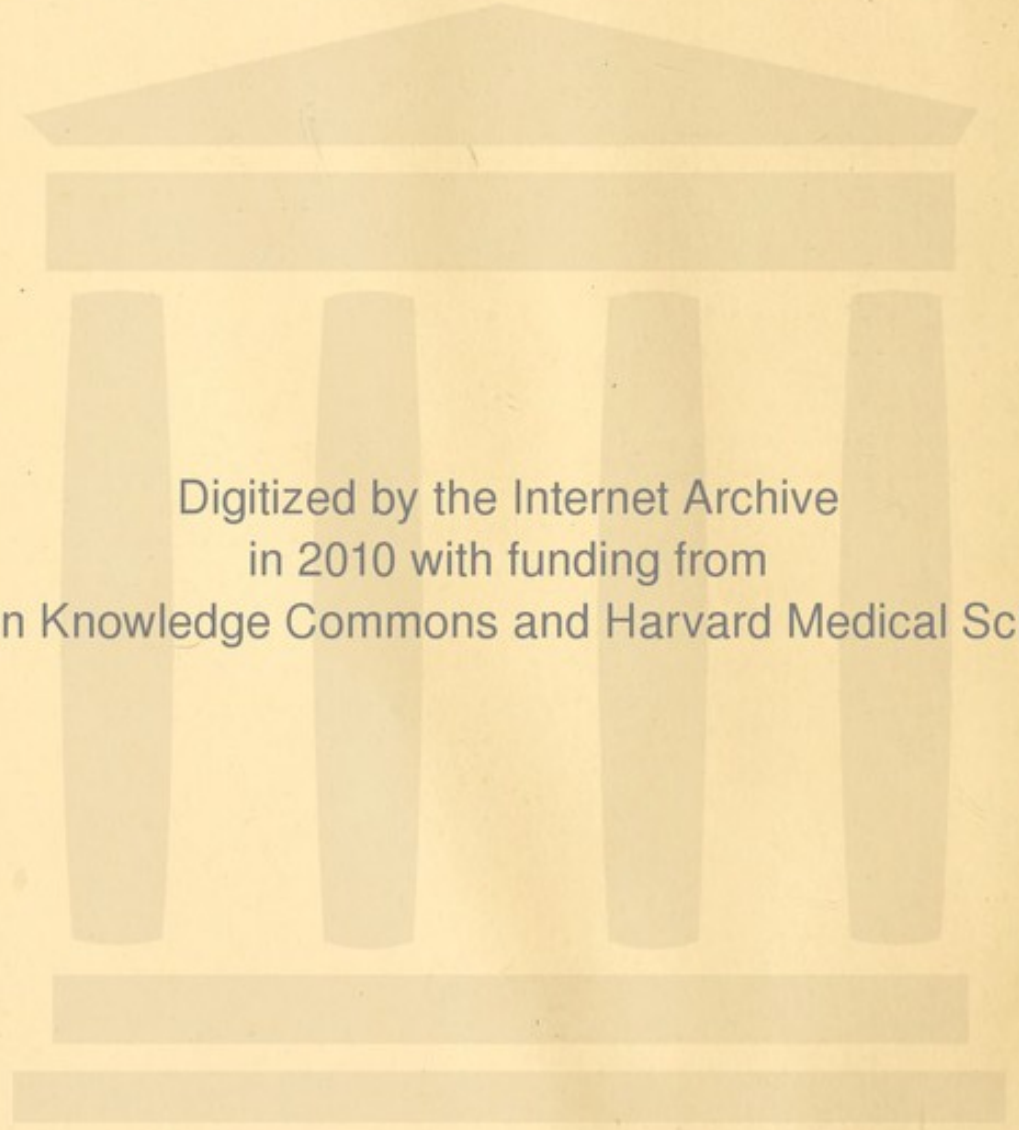
Spinal concussion : surgically considered as a cause of spinal injury, and neurologically restricted to a certain symptom group, for which is suggested the designation of Erichsen's disease, as one form of the traumatic neuroses / by S. V. Clevenger.



With Compliments of the Author

SPINAL CONCUSSION:

SURGICALLY CONSIDERED AS A CAUSE OF SPINAL INJURY, AND NEUROLOGICALLY RESTRICTED TO A CERTAIN SYMPTOM GROUP, FOR WHICH IS SUGGESTED THE DESIGNATION

ERICHSEN'S DISEASE,

AS ONE FORM OF THE TRAUMATIC NEUROSES.

BY

S. V. CLEVENGER, M.D.,

CONSULTING PHYSICIAN REESE AND ALEXIAN HOSPITALS; LATE PATHOLOGIST COUNTY INSANE ASYLUM, CHICAGO; MEMBER OF NUMEROUS AMERICAN SCIENTIFIC AND MEDICAL SOCIETIES: COLLABORATOR AMERICAN NATURALIST, ALIENIST AND NEUROLOGIST, JOURNAL OF NEUROLOGY AND PSYCHIATRY, JOURNAL OF NERVOUS AND MENTAL DISEASES; AUTHOR OF "COMPARATIVE PHYSIOLOGY AND PSYCHOLOGY," "ARTISTIC ANATOMY," ETC.

WITH THIRTY WOOD-ENGRAVINGS.

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PREFACE.

A CLASS OF INJURIES that is frequently caused by railway accidents can be studied to advantage in any large metropolis. Chicago, being a great railway centre, naturally affords considerable material for such investigation, though the newness of that city and its consequent dearth of scientific and medical libraries oppose obstacles to research that can only be overcome by labor and sacrifices not experienced by students in older cities.

The need of a new work on Spinal Concussion is apparent in the scattered condition of the essays on the subject, and from the fact that the treatises now in use are twenty years behind the times.

The recent scientific Franco-German contest concerning the pathology of the disorder has ended in an advance of our knowledge, but the change from a spinal to a cerebral explanation of the symptoms, and their inclusion with other widely different phenomena, resulting from wounds in general, under the title "Traumatic Neuroses," appears to the author to be unjustifiable.

An attempt has therefore been made in this work to carefully review the entire subject, with reference to anatomical derangements that will best explain the symptoms.

That the spinal sympathetic nervous system is the main seat of the disease, and that in consequence the cord functions are deranged, accounts, in the author's opinion, for much, if not all, that has been hitherto unexplainable. These views are original and were not heretofore advanced, for they are based upon quite recently discovered symptomatology and an exclusion

of previous errors in diagnosis, which would not, until this time, have enabled any such conclusion to have been reached.

The importance of electro-diagnosis in spinal ailments required the space and revision it is accorded in Chapter XI.

The substitution of the name "Erichsen's disease" for the various ambiguous and improper titles should alone help to clear away wrong impressions; and "concussion of the spine" may hereafter be properly used as *causing* meningo-myelitis, compression symptoms from vertebral fractures or dislocations, hæmorrhages, etc., and it may or may not also cause "Erichsen's disease," pure or complicated.

Acknowledgments for help in the preparation of this book are due Drs. O. L. Schmidt and G. J. Schaller, the latter especially for valuable assistance with the German literature.

The author regrets the unavoidable polemics of parts of the book, though it is by controversy that the truth is often evolved from error; and his strong feeling against the political corruption in our country is explained by its opposition to all progress through the mediocrity and ignorance in most of our public institutions, scientific and medical,—placed there by men of like character. A spring cannot rise higher than its source.

Unsparing criticism is invited, particularly as regards the author's pathological-anatomy views, and communications or reviews sent to him will influence the arrangement of subsequent editions and be properly accredited.

CENTRAL MUSIC HALL,
CHICAGO, October 15, 1889.

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SPINAL CONCUSSION.

CHAPTER I.

HISTORICAL INTRODUCTION.

SPINAL CONCUSSION is often the subject of controversy in law courts, and the railway companies of Europe and America annually pay millions of dollars in the settlement of claims wherein this disorder is justly or unjustly alleged.

Corporations are victimized by malingerers, and individuals lose their damage suits through want of correct knowledge on the part of physicians and attorneys as to what constitutes spinal concussion.

If we consider law as a science intended to minimize the confusion that arises in the settlement of disputes, justice can be furthered by whatever enlightens as to matters of fact and simplifies hitherto abstruse subjects. And it is, *cæteris paribus*, usually in proportion to the correctness of medical information in medico-legal cases that just decisions can be reached by judge and jury.

There are many causes for our imperfect knowledge of a great number of bodily ailments, of which spinal concussion is but one, which circumstances have singled out from obscure disorders and made conspicuous as an *opprobrium medicorum.* Medicine has many triumphs to record, especially in the last quarter century, as regards the more generally recognized diseases; nor can we tell how far our better knowledge of these may assist clearer conceptions of the less frequently occurring

ailments until we have taken account of what we have learned and what we can make available for extended research.

Notwithstanding the observations of Leeuwenhoek with his imperfect microscope in 1687, and Prochaska's announcement, in 1779, of the brain structure, the ancient idea that the "spinal marrow" was similar to the marrow in the hollows of long bones, fatty and structureless, was as rife among the medical men in the early part of this century as it is among the uninstructed people of to-day.

Erichsen instituted an epoch in spinal concussion study from 1868 to 1875, at a time when the minute anatomy of the spinal cord had begun to be better noted. In fact the greater part of all we know of an exact nature concerning this most important organ, the spinal cord, has been accumulated mainly in the last half of the present century by writers such as Longet, 1847, and, later, Stilling, Kölliker, Van der Kolk, Deiters, Schultze, Gerlach, and many others.

Because of this want of knowledge of the time, when P. Frank, in 1792; Harless, in 1814; Kloss, in 1820, and Ollivier, in 1821, investigated the subject of inflammation of the cord, insuperable difficulties were in their way, and it was as late as 1864 before Frommann cleared up the pathological anatomy of cord inflammations.

Clinicians had, with more or less accuracy, separated out many groups of symptoms pertaining to spinal injuries previous to this, among the ablest being Sir Astley Cooper and Abercrombie in the early part of this century, but the genius and indefatigability of these workers had mainly to deal with gross post-mortem appearances in relating cause and effect.

Leyden, in 1875, made important contributions to the literature of spinal concussion in his work on "Spinal Diseases,"* and very little has been accomplished by writers other than Leyden and Erichsen in this field during the past twenty years; medical encyclopædiæ, surgeries, and neurological works containing dis-

* Dr. E. Leyden, Klinik der Rückenmarkskrankheiten, Band II. Berlin, 1875.

cussions of Erichsen's writings, and in one instance an English railway surgeon, Herbert Page, published a book especially directed against Erichsen's views on this subject.

With the utmost uniformity Erichsen has been quoted and copied by later and contemporaneous writers upon surgery with scarcely a criticism. The undoubted value of his writings on general surgery paved the way for a ready acceptance of his work on concussion by writers of surgical works, such as Gross, Holmes, Agnew, and neurological authors, as Erb, Ross, Gowers, and others.

In the progress of medicine valuable books have been superseded by writings more in keeping with recent knowledge, but we should bear in mind that Rokitansky, Graves, Abercrombie, Trousseau, and even far earlier writers afforded much solid material upon which we yet depend. The errors of such standard authors are due largely to the times in which they lived not affording them sufficient collateral information, but we cannot dispense with what they established as true. The bulk of Erichsen's work will continue to be standard, even though revised in the light afforded by Westphal, Thomsen, Oppenheim, and other investigators.

Blackstone is none the less valued by lawyers because his work is antiquated.

Neurologists, surgeons, and attorneys find so much useful information in Erichsen's book that lawsuits wherein spinal concussion is an issue are seldom undertaken without reference to this London surgeon's lectures. Advanced knowledge of the physiology and microscopic anatomy of the spinal cord and the diseases to which it is subject require, however, much consideration in connection with Erichsen's cases and the inferences he has drawn from them and those reported by his predecessors in surgery.

In these chapters no attempt will be made to supplant Erichsen or any other author who has so honestly dealt with the disease; only for the purpose of arriving at a clearer under-

standing of what spinal concussion is, and is not, an abstract of his work and critical review of his cases is attempted, the references being to his 1875 revised edition.

CHAPTER II.

ERICHSEN ON SPINAL CONCUSSION.

ERICHSEN opens by quoting Hippocrates, that no injury to the head is too trifling to be despised, and suggests that this observation may be applied with equal if not with greater justice to injuries of the spine.

These injuries occur in the ordinary accidents of life, but in none more frequently or severely than in railway collisions; a special and painful interest attaching to them from the distressing character of the symptoms presented by the sufferers. Moreover, in these cases, there is always a peculiar difficulty, which is often greatly increased by the absence of evidence of outward and direct physical injury, by the obscurity and insidious character of the early symptoms, the slowly progressive development of the secondary organic lesions, and the functional derangements entailed by them, and by the very uncertain nature of the ultimate issues of the case, taxing the diagnostic skill of the surgeon to the very utmost; and there is no class of cases in which more discrepancy of surgical opinion may be elicited.

While shocks to the nervous system arising from railway accidents do not stand in a different category from accidents occurring from other causes in civil life, the rapidity of the movement, the momentum of the persons injured and of the vehicle, the suddenness of arrest, the helplessness of the sufferers, their natural mental perturbation, render railway injuries peculiar and the cause special.

The thrill or jar, the "*ébranlement*," the sharp vibration transmitted through everything subjected to it is compared to an electric shock, to setting the teeth on edge, that causes the carriage to be shattered into splinters and sends a sharp, tremulous

movement through every fibre of its occupants. In addition the traveller is thrown to and fro without any power of resistance.

In the writings of Sir Astley Cooper, Boyer, Sir Charles Bell, and, later, Ollivier and Abercrombie, are many isolated cases of concussed spines, but since the introduction of railways these injuries have become proportionally more numerous and more severe.

Erichsen refers to seventy-five cases of "contusions and miscellaneous injuries of the spine" recorded in the "United States Army Surgical Reports of the Civil War." Even though "all cases of fracture and dislocation are excluded," the citation can be but of general application to the whole subject of spinal injury, as the exigencies of war made hospital-case reports very incomplete, and there was extant, during that time, very imperfect means of diagnosis of spinal ailments. We simply learn from this that seventy-five undiagnosed spinal injuries, without apparent dislocation or fracture, were noted as follows :—

Discharged as disabled,	27
Returned to easy duty,	3
Returned to military duty,	43
Died from causes unconnected with the accident,	2

Eleven of the cases were under treatment for periods from one month to fourteen months.

At this particular point we arrive at one of the causes of the confusion with which this subject is surrounded. Here are cases grouped in such a manner as to give the erroneous impression that they are what are now known as typical instances of spinal concussion, when they are nothing more than mere mentions of disablements, probably spinal, following upon more or less direct blows to the spine. There is nothing to indicate that a single case exhibited the characteristic symptoms of concussion, which must exclude ruptures of vessels, compression, inflammation, etc. That there was a spinal injury of some kind in every case need not be denied, and each injury may have been, and probably was, caused by a concussion of, or a blow

upon, the spine ; that expression merely describes *the manner in which the accident was received*, and the unfortunate fact that concussion of the spine has both a general and restricted meaning has befogged every discussion.

This ambiguity in Erichsen was doubtless not intentional, but that it led to confusion is undeniable. Lawyers and physicians who are called upon to look up the subject for the first time cannot but be puzzled by the loose way in which the changes are rung upon the simple term concussion of the spine as a cause and an effect, as generic and specific, as etiological and symptomatic.

In all likelihood cases of pure *uncomplicated* disease known as spinal concussion are rare, as meningitis, myelitis, or dislocations may accompany the disorder to a greater or less extent, but we can search in vain the Count de Lordat case, cited from Maty's 1766 report, for other than most superficial resemblances to "typical concussion of the spine." It would seem that Erichsen, from some cause or other, had confounded the disease with the mere name of the manner of injury receipt. The "twist of the neck" resulted in a slowly supervening, severe, cervical and bulbar meningitis and sclerosis, shown post-mortem. Had Maty's report been a little more complete the march of destruction of tracts and other tissues could now be described.

Erichsen properly objects to the substitution of concussion of the cord for concussion of the spine to parallel concussion of the brain, as he claims that the spine is a much more complicated structure than the head. In concussion of the spine we have not only, and not even necessarily, an injury to the bony, fibrous, ligamentous, and muscular structures that enter so largely into the conformation and support of the vertebral column, of the nerves that pass across it, and of the membranes included in it. Injuries of these parts often occasion very grave and most persistent symptoms without any lesion whatever of the cord. He touches here upon suggestions that with the

advance of neuro-pathology may reveal the irritative phenomena to be due to adjacent extra-myelonal lesions.

He approximately defines concussion of the spine as a certain state of the spinal cord occasioned by external violence; a state that is independent of, and usually, but not necessarily, uncomplicated by any obvious lesion of the vertebral column, such as its fracture or dislocation,—a condition that is supposed to depend upon a shake or jar received by the cord, in consequence of which its intimate organic structure may be more or less deranged, and by which its functions are certainly greatly disturbed, so that various symptoms indicative of loss or modification of innervation are immediately or remotely induced.

The primary effects of these concussions or commotions of the spinal cord are probably due to molecular changes in its structure. (Italicized here to emphasize a statement of Erichsen which unjust criticisms of his pathology ignore.) The secondary changes are mostly of an inflammatory character, or are dependent on retrogressive organic destructions, such as softening, etc., consequent on interference with nutrition.

It thus becomes evident that Erichsen includes in spinal concussion what we now know to be inflammations of the cord and membranes, slowly induced, as secondary to blows, jars, etc.

His views were more those of a surgeon than of a neurologist. The former is often nonplussed by the absence of obvious lesions, while the latter is more apt to differentiate symptoms into many distinct groups, which, at the time Erichsen wrote, surgeons were content to denominate as spinal injury. The blow to the back, followed by a diseased nervous system, sufficed to establish as concussion of the spine what we now separate into myelitis, meningitis, scleroses, extravasations, and spinal concussions.

Indeed, Erichsen tacitly admits this in stating that four distinct forms have been included in the term concussion of the spine. 1. A functional disorder; 2. Compression of the cord from extravasation; 3. Compression of the cord by inflamma-

tory exudations; 4. Nutritive cord alterations. The absence of obvious external injury of the spine, such as laceration or compression of the cord, by the fracture or dislocation of a vertebra, constituting the bond of union between these different "kinds of concussion."

Among other severe direct injuries to the spine, he mentions cases that terminated in caries, angular curvature, abscess, and a case where a slap on the back, to cause a newborn infant to breathe, developed dorsal caries.

I think we can fairly understand Erichsen as including in spinal concussion any violent injury to the cord functions without there being demonstrable evidence of such injury in the region of the bony and ligamentous spinal column.

In Lecture II, under the heading "Severe Direct Injury to the Spine: Concussion," Erichsen details thirteen cases, in all of which lesions of the cord plainly existed primarily, from the symptoms, such as paralyses and sensory impairment.

Lecture III describes the symptoms of severe concussion of the spine from direct violence. These symptoms necessarily vary greatly according to the part struck. It is quite possible to suppose that a direct blow to the cervical spine may cause instant death, without dislocation or fracture of the column. But a fracture or partial dislocation may exist unsuspected, and fatal results follow later.

