death, that "the nerves on each side of the remaining phalanx of the ring finger were very vascular. On tracing upwards the ulnar nerve from this point to the elbow, it was of its natural colour; but here, again, it became very vascular for about the extent of two inches. In the axilla it again presented a similar appearance to that at the elbow, the portion of it intervening betwixt these two points being healthy. Tracing the median nerve in the same way as the ulnar, it was found perfectly natural from its digital branch, which supplied the radial side of the ring finger (and which, as stated above, was much inflamed,) to about the middle of the arm, where it again presented an inflamed appearance for the extent of one inch and a half. The portion of it intervening betwixt this part and that confined to the axilla, where it again became vascular, was natural. This vascularity throughout was not confined to the sheaths of the nerves, but occupied their substance; the radial and superficial nerves of the arm, along with its veins and arteries, were perfectly natural." In case 64, previously alluded to, it is mentioned, that about two inches and a half of the median nerve, at the end of the elbow, were very vascular.

The consequence of a continuance of inflammation in a nerve is deposition of coagulable lymph between its fibrils, causing an increase in size, which is distinctly seen in the extremities of the nerves affected with chronic inflammation after amputation. This morbid change was remarked at the seat of the wound in several of the cases which have been mentioned, for the nerves are described to have been thickened, swollen, and red. But in cases 64, 92, and 93, the appearances observed in the course of the nerves, amounting to nothing more than preternatural injection, cannot be considered as consequent upon inflammatory action.

* Vide Dr. Adams's Paper, Glasgow Medical Journal. vol. iii. p. 191.

II. LESIONS OF THE MUSCULAR SYSTEM.

The violent action to which the muscles are excited in Tetanus, has occasioned, in severe cases of the disease, serious lesions of their structure. We find that in case 28 the fibres of the *psoas magnus* were discovered after death lacerated and soft, blood being effused on the surface of this muscle and in the sheath of the *recti-abdominis*, the fibres of which were also torn and quite soft. In case 4, an account of which will be found at a subsequent page of this essay, I found, after death, that about half the fibres of the lower division of the *rectus abdominis* on the left side had been ruptured, the upper portion of the lacerated muscle being retracted, swollen and hard. Several of the fibres of the right *rectus* were also torn in the same situation. A little extravasated blood was found in the sheath of these muscles at the seat of the rupture, which most probably took place in an acute and painful paroxysm that occurred just previous to dissolution*. Baron Larrey relates the particulars of a very acute case of traumatic Tetanus, in which during life, at the moment that the patient was plunged into a cold bath, a tumour, of the size of a hen's egg, was suddenly produced on one side of the *linea alba* below the umbilicus. It terminated fatally; and, on dissection, the right *rectus* muscle was found completely ruptured; and the swelling, which did not disappear after death, was formed by the upper portion of the muscle being retracted and turned in upon itself. Below this a rent was perceived filled with dark-coloured coagulated blood. The rupture had evidently taken place in the severe paroxysm induced by sudden immersion in cold water†. In case 65, after the spasms had partially ceased, an œdematous feeling and appearance were perceived over the pectoral muscles. Also in a case of *opisthotonos*, treated at the *Hôtel Dieu* by Baron Dupuytren, after death, it is said, there was well-marked ecchymosis on the posterior part of the neck, where the muscles gorged with blood appeared to have been torn. The spasmodic contractions have even been so violent as to cause fracture and dislocation of the bones. Desportes gives a case where both thighs were broken by the powerful action of the flexor muscles during a momentary remission of the extensors‡; and in a case mentioned by Fournier-Pescay, the spasms are said to have occasioned a dislocation of the second cervical vertebra.

Those conversant with pathological investigations are well aware that there is very considerable variation in the degree of the rigidity which the muscular system presents shortly after death, as well as in the period at which it commences and in the term of its duration.

* In the examination of the body of a man who expired in a violent epileptic fit, I once found the lower belly of the *rectus* muscle of the abdomen on the right side completely ruptured near its centre, with slight extravasation of blood in the cellular texture of the sheath.

† *Lib. cit.* vol. iii. p. 289.

‡ *Histoire des Maladies de St. Domingue*, ii. 171.

In some instances, as in the bodies of persons destroyed by lightning, the fibres never contract at all; in cases of phthisis and other lingering diseases, their contraction is slight; whilst in Tetanus the rigidity is greater, than in any other disease. This contracted state of the muscles is owing to irritability remaining in the fibre after all the other phenomena of life have ceased, and it subsides as the putrefactive process commences. The change by which the muscles are, in certain cases, deprived at the moment of dissolution of the power of subsequently contracting, is supposed to be in connection with the force which takes from the blood the property of coagulating; yet it is remarkable, that in Tetanus the muscles are not only unusually rigid after death, but the disposition in the blood to coagulate is often delayed, and sometimes even altogether lost.

III LESIONS OF THE VISCERA AND OTHER PARTS OF THE BODY.

The lungs are often found gorged with blood, and sometimes in a state of engorgement. The state of asphyxia, in which the disease so frequently terminates, is quite sufficient to account for this condition.

In all the cases in which Mr. Swan found unusual appearances in the sympathetic system, there was increased vascularity, and an inflammatory state of the mucous membrane of the alimentary canal. Dr. M'Arthur has published the details of four fatal cases of Tetanus, in the dissection of which he discovered inflammation of the stomach and of the intestines*. Andral relates a case, in which, on dissection, he found unequivocal marks of gastritis. In the Philosophical Transactions for the year 1764, are contained the particulars of a chronic case of idiopathic Tetanus, which was caused apparently by worms in the intestinal canal. Sauvages relates a fatal case of Tetanus, in which the intestines were perforated by worms†; and in the Journal of Loder, Mursinna has recorded an instance of trismus, in which the disease was cured after the expulsion of a single worm, ten ells in length. Mr. O'Beirne witnessed three cases of Tetanus in the Peninsular campaigns, where worms were discharged from the alimentary canal; in one ascarides, and in each of the others a lumbricus§. Baron Larrey, in the opening of numerous bodies, after death from this disease, frequently found lumbrici in the small intestines without any trace of inflammation.¶ D. Thompson, of Jamaica, mentions several cases of chronic Tetanus in negro children, arising from the irritation of worms.¶ They were so often met with in the stomach and intestines by M. Laurent, a physician of considerable experience at Strasbourg, that he was induced to attribute

* Medico-chirurgical Transactions, vol. vii.

† Clinique Médicale; tom. iv. p. 444.

‡ Nosolog. Method. tom. ii. tit. Tetanus.

§ Lib. cit. p. 349.

¶ Lib. cit. vol. iii. p. 287.

¶ Edinb. Medical and Surgical Journal, vol. xviii. p. 44.

the disease, in all cases, to their presence*. Worms were likewise observed in cases 12, 35, 42, 50, 65, and 123; and they are noticed also as causes of Tetanus by Morgagni, Trnka, Stoll, and Four-nier-Pescay. These facts render it desirable, in all morbid investigations, to make an accurate examination of the intestinal canal; but, in estimating their influence as an exciting cause of the disease, it is important to bear in mind, that they are more frequently present in negroes than in whites; and Dazille even states, that in the examination of the bodies of negroes who had died of various diseases in many of the French colonies, he had always found the intestines loaded with wormst.

The papillæ maximæ, at the root of the tongue, are sometimes found hypertrophied, and the mucous lining of the larynx highly injected, and containing a quantity of frothy mucus. Baron Larrey observed, in most of the bodies of the tetanic patients which he examined, "the pharynx and œsophagus much contracted, and their internal membrane red, inflamed, and covered with a viscid, reddish mucus†." Similar appearances are generally met with in the examination of patients who have died of hydrophobia. In both cases they are readily accounted for by the spasms and irritations that exist in these parts during life.

SECTION II.—THEORY OF TETANUS.

A primary object in the study of any disease, is to endeavour to refer the symptoms expressed during life to alterations of structure recognizable after death: but in Tetanus the morbid phenomena and changes are so variable and obscure, that our researches into those recondite processes of nature, which are the cause of this disease, have hitherto been unattended with a successful result.

If the nerves supplying a limb which is affected with tetanic spasms be divided, this abnormal action of the muscles instantly ceases, which is a proof that the disease is not situated in the muscular system, but that it is located in some part of that structure from which the muscles are supplied with the stimulus to contraction. Now if it be admitted that the action only of those muscles subservient to the will are deranged, further progress will be gained, since, in the absence of cerebral disorder we are justified in assuming that this morbid action is limited to that part of the nervous mass from which the voluntary muscles derive their stimulus to contraction, consisting of the anterior columns of the spinal cord, the corpora pyramidalia and olivaria of the medulla oblongata, and that prolongation of them through the tuber annulare giving origin to the third and fourth cerebral nerves and to the smaller fasciculus of the fifth, forming altogether the *tractus motorius*. The phenomena of the artificial

* Mémoire Clinique sur le Tétanos chez les blessés, Strasbourg, 1797.

† Lib. cit. p. 139.

‡ Lib. cit. vol. i. p. 247.

Tetanus, excited by strychnia, tend further to establish the fact, that the medulla may be the seat of a morbid action, causing spasmodic contractions, independent of the brain. After division of the medulla, in the dorsal region of a rabbit, I have inserted this poison in a wound on one of the hind legs, and in the struggles which preceded death, have seen all four extremities thrown into spasm. Professor Emmert, of Bern, who has performed some interesting experiments in illustration of the mode of action of strychnine, noticed similar facts. He found, also, that on dividing the medulla oblongata, and keeping up respiration artificially, universal Tetanus might be produced by introducing the false *Angustura* bark into the hind leg of an animal, or by administering it internally*. Now, whether the poison be first admitted into the circulation or be transmitted directly by nerves, it is equally clear that the motor tract is the seat of its operation, and that the involuntary spasms are excited without any connection with the brain. That the spinal marrow is the seat of diseased action in Tetanus, is in truth by no means a modern opinion, having been maintained by Galen, and adopted by Fernelius, Willis, Hoffman, and Lieutaud. But more recent pathological investigations, and the physiological inquiries of Sir Charles Bell and of Magendie, by determining the different centres from whence proceed the nerves of sensation and of volition, have established that the tractus motorius is that part of the nervous system which is principally, if not solely, affected.

It has been contended, that the morbid anatomical characters concur thus far with the symptoms expressed during life, that they afford no evidence to warrant the conclusion that the disease is essentially of an inflammatory nature, and in the absence of a more appropriate name to distinguish the diseased action that exists, I must adopt the term "irritation," which has been used conventionally to express a condition by no means accurately defined, or clearly comprehended. Mr. Travers observest, that "Irritation is the name given to that state which is produced by an extraordinary excitement of the irritability either of a part or of the system; irritation is, therefore, local or constitutional. The phenomena of irritation are chiefly displayed in the nervous system, and it is thus distinguished, pathologically, from inflammation, which belongs to the vascular. Their relation is as intimate as that of these systems, of the extraordinary actions of which they are the results. He also distinguishes constitutional irritation into two kinds, direct and reflected. The first is truly symptomatic, being always dependent on local causes—the second depending on constitutional causes is occasionally purely idiopathic, and is oftener the cause, than the effect, of local action. Tetanus and epilepsy belong to the latter.

It is true, Mr. Travers has scarcely attempted to give us any just notion of the actual nature of morbid irritation, respecting which we

* Meckel's Archiv. fur Anatomie und Physiologie, i. 1.

† Lib. cit. vol. i. p. 39.

are, and I conceive must remain, as much in ignorance as of the essential nature of inflammation. But he has done more, perhaps, than any other pathologist, in illustrating the phenomena by which it is distinguished, and investigating the laws to which it is subjected. The theory* of this morbid action, as applied to Tetanus, is certainly strictly accordant with what we know of its pathology. One of the most important points which he has laboured to establish, is the pathological distinction between irritation and inflammation. It cannot, indeed, be doubted, that a morbid action, partaking of the character of excitement, may go on in the nervous system, and even occasion death, without exhibiting the signs of inflammation. Many important facts, in relation to the pathology of cerebral and spinal affections might be adduced in support of this opinion: and, moreover, to show that a highly injected state of the pia mater with serous effusion, which is so frequently met with under these circumstances, must often be regarded as resulting from a morbid state by no means inflammatory. And although these appearances are not invariably observable in cases of Tetanus, yet they are too frequently present, not to be considered as essentially connected with the deranged action which gives rise to this disease. We are here, then, induced to inquire whether these lesions of the nervous centres are *a cause*, or *an effect*. I believe them to be an effect, and for the following reasons.

First, If they were a cause, they should be more frequently present. By this I mean, that if the essential cause of Tetanus were vascular derangement terminating in serous effusion, we ought in all cases, making due allowance for pseudo-morbid changes, not only to find some trace of this action having existed, but the degree and extent of these lesions ought to be, in some measure, proportionate to the intensity and universality of the spasms. Now, in many instances, the most scrupulous examination has failed to reveal the slightest appearance of abnormal vascularity or of serous effusion, even in the most acute cases of the disease.

Secondly, If they were a cause, we should expect, from our experience of vascular determination in situations less concealed from observation, that it would sometimes terminate in the production of changes unequivocally inflammatory. But we find, that however long the disease may last before a fatal issue, which, in a vigorous constitution, provided the muscles of respiration are unaffected, is often many days, yet, unless inflammatory symptoms have been expressed from the beginning, nothing more is ever found after death than a turgid state of the vessels combined with the effusion of serum. I regard the secretion from the serous arachnoid as taking place precisely in accordance with the same law by which we have increased perspiration in determinations of blood to the skin, and a greater flow of urine in a similar state of the kidneys.

* I hesitate to adopt the term "reflected irritation," which appears to me neither sufficiently precise in its signification, nor adequately restricted in its application.

And, thirdly, It is incompatible with our knowledge of diseases, to consider the same pathological cause as productive of phenomena so different and unconnected as those of delirium tremens, hydrophobia, apoplexy, and epilepsy. The appearances in the brain and investing membranes, often existing in cases of Tetanus, in some instances constitute the sole pathological characters of these four diseases, yet no one would commit the absurdity of referring them to the same morbid cause.

For the above reasons, then, these changes can be viewed as in no other way connected with the disease than as an effect, exactly as in morbid excitement of a cutaneous nerve, there is a local determination of blood to the affected part and increased perspiration, which all pathologists concur in regarding as the effect, and not as the cause, of the neuralgia. The alliance between the nervous and vascular systems is indeed so intimate, that all cases of exaltation of the function of any part of the former, healthy or morbid, are generally accompanied with more or less excitement of the vascular system, although evidence of it cannot always be recognized after death.

Tetanus then appears to consist in a peculiar morbid action in the tractus motorius, the intimate nature of which is altogether beyond our comprehension. This action or irritation, although pathologically distinct from inflammation, may not only co-exist with it, but may also, as has been shown, be excited or caused by inflammatory action in the medulla oblongata, spinal cord, or their meninges. In these cases, as the irritation is superadded to the inflammation by which it is excited, Tetanus, though most commonly present, is not a necessary symptom, and there are some undoubted cases of cerebral and spinal arachnitis to be found in the writings of the French pathologists, who have particularly investigated these affections, unaccompanied with any tetanic symptoms whatever.

The result of tetanic excitement in the tractus motorius, however caused, is an extraordinary supply to the voluntary muscles of a stimulus to action totally independent of volition, which, although supplied in increased force at varying intervals, is so continued as to render the contractions permanent; and it is remarkable for how great a length of time the action of the muscles is prolonged, without occasioning that distressing sense of lassitude ordinarily consequent upon muscular exertion, when induced by the stimulus of the will. But although the spasms in Tetanus are in no degree subjected to voluntary control, yet it is curious that in sleep, when volition is in abeyance, the excitement to action resulting from the morbid irritation is likewise withheld.

From many of the phenomena connected with muscular action in this disease, it would appear that tetanic irritation may be limited to a part or segment of the tractus motorius, as in case vi.; or as in case 74, in which trismus was the chief symptom. Sometimes it would seem to be confined to the tractus motorius on one side. Thus, in the third case of M. Pelletier, related at page 41, it was noticed that the temporal and masseter muscles were affected only on

the side corresponding with the limb that was injured. And in two cases mentioned by Sir Gilbert Blane, the spasms were likewise observed only on the side of the body on which the wound occurred. Or, the irritation would appear in some instances to be more active on one side than on the other, as in case v. ; and in a case of idiopathic Tenanus recorded by Mr. Swan ;* as also in case 122, and in a case that occurred to Baron Dupuytren ; in the two latter of which the spasms were more severe in the injured limb than in the sound one. But why the muscles of the face, neck, and trunk, are much oftener the seat of spasm than those of the extremities, has not been satisfactorily accounted for.

Although cases are recorded by Ollivier and other pathologists, in which inflammation of the membranes of the cord has been limited to a portion of their extent, more or less circumscribed, I am not aware, if we except one of the cases of M. Pelletier, in which it is stated that the indications of inflammation were confined to that side of the medulla connected with the nerves of the injured limb, that any instance has been described in which the preternatural injection, indicative of morbid irritation in the spinal cord, has been noticed only in that segment of the medulla corresponding with the origin of those nerves supplying the particular muscles, to which the spasmodic affection had been confined. The following case is highly interesting as an example of this kind.

CASE II.

Thomas Mountford, aged twenty-one, a light porter, of spare habit, and addicted to drinking, was admitted into the London Hospital, Dec. 29, 1835, at one p. m., labouring under symptoms of acute Tetanus. About three weeks previously, a splinter was accidentally driven beneath the nail of the fore finger of the right hand. The wound healed favourably ; but on Thursday, December 24, he experienced some degree of stiffness and uneasiness about the muscles of the neck, which gradually becoming more severe he was sent to the hospital. There was decided opisthotonos, with pain at the back and præcordia, which was increased every three or four minutes by slight paroxysms. He was unable to open his mouth more than half an inch, and experienced considerable difficulty in swallowing, and constriction about the throat ; pulse 125, perspiration profuse, thirst excessive, countenance tetanic. At four p. m., the spasms were more violent, the paroxysms recurred more frequently, and lasted longer ; the pulse had increased to 144, the pupils were contracted, the bowels freely open, the evacuations dark coloured and offensive. At eight p. m., the tetanic symptoms were aggravated, the pulse was 150 but weaker, there was great pain at the præcordium, and the opisthotonos was more strongly marked. He was nearly suffocated on attempting to swallow.

* Essay on Tetanus, p. 51.

The paroxysms continued increasing in violence and frequency, his countenance became livid and expressive of the utmost anxiety and suffering; he tore everything away from his throat, seemed to be gasping for breath, and was altogether in a most distressing state of apprehension from strangulation. About a quarter before twelve, as the dresser was feeling his pulse, he convulsively put both hands to his throat, and suddenly expired.

Inspection fourteen hours after death.—Considerable congestion of the brain and its membranes. The vessels of the pia mater, investing the medulla oblongata and cervical portion of the medulla spinalis, were minutely injected; whereas in the dorsal and lumbar divisions this membrane was scarcely more vascular than usual. The contrast afforded by the medulla in the two situations was most striking, presenting in the one its ordinary appearance, in the other an uniform red colour, which on examination with a magnifier, was found to result from the minute injection of the plexus of vessels composing the pia mater. This remarkable vascularity terminated abruptly in almost a defined margin about the first dorsal vertebra.* There was no difference between the anterior aspect and the posterior; the substance of the medulla was not particularly vascular, and but little fluid was contained in the theca. Nothing remarkable was observed elsewhere, except that the blood had not coagulated, and flowed freely from the muscles when incised.

When the spasmodic disease is caused by inflammation in the medulla or its membranes, the tetanic excitement is not always limited to the seat of inflammatory action; and several cases are recorded in which Tetanus has been pretty general, although the evidence of inflammation has been strictly confined to the cerebral membranes. The tetanic irritation, too, exists in variable force, which is not always dependant upon the severity of the inflammation, but would seem to be partly owing to a difference in the susceptibility of individuals. In some instances, although the inflammation is active, the Tetanus is slight and transient, amounting to little more than mere rigidity. In others again the spasms are severe, but confined chiefly to the muscles of the back, the paroxysms being of short duration, and occurring at long intervals. Or the Tetanus may be universal and acute. It is the latter description of case which is, however, rare, that is most liable to be mistaken for pure Tetanus; but the symptoms essentially inflammatory are in general sufficiently well marked to render the discrimination easy. When the inflammation is more advanced, and disorganization of the medulla ensues, paralysis takes the place of spasm, a circumstance which never occurs in simple or non-inflammatory Tetanus.

Baron Larrey remarked "among the wounded in Egypt and Germany, that when the wounds causing Tetanus injured the nerves on the anterior part of the body, emprosthotonos was the result, and

* Mr. Luke, under whose care the patient was admitted, was present at the examination, and can sustain me in the accuracy of the observation.

that if the nerves on the posterior part were wounded opisthotonos occurred ; but if the wound traversed a limb, so as to injure equally the two descriptions of nerves, complete Tetanus was established.”* I cannot help doubting the accuracy of this statement, which has not been confirmed by the testimony of any other observer—is at variance with the facts recorded by writers of extensive experience, and is quite irreconcilable with the present improved physiological views of the nervous system. The French soldiers, in the late war, established too high a reputation for bravery, readily to induce the belief that most of their wounds were at the back part of the body ; whereas emprosthotonos is so exceedingly rare compared with opisthotonos, that even its existence, under any circumstances, has been denied.

The doctrine of *antagonism*, advanced by Bellingeri as applied to Tetanus, might appear to receive some degree of confirmation from these observations of Larrey. This ingenious hypothesis, however, of the Italian physiologist, is of so speculative a nature—is so entirely opposed to the well established and generally received views of Sir C. Bell, and to the experiments of Flourens and Magendie, and the objections are so striking and obvious, that a serious refutation of it is not considered necessary in this place.

Dr. Marshall Hall, in a paper† on a new function in the medulla oblongata and spinalis, termed “the reflex function,” thinks that by it some illustration is afforded of the nature of Tetanus, and of some other obscure nervous diseases. The head of a frog having been removed, the spine was divided between the third and fourth vertebræ ; and the upper portion of the animal separated from the lower. “There were then the head, the anterior extremities, and the posterior extremities, with their corresponding portions of medulla, as three distinct parts of an animal. Each preserved the reflex function. On touching an eye, it was retracted, and the eyelids closed, whilst similar phenomena were observed simultaneously in the other eye. On removing the medulla these phenomena ceased. On pinching the toe of one of the anterior extremities, the limb and the opposite limb equally moved. On removing the spinal marrow this phenomenon also ceased. Precisely similar effects were observed in regard to the posterior extremities.”

With the phenomena exemplified in this experiment physiologists have long been familiar, although they have not perhaps been very satisfactorily explained. The mode in which they are produced is aptly termed *excito-motory*. An impression is made upon a certain nerve, which being conveyed to the medulla, is thence reflected by other nerves to parts adjacent or remote from that which received the impression giving rise to muscular contraction. But, that the nerves thus employed constitute a distinct system, and are different from the nerves of sensation and motion, is a proposition which I

* Lib. cit. vol. iii. p. 286.

† Phil. Trans. 1834.

hold to be by no means proved. The truth is, the nerves of sensation may be excited, and motion may ensue in voluntary muscles, independently of consciousness and of volition. Dr. M. Hall errs in not making due allowance for the different endowments of nerves. Their irritability is variously modified according to the necessities of parts, and the nature and importance of the functions in which they are concerned. In man their susceptibility to ordinary stimuli is soon lost when life is extinguished; but in many animals, especially reptiles and the batrachia, the irritability of the nerves, as well as of the muscular fibre, is higher and lasts longer. In them, therefore, the phenomena of actions, excited independently of the will, are more remarkable and more readily observed.