Case 14 is one of unsuspected dislocation between the second and third vertebræ, with sudden death on the fourth day.

Case 15 describes an unsuspected fracture of the spinous process of the fifth cervical vertebra, with death from compression of the cord, a few days later.

Case 16, injury of spine in lower dorsal region and recovery with angular curvature a month afterward.

He deduces from these cases that, notwithstanding the infliction of an injury of a fatal character, life may be prolonged several days, until death is brought about by an accidental movement.

An unnumbered case, following the description of Case 15, mentions a man who fell on the top of his head without fracturing the skull, injuring the cervical cord, showing that fatal spinal injury may be occasioned indirectly.

Lecture IV deals with a class of cases in which the back injury is either very slight, or where the blow has fallen upon some other part of the body than the spine.

Case 17 is not fully reported, "suffered the usual symptoms of spinal concussion," and has not been able to ride since falling from his horse.

Case 18 is one of chronic meningitis of the cord and base of the brain, with imperfect recovery after nine years.

Case 19. Chronic meningitis and imperfect recovery.

Case 20. Chronic cerebro-spinal meningitis; incurable.

Case 21. Injury of spine in infancy; incurable.

Lecture V discusses concussion of the spine from general shock.

Case 22. Meningeal extravasation; recovery.

Case 23. The slow supervention of symptoms and improvement after three months leaves the question between organic and functional derangement undecided.

Case 24. The spinal symptoms imperfectly described, the subsequent cerebral symptoms due to head injury.

Case 25. Meningeal lesion.

Case 26. Meningeal lesion and subsequent myelitis.

Case 27. Meningeal irritation and small multiple cord lesions.

Case 28. Better recorded than preceding cases. Organic cord changes were not evident until late in the disease, but the usual spinal and cerebral symptoms of concussion prevailed.

Case 29. Severe and somewhat typical concussion symptoms with cerebral complications.

Case 30. Concussion symptoms, probable myelitis later.

Case 31. Meningitis and myelitis preceded by "usual symptoms of spinal concussion."

Lecture VI treats of sprains, twists, and wrenches of the spine.

Case 32. Vertebral displacement without cord implication, from strain.

Case 33. Spinal caries, paralysis, and death from a wrench.

Case 34. Strain of cervical spine with paralysis of arm only.

Case 35. Fall on head, twist of cervical spine, body paralyzed; recovery.

Case 36. Spinal twist, paraplegia.

Case 37. Spinal wrench in a railway accident, paraplegia.

Case 38. Cervical spine wrench, paralysis; recovery.

Case 39. Spinal wrench, meningo-myelitis.

Case 40. Back strain. Some of the symptoms similar to those of concussion cases.

Case 41. Back strain. Similar to case 40.

Case 42. Lumbar strain, lumbago, and other symptoms unlike those of concussion.

Under "Complications of Concussion," in Lecture IX, we have:—

Case 43. Syphilitic symptoms, none of concussion.

Case 44. Medulla concussion.

Case 45. Intestinal implication most prominent, spinal symptoms less so.

Case 46. Intestinal and vesical hæmorrhage after fall on back.

Case 47. General shock, mainly abdominal and cerebral.

Case 48. Cerebral and spinal injury.

Case 49. Blow to cervical spine, bladder trouble.

The concluding cases, 50 to 53, have nothing to do with the main issue.

Regarding Erichsen's cases, we find that those numbered 17 and 24 are imperfectly reported; 23 is problematical; 14, 15, 16, were unsuspected fractures and dislocations. The seventy-five army cases, the Count de Lordat case, and 1 to 13, 19 to 22, 25 to 27, were various kinds of cord derangements, such as

myelitis, meningitis, extravasations, etc., primarily or secondarily resulting from external violence, without demonstrated bone or ligament lesion. In many of these, however, there are some symptoms that do not necessarily pertain to the organic diseases that were demonstrated post-mortem, and those symptoms may be accounted for by comparing them with those occurring in the "purer" concussion cases, from which organic lesions may be excluded.

This probably functional disorder is best described in Cases 28, 29, 30, 31, which include the most typical instances Erichsen has recorded.

Many of the symptoms Erichsen mentions in the body of his book he appears to have derived from the statements of other authors. Separating out the conditions that he notes in his own cases, he records individual instances of leg inco-ordination, fever after accident, deafness in right ear, no vision disorder, photophobia, general paræsthesiæ, back paræsthesiæ, in left arm, right leg, left leg; motility impaired on right side, left more than right side; arms, legs, and body without sensation impairment; anæsthesia in left arm, both arms, right arm; general numbness, numbness in both hands, irritability, general sensory disturbance only, no sexual loss, sleep good, suicidal, bedridden, epileptoid fits, general decreased size, decreased size of left leg, both legs; increased size, weakness and exhaustion, vomiting later, digestion good, appetite bad, hemiplegia, arm paralysis, no pain in head or spine, cramps and twitchings in legs, in both arms; dragged and everted left foot, hyperalgesia.

Next most frequent findings are the following symptoms, each separate ailment occurring in two cases: Hyperæsthesia in right arms, both legs; motility impairment in left arms, motility not impaired, straddling gait, anæsthesia of body and legs, nervousness, vertigo, bowels regular, constipation, no emaciation, bad digestion, complete paraplegia with anæsthesia, pain in head, girdle pain, pain in legs, no photophobia.

In three cases, for each symptom, are recorded bad dreams,

depression, loss of sphincter-ani control, emaciation, decreased weight, difficulty in walking up and down stairs, impaired hearing, hyperæsthesia of all senses, motility impaired in both legs, in right arms; numbness of right side, of left leg; no urinary difficulty.

In four cases, for each symptom, there were partial paraplegia, aural hyperæsthesia, motility impaired in left legs, sphincter-vesicæ difficulty, sexual loss.

In five cases, for each symptom, there were subnormal temperature, tinnitus aurium, motility loss complete in arms and legs, numbness in both legs, urinary difficulties.

In six cases tactile hyperæsthesia was noted.

In seven cases there was vision impairment.

In nine the sleep was bad.

In eleven the backs were weak and the same number were disabled immediately after the accident, and memory impairment also occurred in eleven cases.

Twelve cases complained of spinal tenderness.

In fourteen cases the disabilities appeared at shorter or longer periods after the accidents.

In sixteen cases consciousness during or after the accidents was not disturbed.

Twenty-one cases suffered from pain in the back, fourteen of these more particularly upon moving.

The results are noted as follows:—

Single cases recovered in 6 weeks, 6 months, 7 months, 14 months, 21 months. One had improved in 3 months. One made an incomplete recovery. Three had intermissions.

Single cases had not recovered in $2\frac{1}{2}$ years, $4\frac{1}{2}$ years, 5 years, 7 years, 8 years, 9 years, 16 years, 26 years.

One case died in 10 days after the accident, another in 5 years, and a third 11 years afterward.

CHAPTER III.

PAGE ON INJURIES OF THE SPINE AND SPINAL CORD.

HERBERT W. PAGE* states (page 1) that "of all accidents to which man is liable none more serious can befall him than injury to the spinal cord," and then he devotes three hundred and seventy seven pages to discussing the improbability of such an injury through railway accidents.

Alluding to Sir Benjamin Brodie's† divisions of injuries of the spinal cord, they may be condensed as follows:—

1. Bone injuries, causing indirect spinal-cord disease.
2. Vascular injuries of the cord.
3. Injuries of the cord substance, whether demonstrable or not.

Page's criticisms of Brodie, Abercrombie, Erichsen, and others are, in the main, directed to show the absence of omniscience of those writers. His method, throughout, is to suggest the probability of the conditions numbered, as above, one or two existing where number three is alleged, or *vice versâ*, and where the patient survived he calls attention to the absence of post-mortem verification of the conjectured pathology, and where lesions were demonstrated that they were insufficient to cause the symptoms, or if sufficient and secondary, or sequential, that they *might* have been primary.

Thus, on page 8, Page says Brodie "does not record one single case of supposed concussion of the spinal cord *which ended fatally*, and where there was not also serious injury to the spinal column," and cites a case of unsuspected vertebral fracture to disprove "'disorganization and dissolution of the

* Injuries of the Spine and Spinal Cord, without Apparent Mechanical Lesion, and Nervous Shock, in their Surgical and Medico-Legal Aspects. London: second edition, 1885.

† Medico-Chirurgical Transactions, vol. xx, p. 120.

the cord' being produced by concussion pure and simple without some serious mechanical injury being inflicted upon the spinal column as well."

Aside from the fact that Brodie, Abercrombie, and Erichsen included, among concussed spines, cases of cord injuries with or without visible bony lesions, where a fatal ending showed spinal-column injury, it does not follow that the bone and cord lesions were associated. It is well enough to note the findings, but it should also be remembered that grave destruction of vertebræ, from injury and disease, has occurred without interference with the functions of the cord.

The small space allotted by Abercrombie to "Concussion of the Spinal Cord"* has more historical than disquisitional value, and the case he cites is not typical as the *cause* concussion was used instead of the recent symptom-group, known as such. We would not hold Galen to account for some defect in bacteriology.

H. Mayo's† case, J. J., criticised by Page (page 12), as probable syphilis or embolism, was an undoubted fall to begin with, followed by meningeal irritation, and reminds me of a case of hemiplegia and traumatic insanity, caused by a rock falling four stories upon a man's head, and the suggestion of a Western medical-college professor, that syphilis and bromism might produce the same symptoms.

Quoting (page 12) from Boyer‡ three cases of death from spinal hurts, in the first of which there were post-mortem findings of injury in the cord, and in the other two none, he states that "we must remember, however, that the methods of post-mortem examination were then far different from what they are now. With such meagre histories as are here recorded, we shall not, it seems to us, be hypercritical in refusing to accept these often-quoted cases as evidence that the spinal marrow may suffer lesion from the concussion pure and simple of a blow."

* Diseases of the Brain and Spinal Cord, p. 372.
† Outlines of Human Pathology, 1836.
‡ Maladies Chirurgicales. Fifth ed., tom. 3, p. 133.

When ancient post-mortems revealed lesions, either of bones, vessels, or cord, Page accepted them as sufficient to cause the symptoms, when he wished to disprove injury without demonstrable lesion; but when no lesions are found, whether by ancients or moderns, he repudiates the sufficiency of the autopsy, nor is he at a loss for reasons for so doing.

In Boyer's first case:—

"*A l'ouverture du cadavre, nous trouvâmes un épanchement de sérosité sanguinolente qui remplissait le canal de la dure mère depuis sa partie inférieure jusqu' au milieu du dos, et qui comprimait la moelle épinière.*"

While this particular case affords evident enough cause of death, where is it in the next case, when

"*Nous ne trouvons ni fracture, ni lésion de la moelle épinière ou de ses enveloppes, ni épanchement*"?

Or in the third, when

"*L'examen de son cadavre fit voir les parties dans leur état naturel comme dans le cas précédent*"?

Turning Page's reasoning against him, it can be denied that any of the post-mortems revealed sufficient cause of all the symptoms or the deaths, and that where he assumes compression, contusion or extravasation as best accounting for the symptoms, where the parties did not die, he does not realize that his eighteenth-century pathology is as faulty and presumptuous as is that of the surgical patriarchs he derides.

He suggests that it may be claimed (page 14) that concussion to the spine, like that to the skull, may annihilate the cord functions as the latter does the brain functions, in which case a crush of the cord should cause death before paralysis. He loses sight of the fact that paralysis is, practically, death of that part of the body over which the cord presides, and that both brain and cord functions may be *suspended* by blows, re-institution of cerebral and cord functions may subsequently occur or not, as circumstances determine, and death may or may not supervene, from associated causes or their absence.

Syme* is urged (page 14) "as more strictly in accordance with clinical and pathological experience," in stating that "the spinal cord is liable to concussion from blows and falls, particularly the latter, the symptoms of which are similar to those of concussion of the brain, inasmuch as they denote suspension of the functions usually exercised by this part of the nervous system." The very consideration Page had just ignored, but now finds convenient because Syme accounts for it as probably caused by effusion of serum or blood "which, subsequently undergoing absorption, allows the usual actions to be restored." An assumption about as necessary as that when a clock or watch is stopped by a fall, some wheels must be broken or bent, whether its time-keeping function is recovered or not.

Two instances are next taken (page 16) from Lidell,† and Page says: "The second man, in our judgment, died because his cord was crushed; the first man lived because his cord had escaped direct injury." The first man was paraplegic (here, then, he must admit functional paraplegia from a blow, as there was "no direct injury"), and Page does not know whether he fully recovered or not, or that he did not die from supervening disease.

Lidell writes that "not unfrequently a paralysis, more or less complete, especially of the lower extremities, is produced by injury of the spine, without the recurrence of fracture, or, indeed, of any perceptible lesion of the spinal column or of the spinal marrow. The term concussion of the spinal cord has been employed to designate these cases, because of the analogy they are supposed to bear to concussion of the brain. In both alike a more or less complete arrest of special function is produced, without any visible injury to the nerve-tissue. *Cerebral concussion produces* a state of more or less profound *unconsciousness*, and *spinal concussion occasions* a more or less complete *paralysis* of the parts supplied with spinal nerves, the filaments

* Principles of Surgery. Third ed., p. 433.

† American Journal of Medical Sciences October, 1864.

of which either pass through or are given off from the concussed tract."

These words may clearly be made to include *interference*, transient or persistent, with the brain or cord functions.

Lidell's case of paraplegia Page thinks might have been occasioned by a tearing through of the nerves to the lower limbs, as it is only stated that no spinal-column appearances were found sufficient to account for the persistent paraplegia. It is fair to presume that adjacent or extra-spinal lesions would be looked for in just such cases. Certainly Page would have done so, and it is not fair to suppose that such existed because they were not particularly mentioned. The very absence of spinal lesions with such a history would lead any educated surgeon to search elsewhere for causes.

"An ecchymosis of the brain and cord is referred to by surgical authors as affecting these organs," says Lidell, pointing to a genuine *contusion* superadded to the concussion; "but," he says, and Page (page 19) agrees with him, "contusion is much more apt to happen to the brain than to the cord, because, in the first place, the surface of the brain is in close relation with its firm, unyielding osseous case, while the spinal cord is separated from its osseous envelope by a considerable space, occupied by the cerebro-spinal fluid; and, because, in the second place, the brain is a more vascular organ than the spinal cord; or, in other words, the brain is much more abundantly supplied with blood-vessels liable to be ruptured by any contusing force than the spinal cord."

That the vascularity of the brain and cord differs, either absolutely or relatively, in such manner as to render the former more liable to blood-vessel injury, is open to discussion, and, while the nearness of the brain to the thinner skull as compared with the cerebro-spinal fluid separation of the cord from the thicker vertebræ apparently renders the cord less liable to contusive influences, we can refer to the often-cited cases of Page, wherein the vertebral dislocations have contused and compressed the

cord, and ask if the liability of these bone-segments to slip one upon another is not a disadvantage to which the skull bones are not subjected.

This passage in Page is often construed to mean that the spinal cord is better protected from *concussion* than the brain, by reason of the thicker vertebræ and water-surrounded cord, while the skull is thinner and nearer the brain.

Both the brain and spinal cord may be likened, in fragility and liability to injury, to eggs inclosed in boxes of differing thicknesses. It will matter little to the eggs, when dropped, whether they are inclosed in a paste-board box or in an iron safe. The propulsion of the spinal fluid from the part struck to a distant part of the cord may cause conditions comparable to the *contre coup* bursting of ventricular fluids into brain parts remote from the point struck, as was admirably demonstrated by Duret.* He, also, with Rush,† notes the slowness with which cerebral injuries often manifest themselves, making another strong comparison with the peculiarities of cord injuries.

Page thinks (page 22) that the word "'concussion' should be used to indicate rather the manner of the injury than the result of the injury inflicted by the blow," and thus he acknowledges that the term has been used in the two different senses. A careful examination of his book will show that he makes the two forms fight one another. If a surgeon uses the word "concussion" in the sense of a cause, and does not explicitly say so, then Page shows that the functional symptom-group, known as concussion, is wanting, hence it cannot be concussion; next, if those symptoms are fairly present, and he cannot blame them upon organic mischief, he attacks the justice of the designation, concussion, on the ground of the manner of the receipt of the injury, all the more readily, as two cases are seldom hurt in exactly the same way.

The olden writers used the term ambiguously, and not at

* Etudes exp. et clin. sur les Trau. Cerebraux, p. 137.
† Medical Inquiries and Observations, p. 28.

all as Erichsen did, though he was looser in its application than are later writers, who apply it only to a certain symptomatology.

Edmunds,* cited by Page (page 22), misapplied the term for myelitis following upon paraplegia, produced by the concussion of a shot in the spine, which did not injure the cord membranes or vertebræ.

Jonathan Hutchinson† defines concussion of the brain as "a shake of the cranial contents, without any structural lesions of importance." His meaning should be taken rather than his words, for what is meant by "importance" is not explained, and a lesion may be demonstrable or not, and still the case may be a true concussion.

The case of Hewett (page 26) where recovery from a cerebral concussion, wherein there was no visible skull injury, occurred, and he was "as clear in intellect as before," and, twenty years after, extensive destruction of the anterior lobes of the brain was found on autopsy, suggests that there are many erroneous ways of considering people "clear in intellect," for, as Kiernan‡ pointed out, frequently surgeons have dismissed cerebral-concussion cases from hospital or private practice as "cured," and later in life insane asylums received them.

The "American crow-bar case" is often referred to as an instance of extensive frontal-lobe destruction without insanity, when the facts were, as attested by Mr. L. B. Fuller and other credible witnesses, that the victim of the accident underwent radical character changes, and became what alienists would call a traumatic paranoiac.

In what Page considers "a fair and comprehensive classification of the various cases of so-called concussion of the brain" (page 28), he omits reference to cases where the injury may be slight and the after-effects grave and lasting, or where *contre*

* Brain, April, 1884. "Concussion and Inflammation of Spinal Cord from Gunshot Wound of Back."

† Clinical Surgery, vol. i, p. 86.

‡ Journal of the American Medical Association, December 15, 1888.

coup may give rise to symptoms. The writings of alienists and neurologists abound in such instances.

Leading up to his "shock" theory he affirms cerebral concussion to be cerebral paresis of the heart and of the bodily functions generally.

Then (page 30) the reasons Lidell gave for regarding the brain more liable to *contusion* than the cord Page urges as applicable to *concussion*. When his cerebral data are incomplete, and concussion of the brain is dodged as cerebral heart-paresis, his cord analogies must be imperfect.