Experimental physiologists have shown, that there is a point in the medulla oblongata corresponding with the origin of the eighth nerve, which being left entire, respiration may be carried on, although its connection with the brain is cut off. An animal, upon which this experiment has been performed, is precisely in the condition of the anencephalous infant. Born without a cerebrum or a cerebellum, but with its medulla and respiratory apparatus in perfection, the infant in this condition, at a period when its irritability is higher than at a more advanced age, has been known to live for hours. Destroy the medulla oblongata and the respiratory movements are instantly annihilated. Yet we cannot conclude that this segment of the medulla originates these movements, or as some physiologists would seem to believe*, is the seat of consciousness, for a similar effect is equally the result upon division of the eighth pair of nerves. It shows that respiration, being a function essential to life, is not left dependent upon the will for its due performance, and that by some incomprehensible modification of the nervous principle, the respiratory muscles may be excited to regular action independently of the will, by a stimulus transmitted through the medulla. I believe, with Dr. M. Hall, that those physiologists are wrong who regard the respiratory movements as entirely spontaneous; but I must be permitted to differ from him, and to view them as regulated by nerves whose functions are modified—by nerves subservient to the will, but which nevertheless, when volition is in abeyance, can convey a stimulus to action derived from the nerves of sensation with which they are in connection. The medulla is a centre through which the stimulus is transmitted, and whence it is reflected by various nerves according to the movements required.

If there be a distinct system of nerves connected with different parts or segments of the spinal cord, possessing functions and causing movements independent of the brain, and thus regulating the motions of the pharynx, sphincters, and other involuntary actions, why, I ask, are not motions analogous to those observed in the inferior extremities of the frog, excited in the human subject by a similar stimulus in cases of paraplegia from an injury of, or a tumor pressing

* Vide Mayo's Physiology, 3d edit. p. 229 and 230.

on the medulla in the cervical region? Why again in fracture of the dorsal or cervical division of the spine are the sphincters instantly relaxed? That the movements alluded to in the experiments are caused by an influence propagated by nerves, and through the medulla, is proved by their ceasing when the latter is removed; and we are warranted in concluding that in these animals, when life is destroyed, or the connection between the medulla and brain is cut off, that the property of the nerves to transmit impressions is not immediately lost; hence when a part is irritated, the impression is conveyed to the medulla, and contractions are occasioned in the muscles similar to those to which they were habituated when excited to action by the stimulus of volition. In the different experiments a nerve of sensation was excited, a stimulus to action was supplied; but there was no directing power, and the movements which followed were purely automatic. Just as the withdrawal of a limb pricked in sleep, or as in the case of the young gentleman mentioned by Mr. Travers, whose *os frontis* having been driven in by a fall, and a considerable portion of brain extruded at the wound of the scalp, although utterly deprived of consciousness, he made obvious but unavailing efforts to aid the surgeon in getting him into bed, and thrust his arm mechanically into the sleeve of a clean shirt after his hand had been placed in the opening of the sleeve*.

This explanation of the phenomena in question would appear to be sustained by the fact, that in animals, after life is extinct, but before the muscles have lost their irritability on stimulating a motor nerve, an impulse is propagated to the muscles to which it is distributed, causing contraction. Thus, it is well known that in dogs poisoned by prussic acid, on opening the body shortly after death and pinching the phrenic nerve, the diaphragm will be found to act. Now, what is it that causes this action? It must be induced by some stimulus supplied by the nerve and called into operation by the violence done to its structure. If, then, a motor nerve can, after death, propagate a stimulus to action, independent of the nervous centres, why should not the other nerves, under similar circumstances, retain their irritability, and be capable of transmitting the impressions made by their appropriate stimuli. Dr. Macartney has observed† that the ordinary actions of the iris correspond with the impressions of light on the retina, after the head of an animal has been cut off, so long as the retina retains its local sensibility, and the same has been observed after the extinction of human life by decapitation. Whether the head dies immediately that it is separated from the body in decapitation, and whether a person, executed in this way, suffers pain for any length of time, are subjects, which, from occurrences in Paris, have excited some attention of late‡. They are questions not very easily

* Lib. cit. part 1. p. 424.

† Observations on the Structure and Functions of the Nervous System, read before the British Association at Cambridge, in 1833. Vide Report, p. 453.

‡ Vide Medical Gazette, vol. xvii. p. 856, and a paper on the Pathology of Decapitation, by Dr. Rigby, vol. xviii. p. 21 of the same Journal,

determined. That the functions of the brain can be duly performed without the circulation of blood, and after so powerful a shock as must be occasioned in the instantaneous division of all the parts constituting the neck, including the medulla and many of the most important nerves, seems contrary alike to experience and to reason. Those who seek to support this view will do well to bear in mind the experiments on the frog. I have had a turtle's head brought from the tavern to my chamber, and, on touching the front of the eye with a probe, have seen the eyelids close, and, on irritating the nostril, have observed the lower jaws to move, a full hour after its separation from the body. Are we thence to infer that life is not yet extinct, and that the decapitated animal sees and wills? Or, shall we not rather conclude that, although the life of the brain is annihilated, the properties of life are not at once extinguished in the tissues; that irritability remains in the muscular fibre and in the nerve; and that the nerves retain the property of receiving and transmitting impressions, and the muscles the power of contracting? I can conceive that, after decapitation, the lids may close and the pupils contract when the eye is exposed to the sun, and that the protruded tongue may be withdrawn when pricked with a needle; but these phenomena afford no proof that the person still possesses the sense of vision and the perception of pain, or that the life of the brain is not yet destroyed.—It would be incompatible with my present object to pursue further this interesting subject; enough, however, has been adduced to show the fallacy of the view which argues the existence of a new function in the medulla, with a distinct system of nerves for its operation, and the augmentation of which is said to constitute Tetanus and other nervous diseases.

Although the spinal cord is not the source of volition, and when healthy does not supply to the voluntary muscles any stimulus to action, underived from the brain or nerves of sensation; although, in its normal state, it serves chiefly as a connecting link in the nervous chain, as a carrier and conductor of stimuli, yet it may, as well as the nerves proceeding to and from it, motor and sensitive, be the seat of morbid action, and thus be enabled to furnish a motive stimulus giving rise to abnormal muscular contractions, which, as the origin of the excitement is away from the source of volition, are totally without the control of the will. To my mind there is no more difficulty in comprehending that a stimulus to involuntary contraction may originate in morbid action in the medulla, than in understanding that a muscle can be thrown into undue action by the irritation of a motor nerve by a speculum of bone, or by the forceps of the anatomist, or by any foreign substance acting upon a nerve of sensation. In both instances we may define the seat, although we cannot ascertain the nature of the morbid action which originates the motive stimulus.

It has been already stated, that in Tetanus the rigidity of the muscles is greater and persists longer than in any other disease. Now, if nerves can transmit impressions after life has ceased, we

may readily conceive that, under the same circumstances, irritation may remain for a short time in the medulla, and that the nerves may convey the tetanic stimulus, giving rise to permanent contraction. In those cases in which fatal exhaustion, with muscular relaxation, has succeeded to violent, long-continued spasms, I have remarked that the body has subsequently attained a very considerable degree of rigidity, a circumstance deserving of notice, as marking the distinction between the actions excited by tetanic irritation and those induced by the stimulus of volition, for it is well known, that after great muscular exertion, as in animals hunted to death, the muscles do not afterwards contract. In these instances I imagine the powers of life are exhausted but not the tetanic irritation, nor the irritability of the muscular fibre. And this, though conjectural, will perhaps be admitted as not an improbable explanation of the remarkable rigidity observed in these cases after death. In an instance of the artificial Tetanus, produced by strychnine, mentioned by Orfila and Ollivier, the muscles are described immediately after death as remaining contracted, the head bent back, the arms bent, and the jaws locked, so that the spasm appeared to pass into the state of rigidity which precedes decay. This state of rigidity, however, without the preliminary stage of flaccidity immediately after death, does not invariably occur in animals poisoned with strychnine*.

Tetanic irritation is excited in the *tractus motorius* by a morbid influence transmitted from some part which has been subjected to a noxious impression, most probably by sentient nerves. There are other diseases, which appear to originate in a similar manner. Thus infantile convulsions are caused by an impression upon the gums in dentition, or by irritating matter in the *primæ viæ*, and cramp in the limbs is induced by an impression of cold and by acidity or a disordered state of the alimentary canal. These therefore are analogous instances of impressions made upon the extremities of the nerves, and thence propagated to the centre of nervous influences, giving rise to deranged and involuntary muscular actions. In traumatic Tetanus the seat of the primary impression which occasions the disease is of necessity the wound.

Of the cases in the table, it appears that the original wound was on some part of the extremities in 110 instances; and in 69 either on the hands or on the feet. The frequent occurrence of Tetanus, after injuries of these parts, has been attributed to their being more amply supplied with nerves of extreme sensibility, and this view might perhaps be sustained, if it were shown, that the danger of an attack of the disease was in all cases in proportion to the irritating nature of the wound, or to the extent of injury done to the integuments the more especial seat of this sensibility; but such is not the fact. The hands and feet are exposed to injury in a greater degree than other parts of the body, which affords perhaps a sufficient explanation of the prevalent opinion that wounds of them are more liable to be

* Vide Christison on Poisons, p. 803, third edition.

followed by Tetanus*. That it occurs more-frequently after lesions of the larger nerves also appears to be erroneous; since they are often divided in surgical operations, and not unfrequently are included in the ligatures applied upon arteries, or otherwise contused and lacerated, without being followed by the disease. Indeed, to show how little importance is to be attached to the nature of the wound as an exciting cause of Tetanus, Mr. Maxwell has appended to an account of three fatal cases of the acute disease in negroes, induced by wounds so slight as scarcely to attract the attention of the patients, a notice of four lacerated and irritating wounds which were not followed by spasms†.

The production of Tetanus is in no degree influenced by the state of the wound; hence, it is often either healed or going on favourably at the time that the symptoms first become manifest, or if otherwise, the same circumstances which probably predispose the constitution to an attack will also perhaps account for an unhealthy aspect at the seat of injury.

With regard to the opinion of M. Le Pelletier, that the disease always originates in inflammation of the neurilema of the nerves of the part injured, extending to the medulla spinalis, a view which is advocated by the Italian author Bergamashi‡, it must be objected, that inflammation of the structure of the nerves, as far as our present acquaintance with their pathology enables us to judge, very seldom extends in the way just described; that the nerves of the injured limb have very often been traced out with accuracy, without presenting any marks whatever of inflammation; and farther, that local inflammation of nerves is frequently established without being succeeded by Tetanus. But without denying the possibility of inflammation thus becoming continuous, especially since in one of the cases related by M. Le Pelletier, the origin of the disease appears to have been traced to inflammation at the seat of the injury, spreading along the nerves to the medulla and its membranes;|| yet we have ample evidence to show that Tetanus can seldom originate in this way, and it has already been proved that the disease is rarely inflammatory.

In cases 64, 92, and 93, appearances have been described which, though not constituting evidence of inflammation having existed, are too remarkable to be passed over without notice. It has been stated that a highly injected condition of the vessels of the pia mater, with

* Of 510 accidents treated at the London Hospital, from the 23d of June, 1836, to the 26th of August in the same year, 193 were for injuries on the upper extremities, 124 for injuries on the lower, 86 for wounds on the head, and 107 for injuries to other parts of the body.

† Jamaica Physical Journal, 1834.

‡ Bergamashi (Giuseppe) *Sulla Mielitide Stenica e sul Tetano, loro identità Metodo di cura, e Malattie secondarie che ne derivano*, 12mo. Pavia, 1820.

|| It is highly probable that in the case examined by Dr. Hesselbach, referred to at p. 41, the lesions both of the nerves and medulla were inflammatory, and that the disease originated in inflammation extending from the nerves. It must be regretted, however, that the morbid appearances are not described with more precision.

serous effusions, so often observed under circumstances in no respect inflammatory, is most probably the effect of morbid irritation in the brain or spinal cord. Dr. Saunders, lecturer on the practice of physic, at Edinburgh, in a letter to Dr. Duncan junior,* states as the result of his anatomical inquiries in Tetanus, that if any muscle, voluntary or involuntary, has been affected with spasm, it is found on examination that the nerves, which supply that muscle, are covered with turgid red vessels at their visible origins, or where they appear to set off from the brain, medulla oblongata or spinal marrow: but that the nerves serving the muscles which have not laboured under spasm or convulsion, are free from turgid vessels. In short, the nerves exhibiting such turgescence at their origins correspond with the muscles which have exhibited inordinate contraction, and in obstinate and severe cases this appearance may be traced along the nervous cords. According, then, to the observations of Dr. Saunders, the same changes which have been viewed as expressive of morbid irritation in the cerebro-spinal system, are likewise to be met with in the nerves when similarly affected, and this even in cases in which the nervous centres themselves are entirely free from any appearance of undue vascular action. He states that a turgid state of the vessels at the origin of the nerves exists uniformly in Tetanus. I have often searched for it, especially at the root of the portio dura and fifth nerve in trismus; and though I have frequently found appearances of increased vascularity, sufficiently often, perhaps, to entitle them to be regarded as essentially connected with the disease; yet according to my observation they are by no means constant. In the three cases just alluded to, it is not difficult to account for the appearances of increased vascularity in the course of the nerves only at particular situations, as in the vicinity of the joints. The nerves are most freely supplied with vessels near the larger articulations, where the anastomosing communications are very frequent, and the offsets from the principal trunks are more numerous. In the dissection of many injected extremities I have often been struck with the net-work of vessels encircling the nerves in these situations; as for instance the ulnar nerve behind the internal condyle of the humerus, the popliteal nerve, or the axillary plexus. Under circumstances, then, of irritation, propagated along the nerves, it does not appear very surprising that some indication of excitement having existed, should be afforded by increased vascularity in those situations only, where the vessels supplying the nerves are larger and more numerous. This view of the nature of these changes is corroborated by the observations of Dr. Seeds,† who noticed, in several animals destroyed by bloodletting, "that the spasms in the muscles during life, accorded in every instance with the dissection. Were the muscles of the eye convulsed, the third, fourth, and sixth pairs were unusually vascular: were there at any

* Edinburgh Medical and Surgical Journal, vol. xvi. p. 474.

† Vide Medical Gazette, vol. v. p. 429.

time spasms of the neck and sides, the upper spinal nerves were found after death to have a net of red vessels spread round their origins, and serum effused round them." Here, then, there could be no inflammation, and these appearances can only be considered as indicative of the irritation, which affected these parts of the nervous system during life. It appears that in some of the cases described by M. Le Pelletier, there was nothing more than this appearance of undue vascularity, which was mistaken for evidence of inflammation, for no other change is mentioned besides abnormal injection.

Mr. Morgan has made experiments* upon animals to show that there is an analogy between the effects of certain poisoned wounds, and those symptoms which indicate the existence of Tetanus. The poison known by the name of strychnine, occasions both in the human body and in many animals spasms hardly distinguishable from those observed in Tetanus; but if its influence is not sufficiently powerful to cause death in a short time, the effects do not last for any period as in this disease, but gradually subside. In comparing the symptoms resulting from the influence of this poison upon the system, with those of traumatic Tetanus, there is another essential and invariable ground of distinction. In the former case the effects consequent upon the noxious impression are almost instantaneously manifested; in the latter, an interval of time, varying in duration, always elapses previous to their development. Now, it is desirable to ascertain, if possible, whether during this interval the irritation is confined to the nerves immediately impressed, or whether after the injury being directly propagated along the nerves, it remains latent in that structure which is subsequently the seat of morbid action. It has been observed, in some instances, that the appearance of the spasms has been preceded by pain and uneasiness, extending from the seat of injury in the course of the nerves. This was noticed in cases 114 and 123. There are likewise several cases on record, in which we are justified in concluding that the disease has been averted by removing ligatures from nerves and other sources of irritation at the first indication of the disease. Now, however extraordinary it may appear, that a morbid impression made upon a nerve should not be at once conveyed to the centre of this system, but after being confined to the part for some time, should ultimately extend and give rise to one of the most formidable of all diseases, I cannot but think it would be exceedingly difficult to account for many of the circumstances connected with Tetanus without coming to this conclusion. In the existing state of our experience of hydrophobia, it is considered a general rule always to extirpate the bitten parts at any distance of time after the wound, but previous to the appearance of symptoms. I have not met with a single case on record in which that dreadful malady has occurred after the parts have been

* The poison used by Mr. Morgan in his experiments was the "chetik," a strong gum, prepared principally from the juice of a large twining shrub, a species of strychnos, by the natives of Java, for the purpose of poisoning their arrows.

freely excised ; and I have been assured by one of the most experienced surgeons in London, that he is acquainted with several instances in which excision has been performed with success, some considerable time after the bites, where the evidence of canine madness in the animals was unequivocal, since other people bitten by them had eventually died of hydrophobia. These circumstances then, together with the existence of the premonitory pain and uneasiness in the bitten parts, extending, as shown by Dr. Marcet* and others,† in the course of the nerves, as if the local irritation or poisonous impression had by some cause been suddenly excited to action, although deduced from another affection of the nervous system, appear to me to support the opinion that the primary irritation is confined for an indefinite period of time to the seat of the original wound. But it is scarcely necessary to remark, that we are by no means justified, as in hydrophobia, in resorting, in all instances, to excision, to prevent the occurrence of Tetanus, since in every description of wound the chances against such consequences resulting are indefinitely greater, and the means, if adopted to ward them off, would often, for aught we know to the contrary, be as prejudicial as the primary injury.

As, then, in traumatic Tetanus an irritation or morbid action extends by the nerves from the part injured to the seat of the disease, the wound must be regarded as its proximate or exciting cause ; but, when irritation is excited in the medulla, which is almost immediately made manifest by rigidity or slight spasms in the muscles, the disease is rendered independent of the proximate cause, and does not cease upon its removal. Here, then, an inquiry of the utmost importance presents itself :—When or how soon does the disease become *completely* independent of its exciting cause ? If this question could be determined with accuracy, we should at once be enabled to set at rest the uncertainty which even at present exists respecting the value or propriety of local treatment. Our present knowledge of the disease scarcely admits of our coming to any safe conclusion on this difficult point. Mr. Travers states, that a man who had suffered amputation of the leg, above the knee, was attacked with violent tetanic spasms. These increased, until it was deemed expedient to open the stump and examine the ligatures, when it was discovered that the anterior crural nerve had been included in one of them : it was removed, when the spasms gradually subsided, and the man did well. Larrey mentions some similar cases. Opposed to these, it must be observed, that there are cases in which amputation has been performed, and other means taken to remove and cut off all sources of irritation, at the first onset of the disease, without any beneficial result. Additional facts, bearing upon this subject, will be adduced when considering the local treatment of the disease.

The frequent presence of worms, and of irritating matter in the

* Medico-Chirurgical Transactions, vol. i. p. 156.

† Vide Cyclopædia of Practical Medicine, Article Hydrophobia.

intestines, and the appearances of inflammation sometimes observed, have induced some pathologists to refer the source of the disease, both in the traumatic and idiopathic forms, to irritation in the alimentary canal. In two of four cases, where the stomach and intestines were inflamed, Dr. M'Arthur discovered a peculiar offensive yellow matter pervading the intestinal canal*. In four patients, labouring under Tetanus, Mr. Abernethy found the evacuations unlike fæces; and he proposes as a question, in investigating the cause of this disease, "What is the state of the bowels between the inflictions of the injury and the occurrence of that dreadful malady†?" Mr. Swan's explanation of the origin of traumatic Tetanus is, in principle, identical with that of Mr. Abernethy. He imagines that the painful and bad state of the wound, by inducing disturbance in the nervous system, occasions disease of the digestive organs, which so re-acts on the nervous organs, that the disorders reciprocally aggravate each other; and he questions "Whether the disordered state of the digestive organs, established during the irritative state of the wound, may not be the occasion of Tetanus when that irritative state has ceased‡." This hypothesis, however, is open to two decisive objections:—1. The primary wound is not always in a painful and bad state, being, in some cases, remarkably trivial, and often healing from the first without an unfavourable symptom. 2. The digestive organs are not invariably deranged after the injury and previous to the access of Tetanus. But, without adopting the opinion that the production of this disease is always to be imputed to intestinal irritation, yet, considering how frequently the alimentary canal has been found deranged at the time of its appearance, the influence of disorders of the digestive organs in originating many, and in aggravating nearly every kind of disease, especially convulsive and spasmodic; and, also, that in some instances Tetanus appears to have been removed simply by acting upon the bowels; there can be no hesitation in admitting, that the origin of it is often intimately connected with, or influenced by, the state of the intestinal canal.

Mr. Swan considers that the ganglia of the grand sympathetic nerves are the important parts of the nervous system, to which the first irritation, arising in the intestinal canal, tends, and from which it proceeds to the rest of the nervous system. The following account of the examination of a boy, ten years of age, who died of acute idiopathic Tetanus, in the night of the day after he was attacked, is abridged from the essay of Mr Swan, and will afford a good illustration of his views of the origin of the disease in the idiopathic form.—The villous coat of the small intestines throughout had the marks of having been in a state of great irritation, many very vascular patches were observed on it, and it was loaded with a green, and yellow slime and mucus; several lumbrici were found in dif-

* Medico-Chirurgical Transactions, vol. vii.

† Surgical Observations, vol. i.

‡ Treatise on Diseases of the Nerves. Second Edition, p. 348.

ferent parts of the canal. The colon contained a few ascarides, but its mucous coat was healthy; the rectum contained fæces which had not an unhealthy character. All the absorbent glands were enlarged, but those in the abdomen were very vascular, and the mesentery throughout had the same appearance of undue action and irritation. In all of the ganglia of the grand sympathetic nerve, there existed decided marks of irritation. The vessels, usually pale and colourless, were injected with red blood; and the same was observed in some of the intermediate portions of nerve. The left semilunar ganglion exhibited a few vessels, but the right was injected in a beautifully minute manner, quite as much so when seen through a magnifying glass, as the conjunctiva in a state of high inflammation. The same distinction, though not in the same degree, was observed between the two sides in all the portions of the grand sympathetic nerves which were examined. It is deserving of notice in this case, that the spasms in the limbs, though considerable, were much milder on the left side than on the right. On opening the head, every part of the pia mater was found to be minutely injected with blood. Some fluid was in the ventricles and at the base. The pia mater, in the spinal canal, presented exactly the same appearance as that of the brain. The substance of the brain and medulla spinalis was perfectly healthy. Mr. Swan observes, "From the appearances on dissection in this case, it must be sufficiently evident that the proximate cause was in the worms and unhealthy fæces irritating the villous coat of the intestines. The irritation thus produced was undoubtedly conveyed by the nerves of the intestines to the ganglia of the grand sympathetic nerves, and from those essential parts of the nervous system to the cerebral and spinal nerves, and thence arose the tetanic spasms of many of the muscles to which these nerves are distributed: the irritation was communicated lastly to the membranes of the brain and medulla spinalis, as was evident from the congestion of the blood vessels and the effusion of serum."