The case (page 40) of Sir William Gull,* "paraplegia two days after a violent exertion in lifting a heavy weight; softening of the cord opposite the fifth and sixth dorsal vertebræ; no injury of the membranes, ligaments, or bones of the spine; death after six weeks," would disprove the necessity of spinal-column lesions where the cord has been injured, as a severe bend is less liable to damage the structure of the cord than a blow, which can and doubtless does violently propel the soft tissues, in its bag of water, about its encasing bony canal. Holmes'† objection to concussion of the spine as a designation, inasmuch as "we do not speak of concussion of the skull" (page 59), does not properly consider that spine is used in that connection as the spinal column and its contents, and that we speak of concussion of the brain as the part injured, instead of concussion of the skull, though head concussion, as including both skull and brain, would compare favorably, by analogy, with what is usually meant by spinal concussion.

Etymological quibbling belongs to a dead and gone epoch. The pituitary gland secretes no pituita, and is not even a gland; the arteries do not contain air, nor is the sacrum any more sacred now than any other bone in the body. If we know what is meant by an expression it matters little how inexact it may be, and the term concussion of the spine has passed into such gen-

* Guy's Hospital Reports, 1856 and 1858, vol. iv, p. 189.
† System of Surgery, vol. ii, p. 370, foot-note.

eral use that it is doubtful if it can be changed. The best we can or should do would be to clearly determine what we mean by the words when we use them.

Spinal anæmia as a speculation is disposed of (page 93) by the quotation from Erichsen, "a clinical expression, possibly, more than a well-proved pathological fact."

As to the Jeremiad on page 94 *et seq.*, that Erichsen had so few post-mortem examinations to record in verification of his functional-disturbance theories, it may well be asked how many autopsies have we, in print, of the initial stages of any disorder whatsoever? Even so common a disease as pulmonary consumption has left the pre-tubercular stage largely conjectural. What is the pathology of chorea?

On page 99 the claim is made "that *with very rarest exception* the spinal cord is absolutely uninjured in these cases of railway collision, shock, or jar, and that now, not less than of old, the spinal cord maintains its supremacy as the most securely protected of all the organs of the body." A not very modest assertion when we reflect that histological and pathological conditions abound in the spinal cord of which Page could know nothing. Take the single instance of the terrible disease known as Landry's ascending paralysis, undisputably destructive of the functions of the spinal cord, and often proving rapidly fatal, with no *discovered* lesion in the cord or elsewhere. "*Nec silet mors*" of the London Pathological Society may as well be snubbed in this instance by the "*Mors silet*" of Page, in speaking of spinal concussion. As well claim the impossibility of death from melancholia because no associated lesions are demonstrable in the brain.

Erichsen (page 178) quotes Dr. Lockhart Clarke* as affording the only account "with which he was acquainted of a post-mortem examination of the spinal cord of a person who actually died from the remote effects of concussion of the spine from a railway collision."

* Transactions of the Pathological Society of London, 1866, vol. xvii.

The antero-posterior flattening of the cord, adherent posterior membranes, and the structural changes in the posterior columns of the cord, even without the ante-mortem history, would declare the case to have been one of locomotor ataxia; but Page asks how is the limitation of the pathological changes to this posterior portion of the cord explained, and intimates that the disease has been latent in the system and developed by the accident.

Page would aid science greatly were he to describe in what ataxic latency consists. Had any other disorder followed the concussion the same pre-existing latency could as properly have been urged.

That tabes dorsalis has been originated by a blow upon the back, and that during a remission of the disease it may be restarted by spinal injury, is, I think, sufficiently well proven, and *a priori* may be considered quite probable enough not to justify Page's doubt that there was any association of the lesion with the concussion.

In view of the discussion now proceeding as to whether the initial stages of this disorder consist of parenchymatous neuritis, interstitial sclerosis, vascular, meningeal, or posterior root ganglia disease, Shaw's * assumption that there is no precedent inflammation, and hence only a hypothetical relation with concussion, is unwarranted, and the "weighty and well-nigh overwhelming" nature of the objection with which Page challenges Erichsen does not exist.

As to the limitation of a lesion following upon a general or distributed blow, it is not necessary to suggest that a chain may break at its weakest link, for, were the links equally strong, vibrations or stress must culminate somewhere, and a weak portion may escape injury, while a stronger part may succumb, if subjected to the major strain, whether the blow was directly or remotely received. Thus *one* or two coaches in a railway collision are sometimes destroyed while all the other coaches escape harm.

* Holmes' System of Surgery. Second edition, vol. ii, p. 377.

Page's complaint that railway collisions have done nothing to advance our knowledge of the physiology and pathology of the cord (page 106) is justified or not, depending upon how we look at the matter. Any injury, however received, that results in death and affords opportunities for an autopsy may advance knowledge if the skilled pathologist examine the tissues, but it is rare that this is the case. Owing to the general ignorance and want of medical animus of many practitioners, microscopists are rarely furnished the material they need, however abundant it may be. Byrom Bramwell * concludes his excellent work with the request that his readers may send him spinal cords of typical, interesting, or rare cases. If such neuro-pathologists as E. C. Spitzka, or N. A. Starr, of New York, were provided with such specimens in sufficient quantity the probabilities are that railway collisions would afford special knowledge that we do not now possess. It is sad to reflect, however, that the majority of medical men in our country have never seen a human spinal cord, would not recognize one if they did see it, nor would they know how to take it from its bony canal, and certainly would attempt to preserve it in alcohol instead of Müller's fluid, and be surprised to learn that alcohol would unfit it for microscopic examination.

Le Gros Clark's † views are quoted (page 109) regarding spinal-concussion cases: "The most numerous where there is no evidence of physical lesion, and in which the symptoms supervene at an interval, longer or shorter, after the occurrence of the shock, in some which are characterized by loss of muscular strength, shrunk limbs, defective power in co-ordination, feeble exercise of motive volition, and even paralysis and imbecility, there must be organic change which is often progressive." He also mentions cases of "deteriorated health and nerve energy; and in these the impaired health is due to the indirect influence exercised on the organs of assimilation." He traces these to

* Diseases of the Spinal Cord. 1884.

† Lectures on the Principles of Surgical Diagnosis. 1870.

spinal shock directly, which "often assume a more aggravated character as time elapses."

Two cases of "simple concussion of the spine" are narrated from falls on the nates and back, with paraplegia following, which passed away in a few months, in which cases he assumed extravasation with resorption in the theca or canal. In the absence of electro-diagnostic means of examination this suggestion is valueless, though it is likely that organic mischief may occur from such accidents, from which such speedy recoveries are not liable to take place.

Clark then deals with a "special form of railway concussion," the sequelæ of which he thinks are explained, in a measure, "by the influence of emotion," but the more immediately induced diversified results he ascribes to derangement of the organic nerves causing the excretory functions to be imperfectly performed, the organic chemistry to be deranged, and the blood to be poisoned.

He is therefore disposed to regard these cases of so-called railway spinal concussion as generally instances of nervous shock rather than of special injury to the spinal cord.

This suggestion of Le Gros Clark, Page amplifies in a subsequent chapter, as it enables him to substitute "shock to the nervous system" for the older term, spinal concussion, and he adopts just as untenable hypotheses to establish his "shock" as can be found in support of the title he decries. Chapter II is concluded with the statement that "lesion of the spinal cord from simple concussion blow is very rare indeed, and that the existence of meningo-myelitis—an easily recognized pathological condition—as a remote or early consequence of some vibratory effect upon the cord still lacks the solid basis of established observation." Had this paragraph been constructed by an able lawyer it could not have been more misleading, for it appears to deny more than will be found in its careful reading. The functions of the spinal cord are frequently badly deranged by bodily accidents, of which "simple concussion blow" is but one

form of concussion, the occurrence of which may be properly inferred from the symptoms and the nature of the accident combined; and meningo-myelitis as remote and early consequence of such accidents is of very common occurrence in just such cases. In fact, Page's criticisms of Erichsen's cases contain many references to meningeal and myelonal inflammations in accounting for alleged functional disorders.

He tells of a case of traumatic lumbago (page 114) which may have been genuine enough, as such, but as the patient had no symptoms of spinal concussion it does not disprove the possibility of that ailment having occurred in others.

Further along (page 118 *et seq.*), single symptoms, such as tenderness of the back, fear of moving, weakness, tingling, occurring alone, or with a few other difficulties, in the absence of the major phenomena of concussion, are dwelt upon with lawyer-like adroitness, in favor of a ligamentous or muscular strain, rather than a nerve-centre implication.

His chapters IV and V consider Le Gros Clark's suggestion of "Shock to the Nervous System" to account for the symptoms of concussion. He maintains that fright alone may cause the gravest disturbance of function. But neither fright nor nervous shock, as he describes the latter, unless he extends his shock to the nerve-centres in the spinal cord, can account for the very fair array of concussion symptoms described on page 167, in the case of S. W., though the face, arms, and legs are mainly noted as struck. It is extremely doubtful if fright can be properly assigned as the main cause of the ailments detailed. At least Page remains unsupported by other writers in regarding mental shock alone as sufficient to cause concussion symptoms, unless we regard the Charcôt fiasco in this direction as helping the view. This will be considered when we treat of hysteria.

Another case of "fright" follows (page 170), though the patient was "terribly shaken" in a derailed coach. This case "entirely recovered," but "retired" from business.

"In the order of their frequency, as gathered from a careful survey of a large number of cases," he enumerates the following symptoms:—

Sleeplessness,
Disturbances of the circulation,
Headache,
Nervousness,
Excessive sweating,
Asthenopia and pupillary dilatation,
Loss of memory,
Catamenial derangements,
Retention of urine.

A glance suffices to show that Page's "nervous shock" does not coincide in symptomatology with spinal concussion, for but few of the major disturbances are included in his "shock" symptoms, and inconstant troubles are introduced.

On page 184 is the case of a man, forty years of age, who was "violently shaken" in a railway collision, but who was able to go home; the next day he was delirious, complained of feeling seriously injured, but there were no external evidences of a bodily hurt. He died on the thirty-seventh day, and "no organic disease was found on post-mortem examination in any of the viscera. The lungs were greatly congested, and the cavities of the heart were distended with blood, as if death had occurred from failure of respiration and circulation." Vulgarly translated, he died for want of breath, and because his heart stopped beating.

This and the case of the nineteen-year-old girl, next mentioned, who died in five weeks after a similar accident, no brain or cord lesions existing in either, may fairly parallel Boyer's cases of sudden death; only, while it cannot be affirmed that the brain or cord were the seats of the cause of death, neither can it be denied that they were. The "fright" theory admits a functional brain disturbance, and cerebral concussion may exhibit no lesions of importance. Reverting to Page's dislike to admit such a thing as a functional disturbance of the cord from either fright or violence, by analogy why may not the cord participate in fright or shock influence similarly and be functionally deranged? The acme of speciousness is reached in the query (page 185) "whether death may not be the result of some effect

produced upon the blood itself, whereby the natural processes of nutrition are arrested, and life comes to an end."

Would it not be as well to admit that the central nervous system is as likely to be paralyzed by a blow or jar as are the amœboid and red blood-corpuscles. The law of logical parsimony would allow us to adopt the simpler explanation. We positively know that spinal derangement can and does produce extensive nutritive failure, notably in progressive muscular atrophy; we do not know that the blood may be shocked to cause the same conditions; then why try to substitute blood shock for spinal concussion, unless "nervous shock," which may mean the same thing, everything, anything, or nothing, is not thought sufficient?

If these "nervous shock" symptoms, which Page mentions, belong to Hutchinson's fourth stage of cerebral concussion, as the former suggests, how does the brain escape the other preceding stages? Unconsciousness is remarkably absent in spinal-concussion cases and present in cerebral concussion. This effort to transfer the disturbance from the cord to the brain is ludicrous.

"Imperfect recovery of the vasomotor system, and easy production of local turgescence of vessels" (page 195) is quoted from Hutchinson's description of the cerebral-concussion period of convalescence. The turgescence may be from imperfect spinal control of the sympathetic system, particularly when we have spinal ganglia regulating visceral blood-supply, and Budge's centre in front or ventrad of the vertebra prominens, connected with cerebral vessels. Besides, the cord itself is in direct connection with the brain, and cerebral symptoms may be induced by spinal interference; but Page is desirous of ignoring the cord as presenting physiological or pathological possibilities where railway accidents are concerned.

Chapter VI treats of "Functional or Neuro-mimetic Disorders;" the heading indicating that organic disease is genuine, but functional disorders are not, and the text seeks an explana-

tion of many such conditions as paralysis, convulsions, nervous irritability, prostration, etc., in hysteria or other mental disorder. This, and the succeeding chapter on Malingering, will be referred to later in connection with the reasoning thereupon of other authors.

Page concludes with a table of two hundred and thirty-four collision cases which he wishes "could have been more complete and better than it is, but the migratory habits of persons in the poorer walks of life have prevented the success of repeated inquiry and search."

Electrical tests are not noted as having been made, the descriptions are brief, and mental derangements are unmentioned as connected with the accidents.

Of these 234, 10 died; 9 are ambiguously recorded; 3 were malingerers; 106 recovered; 66 cannot be traced; 27 partly recovered; 13 did not recover.

Nine of these cases presented evidences of spinal-cord injury; the remainder were without such injury.

In only one case was an autopsy held, from which it would appear that Page encountered the same difficulty in making, or neglected to make, the spinal-cord investigations,—a failure that he regards as so blameworthy in other physicians.

In the column of remarks annexed to the cases, rheumatism, fright, old age, and phthisis are frequently suggested as the real causes of death, and recovery was good ground from which to suspect malingering. Fraud abounded in most of the claims made. It would be interesting to be able to examine the records of the plaintiffs' lawyers in these cases.

CHAPTER IV.

RECENT DISCUSSIONS OF SPINAL CONCUSSION.

LONG before the introduction of the railroad able surgeons had recorded cases of injuries presenting many of the same symptoms that are now known as those of "spinal concussion," "railway spine" (an absurd appellation), "traumatic neuroses," etc. The writings of Sir Charles Bell, Boyer, Sir Astley Cooper, Ollivier, and Abercrombie afford instances in point, but modern methods of investigation and medico-legal controversies growing out of the claims for damages in alleged concussion cases cause attention to be concentrated upon recent cases and the writings of later observers.

Leyden* devotes a chapter of his "Clinic on Diseases of the Spinal Cord" to a consideration of cord concussions as having special significance from the frequency with which they come to notice as a form of railway injury. He describes small lacerations and capillary hæmorrhages as having been found in the substance of the cord, in post-mortem examination of spinal-concussion cases, by himself, Waters, Bennett, and Kirkbride. These findings have not been verified by other observers, as related to concussion, when other disorders are excluded. Jewell† believes we are justified in assuming some such material change in the molecular structure of the cord to account for the symptoms, and says "there can be but little doubt but that a diligent search throughout the cord, by competent observers, would result in the discovery of undoubted material lesions, sufficient to partly, at least, account for the symptoms in nearly all cases."

Leyden regards the prognosis as bad. "The cases are very prone, where they have endured for a time without improvement,

* Klinik der Rückenmarkskrankheiten, Band II. Berlin, 1875.
† Journal of Nervous and Mental Diseases, April, 1876, p. 280.

to assume an irritative character, leading to difficult and sometimes dangerous forms of myelitis, with its multiform bad consequences. Tetanus sometimes follows concussion of the spine. Also meningeal inflammations," . . . "the indirect consequences of concussion of the spine, are of peculiar interest and of prominent practical importance, and such, indeed, as are not included in the original hurt." These consequences are usually slow to develop, and consist of chronic meningitis, myelitis, myelo-meningitis, neuralgic pains, pareses, paralyses, atrophies, chronic degenerations of the cord, etc. He agrees with Erichsen that concussions arising from railway injuries present no peculiar symptoms, as compared with cases produced in other ways. They are peculiar only by reason of being made the basis of legal action against railway companies.

In repeating Westphal's experiments* on guinea-pigs, he corroborates the observations of small hæmorrhages in the pons, medulla, and upper portion of the spinal cord after concussion of the head and neck, with various degrees of violence. A similar set of symptoms are sometimes produced in man by blows in the same region, and it is presumed they are due to similar lesions. Epilepsy, diabetes, disorders of speech and hearing sometimes follow upon jars transmitted to this upper continuation of the spinal cord.

He makes a clear distinction between shock and concussion of the spine, and shows that the symptoms of the two conditions are quite dissimilar, or that they have but a superficial resemblance.

After the publication of his "Clinic," Leyden† details a case in which, for a time after the spinal concussion due to a railway accident, the symptoms were trifling, and as he did not work or improve he was regarded as a simulator. After many years severe symptoms developed to his death. Post-mortem demonstrated a chronic caseous inflammation of the meninges forming a peripachymeningeal tumor.

* Berliner Klin. Woch., 38, 1871. † Archiv für Psychiatrie, 1878, p. 31.

This case is of such celebrity and importance that Spitzka's fuller translation from the *Archiv* is given in another part of this book.

Erb,* under the titles, "Concussion of the Spinal Cord—Commotio Medullæ Spinalis," includes "those cases in which energetic traumatic influences (falls, blows, collision, etc.) have given rise to *severe disturbances of the function of the cord, without any considerable visible anatomical changes in the latter.* Slight changes, small capillary extravasation, etc., probably exist in such cases, but they do not seem to constitute the proper essence of the disease; for the most part the anatomical change is quite negative, and we do not yet know what changes, if any, constitute the basis of the concussion proper."

Where coarse anatomical lesions are found, as hæmorrhages, crushing, hæmorrhagic softening of the cord, etc., the case is not one to justify the name of the functional disorder, concussion, a restriction greater than that of Erichsen.

Erb inclines to the view that concussion of the cord is a very peculiar kind of disturbance, and that more or less of it is usually present in those severer lesions, but concealed to some extent by the symptoms.

In concussion of the brain he notes that there are no certain and constant anatomical changes, and it may be complicated with crushing and destruction of brain-tissue known as contusion. The two sets of symptoms may complicate one another and yet be separable. Similarly with lesional and functional cord disturbances.

Shock of the spinal cord is another synonym he emphasizes, and one which Page would do well to consider, if he could be induced to regard the spinal cord as part of the nervous system likely to be involved in his "nervous shock."

Erb regards the diagnosis as uncertain (it was when he wrote), and the evidence from autopsies unsatisfactory (a state

* Ziemssen's Cyclopædia, vol. xiii, p. 344.

of things still existing in common with a vast number of diseases).

Besides the mechanical causes of concussion symptoms, Erb quotes Clemens, who assigns excessive coitus as productive of severe spinal symptoms. I do not believe these results can be mistaken for genuine concussion symptoms. Violent mental excitement, especially fear or anger, Erb considers as playing a similar part in the production of paretic symptoms, but he doubts their resemblance to those of concussion.

In speaking of the pathological anatomy he says: "In many cases which are examined at an early period nothing at all is found in the cord, or at most one or two small, unimportant extravasations of blood. Leyden reports a case which ended fatally in five days, in which the most careful examination disclosed no alterations of the cord. In other cases anatomical changes are found, which are not severe enough to be considered causes of death. It is supposed that various forms of degeneration and sclerosis may gradually develop out of concussion, but this is not determined with sufficient precision.