This view of the origin of idiopathic Tetanus is in no degree discordant with the proposition, that the spasms are confined to the muscles of volition; since the primary irritation may be transmitted to the medulla from the sympathetic system by communicating branches, although the effects of that irritation are displayed in muscles supplied by a distinct class of nerves; in the same way that the irritation from a wound is probably propagated by sentient nerves, but the stimulus to contraction consequent upon it, is conveyed to the muscles by the nerves of motion. Mr. Stanley, in a paper in the *Medico-Chirurgical Transactions**, has traced the effects of irritation commencing in the kidneys and transmitted to the spinal cord, in impairing both sensation and the power of motion in the lower extremities. There is, however, no just ground for concluding, because an irritation may be conveyed to the spinal cord by nerves connected with the sympathetic, that those muscles which, in their

natural and ordinary action are entirely independent of the medulla, are ever excited to action by a stimulus derived from that structure when in a state of morbid irritation. If this reasoning be tenable, we can readily understand that, besides being caused by irritation in the alimentary canal, Tetanus may also be induced by irritation excited in other organs supplied with nerves from the sympathetic system, as in disorders of the kidneys or bladder; and the disease actually occurs under circumstances which greatly favour the presumption that it arises occasionally in this way*. Thus Tetanus has been observed in females within the first fortnight after delivery. The native practitioners in Ceylon, state that it is not an unfrequent occurrence after parturition, when it always proves fatal; and Dr. Christie witnessed a case of it in that island in a healthy young woman of the Portuguese caste, who, two days after delivery of her first child, was seized with rigidity of the jaws, and other symptoms of the disease, from which she ultimately died†. Mr. Dickinson, also, met with a case arising from the same cause at Grenada‡. Dr. Currie, in his Medical Reports, speaks of the case of "a poor woman, who, in consequence of a difficult labour, and, as she imagined, of local injury in some part of the uterus, was seized with the spasms, cynicus, and locked jaw§;" and another case is mentioned in the *Dictionnaire des Sciences Médicales* of a female, who, on the sixth day after parturition, being exposed to cold winds whilst seated on a privy on the bank of a river, was seized in a few hours afterwards with a suppression of the lochial discharge and symptoms of Tetanus, of which she was cured by repeated evacuations of blood. Although, in this last case, the disease might have been occasioned solely by the influence of cold, yet in all it was most probably the consequence of irritation transmitted from the uterus, and, since an irritation causing convulsions is often conveyed from this organ by nerves connected with the sympathetic system, I see no sufficient grounds for hesitating to admit that tetanic irritation may likewise be excited in this manner.

In what way cold operates in causing Tetanus is not clearly ascertained. The muscles are at all times very sensibly affected by cold, the influence of which in occasioning spasmodic contractions is exemplified in the instance of cramps occurring after immersion in cold water. Here the effect is immediate, but such is not the case in Tetanus, as some interval generally elapses after exposure to the influence of cold before the disease is produced. This interval, however, is much shorter than that which takes place after the infliction of a wound, and often does not exceed a few hours. Tetanus being more frequent in hot climates, the injurious effects of cold would appear to result, not so much from a low degree as from variation of temperature, especially in a humid state of the atmos-

* Vide cases from Meyer and Vetter, alluded to at p. 39.

† Edinb. Medical and Surgical Journal, vol. viii. p. 415.

‡ Lib. cit.

§ Vol. i. page 142.

phere. Cold is one of the most common predisposing and exciting causes of disease, operating chiefly, either by producing congestions of the internal organs or by suspending the functions of secreting surfaces. In Tetanus, an unfavourable impression is very probably made upon the cutaneous nerves, which, being conveyed to the medulla, becomes an exciting cause of the disease.

In case 102, recorded by M. Fournier Pescay, Tetanus was occasioned perhaps by the combined irritation of the injury and of the cold to which the part was instantly submitted.—A cavalier having had the last phalanx of the little finger of the left hand accidentally removed by the blow of a hatchet, immediately afterwards, in order to arrest the hæmorrhage and to ease the pain, plunged his finger into cold water drawn from a well for the purpose. In about two hours he was seized with Tetanus, for which he was bled and took five grains of opium, but the disease proved fatal in fourteen hours after the accident.

It is said that Tetanus has been caused by an impression made upon the auditory nerves. Thus, a case is related by Dr. Rush, in which it is described to have been produced in a servant by the grating noise occasioned by the cutting with a knife upon a pewter plate*.

There is a question connected with Tetanus and with numerous other diseases, especially those which are endemic or contagious, involved in considerable obscurity. When a number of persons are equally exposed to the same exciting causes of disease, how can we account for only a part of them being attacked? It is commonly explained by supposing that in some persons there is a peculiar susceptibility in the constitution to the development of particular diseases; and, in some instances, we know, from experience, that such is the case. The infrequency of Tetanus and its less fatality in females, justify the assumption that the male sex is more susceptible of it. But, in addition to a peculiar susceptibility to certain morbid impressions, inherent most probably in the nervous system, there are circumstances influencing the state of health and condition of the body, which also powerfully predispose the constitution to the excitement of diseased actions. Hence, as in many other affections, the causes of Tetanus are generally divided into the exciting or proximate, and the predisposing. The predisposing causes of traumatic Tetanus are stated to be—disorders of the digestive organs—the unfavourable influence of damp and cold—a heated and vitiated state of the atmosphere. The proximate cause is the wound, which, it has been shown, may give rise to the disease in three ways. 1. By inflammation in the medulla consequent upon direct injury to its structure, exciting tetanic irritation. 2. By inflammation extending continuously from the nerves at the seat of the injury to the medulla, and inducing this morbid action. 3. By an irritation, totally distinct from any inflammatory action, being transmitted from the wound to

the medulla. The latter is by far the most common. The proximate causes of the idiopathic disease are—impressions made upon the cutaneous nerves, by exposure to damp and cold—irritation of the nerves of the alimentary canal, by worms or acrid secretions—uterine irritation, &c. This arrangement is in some measure objectionable, for there is incongruity in distinguishing the predisposing causes of the traumatic disease, as the proximate causes of the idiopathic. We know that Tetanus may be excited in various ways, and whether the primary impression which determines its access be made on the nerves of the extremities by a wound, on the surface of the body by cold, or on the mucous membrane of the alimentary canal by worms, the disease is equally symptomatic, there being no other predisposing causes than such circumstances as tend to engender a diathesis favourable to the excitement of this peculiar irritation, or such as go to increase an inherent susceptibility to it. It would almost appear as if Tetanus often results from irritation derived from two or more sources being transmitted at the same time to one centre, and thus inducing excited action in the medulla, which any one of them alone would be inadequate to effect. However this may be, a combination of exciting causes would seem to be frequently necessary for its production, for a person may have a wound, and yet Tetanus will not occur, until he suffers a sudden chill or is the subject of intestinal derangement. In those instances of traumatic Tetanus in which the digestive organs were disordered before the occurrence of the wound, which seems to be generally the case in negroes, and in those cases in which the system has suffered from the effects of an impure atmosphere, an unhealthy climate, or great fatigue, circumstances which, no doubt, so act upon the nervous system as to render it less able to resist noxious impressions and more ready to take on diseased actions, these various circumstances may be rightly considered as predisposing causes of the disease. Without their previous influence the wound would have proved harmless. The objection applies to our terming, in cases of traumatic Tetanus, a sudden impression of cold or some accidental source of irritation, which is at once followed by the disease, a predisposing cause, when we have every reason to believe that it is as much concerned in exciting the disease as the original wound. For the same reason, those cases in which the disease is observed to be immediately excited by some disorder in the alimentary canal, exposure to cold, or any other obvious source of irritation, without the previous occurrence of a wound, cannot correctly be termed idiopathic.

Summary.

From what has been observed in the foregoing pages, I am induced to infer—

1. That Tetanus is a functional disease of the nervous system, that is to say, a disease unaccompanied with any perceptible lesion of structure, the nature of which, although essentially distinct from in-

flammation, is completely unknown. There are, therefore, no morbid changes peculiar to Tetanus, and by which it can be recognised.

2. That the seat of this peculiar morbid action, termed *tetanic irritation*, is the *tractus motorius* on either side, wholly or in part, the superior being the portion most generally affected.

3. That the result of tetanic irritation in the tractus motorius, or medulla, is a supply to the muscles of a stimulus to abnormal action, which, although limited to the muscles subservient to the will, is, nevertheless, totally without its control.

4. That tetanic irritation is excited in two ways; *first*, by a noxious impression propagated to the medulla from distant nerves, (most probably sentient) which impression may be caused by a wound, cold, or any other source of irritation; *secondly*, by inflammation in the brain, spinal cord, or their investing membranes, either idiopathic or occasioned by direct injury to these structures, or extending continuously from the nerves of a wounded part to the medulla. Traumatic Tetanus, commonly arises in the first way, its origin in direct injury to the cord, or in inflammation extending from an injured nerve, being exceedingly rare.

5. That, in pure traumatic Tetanus, the primary impression is confined for an indefinite time to the nerves of the part injured, being transmitted at some subsequent period to the medulla, and thus exciting the disease.

6. That when tetanic irritation is once fully excited in the medulla, which is made manifest by spasmodic contractions in the muscles, the disease is independent of the exciting cause, and does not cease upon its removal.

7. That the nervous system in some individuals is more disposed to take on this morbid action than in others, and that as a general rule, males are more susceptible of it than females and negroes than whites.

8. That certain morbid states, as disorders of the digestive organs, the influence of particular climates, and a deleterious atmosphere, render the system more susceptible of this disease.

9. That the derangement of the vital organs in Tetanus is the result of the inordinate action of the voluntary muscles induced by the disease, the disturbance and suspension of different functions, and even fatal exhaustion, being chiefly, if not solely, referrible to the violent muscular contractions. In fact, the tetanic irritation directly interferes with, or affects, no organ nor part whatever besides the system of the voluntary muscles.

10. That tetanic irritation often gives rise to a determination of blood to the cord and its meninges, and to the nerves proceeding from the site of the wound and to the affected muscles, the result of which, in the medulla, is an increase in the natural secretion of the arachnoid. The minute vascular injection of the cord and the nerves, together with the serous effusion at the base of the brain and between the spinal membranes, being nothing more than occasional effects of the disease, are by no means constantly present after death.

CHAPTER III.

TREATMENT OF TETANUS.

IT is a very general remark, that a more striking indication cannot be afforded of our ignorance of the nature of a disease, than great diversity of opinion as to the mode of treating it, and it is most true, that of all the "ills that flesh is heir to," none have been assailed with such a multiplicity of remedies, or have been treated so empirically as Tetanus. There is, however, such irregularity and uncertainty in its exciting cause, course, and phenomena, that it is utterly impossible to determine on any one specific plan of treatment, applicable to all cases and in every stage of the disease.

In order to ascertain what remedies experience has proved to be most efficacious, it was necessary to bring together as much as possible the large body of facts on record; but, in sifting the evidence which they afford, such inextricable confusion and embarrassment are occasioned by the use, in the same case, and incessant change of numerous remedies differing very widely from each other in their effects upon the system, that in many instances of a successful result, it is altogether impracticable to decide to which of them the relief should be ascribed, or to say whether the natural powers of the patient had bade defiance both to the disease and to the influence of the means employed to subdue it. There is no doubt, if the respiratory muscles are unaffected, that the constitution is sometimes able to withstand an attack even of acute Tetanus without the interference of medical treatment. Dr. Morrison notices a well authenticated instance of a negro, who recovered from the disease without having recourse to any remedies. Mr. Morgan mentions a case that occurred at Guy's Hospital, in which although the patient was left entirely to nature the disease ran its course, and eventually the man recovered; and Sir Astley Cooper states, in his lectures, that he has seen similar cases.*

But, although an accurate and fair estimate of the utility of different remedies cannot be obtained from the table, still many useful comparisons may be instituted, and important inferences deduced. Conclusions of a favourable nature in respect to the merit of any mode of treatment, must however be admitted with caution, since it is possible, and even probable, that a similar plan may have been adopted in cases, which proving unsuccessful, have never met the public eye.

* Lectures by F. Tyrrel, vol. iii. Hennen, also, alludes to a case of spontaneous cure detailed by a French writer, Briot.

The utmost encouragement to persevere in the search of some efficient plan of treating the disease, is afforded by the fact, that no lesion of any structure or organ of an irremediable nature, can be perceived after death, and likewise by the circumstance, that the affection of vital organs is only a secondary effect of the tetanic irritation. And without being so sanguine as to anticipate that every case may, hereafter, admit of being cured, yet I would by no means despair of our obtaining the power in all cases of controlling the violence, and in most instances of arresting the progress of this highly distressing and formidable malady.

There are no premonitory symptoms sufficiently well marked and constant in their appearance, to allow of any decided measures being taken to avert an attack of Tetanus. It is stated, however, that twitchings in the muscles of the injured limb—a degree of lassitude, restlessness, great depression of spirits, and an uneasy sensation about the præcordia, are often observed previous to its development. But the most common precursors of both forms of Tetanus are cold chills, and an uneasiness about the throat, leading the patient to imagine that he has caught cold. These latter symptoms are frequent enough to render it important for the surgeon to bear them in mind when attending the subjects of injuries, especially the wounded after a battle. In severe injuries of the extremities, as compound fractures, spasmodic twitchings of the muscles very often occur, without being followed by Tetanus; but in wounds of a less serious nature, slight incisions and punctures for instance, they must be considered as forewarning an attack, and we should act accordingly.

SECTION I.—LOCAL TREATMENT.

Tetanus being a disease consequent upon local injury, it was very natural in the first instance, bearing in mind the axiom, "*sublatâ causâ tollitur effectus*," to endeavour to arrest the symptoms of it by removal of the supposed source of irritation, or to employ means to alter the action of the part which appeared to be primarily deranged. With such views the injured structures were excised, wounded limbs amputated, and stimulating applications resorted to. It will be well to dismiss at once from the inquiry, the propriety of using the actual cautery, and other stimulating local means, to restore the suppurative process or a healthy action; since such barbarous treatment is not sanctioned by experience of its utility, is unsupported by any rational views of the pathology of the disease, and at the present day is most deservedly discarded from practice.

To prevent the propagation from the wound of the irritation supposed to be the cause of the disease, two plans have been adopted: 1. Amputation or excision of the wounded part; 2. Division of the nerves proceeding to the seat of injury.

1. *Amputation.*

Baron Larrey, who is a strong advocate for local treatment, mentions that amputation succeeded in the case of an officer wounded at the battle of Sedment; the symptoms having been severe, and considerably advanced; and that it produced complete cessation of the symptoms in another case of an acute character: but the patient, after exposure to the night air, had a relapse which proved fatal*.

In America much importance is attached to topical treatment, and the following case, in which amputation was performed, is related by Dr. Valentin. A young Virginian had his hand much torn, and the flexor and extensor tendons laid bare, by a gun bursting in his hand. On the first indication of constriction of the throat and jaws, Dr. Valentin, fearing the consequences, obtained permission to amputate the hand. A few grains of calomel and opium were afterwards given, and the patient was ultimately cured†. It has been stated that Tetanus, when completely established, is independent of its exciting cause, and in this last case amputation was performed before the symptoms were fully displayed, at which time only there is any rational ground for expecting a favourable result from it. It was performed in eleven of the cases in the table, seven of which were cured. In case 14, it was employed in conjunction with tobacco soon after the symptoms were fully established. In case 23, related by Mr. White, of Manchester, the symptoms were somewhat advanced, severe but chronic, and opium was freely employed. In case 55, the original wound was of itself sufficiently severe to demand amputation; the operation was performed on the day after the appearance of symptoms, and it is stated that "the tetanic symptoms were evidently kept under and finally removed, chiefly by the use of opium." In case 61, the symptoms were exceedingly severe. The particulars of it are recorded by Mr. Wayte, a surgeon at Calne. The patient was a boy, eight years of age, and on the day after the appearance of Tetanus, which was consequent upon a severe burn on the arm from lime, the limb was amputated. The symptoms subsided gradually, but uninterruptedly, and, in little more than a month, he was perfectly recovered. No other remedies were employed, except one anodyne draught before the appearance of Tetanus, and occasionally a mild purge. In case 77, treated by Mr. Howship, the primary wound was a severe injury to the elbow joint, the symptoms having been mild, and of slow access, and not well marked, and amputation was not resorted to till the third day after they appeared. Case 99 is the instance alluded to by Larrey. In case 119, the patient was a female, and the operation was not resorted to till the thirteenth day after the attack, when the symptoms were subsiding under the influence

* Lib. cit. vol. i. p. 265.

† Coup d'œil sur les différentes modes de traiter le Tétanos en Amérique. Par L. Valentin.

of opium. Dr. Huck, physician to the army in the year 1758, in a case of Tetanus occurring after a fracture of the metacarpal bone that sustains the forefinger, by a musket ball, on the day following the appearance of trismus, amputated the finger, and removed the sharp points of the remainder of the metacarpal bone. Opium was afterwards given, and the patient recovered*.

Although in several of these cases, in consequence of the employment of other remedies, it is almost impossible to ascertain, with certainty, how far amputation was of service, yet it must be admitted that some of them, particularly the case recorded by Mr. Wayte, tend to confirm the propriety of the practice recommended by Larrey. The evidence, however, of the English army surgeons of late years is by no means favourable. Sir James M'Gregor mentions, that after the battle of Toulouse amputation was extensively resorted to without affording relief; and Dr. Hennen and Mr. Guthrie were equally unsuccessful with the same method of treatment. Dupuytren strongly objects to the performance of amputation; and Sir Astley Cooper alludes to the trial of it in three instances, which were all fatal†. Mr. Grimstone mentions two cases where amputation was performed on the first appearance of symptoms, but they terminated fatally‡. Sir Benjamin Brodie unintentionally made the experiment of amputation on a boy who was admitted into St. George's Hospital with compound fracture of the leg, which was followed by gangrene of the limb. The operation was performed while the gangrene was spreading; but subsequently it was ascertained, that the patient had complained of the premonitory symptoms of Tetanus the morning before the operation. The disease was rapidly developed after the limb was removed, and the boy died in less than twenty-four hours||. Here, then, although amputation was performed very early, no benefit resulted. Many nerves are necessarily divided in this operation; and cases have been adduced from the table, in which Tetanus was the sequel of its performance. It is altogether so severe and serious a mode of treating the disease, that we can scarcely ever be warranted in resorting to it when the original wound is slight, especially as, if employed under the most favourable circumstances, a successful issue can never be depended on. In chronic Tetanus, as patients usually recover, it is certainly inadmissible, even when the wound is severe and in an unfavourable state, unless its condition be sufficiently bad to demand the operation independently of the spasms. Amputation can only be regarded as a justifiable proceeding after a severe injury of the extremities, as a compound fracture, or an extensive laceration, immediately that there is the slightest indication of spasm; for if delayed until the disease is more advanced, instead of proving beneficial, it will tend rather

* Medical Observations and Inquiries, vol. iii.

† Cooper's and Travers's Surgical Essays, part ii. p. 176.

‡ Edinb. Medical and Surgical Journal, vol. xi. p. 419.

|| Medical Gazette, vol. ii. p. 346.

to aggravate the symptoms, and to render the constitution less able to sustain the debilitating effects of the spasms.

2. *Division of the nerves.*

The merit of first performing this operation, for the purpose of arresting the transmission of the irritation from the wound, is due, I believe, to Mr. G. Hicks, surgeon of Baldock. In some remarks upon a case of hydrophobia,* he proposes to treat this formidable disease by dividing the nerves supposed to be acted on by the virus of the mad dog; and he instances the following case of Tetanus in which this mode of treatment was tried in the year 1797.

Case.—A cooper was attacked with trismus, which appeared to have come on gradually in the course of a few hours after a contusion on the palm of the hand. Mr. Hicks saw him about three weeks after the injury, at which time the jaws had been completely locked for four days. Observing at the seat of the injury a tumour in a state of suppuration, he made an incision through it, cutting down between the metacarpal bones “with a view of relieving the nervous system by a division of the nerves affected.” Opium was afterwards given in large doses, and the next day the patient could open his mouth, and swallow fluids with ease, the rigidity of the muscles of the face and throat being, in a great measure, removed.

This operation was likewise recommended, although never practised, by Dr. M. Ward, in a Treatise upon Opiate Frictions in Spasmodic Diseases†. It was adopted with success by Baron Larrey in the following instances.—A French general was wounded by a bullet, which passed through the internal and posterior part of his arm, cutting across the radial and internal cutaneous nerves, and a portion of the biceps muscle. On the eighth day afterwards he was seen by the Baron. Suppuration was established, but the wound was uneasy, the appetite diminished, sleep interrupted, and, towards evening, the patient became feverish. On the following day the local pain was more severe, there were convulsive movements in the hand and fore-arm, heat of skin, and closure of the jaws. An incision was made to the bottom of the wound, dividing some nervous and aponeurotic productions, and a bridle formed by a small portion of the integuments and some muscular fibres. The operation was painful, but in two hours afterwards the wound was much easier. All unfavourable symptoms disappeared in two days by the use of anodyne emulsions and emollient applications, and eventually the wound healed, leaving the hand and fore-arm paralysed‡.—In the case of a man who was wounded by the point of a lance in the right side of the forehead, which had injured the frontal bone and lacerated one of the superciliary nerves, after nine days symptoms of Tetanus

* London Medical and Physical Journal, vol. xvii. p. 277.

† Published at Manchester in 1809.

‡ Lib. cit. vol. i. p. 269.

appeared. There was severe pain in the part, convulsive movements of the eyelids, trismus, incipient emprosthotonos, and loss of vision on that side. Emollient applications, and diaphoretic and opiate draughts were resorted to without benefit, and as the case was becoming more severe, Larrey introduced a probe into the wound, which caused very acute pain. He then, with a bistoury, made a deep incision, dividing the nerves and vessels. All tetanic symptoms disappeared in less than twenty-four hours*.

In case 19, recorded by Dr. Murray, in less than 12 hours after the foot had been injured by a rusty nail, slight spasms occurred in the muscles of the neck, and the jaws became nearly closed. The posterior tibial nerve was divided, and immediately he was able to open his mouth. Small doses of camphor and opium were given, and in three days all tetanic symptoms were completely removed. The wound healed, and sensation was afterwards restored in the foot, except in the little toe and heel, but no inconvenience was thereby experienced in walking.

These four successful cases are the only instances, that I am aware of, where this method of treatment has been employed†. In the first case, however beneficial the operation might have proved in relieving the parts, it is very questionable whether the good effects which followed were in any degree owing to the division of nerves. In the other three, the nerves were divided as soon as there was the slightest indication of tetanic symptoms; and it is fair to presume, that an attack of the disease was warded off by the operation. As was remarked of amputation, unless the operation be performed very early, there can be little hope of a favourable result. When it is feasible to divide all the nerves proceeding to a slight wound, this plan is infinitely preferable to amputation, since all the advantages of the latter may be obtained by an operation far less painful, severe, and serious in its consequences. Paralysis may be the immediate, but is not likely to be a permanent result. This operation, therefore, may be regarded as well worthy of further trial.

* Ibid. vol. iii. p. 307. In this case it appears that about a fortnight afterwards cerebral symptoms ensued, and the patient became delirious, and died in two days. On examination, a lamina of the inner table of the skull was found detached, and sanguineous pus was discovered upon the anterior lobe of the brain, the structure of which was in a state of suppuration.

† In case 20, which proved fatal, the injury being a fracture of the tibia and fibula, with extensive laceration of the integuments, the saphena nerve only was divided; the operation, therefore, cannot be regarded as having had a fair trial. In a case which occurred at the North London Hospital, Mr. Liston‡ made an incision on each side of the wound, a laceration of the skin over the tibia, in the form of the letter V inverted, with a view of cutting off, as much as possible, the nervous communication of the part; but as the disease was decidedly chronic, and as this operation was not performed till a fortnight after the appearance of symptoms, and no immediate good effects resulted, we can scarcely attribute the favourable result of the case to the effects of the operation. Where the injury is superficial, this mode of cutting off the nervous communication is, perhaps, the best that can be adopted.

‡ Clinical Lecture on Tetanus.—Lancet, 1835, p. 585.

Dr. W. Pennock, in some observations* on the efficacy of cupping-glasses in preventing and arresting the effects of poisoned wounds, proposes the employment of pressure by weights or ligatures, or the application of exhausted cups over the wound or in its immediate vicinity, in order to paralyse the wounded nerves, and thus suspend the general spasmodic action which is produced by the local irritation. And he recommends, if the constitutional symptoms should be arrested, as a security against their return, before the cup over the wound is removed, an incision so extensive as effectually to remove the wounded portion of the nerves. The suggestion is ingenious, and if in a case in which the wound is cutaneous, there is any hesitation in dividing the nerves, this proceeding might be tried. But as the beneficial effects of local treatment are not in general produced instantaneously, and as in the management of this disease, more perhaps than in that of any other, success essentially depends upon the energy and decision with which we employ the necessary means, I can be no advocate for any such system of dalliance.

SECTION II.—CONSTITUTIONAL TREATMENT.

As topical treatment must always be of doubtful efficacy, is adapted only for particular cases of one form of the disease, and in them is restricted to the early stage of its progress, our chief reliance must be on those remedies which influence the system generally.