"It is rather rash, therefore, to entertain a decided opinion regarding the *proper nature of concussion of the cord.* It seems to be certain that the anatomical report is a negative one. The most common view, therefore, is that which supposes only molecular changes in the finer nerve elements to have occurred, giving rise to either an immediate and complete functional paralysis of the latter, or forming the commencement of further disturbances of nutrition, which at a later time may result in degenerative inflammation."

Erb's symptomatology agrees, in the main, with that of Erichsen, after excluding the gross lesional forms of the latter author, and this grouping is outlined:—

"*a.* General and very severe symptoms at the instant of injury. Death in a short time. Severe form of shock.

"*b.* Severe symptoms at the moment of receiving the injury. Cure in a short time. Slight shock.

"*c.* Severe symptoms at the first; followed by a protracted illness of some years' duration; recovery in most cases.

"*d.* Very slight symptoms at the beginning; a severe progressive spinal disease develops after a longer or shorter time. Result doubtful."

As this last division of cases includes those affording the greater amount of contention in courts, and Erb's summary is so fairly complete, it is best that it should be given here entire. It is based upon Erichsen's descriptions:—

"At the first moment, *e.g.*, if a railway collision, the symptoms are very insignificant. The patient has a sensation of having been severely shaken, a momentary weakness, perhaps some confusion of mind, but soon recovers, picks himself up and walks about, dismisses apprehension from his mind, and goes on his journey.

"On the next day, or several days later or even after weeks and months, more threatening symptoms set in, perhaps preceded for a very considerable time by very slight and unnoticed premonitions. A general depression of strength, sleeplessness, slight mental indisposition, tendency to shed tears, etc., may be noticed; the patient cannot attend to his usual business; pains appear in the back and limbs, and gradually increase.

"Out of these symptoms a group gradually develops, which is very far from being identical in given cases, but which in general presents the following as its chief features: increasing weakness of the legs, which may reach different degrees of severity; the gait is uncertain, straddling, stiff, and dragging; uncertainty in standing; indications of disturbed co-ordination are often present. Stiffness of the back and the general attitude. Back painful, especially when moved; some of the spinous processes extremely sensitive. Girdle-sensation, paræsthesia of all sorts, anæsthesia of various degree and location, and often hyperæsthesia. Weakness of the bladder, diminution and loss of sexual power. Impaired general nutrition; pale, sallow complexion; changed expression of countenance. Marked atrophy

in certain muscles and groups of muscles, often quite extensive. Disturbances of circulation, bluish complexion, cold extremities, etc.

"With these are usually conjoined symptoms which point to a disturbance of the cerebral functions; broken, poor sleep; timidity and irritability, weakness of intelligence, impairment of memory and of power to work, change of character, constriction of the head, increased irritability of the senses, etc.

"These are essentially the marks of a very slow meningomyelitis, associated with more or less considerable disturbances of cerebral functions.

"The subsequent course of the disease usually fluctuates a good deal. Periods of apparent improvement and comparative health alternate with those of downward progress. On the whole, a gradual loss usually occurs; a favorable result is seldom seen; but cases occur in which, after a very long time, the disease has considerably improved, or at least has ceased to make progress.

"This category is largely composed of the cases Erichsen has so admirably described; they have been observed more frequently of late, especially as a consequence of railway accidents, and have acquired a great practical importance in connection with the latter (*railway spine* of the English). They may, however, equally well follow other severe concussions of the body, and especially of the back. Clemens describes a similar case, in which, after a fall from a scaffolding, atrophy and paralysis began to appear three-quarters of a year after the accident. The two last observations by Scholz are excellent instances of this form of concussion. There are various cases of progressive muscular atrophy originating in surgical injury, which might be included here."

Erb separates cases under two forms: "Either (1) severe disturbance quickly appears, most severe immediately after the injury, and is followed in a comparatively short time by improvement, disappearance of the grave symptoms, until recovery is complete; or (2) no symptoms appear at first, or, at most,

only trifling ones; the functions of the cord are comparatively free; the idea of a severe anatomical lesion of the cord seems inadmissible, and yet after a longer or shorter time severe and increasing disturbances do follow, which indicate a profound affection of the cord. In both cases we shall be compelled to assume the existence of molecular changes due to the traumatic lesion."

As diagnostic means have improved since that article was written, his suggestions for differential diagnosis from other spinal diseases need not be considered in this place.

Spitzka* reviewed the subject of "Spinal Injuries as a Basis of Litigation," at a meeting of the New York Society of Medical Jurisprudence, June 14, 1883. The following are extracts from his paper:—

"There can be very little question, indeed, that speculative actions are frequently based on the erroneous allegation of spinal disease after railroad collisions and similar accidents. And there is little question in my mind that, even where an injury has been done, its results are often magnified or perverted, in order to overbalance the denial of defendants, on the false principle that the best antidote for one lie is another. The spectacle of a suit for damages based on alleged disability from spinal disease, as we have witnessed several during the past decade, is a humiliating one to the friends of both professions. In more than one case has the battle been fought without the limits of the court-room by medical and legal detectives, manufactured affidavits and suborned spies, and within it by professional mendacity. On the plaintiff's side we have seen lawyers and physicians exaggerating the results of a spinal shock, with the pocket gaping for a contingent fee unpleasantly visible. On the defendant's side we see the legal and medical agents of a monopoly, who deny the most palpable diseases, and even go so far as to exclude the very possibility of railway injury to the spinal cord.

"It is the belief of physiologists to-day that the func-

* American Journal of Neurology and Psychiatry, August, 1883, p. 540.

tional activities of the nervous system are determined, maintained, and modified by molecular changes of which neither chemistry nor the microscope have as yet revealed the precise nature. It is also an admitted fact that all injuries, particularly of a vibratory force, are capable of arresting or perverting these functions. With theories law has little or nothing to do. For science it suffices that the physiological theory and the observed facts harmonize. It would be little less than a miracle if so complex an organ as the central nervous axis, with its soft tissues, its countless interlacing conducting tracts, its myriads of delicate nerve-cells and their tender offshoots, should not suffer some disturbance in a collision which telescopes heavy cars, plows up the soil like an earthquake, crushes powerful engines into an unrecognizable mass of metal fragments, and grinds steel and oak to splinters. It is, indeed, surprising that more severe and extensive injury is not always done to flesh, bone, and nerve than the coroner and surgeon are called upon to examine.

"The great difficulty under which both the legal and medical gentlemen, connected with trials growing out of real and alleged injuries to the spinal cord, labor, seems to be a belief on the part of the plaintiffs that it is necessary to prove the existence of coarse organic disease of the spinal cord and its membranes in order to convince a court or jury that damage has really been done. On the part of the defense a similar impression prevails, and is aided by an excessive zeal to prove simulation on the part of the plaintiff.

"Violent concussion of the nervous axis may produce instantaneous death, although no evidences can be found in the dead body to explain its occurrence. The fact is there. We can only assume that the molecular arrangement has been shaken to a degree exceeding the limits of viability; just as in the case of strychnia or conium poisoning, where, although respectively the most frightful spasms, or the most profound paralysis, indicating a grave disturbance of the nervous functions, precede

death, no structural evidences of their action can be found; or, as the most violent storm may sweep across the mental horizon without leaving a material trace in the brain of the lunatic.

"It is, I may venture to say, the growing belief among those who have faithfully studied the subject, that most so-called organic diseases of the spinal cord are preceded by a stage in which there are no anatomical changes discoverable by our present methods of investigation. I feel convinced that this applies to so-called spastic paralysis, to locomotor ataxia, and to some cases of multiple cerebro-spinal sclerosis. If this be admitted, there is nothing strange in the fact that a profound shock to the cord which, as just stated, may have death as an immediate sequel, may, in those who survive, lead to chronic degeneration of that organ and its membranes; and, indeed, whatever premises we may start with, and whatever reasoning we may employ, the empirical observation proves that such degeneration, entailing paralysis and other serious ills, does result from spinal shocks. However, gross disease of the spinal cord, such as hæmorrhage, myelitis, or compression, will rarely become the subject of litigation. Few of the subjects of these disorders, if these date from a railway injury, live long enough to bring a suit; of the remainder, still fewer survive the suit, and if they do the character of the disorder is usually so plain that its existence cannot be gainsaid."

Spitzka regards concussion symptoms as indicating spinal irritation, and says: "As all cases of spinal irritation, particularly those due to concussion, agree in being annoying, painful, and disabling maladies, entailing a severe martyrdom of body and mind, these facts should be made the basis of every fair demand for and allowance of compensation."

Erichsen has given "the term spinal meningitis to what should more properly be called spinal or meningeal irritation. But the sufferings of the patient are the same, no matter by what name you call them, and of the reality of his cases there can be no doubt.

"The most difficult element in these cases is the distinction of genuine disorder from simulation. As far as I can judge from the testimony given in a number of them, as to the existence of real or feigned disease, I should be inclined to believe that over one-half of those in which a verdict has been secured, including several in which very large sums have been obtained, were and are shams. One fine day, about three years ago, a physician called at my office, who claimed to have sustained severe injuries to his spinal cord by the fall of an elevator. I did not intend at the time to make an examination of him, for the situation was a new one; I had to sail between the Scylla of neglecting a colleague in alleged distress and the Charybdis of being suspected of copartnership in a speculative action; so I sat listening and reflecting while he continued his history. I soon found that I had a man of low moral tone to deal with, a physician so ignorant that he did not recognize his own ignorance, and had not even taken the trouble to read up the encyclopædias, whose perusal might have enabled him to manufacture more plausible symptoms than he showed; in short, I found that the injuries were entirely fictitious, and that not six cents but six months in the penitentiary would have been a proper recompense for this subject.

"It is usually easy to make an absolute diagnosis between simulation and severe spinal irritation; it is sometimes impossible to demonstrate either the reality or the unreality of the milder forms of this disorder. But as the latter is not likely to be feigned by the simulator, who is rather apt to overdo matters, the cases in which the physician is at a loss must be very few indeed. A more serious element of uncertainty is due to the fact that a co-existing hysterical tendency in females, or a hypochondriacal state in males, may lead to the nursing and development of symptoms for which the mental condition of the patient is responsible, though that very mental state may date from, and be due to, the accident to which the unquestionably real and objective symptoms are attributed. Where a doubt arises as to the existence of such an element, the medical witness owes it to him-

self, his profession, and the cause of justice to call for the opportunity of giving a full and free explanation. It is none of his affair whether the jury will come to an erroneous conclusion; the turning-point in the decision of such cases is not, in my experience, the impression made by the witness or its accentuation or perversion by opposing counsel in their summing up, but the charge of the court; and the medical witness is far safer in appealing to the intelligence and understanding of a judge than to the knowledge and logic of a jury."

He warns simulators that grave nervous diseases and insanity have overtaken pretenders thereto; the simulated disorder becoming real in time. Among many other excellent suggestions Spitzka remarks that "a biased witness is satisfied with the flimsiest evidence," and, encouraging the medical witness to appear unbiased, he says: "I have had the opportunity over and over again of seeing that admissions made by a medical witness, frankly, against, or apparently against, the side which called on his services, do not injure his standing as a witness; on the contrary, an impartial attitude involuntarily calls for respect, though the momentary advantage which a suppression or distortion of facts might accomplish be lost thereby. A medical witness does not, like a lawyer, summing up for his side, speak for the present moment, but for all time. He is not the advocate of a party, but a representative of science; he should inflexibly adhere to the straight line of truth. A lawyer may defend one position in one case, and the very opposite in another, without, as far as I can learn, losing any prestige thereby. But when a medical witness forgets his allegiance to the exact truth for one moment, he may live in constant apprehension of the fact that he may testify in an entirely different way on other occasions, and be confronted with a condemnatory contradiction.

"While it is true that fraud has undoubtedly accomplished its end in more than one litigation, it is equally true that subjects of serious spinal disease have lived, suffered, and died,

under the suspicion of being simulators, and that a post-mortem examination disproved the suspicion."

Spitzka's conclusions, formulated in propositions as follows, are commended to all lawyers and physicians concerned:—

"1. Spinal injuries, entailing as they do unparalleled suffering and disability, are pre-eminently proper grounds for a claim for compensation at the hands of those who, through negligence, are responsible for their occurrence.

"2. Inasmuch as the previous existence of a neurotic state, such as hysteria and hypochondriasis, may be responsible for many disease phenomena ensuing after railway and other shocks, allowance must be made in favor of the defendant to such extent as it can be reasonably inferred that he is not responsible for the plaintiff's disorder. The same presumption and allowance should be made in case the plaintiff is shown to have suffered from syphilis or any other affections, such as certain pelvic disorders in females which predispose to the development of spinal disease.

"3. It is an interesting question whether the burden of proof as to the existence or non-existence of previous disease which may mitigate damages should lie with the plaintiff or with the defendant.

"4. The presumption in the case of a litigant asserting the existence of disease of the spinal cord is that he is really a sufferer. The question of simulation should always be raised where the direct proof of an alleged disorder is not satisfactory; but the burden of such proof should rest with the defendant, and every litigant in such cases should be considered a sick man till he is proven to be a sham.

"5. Every attendant circumstance of an accident or of violence, leading to alleged spinal injury, should be made a part of the trial-record. I find it difficult to understand, from a medical point of view, what the philosophy of the ruling of an eminent judge in the Harrold case was when he ruled out as inadmissible evidence relating to the rapidity of the train before the collision.

"6. The sooner corporations show an inclination to admit the claims of honest claimants for compensation, and to contest complaints on their merits,—in short, to limit themselves to methods which do not smack of chicanery,—the sooner will the public, the press, courts, and juries be able to recognize and willing to condemn improper claims, and to brand and to prosecute those who endeavor to coin capital out of the misfortunes of others by the fraudulent pretense of spinal disease."

In the discussion following the reading of Dr. Spitzka's paper, Dr. M. A. Henry suggested that the existence or non-existence of a predisposition should constitute a strong point in judging of these cases. Persons predisposed to injury of the spine from slight shock, might be predisposed equally to locomotor ataxia from causes which would not produce the same result in other persons. This ought to be taken into consideration. Colonel Moulton said: "I do not believe in government experts; I believe in a healthy rivalry under the present system, by which the best witnesses are bound to be selected. The chief stimulus of honest scientific investigation is a combination of the love of their science and of fame. This will produce more capable and honest witnesses than any government or judicial appointment."

Putnam,* from cerebral symptoms found in cases of injury of the kind under discussion, called attention to the relation between hemianæsthesia and hysteria. Subsequently, Charcôt† pronounced the major symptoms, "which render the patients unable to work or to resume their occupations for months or years, to be often only hysteria, nothing but hysteria," with the symptomatology precisely like that observed in women. Oppenheim conclusively proved that the sensory and motor symptoms, such as anæsthesia and pareses, did not correspond with those

* Boston Medical and Surgical Journal, September 6, 1883.
† Leçons sur les maladies du système nerveaux, iii, p. 251.

found in hysterical subjects, and Charcôt abandoned his former position ungracefully, and now holds that the condition is "a dynamic and psychical paralysis very similar, at least, to the hysterical paralysis."

Next, Putnam,* in a paper on "The Medico-Legal Significance of Hemianæsthesia after Concussion Accidents," alludes to "falls, railway collisions, and the like having given rise, even in male subjects, to impairment of the sensibility, general and special, of one side of the body (sometimes to a less degree of the other also), and it has twice happened that these symptoms have furnished valuable evidence against the probability of malingering, where claims had been made for damages.

"The medical expert is rarely called on to the witness-stand under more annoying circumstances than when required to testify as to the real condition of a patient who claims to be suffering from the effects of a railway collision or similar accident, yet who presents no sign of disease that might not be ascribed to simulation. Under these circumstances anything of the nature of objective signs of disease is heartily welcome, and the symptoms to which I have referred, though not strictly objective, yet possess almost the same degree of significance.

"There is nothing in a hemianæsthesia, especially if incomplete, to appeal to the imagination or sympathy of a jury, and in its typical forms, at least, its simulation would imply an amount of knowledge and skill that none but the best professional cheats would be likely to possess."

Three of Putnam's five cases of the kind were not making any claim for damages, and had no motive for deceit. The discovery of the hemianæsthesia was apparently a surprise to all.

"As Thomsen and Oppenheim point out with regard to their own cases, it is evident that the discovery of anæsthesia, even of the so-called 'hysterical' type, does not necessarily justify the diagnosis of hysteria, and it is indeed high time that this

* American Journal of Neurology and Psychiatry, August and November, 1884.

much-abused and misleading term, with its invidious implications, should be superseded. This is especially true as regards court cases, for the admission of the diagnosis of hysteria is liable to throw a weapon for ridicule and disparagement into a skillful lawyer's hand.

"It seems to be by no means necessary that the injury causing these persistent hysterical symptoms in man should be severe. A sharp, sudden jolt and jar, with its accompanying emotional excitement, is enough.

"Neither is a very neurotic temperament a necessary condition. In only one of these cases was this present to any marked degree.

"The hemianæsthesia does not always involve all the different kinds of sensibility, or certainly not all to the same degree.

"As in the case of true hysteria, there may be a relative analgesia, only discovered by deep pricking, etc., while the contact sense remains apparently unimpaired, and there is, at least, no marked disorder of sight and hearing. (According to Thomsen and Oppenheim, the concentric retraction of the visual field is the most constant symptom.) These partial anæsthesias, however, such as incomplete analgesia, a moderate retraction of the field of vision, a loss or diminution of hearing for bone conduction only, the importance of which as a sign was pointed out by Dr. G. L. Walton,* might justly be taken to indicate a truthful plaintiff better than a claim of complete blindness, etc.

"A loss of sensibility over parts of the body not the seat of paralysis of motion or of injury, and yet limited by the median line, would also, probably, be less likely to be simulated than a loss confined to injured or paralyzed parts.

"A greater degree of anæsthesia over such parts seems, however, to be the rule, even in certainly genuine cases.

"There is one indication of truthfulness on the part of a claimant, which, although only occasionally present, is of

* Brain, No. xx, 1883.

especial value. It sometimes happens that the area of absolute or relative analgesia is bounded by a definite line other than the median line of the body, being confined, for example, to one limb, or part of a limb. If now it is found that this boundary line remains accurately the same during a prolonged examination, or on repeated examinations, it may be assumed with confidence that the patient is not shamming, for it is impossible for a healthy person to observe a line of this sort with anything like accuracy. Such, at least, is the conclusion reached by Dr. S. G. Webber and myself, as the result of some experiments undertaken, at his suggestion, upon several individuals.

"The same test would doubtless be applicable in regard to the visual field. It is also probable that even slight atrophy and diminished electrical reaction, in limbs claimed to be paralyzed, is presumptive evidence against malingering, inasmuch as it would be difficult for persons wilfully to keep a part so still, even when not under observation, as to bring about this result.

"Again, a person feigning hemianæsthesia could scarcely simulate the disorders of the reflexes met with in typical cases, especially the impairment of the reflexes excited by irritation of the mucous membrane.

"Of course, it is not to be understood that these signs of functional impairment of sensation, even if accompanied by impairment of motion, etc., are claimed to show more than that the patient is not an absolute cheat. He may still be guilty of exaggeration, and even though he be proved pretty conclusively to have functional nervous disease, the prognosis may, of course, be good.

"The question often arises in court cases: Does the fact that the symptoms complained of have endured a long time (previous to the trial) warrant the conclusion that they will pass away but slowly, if at all? It is probable that this question may be answered in the negative, so far as the localized functional disor-

ders are concerned. Such symptoms may last indefinitely, so long as the influences are unfavorable to a cure (such as the prospect of a trial), and yet in the end pass away very rapidly. Perhaps this is less often true, however, of cases of the neurasthenic type.

"The question often arises with jury trials, What attitude shall be taken toward the term 'hysteria'?

"Senseless as the designation is, it has to the popular and to the scientific mind two different, yet both pretty definite, meanings. To the former it is almost a term of reproach, suggests exaggeration, if not half-conscious simulation. Its pains and palsies are supposed to be only 'mimic' ailments, which an effort of resolution could dispel. The expert knows, however, that this view is only a coarse half truth; that, in fact, hysteria is, in some of its forms, a distressing, serious, and obstinate malady, and that its 'simulations' of other diseases are in reality only similarities.

"The former, or belittling view of hysteria, is, of course, the one usually taken by the counsel for the defense. But, if the patient really have hysteria, it is certainly better that the fact should be recognized by both sides, an opportunity claimed for explaining the nature of the disease, than that the prosecution, shunning all mention of the true diagnosis, should darkly hint at possible organic lesions, leaving it to the defense to bring forward the obnoxious word, using it as a synonym for exaggeration, womanishness, and deception. The opinion should not be allowed to prevail that hysteria is only a 'mimetic' disease. For, on the minds of those making this statement in court, the designation carries with it a flavor of unreality and insignificance. The paralyses of hysteria are no more mimetic of the organic paralyses than the reverse is true, or than the cough of bronchitis is mimetic of the cough of phthisis. It is a case, as has been said, not of simulation, but of (outward) similarity."

Putnam's cases will be found in another part of this book.

Dana* reviewed the contributions to the matter of "Concussion of the Spine, and its Relation to Neurasthenia and Hysteria," and from his paper the following is extracted:—

"The physician who is called into court to testify in a case of spinal injury witnesses a curious spectacle. The lawyer for the prosecution waves before the jury a volume of 'Erichsen Upon Spinal Concussion.' He reads to them in impressive accents the statement that every injury to the spine, however slight, is full of danger to the sufferer. He asks, with sonorous emphasis, if Mr. Erichsen is not a surgeon of world-wide fame, and if he does not say that slight injuries to the back may cause chronic spinal disease of the most serious character. He sneers at the work of a certain Mr. Page, who is known to be professedly only a railway surgeon. He shows that his client has paralysis, anæmia, meningitis,—in fine, 'spinal concussion.'

"On the other hand, the lawyer for the defense brandishes triumphantly a larger work, by Mr. Herbert Page, on 'Injuries to the Spine;' he reads to the jury cases of malingering therein related; shows that Mr. Erichsen has for years made a business of being an expert for people with injured spines, but that he has never yet found a case that proved fatal. He quotes Mr. Page's two hundred and thirty-four cases of spinal concussion, in most of which recovery resulted, and shows, through his medical expert, that the spinal cord is so admirably protected that it could never possibly be injured by anything so utterly trivial as a railway collision.

"The medical experts themselves in these cases necessarily testify in the most diverse ways, according to their natural bias, or the particular surgical authority or pecuniary support upon which they rely. And authorities are so unsettled and contradictory, and symptomatological data so uncertain, that two medical men can, with perfect honesty, if they go by written works, support quite opposite views."

Briefly epitomizing Erichsen, Page, and other authors, up to 1884, Dana concludes:—

* New York Medical Record, December 6, 1884.

"It seems to me to be proven beyond a doubt, despite Mr. Page's arguments, that external violence and jars, apart from any hæmorrhage or other lesion, may cause an acute, subacute, or a chronic myelitis, with softening or secondary degenerations. Not many of these cases have yet been reported, because they are rare and because there is not yet a widely diffused knowledge of the methods by which the different forms of chronic myelitis are diagnosticated. And it ought, perhaps, to be added, that a certain predisposition, syphilitic or neurotic, is necessary for the development, by traumatism, of most of these forms.

"But it is claimed not only that myelitis, but that a chronic meningitis or meningo-myelitis may be set up by concussion of the cord. It is to this pathological class that Mr. Erichsen relegates a very large part of his reported cases. In doing this he had undoubtedly given a more serious aspect to many of these cases than they deserved. Meningitis and myelitis are, as we have stated, serious diseases, yet the cases Mr. Erichsen describes do not die.

"I fully agree with Mr. Page that a large proportion of these cases, when analyzed, can be shown to be cases of strain or rupture of muscular and ligamentous structures, injury to nerves, or the results of a general nervous shock, and that the spinal cord has no more to do with the disease than the stomach.

"I hesitate to say, however, that Mr. Erichsen is entirely wrong in his pathology, or that there is not set up in some of these cases a low grade of meningeal inflammation or congestion; or even if there be not, as in the case of Mr. Jepson, patches of softening. This is certain, however, that heretofore too little stress has been laid upon the symptoms produced by neuritis, strains, and general nervous shock."

Dana does not doubt that "in the largest class of troubles resulting from accident and injury to the spine, the main source of the symptoms is a general functional nervous disturbance.

"The fright, excitement, and more or less severe bodily injury produce often a profound shock. From this the nervous

system gradually emerges into a state that may be broadly characterized as one of asthenia, morbid irritability, and defective inhibition,—a clinical picture familiar to all.

"Sleeplessness, irritability, states of depression, defective memory, inability to do mental and physical work, headache, tinnitus, nervousness, vasomotor disturbances, excessive sweating, asthenopia, large pupils, spinal pain and tenderness, muscular weakness, tremor and twitchings and irregular pulse, are the ordinary symptoms.

"The use of electricity in testing muscular and nerve irritability and degeneration, when carefully applied, is of the greatest value. At the last meeting of the American Neurological Association, I suggested that the test of diminished or increased electrical resistance in affected limbs might be of value in some cases. In one case, in which I tried it, the alleged lame and injured limb showed slight diminished electrical irritability and increased electrical resistance in two successive trials on different days."

(This was before the days of the absolute galvanometer, the use of which might have shown that the want of uniformity of resistance was apparent, only, and not real.)

"The matter of prognosis, also, calls for more accurate determination. Mr. Page is inclined to take a rose-colored view of the prognosis in these cases. He thinks that a large majority recover, and that nearly all tend to recovery. He does not seem to have met cases like those of Buzzard,* or where organic disease finally set in as in Ede's cases, Petit's, and my own. He never has met any serious results to vision, as have Wharton Jones and Erichsen.

"His views are rather too hopeful, and decidedly are not always borne out by his own notes: 'Patient improving at last accounts' is a formula given, but it may mean very little after all.

* "Nearly twenty years ago, Dr. T. Buzzard (*Lancet*, 1865 and 1867) investigated the after-histories of eight cases of cerebral and spinal concussion. Two to four years later, none were found well, and one had died of phthisis. The same author cites cases apparently showing that spinal concussion may develop pneumonia, phthisis, imbecility, convulsions, diabetes, aneurism. In his cases, however, there seems to have been an element of brain injury."

Traumatic neurasthenia, or railway hysteria, is generally recovered from in a great measure. In my experience, traumatic neurasthenia is the most amenable to treatment. But it is very often the case that the man who has had a severe nervous shock is never entirely the same man he was before. This is particularly the case if he has reached middle life, or is of a neuropathic constitution. The very old and the very young seem to suffer less.

"The object of my paper has been to show:—

"1. That the term spinal concussion is a misleading and often incorrect one, and that the symptoms which are usually associated with that name are really symptoms of traumatic neurasthenia, hysteria, and hypochondriasis, associated more or less with symptoms of injury to the vertebral ligaments and muscles, and to the spinal nerves; that, in other words, spinal concussion is mental shock and physical bruising.

"2. That this traumatic neurasthenia is, in a measure, a real disease, though it is very hard to say how much is real and how much the patient puts on.

"3. That it may be, and often is, simulated, and that it requires the greatest care to detect skilled imposters.

"4. That we need more objective tests for the purpose of determining the existence of these subjective neuroses.

"5. That the prognosis of railway or traumatic neurasthenia and hysteria is very good so far as steady improvement is concerned, not so good as regards complete recovery.

"6. That concussion of the spinal *cord* alone, followed by temporary loss of function, or by myelitis, does occur in rare instances.

"7. That, in the predisposed at least, injuries and jars may set up chronic myelitis, without there being a lesion of the spinal column.

"8. That Mr. Erichsen has in his book on 'Spinal Concussion' erroneously attributed functional troubles to the results of organic spinal disease.

"9. That Mr. Erichsen's book on 'Spinal Concussion' has a strong tendency, erroneously, to attribute to a shaking of the spine and a supposed ensuing meningitis symptoms really due to mental shock, peripheral injury, or malingering."

Following the reading of this paper at the New York Neurological Society, November 11, 1884, Dr. Hammond stated that he agreed with Dr. Dana in the view that there was such a thing as spinal concussion, and, further, "that it is difficult for us to tell by the symptoms what the exact nature of the injury is that the patient has suffered. But this fact, I think, remains, that there is some injury which the spinal cord is capable of suffering, which is not of such a serious character as to cause death, and which is not accompanied by any injury to the bones, or to the muscles or ligaments. That, after all, is the practical point." Dr. Hammond then related the history of two cases of spinal concussion in which he had been called as an expert. The first patient suffered from muscular weakness, spinal pains, severe general nervous symptoms, and walked with a paralytic gait. There was no positive evidence of organic disease of the spinal cord. He received large damages, but he still, twenty years after, suffers from his trouble. The second case, of a somewhat similar character, made a better recovery, but still walks with a cane. Dr. Hammond thought that this patient suffered from some organic disease of the cord. He referred to the first case in this country in which a post-mortem was made. The patient was a physician, who fell on the ice and suffered from the symptoms of antero-lateral sclerosis. On post-mortem sclerotic patches were found throughout the spinal cord. "I think," Dr. Hammond said, "traumatism may give rise to spinal affections without there being any palpable lesion of the soft parts, or of the bony structures, or the ligaments."

He did not think that hæmorrhages in the cord were recovered from, nor could he conceive of concussion of the brain without loss of consciousness.

Dr. J. G. Johnson thought that railway employés suffered less often than passengers from the "pure concussion" symptoms, excluding myelitis or meningitis. The passenger, on the other hand, "who has had a good shaking up and a terrific scare, has no object in getting well. The company has got to pay him roundly; it has to pay him for his loss of time; it has to pay him for his suffering, both mental and physical; it has to pay his surgeon also; his surgeon has an unknown quantity to handle; he has something to treat that the patient does not understand. If the patient has a broken leg he knows what he has got, and the doctor cannot come in and discuss spinal concussion symptoms, and all that. He has seen broken legs before; he has cold extremities, vomiting, exhaustion, and so on; but he has not had the scare of a doctor coming in, feeling up and down his back to see whether it pains him, and asking whether he can stand on his legs, and going through all those symptoms, that unknown quantity which they know so well to do. He has not had some *confrère* to come in and suggest some more doubts. The doctor, in a good many cases, is hungry, and the big corporation may pay his bill. He has to examine that back often; he has to find out just what these doubtful things mean; and the patient having it iterated and reiterated begins to believe himself that there is something terrible the matter with him. He does not dare to go out and take a little fresh air and exercise (which, as my friend, Dr. Hammond, says, is the best thing to restore the nerves), because a railway man might be around and spy him using his limbs. He gets morose, and has no object to get well, because that suit is not settled. He begins to have some motor disturbances; he has those profusé sweats, etc. When you come to take that kind of disturbance—of expecting to recover from the company—out of the question, they get well frequently with indecent haste."

He alluded to the frequency with which loss of virility was alleged in these cases, and continued: "I think there is no doubt that serious lesions of the spine and spinal cord do occur

as the result of railway concussions. We have mingled with it a large variety of other symptoms. When a train is suddenly stopped, the patient is violently thrown backward and forward, shaking up all his viscera and the whole sympathetic nervous system, and the other organs suffer. Added to that their terrific fright and the utter helplessness of their condition, and the effect upon the mind is something severe. But with all that, when you come to consider the fact of compensation, we find these cases so much aggravated that I do not think any physician is right to go into court and swear that the patient has disease of the spine unless he has the physical symptoms, and he should not rely upon the statement of the patient, who is interested to make matters as bad as he can.

"The length of time, doubt, and uncertainty of the cases are important elements to consider. As far as a surgeon for a railway company being affected in his evidence by outside influences is concerned, he would find that truth was the first essential; he would not hold his appointment for twenty-four hours when his company was satisfied that he was not truthful. When we are sent to investigate a case on behalf of the corporation, we make as thorough and as exhaustive an examination as it is possible with the knowledge that we have, and our report is made in writing and goes to the company's office with everything bearing against us as well as for us. If we misrepresented that case, and this is shown in evidence in court when the case comes to trial, it shows that we are ignorant or dishonest, and our walking tickets are prepared. No man can hold his position as a surgeon for a company who is not honest, because they pay on an opinion, and if it is not truthful they do not want it."

Dr. Johnson's railway companies are, therefore, undoubtedly governed upon proper principles, by broad-minded men and policies, but he should not make his inclusion extend to *all* such corporations, for companies are never better nor worse than those who compose them. *Occasionally*, the lowest moral grade

of surgeon, the hardest swearer, irrespective of his learning, is alone successful in being employed.

In his otherwise most excellent volume, Byrom Bramwell* exhibits too much of the influence of Herbert Page in the portion devoted to "Concussion of the Spinal Cord, with Special Reference to the Spinal Symptoms which Result from Railway Collisions, and the Method of Investigating Railway Cases."

He restricts his definition to the symptom-group only, and excludes discoverable lesions. He acknowledges that the functional activity of the gray matter of the brain or cord may be temporarily deranged by vibrations or shocks from without, but doubts permanent effects, "for it will always be impossible in any case, in which apparent simple concussion is followed by permanent organic disease, to be certain that some structural change (however minute) was not present from the very first."

He maintains the existence of organic lesions from the beginning, and divides spinal symptoms from traumatic violence into four great groups:—

"Group 1st. Cases in which symptoms of acute myelitis, or meningitis, or both, or of acute compression of the cord, follow immediately upon and are directly due to the accident."

We can acknowledge at once that these and other organic troubles may be *caused* by a concussion of the spine, and in that sense only should they be considered spinal-concussion symptoms; but in the defense of this group Bramwell is certainly in error in stating that "cerebral symptoms are, as a rule, completely absent unless the head has been injured, and the symptoms of general nervousness, which are so prominent in the great majority of cases of so-called 'concussion of the spine,' the result of railway accidents, are rarely observed."

It is, on the other hand, rarely found that the railway accident, that confers myelitis or compression symptoms, has not imparted concussion symptoms, also, in the strict sense.

* Diseases of the Spinal Cord, p. 312 *et seq.*

"Group 2d. Cases in which undoubted symptoms of acute myelitis, meningitis, or rapid compression of the cord follow, after a brief interval, upon an accident or injury."

He regards these instances as of rare occurrence.

"Group 3d. Cases in which chronic organic disease of the spinal cord, or of its membranes, results from traumatic injuries."

This class of cases Bramwell is in doubt about as to frequency, and thinks that investigations extending over years should be made to elucidate the matter. His most commonly-occurring cases are in—

"Group 4th. Cases in which functional derangements of the spinal cord (which are generally associated with, and probably in many cases depend upon, derangements of the cerebral nerve-centres) result from traumatic causes."

The chief symptoms which patients complain of are:—

"1. Pains in the back and limbs. These are present in the great majority of cases, and are often very prominent; in some there is also tenderness on pressure and hyperæsthesia.

"In some cases the pains in the back are due to bruising of the soft parts in the neighborhood of the spine; in others to sprains of the spine (stretching and twisting of the spinal ligaments and muscles); in others they seem to be more closely allied to the 'sickening, dragging' pains in the back, and down the course of the sciatic nerves, which are so common in spinal nervous weakness (neurasthenia spinalis), and which probably depend upon profound nervous exhaustion." He follows Page in this.

"2. Numbness, prickling sensations, feelings of heat and cold, pins and needles, hyperæsthesia, and anæsthesia.

"3. Muscular exhaustion and debility, which are often ascribed to paralysis and functional paralysis. The muscles are often soft and flabby; there is often general, *but not localized*, muscular wasting; the reflexes are either normal or exaggerated; the electrical alterations, if any, are of a simple kind (simple

diminution); there are no qualitative changes; fibrillary twitchings are sometimes present.

"4. Constipation and slight impairment of the expulsive power of the bladder are sometimes present; the urine may contain phosphates; loss of appetite and diminution of sexual power are common complaints.

"(All of the spinal symptoms just enumerated are met with in purely functional derangements of the cord; indeed, the cases which we are now considering have, in many particulars, a very close resemblance to neurasthenia spinalis.)

"5. Headache, sleeplessness, occasional dimness of vision, confusion of thought, failure of memory, irritability of temper, loss of emotional control, inability to concentrate the attention or to undertake any continuous mental work, irritability of the heart and a tendency to palpitation, mental depression, hopelessness of recovery, dread of paralysis, etc.

"6. Loss of appetite, deterioration of the general health, loss of weight.

"I must, however, repeat that organic disease of the cord *may* result from the injuries sustained in a railway collision, and that positive signs of organic disease may be present in addition to the symptoms of functional derangements which have just been described.

"When well-marked derangements of the functions of the spinal cord follow a blow on the back or other traumatic injury, the practical physician must, in many cases, content himself with endeavoring to determine:—

"1. Whether the symptoms are indicative of organic disease or of functional derangement.

"2. If the symptoms are due to organic disease, what is the exact situation, extent, and nature of the lesion?

"3. If there are no distinct indications of organic disease, are the symptoms (*a*) due to derangement of the functions of the spinal cord or of the cerebral centres, and (*b*) are they genuine, exaggerated, or fictitious?"

Bramwell's subsequent statements are mainly those of either Page or Erichsen, but in addition he makes a most excellent suggestion, one that I have always urged in advising lawyers, physicians, and the court.

"Subjective symptoms *per se* should always be viewed with suspicion, and should be valued according to the character and reliability of the patient, his general behavior, the amount of damages which he is claiming, and the whole collateral (non-medical) facts of the case." Further: "No importance should be attached to slight objective differences obtained by instrumental means, such as electricity, unless they have been elicited by an observer whose capabilities of observation are beyond suspicion."