Purgatives.

Since the publication of the works of Mr. Abernethy, and of Dr. Hamilton, of Edinburgh, great reliance has been placed by many practitioners upon the action of purgatives in the treatment of Tetanus; and, as sources of irritation in the intestinal canal, and obstinate constipation so frequently exist, too much importance cannot be attached to their employment. A brisk cathartic, by causing the expulsion of worms of unhealthy fæces, has produced almost immediate relief in the idiopathic form. Perhaps one of the most important consequences of the free operation of purgatives arises from their favouring the action of those remedies which more immediately influence spasmodic contractions of the muscles; indeed, until the bowels have been fully relieved, it is almost useless to resort to other medicines. Those purgatives should be selected which, being readily soluble, act quickly and powerfully on the intestinal canal, as castor oil, oil of turpentine, and croton oil, especially the latter, since, in addition to its active and rapid operation, in cases of difficult deglutition, a few drops upon the tongue will generally be sufficient to obtain the required effects. It is, indeed, seldom necessary to employ the croton oil in very large doses. In

* American Journal of the Medical Sciences, No. 3.

case 48, which was extremely severe, Mr. Lawrence found that a single drop procured copious evacuations. If, after a small quantity has been exhibited, the bowels are not acted upon in a few hours, it must be repeated in increased doses, until copious evacuations are produced. Should constipation prove very obstinate, the spasms being at the same time violent and general, it would be right to ascertain whether any impediment to the evacuation of fæces is occasioned by spasm of the sphincter or levator ani muscles, and if they are found firmly contracted, an enema, of an infusion of the tobacco leaf, or containing laudanum, will, most probably, be found successful. In cases where no intestinal derangement or irregularity appears to exist, not only should a full dose of castor oil be given, but the action of the bowels must be steadily maintained throughout the disease.

Scammony, colocynth, gamboge, and jalap, are very inferior to the purgatives that have been mentioned, since, in addition to their irritating properties, they are less rapid in their operation, and there is reason to believe that they sometimes remain in, or pass through, the alimentary canal unacted upon, and therefore inert. In case 27, two drachms of calomel, sixteen drachms of jalap, and fifteen grains of scammony, were taken, but the bowels were not relieved for three days; and afterwards, forty grains of calomel, fifty-one grains of the extract of colocynth, and thirty-eight of gamboge, were taken daily during nine days, in order to keep up their action.

Having removed any source of irritation existing in the intestinal canal, the next important indication is to allay the excitement in the nervous system giving rise to undue muscular action. For this purpose, depletion, and all kinds of sedatives and antispasmodics have been freely resorted to. Camphor, musk, digitalis, stramonium, conium, hyoscyamus, belladonna*, and lead, have proved utterly inadequate. Those remedies, therefore, which have obtained any degree of credit in affording relief are treated of separately, and the principle upon which their beneficial influence depends, attempted to be explained.

Mercury

was first recommended in this country as a remedy in Tetanus, by Dr. Donald Monro, on the authority of a physician who had employed it extensively in the West Indies with great success in the idiopathic form of the disease†. It has since been frequently tried, and administered to the extent of producing ptyalism, both in idiopathic and in traumatic Tetanus.

* In a case related by Mr. Travers, a scruple of the extract of belladonna, taken in twenty-four hours, did not affect the pupils.

† Edinb. Physical and Literary Essays, vol. iii.

Although mercury has gained some repute as a remedy in this disease, the evidence of later practitioners, in regard to its influence in controlling the progress of the symptoms, is far from favourable. Baron Larrey found that mercurial friction rather aggravated the symptoms in the cases in which it was tried in Egypt. Sir James M'Gregor, in numerous trials of mercury as a remedy, found it quite inert; and he notices the case of a man who was seized with Tetanus whilst strongly under mercurial influence for the cure of a cutaneous eruption. Dr. Mosely mentions that many people have been attacked in the West Indies under a course of mercury, and expresses the opinion that "it has killed more than it has cured"*. In cases 57 and 62, the patients were likewise completely under mercurial influence when the symptoms of Tetanus first appeared. Dr. Wells has related, in the transactions of a society for the improvement of Medical and Chirurgical Knowledge, three instances of the occurrence of Tetanus, during salivation from the use of mercury†. Sir Anthony Carlisle has informed me of two instances in which the disease was developed in the course of a salivation for another complaint. Dr. Thomson, of Jamaica, witnessed several cases which proved fatal where the full effect of mercury had been produced; he observes, that "he has seen patients expire with a stream of saliva flowing from their mouths"‡. Mr. Maxwell has also recorded a case of Tetanus in a negro, which proved fatal after the production of ptyalism. Mr. Swan, from observing in the examination of animals poisoned by mercury, and of individuals who have died whilst under its influence, decided marks of inflammation of the ganglia of the sympathetic system, similar to the appearances presented by the ganglia after death from Tetanus, is induced to consider the use of mercury as hazardous in this disease§. I have witnessed two traumatic cases in which severe ptyalism was produced without being followed by the slightest mitigation of symptoms. In both of them extreme suffering was occasioned by the increased secretion of saliva. The mouth being closed by the spasmodic action of the orbicularis oris, to prevent the distressing constriction in the throat, and the suffocating paroxysms consequent upon attempting to swallow the saliva, the patients were compelled to keep their lips constantly apart with their fingers. Of fifty-three cases in the table, where mercury was employed, thirty-one proved fatal. Of the twenty-two cases which recovered, in case 57 it is mentioned, that although salivation was produced, the symptoms continued to increase until the quantity of opium was augmented. In case 80 mercury was not resorted to until the disease had been established seventeen days; and in another, case 90, the patient was improving before ptyalism was produced. In twenty of these cases of recovery opium was combined with this remedy; and of the two treated

* Treatise on Tropical Diseases, p. 478.

† Vol. iii. p. 241.

‡ Edinburgh Medical and Surgical Journal, vol. xviii. p. 39.

§ An Essay on Tetanus, p. 95.

without it, in one tobacco injections were employed. Six of the cases also were females. In eleven of the cases, in which neither opium nor tobacco was resorted to, the mercury being given alone, or employed in conjunction with some trivial remedy, as the warm bath or blisters, *all were fatal* except one. Twelve cases of Tetanus, consequent upon severe injuries, are related by Mr. Howship in the London Medical and Physical Journal, in all of which mercury was freely exhibited. Two only recovered, and in both of them it was given in conjunction with opium.

As a remedy no medicine ranks higher, or admits of more extensive application than mercury, but much mischief has arisen from its indiscriminate and empirical use. Such has been the consequence of its employment for the cure of Tetanus, for no one has attempted to show in what way it can act in removing the disease. To its influence in arresting the progress of inflammation may be attributed its efficacy in Tetanus, when attended with inflammatory or febrile disturbance. And in those cases in which tetanic spasms are consequent upon inflammation in the spinal cord or its membranes, I believe that great benefit may result from its free exhibition. This practice was adopted with success in the following case.

CASE III.

A labourer, about thirty years of age, received a severe contusion of the ring and little fingers of the right hand, from the blow of a crane. He was going on favourably, when about a fortnight after the accident, on returning home from work, he complained of acute pain in the back, and suddenly lost the use of his lower extremities. He was attended by a surgeon who bled him largely twice, and gave some aperient medicine, from the effects of which he partly regained the use of his limbs. About a week after the commencement of this attack, he was admitted into the London Hospital. I then observed that his mouth was almost closed; there was a tetanic expression in the countenance, the orbiculares palpebrarum were in constant spasmodic contraction, and the muscles of the neck, of the abdomen, and of the back, were very rigid. He was feverish, had a hot skin, a dry tongue, and a pulse about 140, full and strong. The wounds on the fingers had an unhealthy appearance. Whilst on the edge of a bed in the ward, he was seized suddenly with a severe spasm of the muscles of the lower extremities, by which they were powerfully extended. It lasted a few minutes, and then gradually subsided. He was ordered

Cal. gr. ij. c. opii grss. quâque tertiâ horâ sumend. :
Emplastrum lyttæ nuchæ applicandum.

After two days his mouth became affected. The muscles were less rigid, and the pulse softer and not so frequent. The calomel was then omitted, and a draught, composed of camphor mixture and laudanum, was directed to be taken every fourth hour, and the blis-

tered surface to be dressed with an ointment containing the acetate of morphia, six grains to an ounce. Under this treatment the rigidity of the muscles gradually subsided, the wounds of his fingers improved, and at the end of three weeks he was discharged, slight stiffness still remaining in the muscles of the abdomen and of the jaw.

The symptoms in this case may be viewed as resulting from a slight inflammatory affection of the medulla spinalis, occupying chiefly the anterior columns; for it is worthy of notice, that with the exception of a slight numbness of the fingers of the left hand during the progress of recovery, when the muscles were paralysed, sensation was in no degree impaired. The effect of mercury given to the extent of producing salivation after blood-letting, and the exhibition of purgatives, was certainly in this instance highly beneficial. I am, however, unacquainted with any examples of acute traumatic tetanus, unattended with fever and inflammation, in which recovery could be fairly attributed to the peculiar influence of mercury. And as the symptoms may make considerable progress before the system is brought under its influence—as it can possess no specific power over the disease—and as debility is increased, and the sufferings of the patient are seriously aggravated by the production of ptyalism, in the pure traumatic form of Tetanus, the free use of mercury must be regarded as not only useless but exceedingly injurious.

Blood-letting.

By cautiously analysing the pathological characters of Tetanus, it has been attempted to establish a proposition of the highest import in regard to treatment, “that it is not essentially an inflammatory disease,” most cases of the traumatic form being unaccompanied with febrile disturbance, or with any symptoms indicating the necessity for active depletion. Antiphlogistic treatment, therefore, is generally unnecessary for its removal; but in those cases where inflammation is the cause of tetanic irritation, which though rare in the traumatic form, is a frequent occurrence in the idiopathic, abstraction of blood may be highly beneficial. Thus, a case is related in the *Edinburgh Medical and Surgical Journal**, of idiopathic Tetanus cured by large and repeated bleedings. The blood was cupped and bled, the pulse 100, full and hard, the tongue foul and dry, the urine high-coloured and scanty. The subject of it had been exposed to the sun in a warm climate, without food or covering. In such cases the propriety of blood-letting is unquestionable, but the fever and inflammation having subsided, sedatives may afterwards be necessary; for although the cause originally inducing the disease has been removed, the spasms sometimes remain, and require further treatment to subdue them, as in case III. detailed at page 75.

With the view of removing congestion of the vessels of the me-

* Vol. xxiv.

dulla spinalis, Mr. Swan and other practitioners recommend the abstraction of blood in the course of the spine. Now, numerous experiments and observations have shown that this state, not of congestion, but of vascular excitement terminating in serous effusion, which, it is contended, is the effect, and not the cause of tetanic irritation, is also a very frequent result of excessive loss of blood: hence, unless other circumstances indicated the propriety of local depletion, such a practice should be adopted with the utmost caution, since in some cases it might aggravate, and in none is it likely to remove the disease.

In estimating the utility of blood-letting, it is so important to maintain a distinction between cases attended with febrile and inflammatory symptoms and those purely tetanic, that little value can be attached to general statements of its efficacy without some account of the symptoms in the cases in which it was employed. Mr. Guthrie tried venesection in three cases of traumatic Tetanus. In one, in which the disease had advanced with rapidity, the patient was bled nearly *ad deliquium* several times with good effect, calomel and diaphoretics being given at the same time: he recovered. In the second case, the patient was bled in the same manner, with an evident amendment of the symptoms, when he was seized with diarrhœa, which, in his debilitated state, carried him off. In a third case of a man of sanguine temperament, and suffering from acute Tetanus, venesection, pushed to the utmost, totally failed*. Of twenty-six of the cases, in which blood was abstracted and other remedies also resorted to, thirteen died. Two other cases in this table, unattended with inflammatory symptoms, were treated by bleedings alone; both terminated fatally. In case 28, the pulse was full and strong, beating about 140 in a minute, Mr. Earle bled the patient repeatedly, and, after every venesection, there was decided remission of the spasms. The blood was remarkably buffed and cupped; he seemed to be in a fair way for recovery, when the disease was, upon two occasions, aggravated by the friends giving him, most injudiciously, wine and porter. He died afterwards, apparently from exhaustion.

Loss of blood appears to favour the operation of medicines in this disease, as in other affections. Thus, in case 87, the patient being of a full plethoric habit, bleeding seemed to assist the action of opium.

If the abstraction of blood be determined on, it may perhaps be well to recollect that Dr. Seeds found, in experimenting upon animals, that spasms occurred more frequently after the loss of venous than of arterial blood. If this be equally the case in the human subject, arteriotomy would be preferable to venesection; and, as blood-letting is unquestionably sedative, I apprehend more decided benefit would result in acute inflammatory Tetanus from a single large depletion by which a powerful impression is made upon the nervous system, than from small bleedings frequently repeated.

* Medico-Chirurgical Transactions, vol. vi. page 455.

Mr. Youatt appears to be a warm advocate for the employment of blood-letting in the treatment of Tetanus in the horse. And those who might be inclined to adopt this practice, which, in the human subject, I hold to be dangerous in the highest degree, should also, I think, follow his advice in carrying bleeding to an extent sufficient to obtain its full sedative effects. In traumatic Tetanus occurring to a highly plethoric individual, with a hard and full pulse, but without any symptoms of febrile disturbance, bleeding may sometimes perhaps be resorted to with advantage in the first instance, although I should always be backward in employing it. But, at a more advanced stage of the disease, and in a debilitated state of the system, even moderate bleeding is altogether inadmissible. Although violent muscular action is maintained in an extraordinary manner for a considerable time, yet great exhaustion is ultimately produced; it is therefore always an important object in the treatment of Tetanus to sustain the powers, so that the constitution may be enabled to withstand both the debilitating effects of the disease and the depressing influence of those remedies best adapted to subdue the spasms. Recovery also from Tetanus is generally very slow, and, even when the symptoms are gradually subsiding, or the disease is chronic, if the patient has been much reduced by evacuations of blood, or is not properly supported, he will be liable eventually to sink from debility.

Counter irritation.*

Counter irritation, either over the affected muscles or in the course of the spine, is of no service, unless the disease be inflammatory, in which case benefit may perhaps result from the application of it along the back, as in the case related at page 34. Dr. Chalmers states that blisters have a most pernicious effect; and the only advantage to be gained from them in pure traumatic Tetanus, arises from their rendering the cutaneous surface favourable for the absorption of appropriate remedies.

Opium.

Of the numerous remedies that have been called in aid for the treatment of Tetanus, none have been more frequently or more extensively employed than opium. And there is no question, that in many instances it has succeeded in allaying the spasms; but as it is resorted to in by far the greater number of tetanic cases which occur, too much importance must not be attached to its occasional success. Opium, in various forms, and in conjunction with other remedies, was employed in eighty-four of the cases in the table, being more than two-thirds of the whole number. Of these, forty-

* Counter irritation cannot, perhaps, be strictly regarded as a constitutional remedy, but since the section comprehending local treatment, has reference only to the exciting cause of traumatic Tetanus, it was found more convenient to consider it under this head.

five recovered, of which ten were females. The result of the ample trial which it has had, both in small and large doses, frequently repeated, has tended, notwithstanding, to diminish the confidence of practitioners in its efficacy. Sir James M'Gregor, in the interesting paper on the diseases of the British army during the campaigns in Spain and Portugal, already frequently alluded to, observes—"From the extensive trials which were made with us with opium and mercury, I consider them as perfectly inert in this disease, when acute, or fully formed; they should only be used as adjuvantia, and we must look to other means." Mr. Travers remarks, that opium is both inefficient and objectionable.

In Tetanus, as well as in hydrophobia and delirium tremens, there appears to be a conventional license for the unlimited exhibition of opium. A drachm, and two drachms of laudanum, or a scruple of the solid opium every three or four hours, are ordinary doses. In a case related by Mr. Leath, in the *London Medical and Physical Journal**, ninety-nine ounces, seven drachms of laudanum, were taken in little more than a month, the quantity exhibited in the course of the twenty-four hours for eleven days, having been three ounces, six drachms. Begin, in his *Traité de Therapeutique*, relates that M. Blaise, in a case of Tetanus, administered in ten days four pounds, seven ounces, and six drachms of laudanum, and six ounces, four drachms, and forty-five of solid opium†. It cannot but excite surprise that such enormous doses of this drug, both in substance and in solution, should have been taken internally in these cases, without in the slightest degree controlling the symptoms of the disease, or producing upon the system any of its ordinary effects. There is, however, reason to believe that these large doses have not always been received into the system. Mr. Abernethy, on opening the stomach of a patient who had died of Tetanus, after taking largely of opium, found thirty drachms of this substance undissolved in the stomach. In two fatal cases of delirium tremens, I found in the stomach of each patient after death several drachms of laudanum and opiate pills, obviously unchanged or unacted upon.

We are unable to explain precisely in what manner opium produces its characteristic effects; but whether admitted into the system by application to the surface of the body, or taken internally, it is well known that its influence diminishes the secretions poured into the intestinal canal, causing costiveness, and the fæces to be expelled of a clay colour, in consequence of suspension of the biliary secretion. Now it is highly probable that it also causes a diminished secretion of the gastric juice; hence those changes which are necessary to render the opium fit for absorption do not take place, and this substance, like the ingesta, when the stomach is weakened by disease, remains unaltered in the alimentary canal. Opium evidently diminishes the sensibility of the stomach and bowels, to which property

* Vol. xxix. p. 100.

† Pereira's *Lectures on Materia Medica*, Medical Gazette, vol. xvii. p. 70.

must be ascribed its utility when combined with antimonials and mercurials. But if exhibited in large doses, it appears to suspend the irritability of the parts with which it comes in contact. Dr. Wilson Philip produced instant paralysis of the intestines of a dog, by applying an infusion of opium to their mucous coat*, and caused immediate cessation of the contractions of the frog's heart by the application of opium to its inner surfacet. It is well known that in man, after a large dose of a powerful narcotic, the stomach cannot be made to reject its contents by the most active emetic. Now, when its sensibility is thus impaired, the stimulus to excite secretion is wanting†; hence this function is not performed, and the opium therefore unacted upon by the gastric juice, the muscular fibres of the stomach being very probably at the same time paralysed, remains in this organ inert and useless.

This attempt to explain how it happens that large quantities of opium, both in substance and in solution, frequently remain inactive in the stomach and bowels, appears in no way incompatible with the existing state of our knowledge of the operation of medicinal agents. But if it be regarded as insufficient, we must not hastily conclude, that in these affections the nervous system generally is less susceptible to the sedative influence of opium. I do not, however, mean to assume that there is no insusceptibility to the influence of opium in that part of the nervous mass which is the more immediate seat of irritation; but only that the healthy irritability of the other parts of this system, as, for instance, the sentient nerves, is also affected in the same degree. My object being to show that the circumstance of opium frequently not producing its ordinary effects, may be partly explained by the operation of causes distinct from the disease, and to urge the utter futility of a blind perseverance in the administration of it in immense and dangerous doses. Thus, although in Tetanus the cerebral functions are undisturbed, yet opium not only fails in allaying the spasms, but is generally equally powerless as a narcotic; whereas, in those cases in which it succeeds in controlling the muscular contractions, its narcotic effects are invariably produced at the same time. That there is any diminution in the susceptibility of the nervous system generally to its influence, is rendered improbable by the fact, that other sedatives, of greater power, as tobacco, for instance, often produce their effects in Tetanus as readily as in health. Opium would appear to be administered sometimes in such large doses in the first instance, as at once to destroy the sensibility of the stomach. More commonly, however, the doses are comparatively small at the commencement, and are afterwards increased when the assimilating powers of this organ must have been weakened by its previous influence.

* Dr. Addison and Mr. Morgan found the same effect to result from the application of tucinas.

† Experiments on opium. Appendix to a Treatise on Febrile Diseases.

‡ The precise nature of the influence of the nerves upon secretion is at present not ascertained. It has, however, been demonstrated that when the eighth pair of nerves is divided, and when the fine sensibility of the conjunctives is destroyed, the gastric juice and tears are no longer duly secreted.

In idiopathic Tetanus in this climate, after a free action of the bowels, opium generally succeeds in removing the spasms. Experience, however, has fully shown, in whatever way it may be explained, that when exhibited, even in the largest doses, this remedy cannot be relied on in the treatment of the acute form. It would seem as if the sedative influence of the ordinary preparations of this drug, was neither adequate in power, nor sufficiently rapid in its operation, to allay such active irritation as exists in this disease; and, I believe, that in traumatic Tetanus, if no amelioration or effect result in a short time from a full but not inordinate dose, once or twice repeated, it will be utterly useless, and indeed a most fruitless loss of time, to persevere in the administration of it in still larger doses.

The salts of morphia, which are supposed to contain the anodyne properties of opium, have been tried lately in some few cases of Tetanus. Morphia does not possess the constipating qualities of opium; and in cases attended with difficult deglutition, its effects may be obtained by application to the skin denuded of its cuticle. But the endermic method of affecting the system is not so well adapted for acute diseases; and I believe it will be found, that the influence of morphia, when exhibited in this way, will not be of sufficient power, and will be too slowly produced to prove of much benefit in the severer forms of Tetanus. Of two cases in the table, in which the acetate of morphia was applied in the form of ointment to a blistered surface, one was fatal: in the other, the patient, a female, recovered. Further experience of its effects, as a remedy in this disease, is however desirable. I am not acquainted with any case of this disease in which it has been exhibited internally.

In the treatment of Tetanus it is a most important consideration that the system can be affected by remedies introduced into the large intestines. When medicines taken by the mouth fail in producing their effects—when the trismus is complete, or when the risk of suffocation precludes even the attempt to swallow or to introduce an elastic instrument into the stomach through the nostrils, we may sometimes succeed in this way in obtaining the influence of opium. This remedy has indeed been exhibited in glysters upon several occasions with advantage. In two cases of acute traumatic Tetanus, unaccompanied with inflammatory symptoms, that I have seen recover, the spasms were gradually removed by laudanum injections frequently repeated, so as to keep the system constantly under narcotic influence. One of these cases (case VII.) is related in the essay. The other occurred in the practice of the late Mr. Headington, and the opium was not resorted to till after the employment of purgatives and of mercury carried to salivation without any amelioration. In a few of the cases in the table opiate injections were resorted to, in conjunction with other remedies, and, in some instances, with a successful result.

It has been stated as a reason why opium more readily produces its effects, when administered by the rectum, that this viscus being a reservoir for the residue of digestion, absorbs and does not digest, so

that substances introduced into it more certainly reach their destination ; whereas, in the stomach, the virtues of many medicines, especially those of the vegetable class, are liable to be impaired or destroyed by the digestive powers of the organ. But although this method of employing opium is likely sometimes to be attended with benefit ; yet, even in this way, its effects are not always produced, and are not generally of sufficient power to control the spasms in acute Tetanus. And, as we should expect from the experiment of Dr. Wilson Philip, which has been alluded to, the sensibility of the rectum appears to be similarly, though not so readily, affected by opium as that of the stomach.

The following case, which occurred at the London Hospital, in 1834, will afford some illustration of the preceding observations.

CASE IV.

Thomas Moss, aged twenty-two, was admitted October 10th, on account of a compound dislocation of the great toe of the right leg. The bone was readily replaced, and the wound was healing favourably, when, about ten days after the accident, he experienced slight twitchings in the muscles of the injured leg, which were followed, in a short time, by uneasiness and stiffness about the neck and jaw, inducing him to imagine that he had caught cold. This rigidity gradually increased, and, in about two days after its first appearance, on visiting him, I found the muscles of the abdomen and back slightly spasmodic. There was a little difficulty in swallowing, partial trismus, and a tetanic expression in the countenance. The pulse was 110, and full ; the wound had a healthy aspect, and the bowels had not been relieved for two days.

Cataplasm : *Farinæ lini c. extracto
opii ad dextrum pedem applicandum.*

*R. Opii ℥iij. in enemate,
administrandæ tertiis horis,*

Eight p. m. After two injections had been administered, he dozed for about half an hour. There was slight opisthotonos ; the difficulty in swallowing was rather diminished ; the pulse had increased to 116, and there was a free diaphoresis.

Ol. Ricini ℥i. statim.

On the following day, October 26th, the tetanic symptoms were much the same as on the preceding evening. The pulse was 120, but weak. In the night, in consequence of his having dozed considerably, the opiate glysters were discontinued. The castor oil was repeated, and, by the evening, the bowels were perfectly opened, when the laudanum injections were directed to be continued.

Beef tea ad libitum.

27th. The spasms were rather less rigid, and no difficulty was experienced in deglutition. Pulse 108. Perspiration profuse. He had slept a little during the night, but was frequently disturbed by sudden startings in his sleep. In order to check the excessive cutaneous transpiration, he was ordered—

Acidi sulphurici dil. \mathfrak{m} . vi. ter in die.

Two pints of porter daily, and the glysters to be continued.

28th. He had passed a restless night, but was slightly under narcotic influence. The spasms were a little diminished, the pulse weaker, the appetite good.—The allowance of porter was increased to three pints, and the opiate injections and sulphuric acid were directed to be continued.

29th. Tetanic symptoms were much the same as on the preceding day, but the perspiration was not so profuse, the pulse was still weak, and the bowels were confined. During the night, he had experienced, in a remarkable manner, the exhilarating effects of the opium.

Ol. Ricini \mathfrak{z} i.

Rep. med. et enem.

31st. In the course of the last two days, the muscles gradually became more rigid. The abdomen felt very hard, and pain was experienced in the course of the recti abdominis and at the epigastrium. Deglutition was difficult, and there were occasional spasmodic twitchings in the muscles of the neck and jaw. Perspiration less, and the bowels open.

Contin. enem.

Wine \mathfrak{z} viii.

Acid. sulph. dil. \mathfrak{m} . x ter in die.

Nov. 2d. The jaws were more closed, the abdominal muscles much more rigid, and, upon placing the hand upon the recti, they were felt to contract with great force, the different divisions of these muscles presenting distinct elevations between the lineæ transversæ. There were slight paroxysms, in which the tongue was frequently lacerated. Perspiration very profuse. Pulse 108, and weak.—Towards evening he was actively purged. The sulphuric acid was therefore omitted, and he was directed to take the mixt. cretæ, with aromatic confection, which stopped the diarrhœa in a few hours.

Contin. enemata.

3d. The jaws were nearly closed; the recti abdominis still remarkably rigid; the pulse weaker; the tongue dry and parched; perspiration rather increased; very little urine was secreted, and he was constantly dosing, being, however, very frequently disturbed by the paroxysms. On the following day, the tetanic symptoms being much the same, the quantity of laudanum in each glyster was increased to \mathfrak{z} iv. Wine and porter ad libitum.

5th. The countenance was much altered, having an expression of great anxiety. The paroxysms were more frequent and distressing, and the pulse was gradually declining. About nine P. M. he became

delirious, and his respiration laborious and hurried. After a severe paroxysm of considerable duration and attended with excessive pain, he became greatly exhausted, almost pulseless, and the spasms were completely relaxed, so that he could widely separate his jaws. From this time he sank slowly, and died about three A. M. the following morning*.

Although, towards the termination of this case, the spasms were very severe, yet, in its origin, progress, and duration, the disease must be regarded as chronic. But little influence was produced on the system or on the muscles by the opium, until the bowels had been freely acted upon, when, on the third and fourth days, after the glysters were first employed, there was decided remission of the spasms, and the patient experienced those exhilarating sensations which are its ordinary effects in small doses. In the first instance, three ounces of laudanum were injected in the course of the day; and the quantity used amounted, altogether, to upwards of ℥xxxij . Its effects, however, were very trivial; and, latterly, notwithstanding the patient was constantly dosing, at which time the muscles became slightly relaxed, yet, upon his awaking, the spasms recurred as forcibly as ever. In this instance, then, we must admit that the opiate glysters were fairly tried, without success.

In the fourth volume of the Medical Transactions there is a paper by Dr. Latham, in which the pulvis ipecacuanhæ comp. is strongly recommended, and several cases are related in which it appears to have been given with success, in doses of 10 grains every two or four hours. Of three cases in the table, treated with Dover's powder, two recovered. The beneficial influence of this preparation must be attributed to the opium which it contains.

Dr. Stutz, of Suabia, has published the particulars of three cases of traumatic Tetanus which were cured by opium combined with alkalies, and warm-baths impregnated with the deutoxyde of potas-

*The following is an account of the post-mortem examination, twelve hours after dissolution. —Increased vascularity of the pia mater enveloping both the brain and spinal cord, but no serum effused between the membranes. A turgid state of the vessels of the cerebral substance, and, on making a section of the medulla spinalis in different places, the anterior columns alone were observed to be unusually vascular. Abdominal viscera and heart healthy. Lungs slightly congested. Mucous surface of the intestinal canal natural. The internal plantar nerve, traced to the wound caused by the dislocation, appeared thickened, and its neurilema præternaturally vascular. The aspect of the wound itself was perfectly healthy. About half of the fibres of the lower division of the rectus abdominis, on the left side, were ruptured, and the belly of this part of the muscle retracted, swollen, and hard. Several of the fibres of the right rectus abdominis were also torn in the same situation. A little extravasated blood was found in the sheath of these muscles at the seat of the rupture, which, most probably, took place in the acute and painful paroxysm that occurred just previous to dissolution, the immediate cause of death being, evidently, extreme exhaustion†.

† The lacerated portion of the left rectus muscle is preserved in the museum of the College of Surgeons.

sium and lime*. It is supposed that the alkali favours the operation of opium upon the system. I do not know what benefit could be derived from the baths, but M. Fournier-Pescay mentions that he has succeeded in curing a case by baths medicated in this way.

Tobacco.

The earlier writers had great confidence in the efficacy of tobacco, especially of the *oleum tabaci*, when applied externally to the neck and back. There is a little book, entitled the "*Trial of Tobacco*," published by Dr. Gardiner in the early part of the seventeenth century, which contains the following passage: "the suffumigation of tobacco being taken is a good remedy for the starkness or stiffness of the neck, called Tetanus." Campet, who had considerable opportunities of witnessing this disease in the French colonies, appears in the last century to have employed tobacco injections with very great benefit in conjunction with wine by the mouth; and he has related several cases in which it proved successful. Attention has, however, been more recently directed to this remedy in this country by a paper in the third volume of the *Dublin Hospital Reports*, by Mr. O'Beirnet, and from some cases published in the *Edinburgh Medico-Chirurgical Transactions*, by Dr. Anderson†.

Tobacco has two active principles, an essential oil and nicotine. According to the experiments of Sir Benjamin Brodie, the former produces its effects on the brain without directly acting on the circulation. The latter influences the heart through the medium of the nerves, rendering it insensible to the stimulus of the blood; and it has been suggested that the spinal marrow is that part of the nervous system primarily affected§. The symptoms occasioned by the influence of tobacco on the system are, extreme and alarming prostration, great reduction in the pulse, nausea, vomiting, tremor, syncope, cold sweats, and paralysis of the muscles of voluntary motion. This state of prostration bears some analogy to the state of extreme depression, to which the spasms give place just previous to death, after the more violent paroxysms of Tetanus. But there is this essential and important distinction: in the one case prostration is occasioned by a sudden and powerful impression upon the nervous system, which, if not carried too far, is only temporary, the vital powers not being permanently impaired. In the other, however, the powers of the system are so completely exhausted, that re-action cannot take place unless it be artificially excited, and very often not even then. There is, perhaps, no medicine which tends so powerfully to relax muscular action as tobacco, and on this account it has been used extensively for favouring the reduction of a strangulated hernia with the most beneficial effects. Mr. Earle has employed it, with marked

* *Medicinisch-Chirurgische Zeitung Salzburg*, No. 6.

† Vol. iii.

§ *Philos. Trans.* 1811, part i.

‡ Vols. i. and ii.

success, in the treatment of retention of urine produced by spasm in the urethra. He also exhibited it by enema in a very bad case of traumatic Tetanus, in which, although there was a temporary alleviation from spasm, so much agitation was occasioned that it was not persevered in*. The sensations which are caused by tobacco are particularly distressing, so much so, that after its full effects have been produced, patients will hardly be induced to submit to a repetition. In one of the first cases of Tetanus, in which the tobacco fume was given with success, described by Mr. T. Duncan, of Grenada, the patient said that "the sensation of fainting was so dreadful that he would rather bear the convulsions, painful as they are†." A case of trismus is also mentioned by Sir Wm. Blizard, the symptoms of which were entirely removed by a tobacco injection; but the ordinary effects of the glyster were so powerfully felt by the patient, and his dread of a repetition of them such, that he left the hospital rather than submit to another. There was, however, no return of the spasms‡. It is said that tobacco increases the action of the intestines; and although such is no doubt the case, yet the evacuations from the bowels, which often take place shortly after the exhibition of it in Tetanus, is likewise attributable to its influence in causing relaxation of the levator and sphincter ani muscles.

In an interesting case of traumatic Tetanus, the particulars of which have been minutely detailed by Mr. O'Beirne, the symptoms progressively increased in severity till the fifth day after their appearance, when they arrived at their greatest height. Tobacco was then resorted to, and it is described at once to have prostrated nervous energy, to have unlocked the bowels which were previously obstinately bound, and to have produced, during its operation, an amendment of all the symptoms; but being discontinued, either by design or accident, the spasms became aggravated, and recurred with force. On reverting to its use an instantaneous amelioration took place; and being persevered in, so as to keep the constitution constantly under its influence, it, unassisted by other means, conducted the case to a prosperous issue. The tobacco was administered in the form of an enema, composed of a scruple of the leaves infused in eight ounces of water, which was repeated two or three times a day, and sometimes oftener, as appeared necessary to allay the spasms, and was continued for eighteen days. This remedy, then, was here fully and fairly tried, the treatment having been committed to its influence alone.

In the two first cases in which tobacco was employed by Dr. Anderson, the patients were negresses, and the disease was traumatic, and rather chronic. A decoction, made of the fresh leaves of the nicotiana was used as an enema, and in impregnating a warm bath, into which the patients were placed several times during the day.

* *Medico-Chirurgical Transactions*, vol. vi. Case 23 in the table.

† *Edinburgh Medical and Surgical Journal*, vol. ii.

‡ *Vide Appendix to an oration delivered before the Hunterian Society, February 9, 1826.*

This treatment was continued until the spasms had nearly ceased, a nourishing diet with wine being allowed. In one of them, acting upon the bowels, seemed greatly to promote recovery. Two other traumatic cases occurring in negroes were treated in a similar manner, with a favourable result. In one, where the symptoms were very severe, advantage was taken of the state of collapse, produced by the influence of the tobacco, to support the patient with nourishment and wine, which at other times he was unable to swallow. The baths appeared to cause an intolerable itching of the skin, and an eruption, the nature of which is not stated. A fifth case, treated upon this plan, had a fatal termination; but Dr. Anderson had strong reasons for doubting whether the means prescribed were regularly administered.

Of nineteen cases in the table, in which tobacco was employed, nine recovered. Of the ten fatal cases it must be remarked, that in case 20 the remedy was not resorted to till the patient was dying. In case 28, treated by Mr. Earle, and in case 49, the case of Dr. Anderson's just alluded to, it would appear that this remedy was not fairly tried. In case 39, there was organic disease in the brain, and in case 52 the symptoms were always moderated after the injections; but the patient was not kept constantly under its influence. Case 53 was remarkably severe, the disease having proved fatal in forty hours, and the remedy was scarcely resorted to in time. In neither of the two cases (cases 105 and 106) treated by Mr. Carmichael, does it appear that the tobacco was exhibited to an extent sufficient to produce that powerful impression upon the system by which alone the spasms in the acuter forms of the disease can be combated. In the remaining two, I witnessed the treatment, and closely watched the effects of the tobacco: they were both cases of patients in the London Hospital at the time that I attended as a pupil.

CASE V.

In this case the patient was a muscular individual, forty-two years of age, and the injury, giving rise to the disease, was a wound in the back of the thigh, inflicted by an iron spike, which was healing favourable, when on the ninth day afterwards, stiffness, and an uneasy sensation, were experienced about the jaw and neck. On the twelfth day tetanic symptoms were very severe, the expression of the countenance being well marked, the pain at the præcordia acute, and the abdomen tense: there was decided opisthotonos, frequent paroxysms, and the pulse was quick and intermittent. Opium was given in large doses. On the following day all the symptoms were greatly aggravated, he was unable to swallow any thing, considerable anxiety was expressed in his countenance, perspiration was profuse, and his pulse was 120, and weak. Towards evening respiration became much more oppressed, the pulse was increased to 130; he was evidently much weaker, and did not appear likely to live many hours. An enema, composed of 3ss of the tobacco leaf, was now given. In a few minutes the pulse became almost imperceptible, the rigidity of

the muscles of the abdomen and lower extremities diminished, respiration became less difficult, a slight rigor occurred, and he complained of a most distressing sense of depression. In about twenty minutes after the first injection another, containing the same quantity of tobacco, was exhibited. In a short time all the muscles seemed to be relaxed; he was able to clear the fauces, could speak without difficulty, and contrived to swallow some wine. The pulse was at first rather accelerated, but in about ten minutes there was great determination of blood to the head, in which he complained of violent pain and heat, but several times expressed himself relieved from the painful spasms; perspiration very profuse, pulse declining fast. A scruple of the tobacco leaf was now introduced into the rectum; complete collapse soon ensued, and in rather more than an hour after the first enema, the patient died.

The exhibition of tobacco was here carried too far, and the patient, being already much exhausted from the effects of the disease, it undoubtedly accelerated his death. Unless there is imminent danger of suffocation, as in this instance, it should not be resorted to in extreme cases where there is great depression, which should rather be treated with stimulants and tonics. The spasms were certainly removed by its influence, and had it been employed more cautiously, very possibly a less unfavourable result would have occurred.

CASE VI.

A powerful man, twenty-six years of age, was struck on the forehead with a stick, and thrown into a canal. He was taken out and carried home. He supposed that he caught cold; but the wound was healing, when, on the morning of the fourth day after the blow, a sense of stiffness was experienced about the lower jaw. On Tuesday, the third day from the appearance of trismus, he was seen by a medical man, and ordered to take frequent doses of calomel and opium. In the evening of the following day he was admitted into the hospital. The wound was then slightly inflamed, he was unable to open his mouth above a quarter of an inch, and complained of pain at the pit of the stomach. He had a dose of senna and salts, which acted slightly on the bowels during the night, and he was then ordered—

Cal. gr. ii. c. Opii. gr. i. quâque tertiâ horâ.

Thursday. Early in the morning he took a drop of croton oil, which caused copious evacuations in a few hours. In the afternoon I saw him for the first time. His jaws and mouth were quite closed, the alæ of the nose elevated; his face, however, was not marked with that expression so characteristic of the disease. The muscles of the abdomen and back were unaffected. Pulse 120, and weak. An infusion of half a drachm of tobacco leaf was exhibited, as an enema. In about ten minutes the pulse was reduced to less than 100; he became giddy and sick, but was able to open his jaws, and to

separate his lips without the assistance of the hands. In the evening, ptyalism being produced, the calomel and opium were discontinued. Another enema, of the same strength as the preceding, was administered without producing much effect, reducing the pulse only twelve beats.

Friday. He had not slept during the preceding night, the mouth was firmly closed, great difficulty was experienced in deglutition, and the pulse was 108, and stronger than on the day previous. A glyster, composed of ℥ij. of tobacco was given, but it affected him very little.

Saturday. He had passed a sleepless night, muscles of the face and of the jaw still firmly contracted; he was, however, free from pain at the præcordia. An injection, containing ℥ij. β. of tobacco, was administered about twelve o'clock, after which the pulse was rather accelerated, and he was able to open his jaw and to speak with less difficulty. In the afternoon, whilst drinking some broth, he was suddenly seized with a violent paroxysm, in which he was nearly suffocated. About four p. m. the enema was repeated, and again in the evening; on both occasions no sensible effect resulted from it. He was also again nearly suffocated in a severe paroxysm, brought on by an attempt to swallow his saliva, which was secreted in great abundance.

Sunday. In the morning he seemed weaker, but was otherwise much the same as on the day before. He had another injection, containing ℥ij. β. of tobacco, which caused slight nausea. The ptyalism was the occasion of extreme distress, and he was in such fear of a paroxysm being induced by the saliva getting into his throat, that he constantly kept the lips apart with his fingers, in order to enable it to flow from the mouth. Thirst was excessive, which, however, the dread of instantaneous suffocation prevented him from allaying by drink. He had not swallowed any thing since the preceding evening, and appeared sensible of his danger, often pointing to the throat as the seat of his distressing sensations. A tobacco enema, similar to the last, was exhibited about two p. m. In about twenty minutes it reduced the pulse a little, and caused an attempt to vomit. This action of the stomach instantly excited spasmodic contractions in the muscles of the throat and glottis. Respiration being impeded, his face became livid, his eyes, fixed by the firm contractions of the muscles of the globe, seemed ready to start from their sockets, and, bathed in perspiration, he dashed from the bed, struggling furiously for breath. He continued thus convulsed, in a state of partial suffocation and intense agony, but perfectly conscious, for above an hour, when his strength began to fail, the spasms became relaxed, the pulse imperceptible; free respiration returned for a few minutes, the extremities became cold, and the vital powers being quite exhausted, he was released from the most frightful sufferings by death.

In this instance the original injury was a contused wound of the head, and it would appear that irritation was confined to a small part of the tractus motorius, since the only muscles affected were the

diaphragm and those of the face and throat. It is somewhat difficult to determine how far the tobacco was here beneficial or otherwise. Before the patient was subjected to its influence, he had taken largely of calomel and opium, and the salivation which resulted added greatly to his distress and very much aggravated the symptoms. The quantity given in each enema was large, but its sedative effect was not so considerable as might have been expected, and upon some occasions, the system was uninfluenced by it. Dr. Anderson also noticed the difficulty of producing the collapsing effect of this medicine after the system had been previously affected. The constitution was evidently not kept constantly under its influence, although the spasms were several times relaxed after the exhibition of it; and if, when first resorted to, it had been increased in proportion to its effects, the patient, being very carefully watched, I am inclined to believe that the spasms might have been subdued. In the case recorded by Mr. O'Beirne, the patient was young, and the dose small, and apparently ill-proportioned to the disease to be contended with; but by being repeated according to the urgency of the symptoms, every advantage was attained, without incurring inconvenience or danger. Every one who has often witnessed the exhibition of tobacco will agree in the remark, "that its action is not only uncertain and unequal on different persons, but on the same individuals at different periods, and under different circumstances." Large doses certainly should not be employed at first, but as it appears that the repeated use of tobacco generally renders the system less susceptible to its influence, in nearly all instances it will afterwards be necessary to increase the quantity. In this second case also, death was perhaps rather accelerated by this remedy, since without sufficiently controlling the spasms it increased the debility, and unfortunately caused vomiting, which act evidently brought on those dangerous spasms of the muscles of the throat and glottis that occurred just previous to death. It must be concluded, that in neither of these two cases had the tobacco a fair and satisfactory trial.

Mr. Travers has given his testimony strongly in favour of this remedy, which he observes "may be employed with signal effect in calming the spasm of Tetanus. It may be used twice or thrice daily, with perfect safety, in the onset of the disease. It produces nausea, perspiration, and sleep often of hours' continuance; but above all, it diminishes its force and frequency, if it does not arrest the morbid action, and gradually restores the pliancy of the fixed and board-like muscles."

Mr. Alexander, a surgeon in the navy, has published an account of a very acute case* of traumatic Tetanus, in which decided emprosthotonos was produced. The following means were adopted.

Amputatio digiti.
V. S. ad 3xxx.
R. Tabaci folior. 3j.
Aq. bullient. 3iv.

M. fiatque infusio, cujus sumat dimidium statim, et reliquum post horas duas.

* Case 13 in the table.

The first dose is stated "to have induced nausea, with a marked alleviation of the sternal pain; the second dose, both vomiting and purging, with still greater relief; suffice it to say, after two doses more of a similar infusion, there were no symptoms remaining of the emprosthotonic state, but merely that sense of stiff soreness in the pectoral and cervical muscles, which I believe generally succeeds relaxation of the spasm*." From the prescription it is to be presumed that the infusion was given internally by the mouth. If such be the case, the effects resulting from so large a dose, although sufficient to allay the undue muscular action, were otherwise remarkably trivial. It must, however, be recollected, that the patient was a sailor, who very probably was in the habit of chewing the plant, and swallowing part of the saliva thus impregnated. Now, this is the only instance on record that I am acquainted with, in which the tobacco infusion has been taken into the stomach, and however efficacious this method of administering it may prove, it is not adapted for all cases, and I apprehend that glysters will not only be found more generally applicable and convenient, but also equally well fitted to obtain the required effects. In the case described by Mr. Carmichael, in which the *vinum nicotianæ tabaci* was employed, the dose was small, and it did not seem to produce any effect†.

I conceive that more has now been advanced in proof of the efficacy of tobacco than can be adduced in favour of any other remedy yet resorted to‡. I have not, indeed, succeeded in finding a single case, in which, being fully and fairly tried before the powers of the constitution had given way, it has been known to fail. Many more cases have been cured by the use of opium, and for the obvious reason, that a far larger number have been treated with it. Tobacco is a more certain and potent sedative than opium, the latter being a remedy that can never be relied on, having failed far oftener than it has cured. Many appear to dread so powerful an agent, as a remedy more dangerous than the disease; but, without resorting to so weak an argument, "*melius anceps remedium, quam nullum*," it may be justly alleged, that only the rash abuse and not the judicious exhibition of tobacco can afford grounds for apprehension. I would not say, that tobacco is a remedy, which, even resorted to at an early period, and employed with judgment, will always avail; for I believe, that in its worst forms, Tetanus is a disease of too destructive a

* Medical Gazette, vol. ii. p. 141.

† Trans. of the Queen's College of Physicians, Ireland, vol. iv. p. 277.

‡ A case is recorded in the Philadelphia Journal, for May, 1827, in which the tetanic symptoms were quickly subdued by the tobacco injections. There is likewise an account of a case of Tetanus, supposed to have been produced by the passage of large, rough, angular pieces of clay from the intestinal canal into the vagina, cured by tobacco injections, related by Dr. Burleigh Smart in the sixth volume of the American Journal of the Medical Sciences, 1830.

In the fifty-fourth volume of the London Medical and Physical Journal, a severe case of traumatic Tetanus in the horse is recorded by Mr. Egan, which was cured by repeated enemas of an infusion of the tobacco leaf, with suppositories of the same plant.

nature to be arrested by any treatment whatever. But I hold it to be the best remedy that we at present possess, and one which will generally be found capable of diminishing the severity of the acute disease, and often of subduing it altogether.

The doses should be regulated by the age, habits, and constitution of the patient, who, during its use, must be supported by a nourishing diet, tonics, wine, and other stimulants. The carbonate of ammonia in particular is well adapted to counteract the extreme prostration sometimes induced. At the commencement a scruple of the tobacco leaf, infused in eight ounces of water, will be enough for an injection, which must afterwards be increased in strength in proportion to its effects. A stronger infusion will be necessary for those who are accustomed to the use of this plant as a luxury. Unless in chronic Tetanus, baths impregnated with it are not only insufficient, but objectionable.

Antimony.