Philip Coombs Knapp* regards Erichsen's composite of "Concussion of the Spine" as compounded of too many distinct conditions to be trustworthy, and from the vagueness of his classification his ideas on prognosis proved misleading. A reaction against Erichsen, of course, followed, and it was aided by the cynicism that naturally arises when we see a man, who has claimed to be permanently injured, walk off as well as ever when the damages have been paid. It has seemed to me, however, that this reaction has gone too far.

Knapp thinks that Page's work reads "like that of a special pleader for the railway companies," and calls attention to no mention of the reflexes being made in any of Page's cases.

"Trauma," he says, "may produce certain definite lesions of the spinal cord and its coverings, besides the vague and questionable results of pure 'concussion.' It may, in the first place, cause fracture or dislocation of the vertebræ, and, secondarily, affect the cord itself. In these cases it not infrequently happens that the patients exhibit the symptoms of injury to the cord, while the injury to the vertebræ is noted only at the autopsy. With or without injury of the vertebræ, however, we may find serious

* Boston Medical and Surgical Journal, Nov. 1 and 8, 1888.

injury to the cord,—hæmorrhage into the meninges, or into the cord itself, rupture of the pia with hernia of the cord, or acute myelitis.*

"In addition to these cases of what may be called 'acute injury to the cord,' where the symptoms develop immediately after the accident, it is a well-attested fact that chronic degenerative processes may be due to an injury; and here, of course, the symptoms are very insidious in their onset. Spitzka† and Gowers‡ cite cases of tabes dorsalis due to injury, and Hoffmann§ has just reported a very interesting case of tabes from Erb's clinic at Heidelberg due to a prolonged daily concussion of the whole body, especially the abdomen. Dana,‖ too, has cited a case where tabetic symptoms followed a railway accident to a syphilitic subject, where he thinks the accident determined the localization of the morbid process. Besides tabes, injury may produce lateral sclerosis, progressive muscular atrophy,¶ diffuse sclerosis,** and disseminated sclerosis,†† the last two affections being extremely difficult to diagnosticate in their early stages.

"There is, or rather was, another lesion of the cord which was once deemed of great importance, and was regarded by Erichsen as the chief source of the symptoms of his 'Concussion of the Spine,' namely, spinal leptomeningitis. We used to hear of it, but lately the cases have become rare, and, in fact, few now diagnose with Strumpell's dictum,‡‡ 'A case of primary chronic leptomeningitis, which can be surely and convincingly proven clinically and anatomically, does not exist.'

"Finally, in the brain and its coverings injury may produce

* E. Leyden, Klinik der Ruckenmarkskrankheiten, i. 371, ii. 61, 92, 139.

† Spitzka, The Chronic Inflammatory and Degenerative Affections of the Spinal Cord. Pepper's System of Medicine, vol. v, p. 855.

‡ Gowers, Diseases of the Nervous System, i, 289.

§ Hoffmann, Archiv f. P. und N., xix, 438, 1888.

‖ Dana, Nervous Syphilis Following Railroad Injury. The Post-Graduate, April, 1888.

¶ Gowers, *op. cit.*, vol. i, p. 450.

** Gowers, *op. cit.*, vol. i, p. 238.

†† Spitzka, *op. cit.*, p. 884.

‡‡ Lehrbuch der speciellen Path. und Therap. der in. Krankh.

various lesions—fracture of the skull, meningeal and intracerebral hæmorrhage, pachymeningitis interna hæmorrhagica, meningitis, softening, abscess, tumor, and various functional disorders, such as epilepsy, paralysis agitans, and chorea.*

"Furthermore, injury may give rise to various psychoses† and chronic degenerative processes, especially paretic dementia.‡

"Besides these affections there are other cases of a more obscure character where our diagnosis is often doubtful and our prognosis sadly at fault.

"Whether there is a true 'concussion of the spinal cord' is still a matter of doubt. By this term I mean a paraplegia following injury, where the cord has sustained no coarse mechanical lesion, where 'molecular changes in the finer nerve-elements have occurred, giving rise to an immediate and complete functional paralysis' (Erb), a condition analogous to the common concussion of the brain. Page questions the possibility of such an affection, but cases have been reported which clinically answer the requirements.§ The anatomical relations of the cord naturally render it difficult for true concussion to occur; and, moreover, in simple concussion there is apt to be recovery, so that post-mortem evidence is lacking. Cases have been reported (Leyden), however, where paraplegia came on suddenly after an injury and terminated fatally, although no lesion could be found after death. Some of these cases are, of course, untrustworthy, as they were observed at a time when the methods of examining the cord were less exact, so that it is hard to exclude the existence of contusion or punctate hæmorrhages into the cord. Duménil and Petel,‖ however, still hold to the belief in commotion of the cord, which may be the origin of consecutive inflammatory lesions or sclerosis, and Dana¶ admits the existence rarely of true concussion. Some writers, Obersteiner** among them,

* Ch. Bataille, Traumatisme et Néuropathie.
† Hartmann, Archiv f. P. und N., xv, 98, 1884.
‡ R. v. Krafft-Ebing, Lehrbuch der Psychiatrie, vol. i, p. 166.
§ Wm. Hunt, Concussion of the Spine. Pepper's System of Medicine, vol. v, p. 913.
‖ Archives de Neurologie, January, March, May, 1885.
¶ Medical Record, December 6, 1884.
** Med. Jahrbücher, p. 531, 1879.

hint at the existence of chronic concussion in men who are constantly exposed to jarring, as railway employés, but such cases are more likely to be classed among the degenerations of the cord, as in Hoffmann's case already cited."

Knapp's most typical cases are recorded elsewhere in this volume. He sums up his cases to the effect that the commonest symptoms were cerebral disturbances. Eight had headache or pain in the head, and eight had vertigo; ten had some psychical disturbance, nervousness, restlessness, irritability, inability to make prolonged effort, depression, anxiety, loss of memory, and, in at least one case, distinct mental impairment; two had some sort of convulsive seizure, one only seemed to have been affected by any terror, and in him the effect was slight.

"Motor disturbances were not uncommon. Seven patients had muscular weakness, which sometimes amounted to actual paralysis, although chiefly when there was neuritis. Several had tremor, two had Romberg's symptom, and one inco-ordination. Several had muscular wasting, and four diminished electrical excitability, chiefly from neuritis. The knee-jerks were increased in three cases, diminished in three, and absent in one.

"Sensory disturbances were less common. In only four cases was there poor vision, due generally to definite causes independent of the injury. In three cases the other special senses were impaired, generally on one side. Three patients had diplopia and one nystagmus. One had monocular diplopia, sluggish pupils, and xanthopsia; the last symptom was noted in one of Oppenheim's cases. Contracture of the field of vision was found but once, but in a few instances the fields were not examined. Anæsthesia in varying degrees was noted in seven cases, due in two, at least, to neuritis. In four of these seven cases, and in two others, there was paræsthesia. In no case, unless possibly one, was the anæsthesia strictly unilateral hemianæsthesia.

"Digestive disturbances were occasionally seen, and in five cases there were vesical symptoms—signs of paresis of the

bladder. Two men reported impotence. Pain in the back was found in seven cases, and several others had pain in the side, limbs, or abdomen. The pain in the back was usually associated with tenderness over the spinal muscles and was increased on motion. In a few instances it was associated with tenderness over the spinous processes.

"What is the cause of such an array of symptoms? Is there only hysteria,—nothing but hysteria? Is there merely a strain of the muscles of the back, with neurasthenia added to it? Is there merely a functional derangement, or is there some structural change in the nervous system? Of course, it is not possible to find any one diagnosis to fit so many different cases, but these cases and their attendant symptoms may furnish us with some data to aid in considering the whole subject of so-called concussion of the spine.

"Before discussing the question further, it is essential to give some sort of a definition of what is meant by the two vague terms, hysteria and neurasthenia."

He inveighs against these terms as "convenient 'dumps' for cases where we can make no diagnosis," reviews Charcôt unfavorably, indorses Oppenheim's conclusions, and notes that Westphal* also "asserts that these cases cannot be brought under the rubric of hysteria.

"After severe concussions, or the psychical trauma of injury, the victim is thrown into a pronounced neurasthenic state, which may last for years. His nervous system is utterly shattered, or, to use the phrase of the day, he is 'all broken up.' He is nervous, irritable, emotional, perhaps hysterical; he is overcome by trifles; he is exhausted by the slightest effort. He may present no objective symptoms, but he remains an utter wreck. There is a general weakening and a decline from the normal standard in the functions of the central nervous system, especially in the domain of thought, the will, and the emotions. The symptoms may be milder. Here the patient finds himself

* Archiv f. P. und N., xvii, p. 282, 1886.

changed. Instead of being capable of continued exertion or strain, he is easily upset; trifles annoy him; he is irritable and quick-tempered; he has lost the power of rebounding after pressure, of maintaining the calm, good-tempered spirit which perhaps he had before; his sleep is not so sound; he starts when a door slams; his children annoy him; he is fretful and fault-finding. It may be that such a man is able to work as well as before, and to earn as much money, but if he be in some responsible position perhaps his judgment is less sure, or his bearing toward his associates less agreeable. He is no longer a 'good fellow,' but nervous and disagreeable.

"The psychical conditions noted: Depression, anxiety, loss of memory, mental impairment, the tremor, the exaggerated reflexes, and the swaying with closed eyes; the pronounced paræsthesiæ, the vertigo and headache (persistent headache being confessedly not a symptom of hysteria [Charcôt]); nystagmus, vesical paresis,—all these point to something besides hysteria or the hysterical state. Moreover, incontinence of urine, nystagmus, and exaggerated reflexes are symptoms which we should expect to find in organic rather than in functional disease.

"It seems to me that the theory of an organic lesion, possibly the lesions suggested by Westphal, is the one which is the most satisfactory in many of these cases."

He appeals for support to Bramwell's similar views and to the general lesions found in the bodies of some of those killed by the great railway accident at Charenton in 1881.

Knapp's conclusions are as follow:—

1. Concussion of the spine, in the strict sense of the term, although probable, is still a matter of doubt.

2. Muscular strain, spinal irritation, and peripheral neuritis are not uncommon complications.

3. Injury may give rise not only to gross mechanical lesions of the central nervous system, with symptoms coming on soon after the accident, but also to typical chronic degenerative processes of insidious onset.

4. Injury may also give rise to various functional affections of the nervous system, including psychoses, hysteria, and neurasthenia.

5. Hemianæsthesia is not pathognomonic of hysteria, but is found in other conditions.

6. Psychical disturbances—anxiety, hypochondriasis, depression, emotional disturbance, and lack of power of application—may exist alone or in conjunction with other affections.

7. The neurasthenic state is often produced by injury, but true hysteria is rare.

8. Both the hysterical and the neurasthenic states may be superimposed upon organic disease, obscuring the diagnosis.

9. There is a fairly typical symptom-complex, with psychical disturbances, paræsthesia, anæsthesia, slow and feeble movements, exaggerated reflexes, etc., which is not uncommon, and is probably due to organic disease.

10. The prognosis of these conditions is grave. Improvement is not uncommon, but complete recovery is rare.

Bremer* states that "modern investigators, though not able to establish the pathogenesis of the ailment, have succeeded in doing away with a considerable mass of superstitious rubbish that used to cling to the subject, and, by the comparative study of related disorders, have been enabled to throw considerable light on the nature of certain heretofore inexplainable and paradoxical symptoms."

He details the case of a negro whom he suspected of shamming, particularly as the sensory and motor failures were upon the same side of the body as the injury to the head. Four years later the patient was found to be wasted with bladder and head trouble, "a complete wreck, the very reverse of his former self," and living on the charity of his friends. Bremer says: "This case taught me how imprudent it is to proceed in the examina-

* A Contribution to the Study of the Traumatic Neuroses (Railway Spine). Alienist and Neurologist, July, 1889.

tion and the judging of nervous affections in too dogmatic a manner."

Referring to Oppenheim's notice of the frequency of equilateral paresis in concussion cases, Bremer next records the case of a farmer who was thrown from his wagon and struck the left side of his head, back of the ear, against a stump, with left-sided paresis and anæsthesia following. Dr. Prewitt is mentioned in the same article, in another case of "traumatic neurosis" in a young man whom he, too, suspected of malingering, on account of an alleged equilateral paresis in an injury of the head.

Bremer well says: "There can, of course, be no doubt that a large portion of this money (twenty-five million dollars estimated as annually paid to injured railroad employés in the United States and England) goes to parties who are in no wise entitled to damages, who owe them, not to the gravity of their complaints, but to the deeply-rooted prejudice of the average juryman against corporations, especially railroads.

"But exceptionally the reverse is the case. Owing to the ignorance of some lawyers who have not familiarized themselves with the peculiarities of the nervous disorders produced by traumatism, coupled with fright, the honest sufferer is sometimes wronged, because his counsel does not understand enough to lay before the testifying physician or medical expert appropriate questions to elucidate the nature of the nerve trouble for which the plaintiff asks damages. It is especially the unsophisticated plaintiff who will appear to his disadvantage in the witness-chair if the hysterical and emotional side of the case be not fully explained to the jury. Such a man is apt to appear as an impostor, especially when counsel for defendant knows how to take advantage of the mental weakness of the plaintiff. The line of argument of the opposing counsel generally is as follows: (1) To prove that plaintiff did not receive the injuries for which he sues at the time and under the conditions stated; (2) if he did, it was his own fault, owing to the lack of ordinary care; (3) that the symptoms of which he complains are the result of a vivid

imagination, or, to say the least, that they are erroneously exaggerated for the purpose of working upon the feelings of the intelligent jury." A case in point is given where, in spite of grave disease, mainly subjective, "the patient looked stout and had a florid complexion. At the time he sued his employers for damages, about two years after the accident, he had very much improved. The plaintiff was treated by counsel for defendants as an impostor and lazy 'good-for-nothing,' and, as he made a bad impression on the jury by his overemotional, unmanly, and hysterical behavior, but principally by the fact that his looks seemed to belie the gravity of his symptoms, a verdict was rendered in favor of defendants. His lawyers had not the slightest idea of the nature of the disease of their client. The man will never recover; his working power will be damaged for the rest of his life."

As an offset to the foregoing, he gives the instance of an iron-worker, of about forty years of age, who "had received an injury very similar to that of the above patient, except that there was no epileptogenic zone, and that his trouble consisted principally in a paretic condition of the left leg. The wailing of his wife, the commiseration of the neighbors and friends, and probably the examinations of the doctors and lawyers, had all helped to develop a rather serious case of railway spine. The man's claim was settled about fourteen months after the accident, but there was no improvement. He continued to remain in bed and to harass his family with his everlasting complaints. This proved too much for the wife. She ran off with another man, taking all the money with her. On the following morning the patient got up, dressed, went out, inquired for and obtained work, and succeeded in making a living for himself and three children. Several years ago he moved out West and went to farming."

This was hardly a genuine case of "railway spine," but, admitting that it was a veritable concussion case, recovery might have taken place gradually, and the bedridden habit have been broken up by the mental impression, as in "Christian science

cures." There is too much uncertainty about the matter, as the case is reported, to enable a decision between real and feigned disease.

Seguin,* under the heading "Traumatic Neuroses," deals with the recent literature of "all the functional or quasi-functional morbid states of the nervous system which result from injury," variously designated cerebro-spinal concussion, spinal concussion, railway spine, railway brain, etc. He admits that the "psychic, sensory, special sensory, motor, and so-called trophic functions may be altered, and give rise to symptoms variously grouped," after concussion accidents. Oppenheim's classification is preferred, and the hypochondriacal condition, auto-suggestion, and other features urged by Page and Charcôt are dwelt upon.

"Nothing is easier," he says, "for an ordinary human being than to resist the slight pain inflicted in ordinary tests for anæsthesia. In none of Oppenheim's, Wolff's, and Knapp's cases was the crucial test of faradic excitation by a wire point tried. Pricking and pinching are useless tests, and even the intense secondary faradic current delivered by a single wire may be withstood by a normal human being. This I have witnessed."

This recalls Bramwell's reminder that electrical tests are especially fallacious in the hands of inexperienced persons. In cases where (however rare) the physician is not incompetent and the patient is not an expert, where the plaintiff does not know everything and the doctor nothing, a fair opinion might be reached as to whether the will-power was sufficient to withstand anything short of a thunderbolt.

"As regards motor symptoms, it is noticeable that in these cases, excepting where a local definite injury to a member was produced, true paralysis, and especially the reaction of degeneration, were absent. The walk, when affected, differs from that of any known symptom-group indicating central nervous disease.

* Annual of the Universal Medical Sciences, 1889, vol. iii. Philadelphia: F. A. Davis.

Reflexes, more especially the patellar reflex, are, as a rule, increased. The latter condition has extreme examples afforded by sexual neurasthenia," says Seguin,—a remark paralleled by Page's * quotation from Hutchinson that "no condition of defective tone is more certainly revealed by large pupils than that which results from sexual irregularities in early life."

It is probable that there are a few complaints not dependent upon sexual disease or sins, even though the sufferer may have been in a railway accident. The fact that syphilis, etc., may produce a great range of troubles similar to, and in some cases identical with, those caused by bodily injury is not usually lost sight of by damage contestants. "The action of the bladder is often reported as abnormal, but in most cases this is impossible of verification. We must take the patient's word for the incontinence or irregular micturition, which he can most easily produce." This is true of pretended sphincter loss of control, but in alleged detrusor failure the test for ammoniacal urine should be made. Even this, however, merely indicates that the urine, when retained, is ammoniacal.

Impotence he regards as an unreliable symptom. "We are utterly unable to control the patient's assertion on this point, which usually appeals very strongly to the sympathies of a masculine jury. Cases are recorded where fecundation was successfully accomplished by a 'victim' shortly after a favorable verdict." Pending the trial of a case, a "victim" seemed to be honestly puzzled over approaching paternity. Then, again, fecundation is possible without erectile ability.

Seguin points out a very important resemblance of the symptom-group of Knapp to that of many non-traumatic cases which annoy the physician so much by their vagueness, their subjectivity, and by their incurability.

"We acknowledge that we do not fully understand the pathology of these cases, which we classify as hypochondriacal, hysterical, or even delusional, and which we sometimes see

* *Op. cit.*, p. 181.

twenty years after the beginning of symptoms sometimes much worse, but usually not so in reality."

The pre-existence of symptoms before an accident, he thinks, should be looked into, and Page's claim that bromide of potassium may cause conditions allied to those alleged as occurring in concussion Seguin commends. There are few cases brought into court wherein this is not at least insinuated as responsible. Seguin is right, however, in stating that the bromides are frightfully abused in medical practice.

That hypnotism and the mere *witnessing* of a railway accident may cause full concussion symptoms can be left to the judgment of any one.

"The escape of persons who are asleep, at the time of a railway accident, from the symptoms of traumatic neuroses, is admitted by all writers, and should exert a powerful influence on our judgment of the pathology of the affection."

Seguin is in error in supposing that "all writers" have anything like unanimity on this point. Few writers mention the matter at all, and I know of two cases, reported in Chapter VI of this book, where sleeping at the instant of the accident did not confer immunity.