Antimony being a remedy which diminishes the heart's action and depresses the vital powers, has sometimes been employed for the relief of Tetanus. Of ten cases in the table in which it was resorted to, six were fatal, but in these the disease was very acute. This remedy is best adapted for the more chronic forms of the disease, for, although it has a decided influence in lessening muscular energy, its depressing effects are too uncertain, and are generally insufficient in power to arrest the course of the acute disease. It is objectionable, also, when the muscles of the larynx are affected, as the nausea and sickness which it produces add to the patient's distress, and are liable to induce paroxysms. Tartar emetic was exhibited with decided advantage in a case of chronic traumatic Tetanus treated by Mr. Liston at the North London Hospital. It was given internally, in doses of one grain every hour, together with a warm bath, containing in solution half an ounce of tartarized antimony, thrice in the course of the day. The pulse, after the baths, was generally accelerated, but became much softer as soon as the copious sweating, by which it was followed, appeared. The chief benefit, however, seemed to arise from its internal administration*. Mr. Woodward has related a case of idiopathic Tetanus, in which the symptoms became aggravated under treatment with Dover's powders, blistering, and turpentine enemata; but, on exhibiting antimony, great debility was produced, the pulse fell, muscular rigidity diminished, the patient was soon able to swallow, and, by persisting in this remedy, gradually recovered†.

Cold Affusion.

This remedy was originally recommended for the cure of Tetanus

* Lancet, vol. for 1834-35, p. 581.

† Dublin Journal of Medical and Chemical Science, for July, 1835.

by Hippocrates*. In later years it has been adopted and employed with great success in the West Indies by Dr. Wright†. It has also been advocated by Dr. Rush of Philadelphia, and Dr. Currie of Liverpool.

The prolonged influence of cold acts upon the system as a sedative, rendering the circulation weak and slow, and the muscular contractions feeble. It determines the blood from the cutaneous surface to the large vessels and internal organs, impairing the functions of the brain and causing convulsions. That cold operates as an exciting cause of Tetanus is not a material objection to its employment as a remedy in the same disease, since the effects resulting from its influence in the two cases are somewhat different; in the former being remote, in the latter immediate. To produce the sedative influence to which its efficacy must be ascribed, affusion should be employed with water at a temperature but little above the freezing point, poured in a continuous stream and from a considerable height. The effect of cold affusion, employed in this way, is to produce the utmost prostration, and it may be carried to the extent of causing fatal syncope. A less powerful impression may be made by suddenly dashing water on the body of the patient, or by plunging him into a cold bath. The primary effect of cold affusion is often a severe and sudden exacerbation of the spasms, as in case 46, which sometimes proves fatal, as in an instance recorded by Baron Larrey. Mr. Morgan likewise mentions a case, where the patient was plunged, by his own desire, into a cold bath; all the symptoms of Tetanus disappeared in a moment, and he was almost instantly taken out lifeless. The shock produced on the system, by the impression of cold upon the surface of the body, had occasioned instant death. In a severe case of Tetanus, described by Dr. Currie, the patient was plunged into cold water, at 36° Fahr. When taken out, the pulse and respiration were almost entirely suspended. Warm blankets, however, had been prepared, and general friction was diligently employed. The respiration and pulse became regular, the vital heat returned, the muscles continued free from spasm, and the patient fell into a deep sleep. In this case a single impression was sufficient to arrest the disease. In case 120, its immediate effect was to suppress respiration and to extinguish the pulse at the wrist and the heat of the surface of the body. In case 90, during its operation, the pulse was reduced from 150 to 90.

It must be acknowledged, that the evidence in favour of cold affusion chiefly refers to cases of the idiopathic form of Tetanus, in which it has been extensively employed, by Dr. Wright‡, Dr. Cochrane||, and other practitioners. I cannot, however, agree with Mr. Samuel Cooper§, that it presents no hope of benefit in cases of Tetanus,

* Hippoc. Aph. sect. v. aph. 21.

† Med. Obs. and Inq. vol. vi.

‡ Lib. cit.

|| Edinb. Medical Commentaries, vol. iii.

§ Surgical Dictionary—Tetanus.

arising from wounds. It has been shown that cold is eminently adapted to fulfil the most important indication in the treatment, the production of a sudden and powerful sedative impression; and it will be found that in most of those traumatic cases where it fails, this impression is not effectually made. Sir James M'Grigor observes, that the cold bath was worse than useless in the Peninsular war, and one can readily understand that such would be the effect of a hazardous remedy, if inefficiently or injudiciously employed. But he has adduced a curious case, which admirably illustrates the beneficial operation of cold. It occurred in the march of the guards through Gallicia, and the account of it is furnished by Mr. Nixon, Deputy Inspector of Hospitals. The symptoms of Tetanus arose from a slight wound of the finger, and are stated to have been unusually severe. As it was impossible to think of leaving the man in the wretched village where he was attacked by the disease, he was carried on a bullock car after the battalion. During the first part of the day he was drenched with rain, the thermometer standing at 52° , but, after ascending one of the highest mountains in Gallicia, the snow was knee deep, and the thermometer below 30° . The patient was exposed to this inclement weather from six o'clock in the morning till ten at night, when he arrived, half starved to death, but perfectly free from every symptom of Tetanus. This man was, therefore, solely indebted for his recovery to the sedative influence of intense cold, to which he was accidentally subjected. Dr. Wright has recorded two traumatic cases, which were cured by the use of the cold bath, but his opinion that the efficacy of this remedy is dependent upon a tonic effect I believe to be erroneous. Sir Benjamin Brodie is reported to have found cold affusion of more service than any other remedy that he has employed*. Of twelve cases in the table in which cold affusion and other means were adopted, seven terminated favourably†.

With the exception of tobacco, I know of no remedy so well adapted to produce an impression on the nervous system, of power adequate to control the severe spasms of this disease, as cold affusion. I believe that even in the most aggravated cases, by boldly persevering in the application of it until syncope or extreme depression of the vital powers is produced, the spasms may be completely removed. Unless, however, a powerful impression is made, and even kept up for some time, and the remedy repeated as soon as the spasms recur, it will prove ineffectual. The utmost care is necessary not to carry it so far as to take away all power of reaction, and it may be desirable to administer brandy or a diffusible stimulant during the operation. The remedy possesses this advantage, that other means, fitted to cause the same effects, may always be combined with it. Cold

* Lib. cit.

† M. Guérin de Mamers, by means of cold affusion, was able at once to arrest the tetanic paroxysms occasioned in animals by *nux vomica*.—Bulletin Générale de Therapeutique Médicale et Chirurgicale.

affusion is certainly not a remedy unattended with danger, even when judiciously exhibited, but, unless practised with boldness and perseverance, it had far better never be resorted to.

The preceding remarks on cold affusion were completed when I met with an account of three cases of traumatic Tetanus, where this remedy was employed, which so strikingly exemplify its efficacy, that a slight outline of them is here inserted. They are recorded in the *Nouvelle Bibliothèque Médicale* for March 1828, by M. Fr. Olivier Doucet, M.D. of the United States, to whom great merit is due for the judgment and skill exhibited in the treatment of them.

1. A man aged thirty-seven, of robust constitution, was attacked with symptoms of Tetanus, in about sixteen days after a slight wound on the great toe. On the third day of the disease, no benefit having been derived from the exhibition of camphor and opium, fifteen pails of cold water were poured upon the patient from some height, which soon produced syncope. He was immediately taken from the bath, enveloped in flannel, and subjected to general friction, by which means reaction was speedily established. A little warm wine, with half an ounce of paregoric elixir, was then given. In the evening it was necessary to repeat the cold affusion till a state of collapse was again produced, when reaction was restored as before. He was decidedly relieved for some hours; during the night, however, the symptoms increased in severity, and on the following day, after considerable persuasion, he was induced to submit to a further repetition of this remedy. He would not bear the douche, on this occasion, oftener than six times. In the evening he was worse, but would not hear of cold affusion; the spasms, however, having returned with augmented violence in the night, he consented on the following day to submit to it. The bowels were afterwards evacuated by a common injection; and in the evening, as he again refused to undergo the cold affusion, two doses of laudanum, of a drachm each, and a tobacco enema, were exhibited. On the sixth day, the spasms being very violent, the douche was again recommended. So great, however, was the repugnance of the patient to it, that a paroxysm was occasioned by his viewing the necessary preparations. At night it was repeated, till collapse was produced. He afterwards passed a tranquil night, and the following day was much improved. By persevering in the frequent use of cold affusion for about ten days longer, at the same time supporting him with wine, and continuing the paregoric elixir, the disease was completely removed.

2. A man, thirty-two years of age, and a strong constitution, was seized with symptoms of Tetanus, in a short time after cutting a corn. The muscles of the back, abdomen, and neck, were rigidly contracted, and the jaws were so firmly closed, that it was scarcely possible to introduce the handle of a spoon between the teeth. Cold affusion was resorted to in the first instance, but the patient would not permit it to be carried to a sufficient extent. On the following day the symptoms were more severe, and intense pain was experienced at the præcordia. As he would not submit to cold affusion,

mercurial and opiate frictions, with laudanum injections, and large doses of calomel, were employed. In two more days salivation was produced, but the symptoms were greatly aggravated, the face being hippocratic, respiration difficult, and the body forcibly curved backwards. A lumbricus was discharged in the copious evacuations that were occasioned by castor oil. The patient now begged to be subjected to cold affusion. He was, therefore, placed in a bath, and twenty-six pails of cold water thrown upon his head, when he fainted, and all his muscles became relaxed. It was thought at first that the remedy had been carried too far; but by means of flannel and warm wine, reaction was soon brought about. Seventy drops of laudanum were given, and on the following day there was very considerable amendment. Cold affusion was repeated, the laudanum continued, and he was allowed two bottles of Madeira wine a-day. Under this treatment he rapidly recovered.

3. A man of robust health, thirty-four years of age, was attacked with Tetanus, the symptoms being difficult deglutition, trismus, opisthotonos, and pain at the ensiform cartilage. He was bled to twenty ounces, which caused syncope and some abatement of the spasms. Small doses of tartar emetic were afterwards ordered. The next day the symptoms were greatly aggravated; laudanum was taken by the mouth, and exhibited by injection. On the following day, no amendment having taken place, sixteen pails of very cold water were dashed upon the patient, so as to cause fainting. He was then wrapped up in flannel, placed in bed, and some paregoric elixir administered. In about half an hour very evident improvement was observed. The laudanum injections were repeated. On the next day, however, the paroxysms were more violent, and lasted longer than upon any previous occasion. But by persevering in the use of cold affusion, and at the same time keeping up his strength with port wine, the spasms were gradually and at length completely subdued.

The Warm Bath.

This remedy has been resorted to occasionally in the treatment of Tetanus, but with little if any benefit. Sir James Macgrigor found it to produce only momentary relief. De Haen and Dr. Hillary* state, that instantaneous death sometimes follows its employment. This is no doubt owing to the excitement of a paroxysm by the sudden immersion. At a high temperature the warm bath occasions considerable depression, and frequently syncope, to which effects, if ever successful as a remedy in acute Tetanus, its efficacy must be ascribed. But although no benefit can be expected from the use of this remedy in the severest forms of the disease, it may be useful in promoting recovery in chronic cases, and in relieving the uneasiness and stiffness so often remaining, for some length of time after an

* On the air and diseases of Barbadoes.

attack of acute Tetanus. In a case where the muscles possessed, for many years after the spasms had been removed, a degree of rigidity which was increased by the slightest irregularity in diet, or variation in the atmosphere, and accompanied with acute pain, great relief was afforded by warm baths and the use of musk*. In case 23 it likewise appears to have been of service in removing the stiffness of the muscles after the spasms had been subdued.

The Vapour Bath.

Dr. Marsh, of Dublin, has recorded three cases, in which the patients were subjected, for many successive hours in the course of the day, to a vapour bath, at a low temperature. Two recovered. One was the case of a boy six years of age, in whom the symptoms came on gradually, after an injury of the great toe. Croton oil was taken internally, and the vapour bath was employed at a temperature of 90° , for four and six hours at a time, after the patient had taken calomel and opium for several days without benefit. In the other case, it was not resorted to till after ptyalism had been produced without any good result, when it was persevered in for several hours daily, until the symptoms had gradually subsided. In the case which proved fatal, it appears to have abated the violence of the paroxysms without however influencing in the slightest degree the permanent rigidity of the muscles.

In one of the numbers of the *Journal Hebdomadaire de Médecine*, for the year 1828, are recorded two interesting cases of traumatic Tetanus, which were treated successfully by the repeated influence of vapour baths, at the temperature of 30° of Reaumur. In one of them the patient was in great danger from impending suffocation. A third case is mentioned, in which the spasms were mitigated by a vapour bath at 40° Reaumur, although it eventually terminated fatally. In case 16, taken from the *Lancette Française*, after active depletion and opium, the vapour bath was employed, but without at all mitigating the spasms, and the disease proved fatal. This mode of treating Tetanus was first suggested by Ambrose Paré.

The effects upon the system of a vapour bath at a high temperature, are very similar to those of the warm bath. M. Berger was obliged, in twelve minutes and a half, to come out of a vapour bath, of which the temperature had risen from $106^{\circ} 25$ Fahr. to $128^{\circ} 75$. He was weak, and tottered on his legs, and was affected with vertigo. The weakness lasted the remainder of the day†. Dr. Edwards has shown that there is a remarkable advantage in the vapour over the liquid bath, because, in the former, the air is in communication with the whole cutaneous surface, whereas, it is excluded from nearly the whole extent of the skin in the latter. If hot baths be employed, this

* Dictionnaire des Sciences Médicales—Tétanos.

† Dublin Hospital Reports, vol. iv. p. 567.

‡ M. Delaroche et M. Berger Exp. sur les effets qu'une forte chaleur produit sur l'économie, etc. Paris, 1806.

advantage is of no slight importance, since, in order to keep the spasms under control, it will be necessary to subject patients to their influence for some length of time. But however useful they may prove in relieving the symptoms of chronic Tetanus, we must by no means rely on them in the treatment of the acute form of the disease.

Tonics and Stimulants.

The efficacy of tonics and stimulants, in the treatment of Tetanus, is supported by the testimonies of Drs. Wright, Currie, Rush, Hosack, and other practitioners.

It seems, at first sight, unaccountable how any degree of success could attend a plan of treatment apparently so ill adapted to answer the indications required to subdue this disease. In that state, however, of debility and exhaustion, occasioned by the continuance of tetanic spasms, which is often greatly increased by the curative means employed, the free exhibition of tonics and stimulants becomes absolutely necessary to sustain the sinking powers of life. In the extreme prostration, produced by tobacco and cold affusion, without them, these depressing remedies would frequently be almost as dangerous as the disease. A sudden and powerful shock is required to allay the spasms in an acute paroxysm, but unless counteracted by stimulants, this impression may at once prove fatal, or it may occasion such excessive exhaustion, that, although the spasms are removed, the unassisted powers become inadequate to produce reaction and sustain life. Now, it will almost invariably be found, that in those instances in which this mode of treatment has been adopted with success, the disease was either originally chronic, or, if acute, had not attacked the respiratory muscles, or this plan was not pursued until the strength was giving way under the prolonged influence of the undue muscular action. The advocates of this plan of treating the disease seldom trust to it alone, but generally combine with it opium or other sedatives; in short, they resort to it only as subsidiary to other means. Viewed in this light, I am satisfied that too much importance cannot be attached to the employment of tonics and stimulants, and that they must be regarded, not only as useful but as necessary remedies in the treatment of Tetanus. The evidence of Mr. Travers in their favour is sufficiently forcible; he observes, that "patients have been lost in Tetanus from want of proper nourishment and cordials oftener than from want of proper medicine*."

A remarkable case, of which the following is a brief outline, is related by Dr. Currie, of Liverpool.—A gentleman was seized with Tetanus, which was excited by a splinter having been driven under the nail of his middle finger. In less than a month, he drank, mixed with nourishment, one hundred and forty bottles of Madeira wine, finishing four or five in the twenty-four hours, besides ale and brandy, two gallons of strong broth, and about two drachms and a half of

* Lib. cit. part ii. p. 306.

laudanum. Laudanum and æther were also freely used as embrocations ; and, in addition to this, he bathed altogether sixty-five times, the water being from 60° to 64° of Fahr., by which he was always relieved. His previous habits, in regard to the use of wine, are not mentioned ; but it is stated, that he was in the vigour of life, of great bodily strength, and that, during the paroxysms, that sweat poured in torrents from his body. Recovery took place very slowly, and although, without doubt, the laudanum contributed to it, yet if he had not been supported, the power of his constitution would probably have been at length worn out by the violence of the spasms so long continued. It is also not unlikely but that the employment of tobacco or cold affusion, so as to occasion a powerful shock, would have arrested the disease much sooner.

In the following case the spasms were very severe, although the symptoms were slow in developing themselves. The patient was a lad of strong constitution, and the respiratory muscles were nearly free from spasm. I attribute the successful result in a great degree to these circumstances and to the judicious combination of laudanum injections with means calculated to sustain the powers, together with attention to the state of the bowels.

CASE VII.

A robust lad, aged nineteen, was admitted into the London Hospital, under the care of Mr. Scott, August 14th, 1835. About three weeks previously the sole of his left foot had been slightly injured with a nail. The wound healed readily in a few days, but, on the 9th instant, he experienced slight difficulty in opening his mouth, which gradually increased until the 13th, when his jaws were nearly closed, and he was seized with pain between the shoulders and down the back. When admitted, his countenance was tetanic—he could not open his mouth more than half an inch—the muscles of the neck and back were extremely rigid—there were strong spasms of the muscles of the lower extremities, especially of the calf of the left leg, with slight opisthotonos—pulse one hundred and ten—skin cool and moist—bowels open.

An incision was made at the site of the wound in the foot, and an ointment, composed of the deutoioduret of mercury, thickly spread upon lint, was applied to the back in the direction of the spine.

15th. The spasms had increased in force, and frequently recurred in slight paroxysms—the opisthotonos was more marked, and he had suffered greatly from the irritation induced by the ointment. The bowels not having been relieved for twenty-four hours, he was ordered a dose of croton oil and to discontinue the ointment to his back.*

16th. In every respect worse—the spasms more violent: he had passed a sleepless night, and complained greatly of pain in the back—perspiration profuse—pulse one hundred, and weak. He was ordered as much porter as he could drink.

* The counter irritation seemed to afford no benefit whatever.

Nine p. m. The tetanic symptoms were much aggravated, and the spasms were so painful, particularly in the left leg, as to cause him to scream aloud during the paroxysms. The legs were bandaged, which appeared to afford some slight relief: and an enema, containing two drachms of laudanum, was ordered to be exhibited at intervals of two hours.

17th. The spasms decidedly mitigated and the rigidity of the muscles diminished—pulse ninety-five, soft and weak—bowels confined.

Rep. Ol. tigllii and contin. enem.

A liberal diet, with wine and ale ad libitum.

18th. Spasms less severe and recur less frequently—had dozed a little during the night—pulse eighty-five, and still feeble—perspiration profuse.

Contin. wine, ale, and the opiate injections.

21st. He has continued to improve during the last three days. He takes about three pints of wine and four pints of ale in the course of the twenty-four hours—pulse one hundred and fifteen, and weak—the opiate injections appear to constipate the bowels, which is counteracted by occasional doses of croton oil. Spasms still continue to give him considerable pain, especially in the muscles of the back.

28th. The tetanic symptoms gradually subsiding—he sleeps a good deal during the night, eats heartily, and drinks eight pints of ale in the course of the day without any intoxicating effects. The injections are now administered less frequently.

From this time the spasms and rigidity of the different muscles slowly disappeared, he gradually regained his strength, and was discharged, cured, October 8th, a slight sense of stiffness about the muscles only remaining.

M. François, a distinguished surgeon in the French navy, witnessed four cases of traumatic Tetanus and one of idiopathic treated successfully with the volatile alkali.—Bark, the sulphates of zinc, iron, and quinine, and the muriated tincture of iron, in large doses, have also been found useful as tonics in Tetanus.

Carbonate of Iron.

Though a tonic medicine, is supposed to exert a specific influence over several nervous affections and it has been strongly recommended by Dr. Elliotson, as a remedy in Tetanus.* In two severe cases, (33 and 34) after the bowels had been freely acted upon by turpentine, he gave the carbonate of iron, in doses of half an ounce, every two or three hours: both terminated favourably. In a third case, the disease was far advanced when the remedy was resorted to, and the patient died, within thirty hours afterwards, in a violent paroxysm.

* Medico-Chirurgical Transactions, vol. xv. p. 161.

Another case, (17) treated with the carbonate of iron, at the Brighton Hospital, also ended fatally. In a fifth case, (21) in which it was tried by Dr. Dehane, of Wolverhampton, the symptoms were severe, and, in the first instance, bark, ammonia, and laudanum were resorted to; but, on the fourth day, no amendment having been produced, the carbonate of iron was given, to the extent of 1 ℥. daily, under which treatment the spasms gradually subsided. It was remarked, in this last case, that, on the fifth day after the iron had been used, the patient having voluntarily discontinued it, the spasms were increased, but they slowly subsided as soon as it was resumed. I am not acquainted with any other case in which this remedy has been tried.

In three of the five cases which have been adduced, the exhibition of large doses of the carbonate of iron appears to have been attended with success. There is, however, no sufficient reason for considering that it exerts a specific influence over the disease. As Tetanus is not essentially an inflammatory affection, and occasions no perceptible change in the structure of any important organ, if death were not produced by spasms attacking the muscles implicated in respiration, there is every reason to believe that, in individuals of a strong constitution, the disease would often wear itself out, without the interference of medical treatment; and that in other instances, simply by counteracting with tonics and stimulants the debility and exhaustion consequent upon its continuance, the spasms would slowly and gradually subside. In severe cases, the risk of suffocation is too great to justify this course of proceeding, and it therefore becomes necessary to resort to such energetic means as will at once arrest, or render less frequent those distressing paroxysms in which the disease so often terminates fatally. In regard to the carbonate of iron, Dr. Elliotson, indeed, observes, "that some cases will be too rapid for its action to be exerted, and that in others the degree of trismus will prevent its sufficient exhibition." As a tonic it is a most valuable medicine, and in chronic Tetanus free from fever, or in promoting recovery from the acute form after the more severe spasms have been subdued, it may often be highly useful; but when the symptoms are urgent, to depend on a remedy that is stated to require two or three days to exert its influence, cannot be viewed as a rational practice. When the carbonate of iron is employed, I believe that larger doses than one or two drachms are unnecessary.

Hydrocyanic Acid.

It appears, from recent investigations, that this acid acts on the brain and spinal marrow independently, its action on the latter causing spasms closely resembling those excited in Tetanus. Its effects, therefore, are obviously ill adapted to afford relief in this disease; nor do the few trials that have been made of it seem to have been attended with much success. The hydrocyanic acid was first recommended as a remedy in Tetanus, by Mr. H. Ward, of Gloucester,

who published some cases in which he supposed it to have been of service*. It was employed in small doses, in cases VIII. 13, and 89, all of which were fatal. In one of them, case VIII., which occurred at the London Hospital, it can scarcely be said to have had a fair trial. The acid was given in doses of three minims every four hours, without producing the slightest effect; but the original injury was so severe, a compound dislocation of the astragalus and os naviculare, with laceration of the posterior tibial artery, that before the access of Tetanus it was evident that the only chance of saving life was afforded by removal of the limb, to which operation the patient would not consent. In case 13 it was noticed that the pulse was remarkably increased, after every dose of the acid which did not exceed a minim. In a case recorded by Mr. Ward, the patient was a girl, eight years of age, and the disease occurred after a burn in the axilla. The limbs were extended, the eyes fixed, the belly tense, the jaws locked, and the tendons affected with subsultus. A drop and a half of the acid in cinnamon water was given every half hour. In three hours the spasms were greatly relieved. This medicine was then ordered to be taken every four hours in conjunction with wine. This plan was persisted in for nearly a fortnight, when the dose was lessened. The patient ultimately recovered. This is the only case mentioned by Mr. Ward, or by any writer that I am aware of, in which this acid has appeared to promote recovery. The patient was, however, a female, and it is somewhat doubtful whether the disease should not be regarded as idiopathic, since tetanic symptoms did not show themselves till ten weeks had elapsed after the burn.

Other Remedies.

Dufresnoy has recommended the *colchicum autumnale* for the treatment of Tetanus; and Dr. Smith, an American physician, states that of four cases treated by him with the vinous tincture, three recovered†.

The introduction of remedies into the system by injecting the veins, is too hazardous a mode of treating disease to meet with much favour in this country. It is only in affections of formidable severity, as malignant cholera and hydrophobia, that we can ever be warranted in resorting to such dangerous measures. On the continent it has been attempted to subjugate the symptoms of Tetanus by the employment of remedies in this way. MM. Percy and Laurent are reported to have made trial of the injection of an aqueous solution of opium into the crural and median veins in seven instances. In three of them, the experiment was performed upon Russian soldiers, who recovered. In the case of a Spanish female, aged fifty, who was attacked with Tetanus, after the application of an antimonial caustic to an ulcer at the neck of the uterus, a scruple of opium,

* Observations on Tetanus. Gloucester, 1825.

† American Journal of the Medical Sciences. Nov. 1835.

dissolved in two ounces of water, was introduced into the cephalic vein on the first day of the disease, in three injections, at intervals of twenty minutes. The patient in a short time fell asleep, the muscles relaxed, and the pulse fell from 120 to 70. The effects, however, of the opium on the system ceased at the termination of eight hours, when the patient awoke and the spasms returned. The operation was repeated several times, but with the same result; the disease progressed, and had a fatal termination on the third day*. MM. Percy and Laurent have likewise injected the *datura stramonium* in several case of Tetanus, with a successful result. They employed twenty grains of the extract dissolved in half an ounce of water, or a strong decoction of the plant.

From the experiments of Sir Benjamin Brodie, it appears that the upas antiar, a poison obtained from Java, when inserted in a wound, occasions death in the same way as tobacco when injected into the intestines†. It is known also that the influence of the ticunas, a poison procured from the North American Indians, is to paralyse muscular action; and from some experiments performed by Professor Emmert, it would appear to act on the spinal cord without affecting the brain. The powerful sedative effects of both these poisons might justify a very cautious trial of them, in such a formidable disease as acute Tetanus. Mr. Morgan produced in dogs, by means of strychnine, artificial Tetanus, the spasms of which he completely succeeded in controlling by inoculation of the ticunas; and Mr. Sewell, of the Royal Veterinary College, made trial of it in a horse and in an ass, affected with idiopathic Tetanus. The Tetanic symptoms were completely removed under its influence, although the animals subsequently died, not however from the experiment, nor from the return of Tetanus, but one from inanition, and the other from repletion.

Concluding Remarks on Treatment.

It appears from the preceding review of the numerous remedies and plans which have been resorted to for the relief of Tetanus, and of the description of cases and circumstances to which the dissimilar remedies are specially adapted, that the disease is developed in three forms, each requiring a different mode of treatment. 1. Pure acute Tetanus; 2. Acute inflammatory Tetanus; and 3. Chronic Tetanus. This division being founded upon the symptoms of the disease, without reference to its exciting cause, is obviously more practical than the one generally adopted.

1. *Pure Acute Tetanus*.—If the disease be traumatic, and the patient is seen at the very onset, topical means may be applicable. The medical treatment of this form mainly consists, in maintaining

* Journal des Progrès, 1830, vol. iii. p. 256. At the Veterinary School, at Alfort, the injection of the acetate of morphia into the veins was tried upon two horses affected with Tetanus, but the result was unfavourable.—Hurtrel d'Arboval. Dictionnaire de Médecine et de Chirurgie Vétérinaires, vol. iv. p. 269.

† Phil. Trans. 1811.

a free action of the bowels, in allaying the spasms with the tobacco, cold affusion or any other sedative equally effective, and in the due exhibition of tonics and stimulants. Here success, especially in cases attended with impending suffocation, chiefly depends upon the energy, perseverance, and judgment with which the necessary means are employed. No time must be lost in the trial of inactive remedies, or of such as experience has demonstrated generally to fail. From the period that the patient is first seen, he should never be left until the spasms are in a great degree relieved. If opium be tried, unless its influence be speedily produced, and the muscles relaxed, it must be at once abandoned. By the use of cold affusion, or of tobacco, the spasms can generally be controlled. These remedies, therefore, must be vigorously employed and persevered in, until the required effects are obtained. Brandy and ammonia should be at hand; and as soon as reaction is established, and the paroxysms return, these sedative means must be again resorted to. Tobacco being more manageable, and if employed with sufficient care, unattended with danger, is preferable to cold affusion, which might only be used when the other remedy is unattainable.

2. *Acute Inflammatory Tetanus**.—The means necessary for the removal of this form of the disease are, purgatives, local and general depletion, counter irritation, mercury. As the tetanic irritation is here excited by active inflammatory action, in some part of the cerebro-spinal centre, or its membranes, the most energetic antiphlogistic measures must be pursued, until the symptoms of inflammation are subdued. Should, however, the spasms still continue, tetanic irritation remaining after its exciting cause is removed, the means recommended for the treatment of the first form, or of the third, according to the severity of the muscular contractions, must be then resorted to.

3. *Chronic Tetanus*.—The following remedies may be variously resorted to, according to the particular circumstances of the case. Purgatives, opium, antimony, vapour and warm water baths, the carbonate of iron, and other tonics, electricity. If the case be attended with febrile or inflammatory symptoms, proper means must be taken to remove them. In such instances the exhibition of opium, and other sedatives, may often be advantageously combined with antiphlogistic treatment; and it should be borne in mind, that although the spasms may be partly allayed by depletion, their complete removal does not depend upon the extent to which it is carried; and that the debility resulting from active depletion, is invariably prejudicial to ultimate recovery from tetanic irritation.

* That I may not be mistaken, I think it necessary to repeat that, by this form of Tetanus, I mean those cases of cerebral or spinal arachnitis, or of inflammation of the medulla itself, in which the tetanic irritation, excited by and superadded to the original disease, is distinctly and pretty fully developed. Vide page 50.

In offering these suggestions for the management of Tetanus, on what I conceive to be more scientific principles, I am fully conscious how little value can be attached to them from any adequate trial of the means recommended. And yet they are not submitted without mature consideration. The whole phenomena of Tetanus have been carefully investigated, the experience and opinions of different practitioners duly weighed, and my own opportunities for observation at a large hospital, remarkable for the number of its accidents, have not been neglected. Future experience, however, will decide how far the class of remedies recommended are calculated to meet the exigencies of the different forms of the disease. Perhaps for acute Tetanus, a sure and safe remedy in all cases is yet to be discovered. But if we clearly understand the indications to be fulfilled, and direct our treatment accordingly, we are infinitely more likely, as science advances, to find out this remedy, than by groping in the dark, or by disregarding the lights of experience, and stumbling where others have failed before us. If our present means are inadequate to the ends in view, we must seek for fresh resources from the botanist and the chemist; but in the application of these resources, we had better far pursue the course which reason suggests, than trust to the chances of empiricism.

CHAPTER IV.

TETANUS NASCENTIUM, NEONATORUM, OR INFANTUM.

THIS is a variety of traumatic Tetanus, occurring, as its name implies, in children soon after birth; generally in the course of the first week, or before the ninth day, having scarcely ever been observed to supervene at a later period than a fortnight. The muscles most frequently affected are those of the lower jaw, hence the term *Trismus* is commonly applied to this disease; but as many of the other muscles almost invariably participate, the term *Tetanus Nascentium* is more appropriate. In a case recorded by Dr. Furlonge, at page 111, it was observed that the face was strongly marked with a tetanic expression.

Tetanus Nascentium very rarely attacks children in this climate. Dr. Cullen, however, speaks of it as occurring in the Highlands of Scotland, and in Switzerland; and Dr. Clarke and Dr. Colles have met with it in Dublin. It is said to occur occasionally in Germany, at Paris, Vienna, and Brussels.* That the disease is seldom the cause of death in this country, is shown by a valuable table taken

* Dictionnaire des Sciences Médicales—Tétanos.

from the register, kept with great care at the Rusholme Road Cemetery in Manchester, and published by Mr. Robertson, to illustrate the mortality arising from various diseases at different periods of childhood. In four years from April, 1821, there were 2056 deaths under the age of ten years, of which number 146 died during the first month after birth, but not one from Tetanus.* Dr. Francis Ramsbotham, who has been connected for several years with a very extensive lying-in charity, assures me that he has not met with a single case. Like other forms of Tetanus, it is more frequent in warm climates,† especially in the West Indies, where the disease is the cause of mortality to so great an extent, that one writer states that a tenth of all the children that are born die of it.‡ Mr. Maxwell calculates its depopulating influence at about twenty-five per cent., which he justly observes has scarcely a parallel within the bills of mortality. Dr. Hancock remarks, it is so frequent and fatal in the colonies of Essequibo and Demerara, that at an average estimate it kills one half of the whole number of infants born there, and the fatality he reckons at least at ninety-nine in a hundred.§ Mons. Fourcroy calculates that at St. Dominique eighty out of every hundred of the negro children die of it before the ninth day.|| Dr. Morrison, who practised for some years at Demerara, has never known one authenticated case of recovery. Dr. Valentine witnessed several cases in America, but had never seen one cured. A Spanish physician, of the name of Hyacinthus Andreas, at the end of the seventeenth century, published an account of it as met with in the island of Minorca, in which he states that in twenty-six years' practice he had scarcely known six cases of recovery.¶ As was observed of traumatic Tetanus, negro children are more subject to this disease than the whites, which appears to be partly owing to the greater care taken with the latter after birth. Dazille affirms, that during thirty years' practice in different colonies, he had never seen or heard of a single white infant who had died "*du mal de mâchoire*." Campet states that the disease usually proves fatal on the second or third day; but that sometimes, when rapidly developed, it destroys in less than twenty-four hours.

Dr. Holland, in a summary of the diseases of the Icelanders, observes that although Tetanus Nascentium occurs very rarely, if at all, on the mainland of Iceland, it is eminently disastrous in Heimaey, one of a group of islands consisting entirely of lava, situated on the southern coast. The population of Heimaey, which is the only one of these islands that is inhabited, amounts to about 200 souls, being

* Observations on the Mortality and Physical Management of Children. Lond. 1827.

† A German author (Akermanns), who wrote on the disease in the last century, states that it is endemic in Guinea and other parts of Africa.

‡ Rush's Medical Observations and Inquiries. Philadelphia.

§ Edinburgh Medical and Surgical Journal, vol. xxxv. p. 343.

|| Les Enfants élevés dans l'ordre de la nature.

¶ Dr. Cleghorn's Observations on the Diseases in Minorca.

almost entirely supported by migration from the main land, as scarcely a single instance has been known of a child surviving the period of infancy. From the symptoms described by Dr. Holland, no doubt can be entertained of the tetanic nature of the malady that proves so fatal. The following table, which includes a period of twenty-five years, shows the mortality consequent upon this disease in that island, and exhibits also the days upon which death happened.

Children.				Days.	Children.				Days.
1	-	-	lived	2	18	-	-	lived	9
3	-	-	-	3	10	-	-	-	10
14	-	-	-	4	2	-	-	-	11
16	-	-	-	5	1	-	-	-	12
22	-	-	-	6	1	-	-	-	13
75	-	-	-	7	5	-	-	-	14
16	-	-	-	8	1	-	-	-	21

It will be seen from this table that the number of deaths on the seventh day greatly exceeded those on any other; and also, that they are more frequent on the fourteenth day, than on the days immediately preceding or succeeding it. No methods of cure had been resorted to by the inhabitants. There is no vegetable food, and the natives live principally on the sea fowls called fulmars and puffins, (*procellaria glacialis et alca arctica*, Linn.) which are slightly salted and barrelled. The only cause to which Dr. Holland could attribute the origin of this malady was, the practice of giving to the infant a strong and oily animal food, almost immediately after birth, which, it is supposed, would create irritation in the bowels. It is the more probable that the disease has some connection with the diet of the natives, as it appears to have been much more frequent, since their fishery was destroyed by the volcanic eruptions in 1783; and also from the circumstance, that in St. Kilda, the most remote of the Western Islands of Scotland, the inhabitants of which, in their diet and mode of life, much resemble the natives of Heimaey, the same disease exists*.

Tetanus Nascentium has been thought to arise from the irritation produced in the intestinal canal, by retained meconium; and Dr. Hillary noticed in cases where purgatives had been employed, that a large quantity of unnatural matter was dislodged from the intestines. Dr. Morrison, however, observes, that it has often been witnessed upon occasions when retention of the meconium could not be considered a cause, and he is inclined to attribute it rather to the influence of cold, or of vitiated air. Dr. Hancock regards active purging soon after birth, as one of the efficient causes of this disease; and he states that the nurses of Demerara usually give a new-born infant, of one or two days old, a dose befitting a child of two years. Dr. Joseph Clarke has published an account of this disease as occurring in Dublin, at which city it formerly proved fatal to a great many of the

* Travels in the Island of Iceland, during the summer of the year 1810. By Sir G. S. Mackenzie, Bart. Edinburgh, 1811.

infants born in the Lying-in Hospital. At the conclusion of the year 1782 it appears that, of 17,650 infants born alive, 2944 had died within the first fortnight after birth, being nearly every sixth child, or about seventeen in the hundred. Two forms of this affection are described; one acute, carrying the infant off in from eight to thirty hours, during the paroxysms of which the face was observed to become livid. The other was more chronic in its character, the patient surviving from three to five days, and in some rare instances to seven, or even nine. The memory of the oldest person, it is stated, does not furnish an instance of one being cured. Dr. Clarke believing that this great mortality originated in an impure atmosphere, suggested alterations for the more complete ventilation of the institution. Of 8033 infants born since the period at which these alterations were made, only 419 died of this disease, the rate of mortality being thereby reduced from seventeen per cent. to five or six*. In Jamaica, also, the occurrence of Tetanus Nascentium is attributed by Mr. Maxwell to a vitiated atmosphere, and in Germany it is said to be owing to close and unventilated chambers. It scarcely appears surprising that a vitiated atmosphere should be a predisposing cause of this disease at such a critical period, when its vivifying influence must be so essential for the preservation and support of the independent existence of the infant, especially when we reflect upon its effects in the production of the same and of other diseases at a more advanced age. Ledeschault states,† that compression of the fontanelles, and pouring cold water on the head in the ceremony of baptizing, have been known to bring on the disease.

It has been stated, that this disease is only a variety of the traumatic form of Tetanus, and since it occurs invariably within a very limited period after birth, we are justified in assuming that the injury done to the umbilical cord in its division or separation, bears the same relation to Tetanus Nascentium as the primary wound to traumatic Tetanus. Dr. Colles, of Dublin, has attempted to show that the immediate cause of the affection is inflammation and ulceration of the umbilicus. In numerous dissections of children who had fallen victims to it, the following morbid appearances were observed:—Externally in the vicinity of the umbilical vein, there were evident marks of superficial ulceration in some few instances, and in all the edges of the vein were thickened. The peritoneum covering the umbilical vein was highly vascular, as if from inflammation: this extended sometimes up to the fissure of the liver; often, however, not for a greater length than one inch above the umbilicus. The peritoneum, in the course of the umbilical arteries, seemed still more inflamed, an appearance which extended often as far as the sides of the bladder. The inner surface of the umbilical vein was pale, and free from any marks of inflammation, yet its coats were very much thickened. On slitting open the umbilical arteries, coagulable lymph was found

* Trans. of the Royal Irish Academy, vol. iii.

† Dissertation sur le Tétanos. Paris, 1815.

within their coats, and in all instances their coats were much thickened and hardened, even as far as the fundus of the bladder. The centre of the umbilicus was occupied by a soft yellow substance, resembling coagulable lymph*.

Although the appearances described by Dr. Colles, and considered as morbid, are stated to have been found in all the tetanic cases which he inspected, but were not discoverable in infants of the same age, who had died of other diseases, yet I am induced to regard them as little else than the ordinary results of the natural process towards the obliteration and closure of those vessels which, after birth, become useless. This view is corroborated by the investigations of Dr. Labatt, of the Dublin Lying-in Hospital, who has clearly shown, by several dissections, that the appearances described are not, as Dr. Colles represents, always present in infants who have died of Tetanus Nascentium, and that they are sometimes found in those who have died of other diseases†. And it is further confirmed by Dr. Thomson, in the examination of nearly forty children who died of this affection in Jamaica‡.

Tetanus Nascentium has, by Dr. J. W. Heustis, been attributed to the injury done to the umbilicus; he states that amongst the negroes in the West Indies, the cord is generally cut with a dull pair of scissors, and the part suffered to remain undressed, to ulcerate, and to run into gangrene, purely from carelessness and inattention||. Campet, a French writer of considerable experience, likewise attributes the origin of the disease to the improper treatment of the cord, and of the umbilicus, after its separation. Agreeably, however, to the view which has been taken of the state of the primary wound in traumatic Tetanus, I apprehend no greater importance can be attached to an inflamed or unhealthy aspect of the umbilical parts, than considering it as sympathetic of and indicating constitutional derangement, either from disorder in the alimentary canal, a vitiated state of the atmosphere, or other causes, a condition eminently favourable to the production of every form of this disease.

The pathological changes, remarked after death from Tetanus Infantum, appear to be equally inconstant with those observed in the other varieties of the disease. Dr. Goëlis, of Vienna, in the examination of children who have died of this disease in the Foundling Hospital of that city, frequently found an appearance of increased vascularity in the substance of and in the membranes enveloping the upper part of the spinal marrow§. The same has been observed by Dr. Thompson, of Philadelphia; whereas in the bodies examined by Dr. Thomson, of Jamaica, no morbid change in any part of the body could be detected.

The following are considered the predisposing causes of Tetanus

* Dublin Hospital Reports, vol. i. p. 285.

† Edinburgh Medical and Surgical Journal, vol. xv. p. 216.

‡ Ibid. vol. xviii. p. 41.

|| Observations on Tetanus. Medical Repository, New York, vol. iii. p. 122.

§ Dictionnaire des Sciences Médicales—Tétanos.

Nascentium ;—unwholesome nutriment—irritation of the intestinal mucous membrane, from the retention of unhealthy secretions, or from acrid purgatives—an impure atmosphere—damp and cold. In the West Indies it is sometimes found to prevail in certain districts, or on particular estates ; whereas, in other parts of the same island it will scarcely be known for many years. This apparent anomaly is very probably owing to some difference in the economy of the estate or districts, the food, soil, ventilation, or salubrity of the situation.

The dreadful fatality of Tetanus Nascentium, which, in fact, appears hitherto to have baffled treatment in almost every instance, renders necessary the utmost attention to avoid all those circumstances which are supposed to favour its occurrence. And here a more cheering prospect is presented to the medical practitioner. The great success that resulted from the judicious measures adopted by Dr. Clarke, in respect to ventilation, at the Dublin Lying-in Hospital, has been already adverted to. Mr. Maxwell remarks, that by paying attention to the same important circumstance and to the condition of the bowels and the navel, the disease was soon rarely to be met with. Dr. Lionel Chalmers, Dr. Hillary, and Dr. Cadwallader Evans* found, that by attending to the state of the bowels, and by exhibiting purgatives, the disease became much less frequent. Dr. John Stewart employed spirits of turpentine, as an application to the umbilicus in the prevention of this affection, with great success†. Dr. Colles also recommends the use of the oil of turpentine, as a dressing, and states, that on the estate of a lady in Jamaica, since this practice has been adopted, together with plunging the infant into a cold bath daily for the first nine days, this disease, which had formerly carried off a very great proportion of the children of the negroes, is now scarcely to be met with. Dr. Hancock mentions, that in Demerara cold bathing is looked upon as a certain prophylactic, and he strongly recommends the exhibition of opium for the same purpose. In warm climates, where the greatest regard should be paid to cleanliness, the frequent use of a bath must, no doubt, be highly beneficial in promoting the due performance of all the important functions. I can, however, see no advantage to be gained by employing stimulating applications to the umbilicus, but I would rather resort to the mildest dressings, and, should there be any appearance of inflammatory action, to cold lotions or emollient applications.

In the treatment of this disease, the same principles should be acted upon as in the treatment of traumatic Tetanus. Having cleared out the alimentary canal with castor oil or the hydrargyrum cum cretâ, small doses of laudanum may be given—one, two, or more drops, as may appear necessary, every hour, until rest is obtained or the spasms are relaxed. Should any difficulty be experienced in the exhibition of remedies by the mouth, injections might be employed.

* American Philos. Trans. vol. ii. page 336.

† Dr. Chisholm's Essay on the Malignant Pestilential Fever.

I have only met with one case of recovery, the particulars of which have been recorded. It occurred in the practice of Dr. Furlonge, at Antigua; and the following is an account of it, slightly abridged.

Case.—An infant, on the eighth day after birth, refused the breast, and, at the same time, a stiffness of the jaws was observed. The next morning a dose of calomel and jalap was given, and the infant was placed in a warm bath every three hours. On the following day, it was not only affected with trismus, but was universally tetanic, the characteristic expression of the countenance being well marked. Although the case was considered hopeless, Dr. Furlonge ordered one drop of laudanum every three hours, a warm bath four times in the course of the day, the jaws to be rubbed frequently with warm laudanum, the umbilicus to be dressed with turpentine and mercurial ointment, the nape of the neck and back to be blistered, and two grains of Dover's powder with five grains of the sulphate of zinc, to be taken between each dose of the laudanum. Next day, the bowels had acted and the blister risen well, and it was remarked that the jaws were less tightly closed. The belly was now directed to be rubbed with warm laudanum, and a small quantity of camphor was added to the powders, and the blistered surface dressed with turpentine and mercurial ointment. This treatment was continued for three weeks, during which time the child slept much, evidently from narcotic influence. It could not take the breast for a fortnight, but, in four weeks from the first invasion of Tetanus, it was free from every symptom of the disease, with the exception of considerable tenderness of the abdomen on pressure.*

Dr. Duncan, surgeon at Grenada, states, that he knew one instance of recovery simply by the use of the warm bath.†

With these cases I shall conclude a treatise, in the course of which it may be thought, that on some occasions the opinions of accredited and experienced authors have been opposed with a freedom ill-befitting a young writer; yet I would rather render myself liable to this reproach, than diminish the force with which those views, that are the result of conviction, are expressed, by an overweening and squeamish regard for authorities. I trust, however, that on no occasion have they been treated with disrespect. Some may think that the facts which justify my conclusions have not always been stated sufficiently in detail, and that the references are brief and scanty. Prolixity is a fault always more readily incurred than avoided; and, if these pages have not been swelled with the abundant materials on record, it must not be inferred that the data which they furnish have been the subject of less patient and attentive consideration. Imperfections and defects, I fear, are numerous, but they are in some degree unavoidable. Those who have more especially studied the diseases of the nervous system, best know the difficulties which beset

* Edin. Med. and Surg. Journal, 1830, p. 57.

† Ibid. vol. ii. p. 203.

the path of him who strives to improve our knowledge of their pathology and treatment. In no part of medicine is the field more open—in none have the investigators been more numerous, persevering, and skilful; yet no where has the progress of advancement been slower and less sure. The toil must still be shared by many labourers; and if in the prosecution of a branch only of a class of the diseases of this intricate system, I have succeeded in dissipating some slight portion of the error and fallacy which invest it, or have aided in establishing any one principle of importance and utility, I shall have a sufficient apology for submitting the preceding observations to the notice of my professional brethren.

APPENDIX.