Henry Hollingsworth Smith,* at the American Medical Association meeting, Newport, R. I., June 25, 1889, in a paper entitled "Concussion of the Spine in its Medico-Legal Aspects," stated that the legal liability of capitalists and corporations for pecuniary damages through negligence was established by the English Parliament, in 1846, through "Lord Campbell's Liability Act."

"In Michigan the limit of the claim is fixed at five thousand dollars; in New York it is ten thousand dollars; in Mississippi it is such compensation as shall be deemed fair and just in reference to the injury sustained by the plaintiff; in Tennessee it includes mental and physical suffering, loss of time, necessary

* Journal of the American Medical Association, August 10, 1889.

expenses of the deceased, and damages to the beneficiary; but in Pennsylvania, since the adoption of the new Constitution, there is no limit.

"So generally is this liability for injury caused by negligence admitted that most corporations or employers do not hesitate at a prompt settlement of a just and reasonable claim, being influenced thereto not only by a proper regard for the suffering induced, but also as an acknowledgment of 'the majesty of the law,' it being now a well-settled principle that 'they are liable for past and future physical and mental suffering, together with the loss of earning power, where the consequences are such as, in the ordinary course of nature, may be reasonably expected to ensue.'*

"A recent example of the disposition of a corporation to promptly relieve suffering, and settle a just pecuniary demand for injuries received in transit, is shown by the action of the Lehigh Valley Railroad, of Pennsylvania, where, after an accident to an excursion train at Mud Run, in October 30, 1888, in which sixty-three persons were killed and over eighty wounded, the company made a prompt and amicable settlement with most of the claimants, at a cost of over $150,000, though the coroner's jury, after a rigorous examination of the case, failed to report any want of care or proper vigilance on the part of those in charge of the train."

He quotes the opinion of Judge Willard Bartlett, of the New York Supreme Court,† on "the relation of scientific experts to the administration of the law." "In an action for damage," says the judge, "arising from accidents on railroads, the respective parties are often assisted by surgeons who testify to the nature, extent, and consequences of the plaintiff's injury, and also often advise counsel as to the conduct of the surgical part of the case. A wise doctor should, however, take care not to act in both capacities. If he testify, he should not act as assist-

* Patterson, Railway Accident Law. Philadelphia, 1886.

† Proceedings Sixty-first Meeting of the New York Society of Medical Jurisprudence and State Medicine. New York, March 14, 1889.

ant counsel, and if he act as assistant counsel he should keep off the witness-stand, because he will naturally become prejudiced in favor of the party in whose service he is acting, and the jury will regard such a witness as prejudiced, and his testimony as that of a partisan, thus materially detracting from the force and effect of his evidence. The attitude of the physician called as an expert should be as nearly as possible one of entire impartiality as between the litigants." Judge Bartlett also says: "I have every reason to believe that cases are not unknown in which the plaintiff's counsel have said to a physician, 'I think my client's injuries are serious; go and see him for me; if you find that he is not seriously hurt I shall not expect you to charge me anything for making the examination, but if you conclude that his injuries are incurable I will call you as a witness and pay you handsomely.' As this is manifestly incorrect, no such proposition would be accepted by a really honorable professional man of high character."

These important matters will be taken up in this book in the part assigned to medico-legal considerations.

Dr. Smith mentions a case of Hodges,* wherein the plaintiff celebrated his $10,000-verdict victory "by becoming uproariously drunk, and it required the united strength of three policemen to take him to the station-house." In the implied malingering of this case it is to be remembered that in the traumatic neuroses, particularly where the brain or cord is injured, there is an undue susceptibility to alcoholic influence; very little suffices to cause frenzy. But in the other case cited by Hodges, "in which there was a claim of impotency resulting from the injury, and the jury expressed their sympathy by a verdict of $18,000, yet not long afterward the man was convicted of bastardy," if impotency claim alone was the cause of the verdict, apparent injustice was done the defendant, though impotence is used in too wide a sense to include erectile loss, sexual impairment, indisposition; and, so far as procreation is concerned, the

*Boston Medical and Surgical Journal, April, 1881, p. 363.

only true impotency consists in spermatic defects, which latter may not exist and the other difficulties may be present.

Certainly the culprits guilty of substituting a badly injured person for the real plaintiff should have penitentiary punishment. The doctor quotes Judge Wilson, of the Philadelphia Court of Common Pleas, as recalling an instance of this kind where large damages were obtained.

A case of probable malingering follows which would be worth reporting if the subsequent history had been reported, or at least enough of it to warrant more than the query: "Was this a case of successful malingering, or was it paralysis from hysteria?"

Dr. Smith unadvisedly remarks (page 185) that "if the disturbance is *functional* it can be cured, and there may be no permanent disability," forgetting that "functional" ailments are as infrequently curable as are the organic; but he very properly alludes to the necessity of eliminating "all symptoms not evidently free from the disorders of the spinal cord due to pre-existing diseased conditions, or show to what extent the accident was connected with them."

In view of Charcôt's discomfiture the citations from him on hysteria are unhappy. Dr Smith has often seen such cases as Reynolds describes, "in which a patient has no intention to deceive, but really believes that he is the victim of serious organic disease. He is usually of a highly nervous temperament and often very active, mentally. His fixed belief *induces* functional disturbances, as twitching, muscular pain, excitable action of the heart, palpitation, exhaustion after slight exercise, and he becomes impressed with the idea that he is unable to do anything; that he is paralyzed, and that he cannot sleep, awaking unrefreshed." These hypochondriacal conditions evidence the unhealthy effect of the mind upon the body in *some* cases, and this influence finds its ultra expression in the alleged ability of the Sandwich Islander to lie down and die by mere will effort. Mental impressions should be properly weighed but not

regarded as productive of all symptoms in all cases, unless we except the Sandwich Islander.

That injury to the spinal cord should *always* be indicated by atrophy of the muscle should not be inferred, as Dr. Smith thinks, from anything Gowers has written, and hence the conclusion is wrong, that "when no change is noted in the nutrition of the muscles doubt may well exist in the mind of the expert as to there having been any concussion of the spinal cord." (See Bramwell, on trophic centres, in his "Diseases of the Spinal Cord.") Dr. Smith also runs counter to most authors in limiting the advent of symptoms to hours or days, and "not weeks subsequently, when his mind, by dwelling on the accident and being posted as to the symptoms of successful awards made in other claims, has induced that emotional, hysterical or decidedly fraudulent condition of the body and mind which constitutes malingering."

H. Judd* at the same meeting stated that in twenty years he had found but two cases of alleged concussion of the spinal cord aside from litigation cases.

"It is demanded by the honest business interests of the country, by cities, by transportation, mining, and manufacturing companies, and by all employers of laborers, that the subject of spinal concussion receive the most thorough attention at our hands. If we do not expose the cheats and frauds, and protect the deserving claimant, who can do so? That cities and corporations are robbed of vast sums of money yearly by malingerers, aided by unscrupulous legal talent, and by ignorant or dishonest surgeons we all know to be true. This subject has reached this disagreeable status: a person can claim to be injured in a collision of trains, or by other accident; no objective symptoms or signs can be discovered, nor upon close examination found. Nevertheless, such person never fails to find abundant medical testimony and the assistance of friends, which, with the required

* Journal of the American Medical Association, *loc. cit.*

legal talent, will be sufficient to successfully prosecute a suit. Especially is this true when the defendant is a corporation. Such cases can be and are based upon, and carried to the end upon, only a few vague subjective symptoms, every one of which depends alone upon the word of the claimant who seeks damages."

Dr. Judd furnishes seven instances of malingering in which railways were victimized, and further says:—

"I must certainly question if there be such a disorder or injury as concussion of the spinal cord, as some of the books tell us or describe it;" and he refers to "notorious cases of pure fraud and malingering in which honest but credulous physicians were misled, deceived, and their reputations injured.

"To learn the truth these cases must be followed and observed, not only before judgments are paid, but for months afterward."

Dr. W. H. Pancoast observed, after the reading of these papers, that he firmly believed that cases of concussion of the spine occurred, and were followed by serious consequences, for he had seen such. "I have seen cases where a violent concussion in a railway accident has so affected the contents of the spinal canal as to cause effusion, or such alteration of the membranes of the cord, or of the cord itself, as to be followed by paralysis more or less complete. Many members of this Section of Surgery and Anatomy must, in the course of their lives, from mis-steps or other accidents, have recognized the force and painful effects of concussion. I have within the past few weeks been engaged in a medico-legal case, where a delicate lady, the wife of a physician engaged in a large and active practice, was thrown from a carriage in which they were both driving. A careless coachman driving a heavier carriage ran into them, and the collision threw her to the ground, and against a wheel, with such violence that she became insensible. She has remained an invalid ever since, with marked symptoms of paralysis on one

side. In neither of these cases was there hysteria or malingering.

"There are malingerers, and we must be on our guard against them, and I have such faith in the honor of the members of our regular profession, as a class, that I do not believe they would be parties to such a deception. I have been called as an expert in several such cases, and have sometimes settled the medico-legal questions in my office to the satisfaction of both sides. I feel assured that this learned body recognizes the existence of such an injury as spinal concussion, and also that, while the great railroads that do so much for the benefit of the country should be protected from suits inspired by fraud and ignorance, the great public should also have protection. I think that if corporations would give fair compensation for injuries received at their hands, through accident or the carelessness of their employés, and not insist that such injury should be proved to be permanent, a cause exciting to fraud or malingering will be removed.

"I give credit to the corporation surgeons of desiring to be honest, and giving a truthful, scientific diagnosis from their stand-point; then, why should we not also recognize the statements of the surgeon of the injured, as being inspired by the same motive, even if some may occasionally be deceived by an ingenious and artful malingerer.

"From my experience, I think that very many railway injuries can be satisfactorily adjudicated, and the sufferers properly compensated, by the judicious surgeon acting as mediator between the opposing lawyers, to the honorable satisfaction of both parties."

CHAPTER V.

OPPENHEIM ON TRAUMATIC NEUROSES.

SOME of the most important contributions, in twenty years, to the subject under examination, have been made by H. Oppenheim, of the Berlin University.* His numerous monographs he has recently revised and condensed in book form. He was a pupil of Westphal, to whom he gratefully inscribes his work. He owes its instigation to Westphal, who favored the view that the so-called functional symptoms were due to small myelitic or encephalitic points analogous to multiple sclerosis.

Introductorily, Oppenheim states that in Germany more interest had been aroused concerning spinal injuries since the 1871 law, relating to the liability of corporations, etc., and the publications of Bernhardt, Westphal, and Rigler. The latter inclined to "spinal irritation" as accounting for the phenomena.

Oppenheim abandoned his original idea of organic causes, derived from his teacher, and later suggested, in lieu of spinal concussion, the term Traumatic Neuroses. Others had styled it Traumatic Neurasthenia. The objection to the neurosis designation is contained in its generically including a great many surgical ailments, wholly outside of the matter of concussion, such as direct injury to the sciatic or other nerves, head injuries, neuritis if instituted by trauma, epilepsy induced by a fall, chorea similarly caused, and other nervous derangements; and even if the more definite restriction to *a* traumatic neurosis is used, it then is necessary to explain that spinal concussion is the particular traumatic neurosis meant.

Neurasthenia also is applicable to too many differing conditions. It is as great an omnibus as is "softening of the brain."

* Die traumatischen Neurosen nach den in der Nervenklinik der Charité in den letzen 5 Jahren, gesammelten Beobachtungen bearbeitet und dargestellt von Dr. Med. Herm. Oppenheim, Docent an der Universität. Berlin. Verlag von Hirschwald, 1889.

Oppenheim excludes consideration of fractures and other direct lesions and holds to the belief that many cases supposed to be organic were really functional neuroses and that simulation had frequently been unjustly suspected.

He notes also, that concussion can produce insanity, and he lays special stress upon the cerebral affections; a certain group of symptoms being mainly cerebral. Too little attention, he claims, has been paid to the fright and excitement as factors too potent to be neglected.

There was a tendency on the part of many authors to confuse hysteria with simulation. The often-mentioned sensation disturbances, he claims, justify the term railway brain rather than railway spine, as the brain and not the spine is the seat of many described conditions.

But, he also notes, it must be observed that cerebral ascriptions are often wrongly made, and Charcôt has particularly erred in dwelling upon hysteria as mixed up with these. That author paid too much attention to mixed anæsthesiæ and hysteroid spasms, to the exclusion of other derangements. The melancholic conditions and other psychoses are referable to the injury and have nothing in common with hysteria. Finally Charcôt was led to accept this view, as he had not carefully differentiated simple hysteria from what he calls traumatic hysteria. He, with others, dwelt too much upon the emotional phenomena, to the neglect of the trauma. He experimented with hysterical subjects, and by hypnotic suggestion caused them to believe that they had the paralytic conditions such as are found in concussion cases, and where trauma had enfeebled the emotions by auto-suggestion paralytic conditions and contractures were produced. Page inclines to these ideas. Charcôt now admits that all the symptoms cannot be classified under hysteria.

Oppenheim relies upon his own observations made in hospital and consultation with other physicians, during the preceding five years, rather than upon the statements of other observers. His object was to afford the practicing physician information

concerning this very difficult class of diseases. He regards the points of theoretical discussion as more important than the general literary opinions, to which latter he gives but little room. To the symptomatology he considers the main interest attaches.

An outline of each of his thirty-three cases is given in the next chapter. From his analyses of these cases he deduces material for his remaining chapters; the third division of his book being:—

"*The Causes and Characteristics of the Injuries.*—A part of the cases under observation were due to railway accidents. We do not include cases of skull fracture or spinal luxation which occur through crushing of vehicles, etc., productive of symptoms of central nervous injury. Functional troubles only that are caused by collision and derailment are considered in this connection.

"The most common manner in which such injuries are sustained is through the person being thrown upward and backward, or the head is struck against the sides of the car, or, in the case of engineers, against the boiler; and occasionally the victim is thrown to and fro.

"While there may be no external injuries, worth mentioning, which could account for the nervous lesion, all authors agree that such concussions and jolts of the body can unduly stretch and tear the ligaments, muscles, and other structures, or cause severe bruises.

"It often happens that the patient may have lost consciousness, but retains his recollection of the events.

"Causes of different kinds may produce identical pathological conditions; as falling from a suddenly started locomotive may set up troubles similar to those sustained by collisions or derailments.

"There is nothing specific about railway injuries, as similar disorders are frequently induced by machine accidents, such as encounters with rotating wheels, revolving belts, etc., catching

the hand or foot and striking the head or back, tossings toward the ceiling, falls from ladders. Sometimes beams fall upon the patient, or he is in an explosion, or slips on the ground. Any one of these may be followed by symptoms of traumatic neuroses. This shows that the manner of the injury receipt may vary, and that the symptoms depend more upon the nature of the hurt and the location of the lesion. It is noticeable that when severe accidents fractured the bones the symptoms of traumatic neuroses seldom developed. This suggested to Erichsen the idea that the fracture saved the cord from gross injury, the force being spent in breaking the bones.

"Most of the cases were factory hands, presenting symptoms superficially related to the subject, and who were sent by the benefit societies to the Charité to secure the opinion of the physicians.

"A few of the cases were of the non-damage kind, and the development of their symptoms is similar to that of the others.

"In the greater number the emotional disturbance was severe enough to produce the troubles. Patients have stated that at the time they were so frightened that it was impossible for them to do anything, while in other instances fright was denied, which may be true for some strong organizations, for in a few it was very difficult to discern the emotional extent. That fright, however, has a great influence upon causing the neurosis is best proven by the mental shock predominating.

"An instance is afforded of one who was locked up in a burning house, and of a second whose locomotive was about to collide with another, and yet each person had presence of mind enough to do the right thing at the right moment.

"*Symptomatology. A General Sketch of the Disability Picture.*—Immediately after the injury, or weeks or months thereafter, variable symptoms develop and differ in severity, but, nevertheless, show the familiar combination of symptoms of traumatic neuroses in a general way, as the extent of the injury and individual analysis of the symptoms will show.

"There may occur a stunned condition of a few hours' or days' duration, but, as often, there is a climax of unconsciousness or bewilderment. Occasionally a hallucinatory bewilderment appears. In numerous instances the patients do not have any symptons at first, and can render assistance to others at the time, but, after a few days, or a longer while, disease may appear. There are cases where both patients and physicians look for weeks for surgical symptoms, and overlook the nervous disturbances which were present all the time, and the beginning of which cannot be fixed. The first troubles are usually of a subjective character. Complaint is made of pain at the point of external hurt, and, when there was a general concussion of the body, pain was located in the lumbar and sacral regions. Such pains are aggravated by movements, and in walking, standing, or taking hold of anything it becomes necessary to balance or steady the motions by a will effort. The subjective symptoms which are externally apparent, are restlessness, excitement, fright, and a disposition to be easily frightened or startled. These derangements begin slowly, though sometimes they are quickly intensified and may be increased to a mental alteration, such as hypochondriasis and melancholic depression, the easily terrorized state, and an abnormal irritability.

"One of the most common conditions is *insomnia.* Intelligence is not usually much affected, but it may be so. *Vertigo* and *fainting spells*, with or without spasms, are frequent in the clinical picture. At times there may be found a *tremor* which, under special circumstances, may be transformed into a convulsion. To these symptoms may be added paralysis and disturbances of gait. Sometimes this latter may be due to pain, as there will be a disinclination to walk when it is attended with suffering. Aside from this there may be a paresis, which, exceptionally, may amount to a paralysis.

"The kind of injury and its location, and other things, may cause motor disturbances in all four extremities, or a paraparesis of the lower extremities, or of one extremity, or even

part thereof; but it never affects muscles that are innervated by a single nerve-strand. The paralytic features exhibit peculiar characteristics distinguishing them from organic brain or cord diseases or peripheral injuries; and the abnormal contraction of muscles differ from the ordinary contractures such as are produced by organic lesions.

"Tendon-reflex increase is frequent, its diminution is infrequent.

"The muscles involved in the paralysis do not lose their normal size, but, notwithstanding, there is electrical and histological proof of atrophy and dystrophy.

"When the cerebral motor nerves are implicated it is observable that more than one is included. A disturbance of the harmonic actions of different muscle groups results.

"Above all the *speech defect* is prominent. This is neither aphasia nor articulation impediment.

"Of special importance is the sensibility disturbance (in connection with the general grouping of phenomena), which is peculiarly characteristic in the sensory-nerve disorders not being restricted to single distributions of nerves, and with the cutaneous and mucous anæsthesia there are anomalies of the special senses; frequently the sight is concentrically diminished.

"Vasomotor derangements are marked by œdema. The bladder functions are not often affected, though difficult micturition may infrequently be found, as well as incontinence, or retention.

"Sexual impairment frequently occurs.

"The skin reflexes intermit, and may be exaggerated, weakened, or entirely absent.

"Abnormal irritability of the cardiac nervous system is almost constant as a symptom, but very rarely does any serious organic heart disease occur.