TABLE OF ONE HUNDRED AND TWENTY-EIGHT

Showing the Sex, Age, nature of the Injury, at what period after the Wound Tetanic Symptoms, the Remedies resorted to, and the

MA

No.	NAME.	AGE.	NATURE OF THE INJURY.	Appearance of Symptoms.
I.	—	10	Gunshot wound of the calf of the right leg	5th day
II.	Thos. Mountford	21	Forefinger of the right hand injured by a nail	3 weeks
III.	—	30	Severe contusion of two of the fingers of the right hand	A fortnight
IV.	Thomas Moss	22	Compound dislocation of the great toe of the right leg	10 days
V.	Sanderson Philipps	42	Right thigh wounded by an iron spike	9th day
VI.	—	26	A blow on the head, and thrown into a canal	4th day
VII.	—	19	Sole of the left foot injured by a nail	3 weeks
VIII.	—	31	Compound dislocation of the astragalus and os naviculare	7th day
9	Thomas Purkiss	40	Contused knee	9th day
10	William Kidd	16	Laceration and contusion of the hand	13th day
11	William Golden	16	A blow on the back of the neck	Following day
12	John Thompson	25	Lacerated wound of the little toe	10th day
13	W. Hayes	14	Sole of the foot wounded with an iron spike	11 days
14	H. S.	—	Forefinger wounded with a blunt piece of tin	12 hours
15	L. —	21	Wound in sole of the foot with a nail, followed by an abscess	16th day
16	— Cavazo	33	Foot slightly wounded with a nail	A month
17	James Coppard	70	Contusion of right hand, with fract. of 3 of metacarpal bones	10 days
18	Robert Gutter	21	Lacerated wound of integuments of leg closed with sutures	16th day
19	William Pile	15	Foot wounded with a rusty nail	11 hours
20	—	10	{ Fracture of both bones of the right leg, with extensive } laceration of the integuments	9th day
21	Robert Ireland	43	{ Fractures of left leg, crista of the ileum and great toe } of right foot, with lacerations	10th day
22	James Greaves	mid. age	Foot wounded with a nail	14th day
23	Samuel Wood	20	Contused wound of the finger	A month
24	Angus M'Farlan	23	{ Amputation at the shoulder joint, on account of a gun- } shotwound of the arm	26th day
25	Frank, a Negro	22	Contusions about the head and body	—
26	—, a Negro	25	Sole of the foot wounded with a rusty nail	3d day
27	Samuel Joyce	35	Contused wound on the forehead	24th day
28	Joseph Owen	—	Laceration of the great toe	3 weeks
29	J. Collins	30	Amputation of two fingers	11 days
30	W. Merrit	30	Amputation of the leg	13th day
31	W. Harris	—	Amputation at the shoulder joint	12th day
32	—	19	Slight wound of the left hand	18th day
33	Charles Frasier	mid. age	Compound dislocation of the great toe	14th day
34	Bryan Macquire	44	Right thumb jammed between two pieces of wood	8 days
35	J. Flood	13	Feet torn by machinery	9th day

CASES OF TRAUMATIC TETANUS.

Symptoms were first evinced, the Result, and at what time after the Appearance of Sources from which the Cases have been obtained.

LES.

Result, and in what time after.	TREATMENT.	AUTHORITY.
Fatal, 16 hours	Purgatives. Opium. Tartar emetic bath	The Author . . . <i>vide page</i> 23
Fatal, 4 days.	Purgatives. Opiate injections	— 49
Cured, 3 weeks	V. S. Opium. Calomel	— 75
Fatal, a fortnight	Opiate injections. Stimulants	— 82
Fatal, 3d day	Opium. Tobacco	— 87
Fatal, 9th day	Mercury. Opium. Tobacco	— 88
Cured	Purgatives. Opiate injections. Stimulants	— 99
Fatal, 2d day	Hydrocyanic acid	— 101
Fatal, 6th day	Purgatives. Opiate injections	—
Fatal, 15th day	Purgatives. Opium. Stimulants	—
Fatal, 2d day	C. C. Nuchæ. Croton oil. Opium. Belladonna	Medical Gazette, i. 645.
Fatal, a fortnight	{ Purgatives. Mercury. Opium. Antimony. Musk. } { Turpentine. Belladonna }	— i. 646.
Fatal, 2d day	Cold affusion. Sulphate of Quinine. Hydrocyanic acid	— ii. 343.
Cured, a few hours	Amputation. V. S. Tobacco. Opium	— ii. 141.
Fatal, 10th day	V. S. Leeches. Opium. Musk. Mercurial friction	— vi. 830.
Fatal, 18 days	V. S. Leeches. Opium. Vapour-baths	— vii. 312.
Fatal, 2d day	Blisters. Turpentine injections. Carbonate of iron	— vii. 383.
Fatal, 7th day	Opium	— vii. 828.
Cured, 3d day	Division of the nerve. Opium. Camphor. V. S.	— xi. 623.
Fatal, 2d day	{ Nerve divided. Croton oil. Opium. Antimony. } { Tobacco. Cantery }	— xii. 15.
Cured, a month	Bark. Opium. Carbonate of iron	— xii. 799.
Cured, 6 weeks	V. S. Musk. Opium. Valerian	Medical Obs. and Inq. i. 51.
Cured, 6 weeks	V. S. Blister. Musk. Bark. Camph. Valerian. Amputation	— ii. 382.
Cured, a month	Musk. Opium	— iii. 320.
Cured, a week	Cold affusion	— vi. 148.
Cured, 4 days	Cold affusion. Opium. Bark	— vi. 155.
Cured, 5 weeks	{ Mercury. Colocynth. Gamboge. Scammony. } { Opium Stimulants }	Med-chir. Trans. ii. 284.
Fatal, 7th day	V. S. Mercury. Dover's powders. Tobacco	— vi. 93.
Fatal, 2d day	Opiate injections	— vii. 468.
Fatal, 8th day	V. S. Warm-bath. Mercury	— vii. 470.
Fatal, 2d day	Warm-bath. Opium	— vii. 473.
Cured, 24 days	V. S. Warm-bath. Purgatives. Mercury. Dover's powders	— xi. 384.
Cured, 10 days	Turpentine. Carbonate of iron. Musk. Stimulants	— xv. 163.
Cured, 25 days	Turpentine. Carbonate of iron	—
Cured, 6 weeks	Purgative. Turpentine injections. Leeches. Tobacco	Dublin Hospital Reports, iii. 357.

No.	NAME.	AGE.	NATURE OF THE INJURY.	Appearance of Symptoms.
36	Henry Southerby	14	A bite by a dog in the leg	A week
37	—	15	Both heels lacerated, and left humerus fractured	7th day
38	—	22	Sole of the foot wounded with a nail	5th day
39	John Ashford	40 to 50	A blow on the side of the head	4 weeks
40	John Patrick	12	A burn on the right thigh, penis, scrotum, and abdomen	10th day
41	Richard Burton	37	Foot wounded with a spike	3 weeks
42	—	17	Severe contusion of the left heel	Some days
43	—	44	A wound in the leg	15th day
44	— Payne	—	Finger pierced by a splinter	10 days
45	James Sydling	40	Amputation of the leg	5th day
46	William Godby	54	Lacerated wound of the instep, and great toe fractured	8th days
47	William Collins	30	Laceration of the integuments over the gastrocnemius muscle	20 days
48	—	50	Slight graze on the nose	—
49	Smart, a Negro	18	Slight contusion of one of the toes	10 days
50	Luke, a Negro	12	Punctured wound of the thumb	Several days
51	—, a Negro	22	Slight wound of the head	7th day
52	Wm. Gray, a Negro	28	Thumb wounded with a splinter	9 days
53	—	—	Great toe punctured with a nail	2 weeks
54	Charles Wattell	30	Right hand wounded by a pistol-ball	7th day
55	Manus M'Gowan	22	Wound of the elbow-joint from a musket-shot	16th day
56	—, a Negro	20	Laceration and contusion of the left foot	15th day
57	James Macrae	15	A severe lacerated wound of the left leg	10th day
58	George Pybus	27	A wound on the left leg	A fortnight
59	Robert Millar	20	Two musket-shot wounds in the left arm	A month
60	John Brown	25	A bite on the thigh	2d day
61	Robert Tilling	8	A severe burn on the right hand	10th day
62	—, a Negro	—	Sole of the foot wounded with a rusty nail	13th day
63	Joseph Wishart	20	Contusion of the abdomen	17 days
64	William Boyle	14	Laceration of the hand	12 days
65	Evan Wright	15	Severe compound fracture of the thumb	A fortnight
66	John Key	—	Left arm wounded by a musket-ball	7th day
67	— Gray	16	{ Arm shot away by a cannon-shot. Amputation at } { shoulder joint five days afterwards }	3 weeks
68	Elijah Dunn	14	{ An extensive wound on the right leg, and a slight wound } { on the outer ankle of the left leg }	10 days
69	—	16	A wound on the hip from a splinter	5th day
70	W. Richey	30	Right arm shot away—amputation at the shoulder joint	8th day
71	M. Wheelan	18	Wounded on shoulder and several places on back by splinters	8th day
72	— Robinson	mid. age	Compound fracture of the hand by a grape shot	9th day
73	W. Meath	30	Leg shot away—amputation	9th day
74	J. Cairns	—	Wounded in the groin by a musket-shot	8th day
75	T. Kelly	—	A compound fracture of the leg	10th day
76	W. Connars	29	A severe wound in the back by a splinter	11th day
77	William Taylor	25	Elbow-joint shattered by a ball	22d day
78	James Warring	20	Severe contusion of the thumb of the right hand	15th day
79	— Landers	23	Sole of the foot wounded with a rusty nail	8th day
80	J. Milwood	—	A wound upon the great toe from a hand-saw	10th day
81	Thomas Platt	46	Compound fracture of the thigh	3 weeks
82	J. Adams	44	Severe laceration of the hand and fingers	10th day
83	J. Murdoch	13	Punctured wound of the leg	9th day
84	J. C. Wright	49	Punctured wound of the thumb	8th day
85	Anthony Brunetti	58	An incised wound on the back of the hand	21st day
86	Lewis Fonzi	50	Slight wound on the finger	—
87	Francis Mailhiot	50	Wounded with a nail in the sole of the left foot	10th day
88	John Johnson	20	An incised wound of the extremity of the finger	16th day
89	T. T. Mitchell	20	Wounded with a rusty nail in the sole of the foot	5th day
90	J. Kelly	14	{ Fracture of the radius, and laceration of the integuments } { of the right leg }	16th day
91	Daniel Power	40	Fracture of the leg, with slight laceration of the integuments	6th day
92	Patrick Vallily	15	Scalded on the leg, thighs, and arms, with hot water	10th day
93	William Fleming	17	7th day
94	Thomas Lee	45	Compound fracture of three fingers	10th day

Result, and in what time after.	TREATMENT.	AUTHORITY.
Cured, a month	Purgatives. Mercury. Opium. Leeches. Tonics	Bright's Medical Reports, ii. 558.
Fatal, 40 hours	Musk. Purgatives. Opiate injections.	— 572.
Fatal, 4th day	Opium. Blisters. Antimony	— 573.
Fatal, 4 weeks	Purgatives. Tobacco. Turpentine	— 579.
Fatal, following day	Opium. Musk	Swan, on Tetanus, 77.
Fatal, 6th day	Turpentine. Opium. Mercury. Amputation	— 82.
Fatal, 20 days		Morgagni de Causes, &c. liv. 49.
Cured, 3 weeks	Opium. Stimulants. Cold affusion	Currie's Medical Reports. i. 169.
Cured, 8 weeks	Opium. Stimulants. Cold affusion	— i. 172.
Fatal, following day	V. S.	Parry's Cases of Tetanus.
Fatal, following day	Opium. Cold affusion. Antimony.	—
Cured, 10 days	Opium. Mercury	—
Cured, 10 days	V. S. Purgatives. Opium.	Lawrence's Lec. Med. Gaz. v. 549.
Fatal, 3d day	Purgatives. Tobacco	Edin. Medico-chir. Trans. ii. 366.
Cured, a month	Purgatives Tobacco	— ii.
Fatal, 8th day	Mercury. Opium	Jamaica Physical Journal, 1834.
Fatal, 5th day	V. S. Tobacco	—
Fatal, 40 hours	Tobacco	—
Cured, a month	Opium. Cold-bath. Digitalis. Stimulants	Edin. Med. & Surg. Jour. vii. 14.
Cured, a month	V. S. Opium. Amputation. Warm-bath. Mercury	— viii. 412.
Cured, 6 weeks	Opium. Warm-bath. Tobacco. Stimulants	— xi. 198.
Cured, 3 weeks	Mercury. Opium. Stimulants. Tonics	— xi. 306.
Cured, 6 weeks	Opium. Stimulants. Tonics	— xi. 422.
Cured, a month	Opium. Stimulants	—
Cured, a fortnight	Purgatives. Opium. Mercury. Stimulants	— xiii. 451.
Cured, a month	Amputation	— xvii. 394.
Fatal, 20 hours	Mercury. Opium. Camphor	— xviii. 38.
Cured, a month	V. S. Opium. Blisters. Mercury	— xviii. 191.
Fatal, 10 days	Amputation. Opium. Mercury	— xxi. 292.
Cured, a fortnight	Purgatives. Tobacco. Leeches. Mercury	— xxiv. 277.
Fatal, following day	Opium. Mercury	— xxx. 21.
Cured, a month	Purgatives. Opium. Mercury. Stimulants	— xxx. 28.
Fatal, 12th day	Opium. Stimulants. Cantharides. Cold affusion. Mercury	Med. & Phys. Jour. xiv. 129.
Fatal, 4th day	Warm-bath. Mercury	— xxi. 181.
Fatal, 2d day	Mercury	—
Fatal, 4th day		— xxi. 409.
Fatal, 3d day	Blisters. Mercury	— xxi. 446.
Fatal	Mercury	—
Fatal, 4th day	Blisters. Mercury	—
Fatal, 4th day	Mercury. Amputation	— xxii. 120.
Fatal, 5th day	Mercury	—
Cured, 7th day	Amputation	—
Fatal, 2d day	V. S. Opium. Mercury. Warm-bath	— xxii. 324.
Fatal, 5th day	Mercury. Division of wounded parts	— xxii. 185.
Cured, 8 weeks	Opium. Warm-bath. Stimulants. Mercury	— xxii. 396.
Cured	Mercury. Opium	— xxii. 479.
Fatal, 2d day	Mercury. Opium. Blisters	Medical Quar. Review, iv.
Cured	Purgatives. Opium. Mercury. Cold aff. V. S. Stimulants	Medical & Phys. Jour. xxxvii. 19.
Cured	V. S. Purgatives. Opium	— xxxvii. 23.
Cured, 5 weeks	{ Opium. Warm-bath. Camphor. Hyoscyamus. V. S. } { Purgatives. Mercury }	— xliii. 192.
Cured, 6 weeks	Digitalis. Leeches. Antimony.	— xliii. 239.
Cured, 4 days	V. S. Mercury. Purgatives. Warm-bath	— xlv. 538.
Cured, 5 weeks	Opium. Purgatives. Blisters. Hyoscyamus	— l. 446.
Fatal, 2d day	Purgatives. Hydrocyanic acid. V. S.	— lvi. 319.
Cured, a week	{ Purgatives. Leeches. Carbonate of iron. Mercury. } { Opium. Antimony. Cold affusion. }	— lxii. 220.
Fatal, following day	Mercury. Opium	— lxvi. 42.
Fatal, 6th day	Purgatives. Opium. Mercury	Glasgow Medical Jour. ii.
Fatal, 3d day	{ Leeches. Mercury. Amputation. Antimony. Ace- } { tate of morphia }	— ii.
Fatal, 26 hours	Purgatives. Mercury. Opium. Blisters	Medico-Chirurg. Rev. x. 614.

No.	NAME.	AGE.	NATURE OF THE INJURY.	Appearance of Symptoms.
95	John Triggs	25	Slight wound on the outer ankle of the right leg . . .	7th day
96	Samuel Grigg	40	A lacerated wound above left elbow, and a scratch on nose .	5th day
97	Pierre Genet	30	A fall on the nose, causing excoriation and epistaxis . .	Five days
98	— Moustapha	27	{ Compound fracture, with laceration of the fingers and } hand, from a gun-shot }	A month
99	M. Bonichon		Gun-shot wound of the left foot	A fortnight
100	—	16	A blow on the cervical spine	3d day
101	M. Leydet		A compound fracture of the leg	7th day
102	—	28	{ Last phalanx of auricular finger of left hand removed by } a blow with a hatchet }	2 hours
103	Edward Wyer		Sole of his left foot wounded with a nail	11th day
104	Joseph Parks	15	Fracture of the bones of the thumb with laceration . .	6th day
105	Miles Bartley	60	A slight wound on the ear and temple	7 days
106	James Gaffney	42	Lacerated wound of the thumb	8 days
107	Michael Farrell	24	A contusion and slight laceration on the right shin . .	3 weeks
108	—	22 mo.	Fracture of the tibia and tarsus with laceration . .	8th day
109	—	18	Two fingers amputated on account of gun-shot wound .	10th day
110	—	38	Fracture of both bones of left leg	23d day
111	—	48	Foot injured by a rusty nail	A week
112	—	40	Fracture of the little finger	9th day

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113	Mary Breaklock	30	A cut on the thumb	4 days
114	Maria Ursin	28	Tendon of peroneus long. exposd in an ulcer, pulled in dressing	An hour
115	— W.	40	Lacerated wound on the palm of the left hand . . .	11th day
116	A. B., a Negress	40	Cupping on the temples	5 days
117	Acouba, a Negress	mid. age	Incised wound of the hand and fingers	13th day
118	—	50	A compound fracture of the leg	3 weeks
119	Elizabeth Fox	23	{ Lacerated wound of the ring finger of the right hand— } last joint amputated }	16th day
120	E. E.	22	Sole of the left foot wounded with a thorn	3 weeks
121	Ann Alford	22	Toes frost-bitten	
122	Mrs. Martin	52	Wounded in the left cheek by an arrow	Following day
123	Mary St Gelais		Laceration of the integuments of the right knee . .	18 days
124	Susannah, a Negress	24	Foot wounded with a bit of broken glass	8th day
125	Mary Ann Elliott	14	A lacerated wound of the wrist and palm of the hand .	14th day
126	—	37	Compound fracture of the right leg	18th day
127	Justine, a Negress	18	Amputation of the thigh	10th day
128	—, a Negress	20	A cut on the metatarsus	10th day

Result, and in what time after.	TREATMENT.	AUTHORITY.
Cured, 6 weeks	Dover's powders. Purgatives. Tonics	Med. Transactions, iv. 29.
Fatal, 40 hours	London Med. Repos. xiv. 1.
Fatal, 7th day	Opium. Warm-baths. Caustery	{ Larrey, Memoires de Chirurgie Militaire, i. 241.
Cured, a month	Opium. Warm-baths. Camphor. Musk	— i. 250.
Cured	Amputation. Opium	— i. 265.
Fatal, same day	V. S. Purgatives	Dazille, Observ. sur le Tetanos.
Fatal, 3d day	—
Fatal, 12 hours	V. S. Warm-bath. Opium	Diction. des Sciences Medicales
Fatal, 9th day	Cold affusion. Tonics. Warm-baths. Electricity. Mercury	Med. Facts and Obs. vii. 267.
Fatal, 2d day	V. S. Purgatives. Opium. Cold affusion. Mercury	{ Transactions of the College of Physicians, Ireland, iv. 275.
Fatal, 6th day	Purgatives. Tobacco. Opium	—
Fatal, 3d day	Tobacco. Mercury	—
Cured, a fortnight	V. S. Purgatives. Merc. Antimony. Stimulants. Opium	—
Fatal, 2d day	Travers, on Const. Irrit. ii. 313.
Fatal, 3 days	Purgatives. Belladonna	—
Fatal, 4th day	—
Fatal	Belladonna	—
Fatal, 48 hours	V. S.	—

ALES.

Fatal, 19th day	Leeches. Opium. Antimony. Mercury. Zinc	Dr. Bright's Med. Reports, li. 575.
Cured, 2 days	V. S. Leeches. Warm-bath. Mercury. Morphia	Medical Gazette, ii. 384.
Cured, a fortnight	Opium. Mercury. Turpentine	— vii. 428.
Cured	Purgatives. Tobacco	Edin. Medico-chir. Trans. i. 184.
Cured, 6 weeks	Purgatives. Tobacco	—
Cured, 5 weeks	Opium. Mercury	Medico-chir. Trans. ii.
Cured, a month	Blisters. Opium. Amputation	Medical Observ. and Inq. i. 1.
Cured	Blisters. Mercury. Opium. Cold affusion	Ed. Med. & Surg. Journ. i. 294.
Fatal, 2 days	Opium. Mercury	Parry's Cases of Tetanus, 10.
Cured, a month	Opium. Purgatives. Mercury. Antimony	Med. and Phys. Journ. xxiv. 40.
Cured, a month	V. S. Purgatives. Opium. Mercury	— xlii. 95.
Fatal, 5 days	V. S. Mercury. Opium. Stimulants Warm-bath	Dr. Morrison's Treat. on Tetanus.
Cured, 2 months	Purgatives. Opium. Tobacco	Travers, on Const. Irrit. ii. 323.
Fatal, 3d day	Opium. Æther	— ii. 316.
Cured, 3 months	Purgatives. Tobacco. Opium	Campet, Traite des Mal. graves, 18.
Cured, 3 months	V. S. Purgatives. Opium. Tobacco	— 22.

Account	Particulars	Amount
Jan 1	Balance forward	100.00
Jan 2	To Cash	50.00
Jan 3	By Cash	25.00
Jan 4	To Cash	75.00
Jan 5	By Cash	30.00
Jan 6	To Cash	100.00
Jan 7	By Cash	40.00
Jan 8	To Cash	60.00
Jan 9	By Cash	20.00
Jan 10	To Cash	80.00
Jan 11	By Cash	15.00
Jan 12	To Cash	90.00
Jan 13	By Cash	35.00
Jan 14	To Cash	55.00
Jan 15	By Cash	10.00
Jan 16	To Cash	70.00
Jan 17	By Cash	25.00
Jan 18	To Cash	65.00
Jan 19	By Cash	45.00
Jan 20	To Cash	85.00
Jan 21	By Cash	30.00
Jan 22	To Cash	50.00
Jan 23	By Cash	15.00
Jan 24	To Cash	95.00
Jan 25	By Cash	40.00
Jan 26	To Cash	60.00
Jan 27	By Cash	20.00
Jan 28	To Cash	80.00
Jan 29	By Cash	15.00
Jan 30	To Cash	90.00
Jan 31	By Cash	35.00
Feb 1	To Cash	55.00
Feb 2	By Cash	10.00
Feb 3	To Cash	70.00
Feb 4	By Cash	25.00
Feb 5	To Cash	65.00
Feb 6	By Cash	45.00
Feb 7	To Cash	85.00
Feb 8	By Cash	30.00
Feb 9	To Cash	50.00
Feb 10	By Cash	15.00
Feb 11	To Cash	95.00
Feb 12	By Cash	40.00
Feb 13	To Cash	60.00
Feb 14	By Cash	20.00
Feb 15	To Cash	80.00
Feb 16	By Cash	15.00
Feb 17	To Cash	90.00
Feb 18	By Cash	35.00
Feb 19	To Cash	55.00
Feb 20	By Cash	10.00
Feb 21	To Cash	70.00
Feb 22	By Cash	25.00
Feb 23	To Cash	65.00
Feb 24	By Cash	45.00
Feb 25	To Cash	85.00
Feb 26	By Cash	30.00
Feb 27	To Cash	50.00
Feb 28	By Cash	15.00
Feb 29	To Cash	95.00
Feb 30	By Cash	40.00
Feb 31	To Cash	60.00
Mar 1	By Cash	20.00
Mar 2	To Cash	80.00
Mar 3	By Cash	15.00
Mar 4	To Cash	90.00
Mar 5	By Cash	35.00
Mar 6	To Cash	55.00
Mar 7	By Cash	10.00
Mar 8	To Cash	70.00
Mar 9	By Cash	25.00
Mar 10	To Cash	65.00
Mar 11	By Cash	45.00
Mar 12	To Cash	85.00
Mar 13	By Cash	30.00
Mar 14	To Cash	50.00
Mar 15	By Cash	15.00
Mar 16	To Cash	95.00
Mar 17	By Cash	40.00
Mar 18	To Cash	60.00
Mar 19	By Cash	20.00
Mar 20	To Cash	80.00
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