"*Analysis of Symptoms; Mental Derangements.*—Mental changes are the principal symptoms, and afford the foundation upon which most of the other symptoms develop themselves,

only it is seldom that insanity, in the strict sense, could be made to fit the frame of mental disturbances common to the disorder.

"Certain it is, as Krafft-Ebing* has demonstrated, that directly after an injury or concussion, and consequent thereupon, a form of primary traumatic insanity may occur. Under the description of primary dementia with great disturbance of consciousness, hallucinatory abstraction and severe irritability, which may increase to maniacal exaltation and violence, Thomsen† narrates the case of a man who had been well up to the occurrence of the railway collision, and who after the concussion became at once mentally deranged. He had a very severe hallucinatory delirium, with nonsensical ideas of being chased. On the third day the psychosis faded out, leaving no memory of its having occurred, while the other concussion symptoms remained, especially the characteristic sensibility disturbances.

"Traumatic insanity has no peculiarities separating it from other forms of mental derangements, for injuries may cause the ordinary types of insanity."

This statement of Oppenheim's I shall, later on, show should have been modified, for traumatic insanity does not *accurately* copy the other mental aberrations and has peculiarities imparted by the trauma.

"In the greater number of instances prodromes are not observed, and even the slight consciousness disturbance may be absent. Moodiness may be the initial start and the nucleus around which the subsequently developed mental changes cluster.

"Consciousness may then become clouded, and a persistent depression set in, observable in the facial expression and actions. The patients are silent or reticent, they avoid company and prefer to be left alone to their depression and to brood over the memory of the events of the accident, which afford a centre

*Ueber die durch Gehirnerschütterung hervorgerufenen psychischen Krankheiten. Erlangen, 1868.

†Zur Casuistik und Klinik der traumatischen und Reflex-Psychosen. Charité Annalen, Jahrg XIII.

for all their thoughts. The remembrance of this is so acute that thinking and feeling is dominated thereby, and constitutes their impressions a pathological condition. This alteration in their affective sphere, and the uniformity of their idea contents, provokes a want of interest in the affairs of the world and even in regard to family matters. This apathy may pass to a complete indifference that is closely related to pure melancholia. The depression is ushered in by terrified and apprehensive feelings, the sense of oppression being very great and enduring, as though a crime had been committed, and danger was imminent. Generally there is heart oppression and sometimes palpitation.

"If the opportunity presents, at this time, a number of objective criteria may be observed: the face expresses fright and despair; the patient may sit crouched in a corner; he is tremulous, though otherwise quiet, or he runs excitedly around the room; the speech is interspersed with deep-drawn sighs, at almost regular intervals, and a principal feature is that the pulse is abnormally increased; his hand seeks the heart region, about which he complains of an oppressive feeling, and at times there may be found dilated or unequal pupils.

"The frightened state lasts from five to ten minutes, but it may be prolonged for an hour or more. It develops spontaneously, though special causes may induce it.

"In rare instances there may be associated special causes for the fright, as when crossing large spaces (agoraphobia), or narrow spaces (claustrophobia), etc. Erichsen in his sixteenth case mentions an example.

"With the fright tendency, at times, there is an incertitude, a feeling of doubt and embarrassment; a will paralysis. The patient may exclaim: 'I don't know exactly what I want. I can't come to a conclusion what to do.' He may be perpetually fault-finding; a feeling of compulsion may be a peculiarity of the mental disturbance.

"From true melancholia the concussion mental condition may be differentiated by two prominent peculiarities:—

"Firstly, there is an abnormal irritability, and, secondly, though excluded from the world and constantly brooding and grumbling, impressions from without act upon such patients abnormally. A slight influence might produce great emotion externally exhibited. The appearance of the physician and consulting him can set up a state of frightened bewilderment, apparent in tremblings and pulse increase.

"Pleasant influences, felt as such previous to the injury, or such things as had no effect formerly, now produce shocked sensibilities, often to the extent of tears. This is vexatious to the patient, and frequently he claims: 'While I used to be indifferent or hardened I cannot now bear to hear anything sad.' If he see a hearse or hear a quarrel he cries like an old woman, and cannot rid himself of the sad feelings. The increased impressionability which follows external irritation causes the patient to seek loneliness and to withdraw himself from company. He states that he feels better when utterly alone.

"Krafft-Ebing calls especial attention to a notable feature: In these traumatic cases there is a marked progressive irritability and a dispiritedness different from anything in the idiopathic insanities, or in any of the stages of those psychoses. This peculiar mental change is specially characteristic of concussion cases. Its intensity alternates in the various patients; it may be exaggerated to the suicidal point. The literature of the subject fully confirms this. It is essentially a hypochondriacal condition.

"Another striking peculiarity is that the events of the injury should be so well remembered, and prominent in recollection is the thought of having been severely hurt. The remembrance seems to be a continued prolongation of the original suffering. Under the influence of these ideas they watch their bodily symptoms, every unpleasant sensation is examined, and this hypochondria gradually augments the disease. We shall, later, see that from this proceeds the greater array of difficulties. The intelligence, in the majority, is not affected, beyond the concentration and one-sidedness of their thinking, which hems

and hedges their ideas so that impressions in general are not readily received, and as names, dates, etc., through inattention are not recalled, a new complaint is afforded them, that of memory failure. But memory may be actually impaired in demented cases. I saw a case wherein the fright induced progressive weakening of the intellect. Bernhardt* also records a case which in the course of the disease developed a mental failure resembling that of paretic dementia, which the general literature of head and spine injuries show is often the case, and that it is also frequently associated with epilepsy.

"Westphal† had also instanced such cases in which occurred delirium of an hallucinatory hysterical nature.

"This narration of mental states peculiar to traumatism should not be concluded without mentioning the fact that a few cases of traumatic neuroses occur without any observable change of mentality. In these the motor and sensory disturbances are more marked, leaving the mind intact. But these instances are so rare that nothing beyond their mere mention need be made.

"*Vertigo and Spastic Conditions.*—Owing to their connection with the mental changes, cramps and dizziness should be described. Patients complain, quite often, of vertiginous sensations. It is known that different feelings are claimed as dizziness by the laity. Frequently it is a sudden roaring in the ears, tinnitus; or it is more properly described by the expression, 'everything turns round,' and the patient has to catch hold of things. I often saw this, and observed that he turned pale, and clutched objects. Loss of consciousness without the associated convulsions seldom occur as a symptom of traumatic neuroses. Commonly these latter are of but short duration, but can extend over a few hours, though genuine epileptic attacks are exceptionally observed. Quite often the patient's description and his surroundings had to be relied upon, and we were in doubt as to the nature of the spasms. I wish, once again, to

* Beitrag zur Frage von der Beurtheilung der nach heftigen Körpererschütterungen, etc. D. Med. Woch, 1888, No. 13.

†Berliner Klin. Wochenschr., 1879, s. 125.

call attention to the fact that both head injuries and fright may induce epilepsy.

"Westphal recorded several cases where railway accidents induced epilepsy with frenzy and memory loss, etc., as well as pure convulsive attacks with unconsciousness.

"He calls particular attention to reflex epilepsy, of which my Case XXXIII is a classical instance. His right hand was crushed between two grindstones and the wounds were seven months in healing, with persistent cicatricial pains. After three months spasms began, preceded by a crawling sensation running from the right arm to the face, and down the leg on the same side, with monospasm of the right arm, and next the right side of the body became convulsed. When the twitchings reached the face there was loss of consciousness. Through pressure on the cicatrix, which was painful, the attack could be arrested. Reflex epilepsy makes itself known through an aura that starts from a cicatrix and the trembling begins in the injured extremity.

"Cases of typical hysteria after injuries are published, more especially, in the French literature. In our lists, which exclusively deal with males, this feature falls to the rear.

"*Sleep.*—Almost all patients afflicted with traumatic neuroses complain of disturbance of sleep. Insomnia is not meant so much as wild dreams, for which the events of the injury afford material, restlessness, and broken sleep. This may be objectively ascertained by those who watch the patient at night. Other patients in the wards cannot rest, owing to the sighing, restlessness, mutterings or screams of the sufferer. Sometimes there is great agitation or fright during the night; he is compelled to leave his bed and run around the room. Others say that they only half sleep. What they may have done during the night they may not remember or be able to recall through having been unconscious.

"*Anomalies of Sensation and of the Special Senses.*—These occur in variable grades and intensities, but their presence is invariable.

"Pain is most frequent, though the most difficult symptom to determine. Its seat largely depends upon the place of injury. If there is a contusion, that part is painful; such injuries are generally in the deeper portions, as in the bones, joints, or muscles. Where the concussion is general, as in railway accidents, the pains are mostly felt in the lumbar and sacral portions of the back, even though the force of the blow may not have been directly to the back. Occasionally girdle or half-girdle pains radiate from the back.

"Headache is very frequent, particularly if the head has been injured. It occurs with the general concussion and with other nervous disorders after those injuries that affect the extremities. It is part of the general derangements, and usually occupies the side of the head corresponding to the body affections.

"Nothing definite can be said concerning the character and intensity of pains. Most of them are spoken of as dull, pressing or boring, and are, according to the expression exhibited by the patient, moderately severe, but which may augment so as to necessitate a morphine injection. One feature is noteworthy, they are never lancinating, and very seldom of a neuralgic character. We have no measuring rule for pain intensity, and hence have to form our own judgments in individual cases. The pains are increased through locomotion, those in the back through movements of the spinal column, and those in the hip-joints are similarly increased, and therefrom results characteristic hindrances to motility, affording important diagnostic points.

"The paræsthesiæ are manifold, numerous, and variable. These abnormalities spring from the mental disturbances, and afford singular phenomena, and are often the first link in the chain of symptoms. From them develop hypochondriacal conditions, and after awhile a crowd of subjective and objective difficulties. The paræsthesiæ do not differ in kind from those originating from organic disease of the central nervous system.

The complaints are of creeping and crawling sensations, numbness, cold feelings, etc. Statements such as these are made: 'I feel as though there were worms crawling under my skull; as if bubbles were bursting under the skin; as though I had no arm; as if the head was not fastened on my shoulders; as if the back of the head was held to the sacrum with a staff,' etc., etc. These prove that perverse sensations lead to perverse behavior.

"Paræsthesiæ occur also in the special sense organ distribution, the ocular instances affording scotomata, flickerings, sparks, scintillations, color hallucinations, and others.

"One patient saw a yellow color for minutes at a time; others beheld divers colors. The aural hyperæsthesiæ were tinnitus, hissing, 'whistling in the head or ears.' Persistent salty tastes and abnormalities of smell sensation were also claimed by some.

"As mental depression combines with increased irritability, so do we have the anæsthesia and the hyperæsthesia in the senses. Blindings and photophobia constitute these in the optic faculty and may be objectively evidenced by the patient's tendency to close his eyes as soon as he goes into the light and his winking or blinking when he reads, or the eyes become watery and by use of the ophthalmoscope the illumination of the fundus produces spasms of the orbicularis. A few times I have noticed that these irritations of the retina caused an abnormal light reaction of the pupils.

"It has been mentioned that the acoustic hyperæsthesia produces exaggerated noise sensations. Hyperæsthesiæ of taste and smell did not specially attract our attention.

"Cutaneous hyperæsthesiæ are more commonly observed, especially in the region of the trauma, which is usually in the skin of the back, after railway injuries.

"Where joint neuroses occur after contusion the surrounding skin is extremely sensitive to even light touching.

"The anæsthesia is of greater importance because the objective proof of this can be more readily made.

"In a number of cases this anæsthesia is mixed, the skin and mucous membranes and special senses being affected. The best-known type of this kind is the hysterical hemianæsthesia: on one side of the body the skin and mucous membrane sensations are absent or impaired, and upon the opposite side may occur the special sense aberrations in more or less severe forms, to be explained *infra*.

"These anæsthesiæ are not sharply separated by the median line of the body, as the sight disturbances almost regularly include both eyes. Most often there is bilateral disturbance of sensibility. For example, we may take a half-sided touch paralysis and its modifications; on the skin and mucous membrane the touch, temperature, pain, and pressure senses may be absent, impaired, or perverted elsewhere than upon one side. Oftener than absolute anæsthesia occurs hyperæsthesia, which may be so slight that the feeling intensity between the two sides of the body may not be evident or measurable.

"Sensation is not always similarly qualitatively affected; the tactile sense may be so lost that the pain sense may also be absent entirely.

"Extremes are frequent in muscular sense deviations, from not being affected at all, to severe impairment, wherein there is no appreciation of the differences of weights. Sometimes neither electrical irritations nor the positions into which the muscles are contorted, by electrical stimulation, are realized.

"Smell, taste, seeing and hearing may be increased, absent, or changed; the most constant and important condition being the sight disturbance. While central vision may be slightly or not at all affected, some derangement of eye-sight is regularly noticed. Eccentric vision range and the so-called concentric contraction of sight may be found. This may be so severe that the central sight alone exists to the extent that familiar objects cannot be promptly recognized. In most cases the contraction is so slight as to require perimetric examination. The color field is generally affected to a greater extent than is the appreciation

of white. Sometimes the concentric contraction is proven only by the color test. Relations between the limits of colors are seldom disturbed, so that the whole field for red oversteps the limits of the blue. Errors should be carefully eliminated from such examinations.

"Confusion of colors, as blue with green, and color-blindness, achromatopsia and dyschromatopsia occur.

"Concentric contraction usually affects both eyes, and where hemianæsthesia exists this is worse on the anæsthetic side. Contraction grades, in these cases, may be so small as to make the relative side comparisons necessary through width differences of both sides of the field, to determine which side is more affected.

"When tactile sense is not half-sidedly impaired the bilateral contraction of vision may be equal in both eyes.

"Noteworthily the field contraction, the only sensibility disturbance, may be this visual contraction, and it is doubtless, therefore, one of the most constant symptoms of traumatic neurosis, though in some instances it may be absent.

"The acoustic anæsthesia causes dullness of hearing, and this is equilateral with the half-sided paralysis.

"Babinsky* noted a perceptible decrease in the speech perception and in hearing the tuning-fork vibrations, whether the notes were high or low. In most cases the cranial tympanic conduction was impaired or entirely absent, but the auditory defect seldom reaches a height that will interfere with conversation, or that he will only understand loud speaking.

"Smell and taste perceptions are dulled, apparently, though tests made in this regard are not satisfactory.

"The hemianæsthesiæ are very often incomplete, especially as regards the extent of distribution, as when single portions of the affected half of the body presents a normal or exaggerated sensitiveness; nor is the connection of the special sense disturbances with this a constant condition, for a severe decrease of the

* Ueber Ohrenerkrankungen, etc. Berl. Klin. Woch., No. 3, 1888.

skin sensibility may be associated with a mild special sense trouble, or the conditions may be reversed; or both special and general sensibility may be equally involved; nor is it necessary that all the special sense faculties take part in the interference.

"The anæsthesia is often measured by the median line of the body, and this typical as well as an incomplete hemianæsthesia may be found after general concussion of the body, as well as after head or peripheral injuries.

"It is an important rule that even after head injuries there is, in concussion cases, always sensibility deficiency, such as hemianæsthesia, upon the same side of the body as the trauma location. This may appear immediately in connection with the injury, or a length of time thereafter.

"The patient is not always conscious of the sensory trouble, but when he is aware of it he feels as if the involved half of the body, or parts, are absent, or are asleep, or he has a deadened pain in that portion.

"But hemianæsthesia is not the proper term to apply to all such cases, for in a great number the half-sided derangement gives place to more or less general anæsthesia of both sides.

"The described hemianæsthesia is very likely functional, though evidently cerebral, and not necessarily directly caused.

"Through the manner of their occurrence it is apparent that these concussion sensory ailments are not of organic origin, as they are not co-extensive with the peripheral distribution of nerves; nor in their external manifestation do they agree with localization areas, as in disease of the brain and spinal cord. In assembling the symptoms we see that the anæsthesia affects the skin of the scalp and forehead, and through its sharp limitation sometimes the term 'night-cap feeling' applies to it, and at other times the anæsthesia spreads to the chest and the term 'doll's head' is expressively used to describe the area of sensation impaired. The hands alone may suffer in disagreement with anatomical distributions. It occurs in the lines of the joints, or

is restricted to a part of the forearm, and at a particular part is enclosed by a circular line.

"The anæsthesia affecting the upper arm abruptly closes at the elbow-joint. The left forearm and right foreleg are affected in some cases, and the loss of sensation may be on the outer side of the extremity, with the median parts normal.

"The sensation loss may be in the form of welts extending on the outside, like stripes, on the lower extremity, and that entire part may be thus affected; or there may be unaffected spots in the midst of large anæsthetic areas, as in Case VI, where only the genitalia were not included, and single parts over the sternum and back regions may be exempt. The special sense functions may be implicated with these conditions, as described, at the same time. It is not necessary to repeat the different modes of the defect distribution, and these examples will suffice. Though the proofs of sensibility changes may be clear and distinct, the findings may vary at times at different examinations. The limits between feeling and want of feeling are not constant, and it happens, in some instances, that the representations of the patient are to be doubted, and you cannot give an opinion if the veracity of the patient is in question.

"*The Reflexes.*—There is nothing constant about the reflexes of the skin and mucous membranes. They are often lessened equivalently with the anæsthesia.

"Entire absence of the corneal reflex I have not observed. The conjunctival, nasal, and foot-sole reflexes may be entirely absent on the side affected with anæsthesia, and less often the cremasteric and abdominal reflexes are absent. At times there is a modification of the reflexes of the sole, when a needle-point prick does not produce a dorsal, but a plantar, flexion and spreading of the toes.

"In the hyperæsthetic regions of the skin the reflexes are generally increased. The pupil reacts normally to light, and affords a pathological criterion from head-injury cases, in which an absence of pupillary light reflexes has been noted by Thomsen

and myself. I presume exaggerated light reflexes, however, may occur.

"*Motility.*—There is a group of cases in which voluntary movements are generally lessened. Motions of the extremities and trunk are sluggish and cramped in their excursions, and the strength is not in proportion to the muscle volume. But a true paralysis never occurs.

"At times the pain alone may cause a checking of movements, slowing and restricting them, and interfering with the patient's control over them. The movements are interrupted, or only incompletely performed. At a certain stage of the motion pain arrests it. Hip-joint flexion is limited by its inducing lumbar and sacral suffering. This is less manifest in the knee- and foot- joints, but the trunk-muscles are particularly affected. Spinal flexion, extension, rotation, or lateral motion, and head rotation and flexion are hindered by pain causing a rigidity or fixation of the trunk. The injured person makes forward or lifting motions, or sits down with difficulty, with his back stiffly maintained, and in seating himself, or lifting, he has to support himself and change position slowly. There is not a conscious or instinctive avoidance of spinal-column movements, but oftener a permanent contraction and rigidity of the lumbar muscles causes this restraint. If the patient is determined not to mind the pain he can voluntarily increase the activity at the expense of suffering, but, in spite of this, erratic motions are made, and with less vigor than intended. The difference is mainly caused by the impulse being improperly distributed, going to muscle groups not intended, or erratic contraction hems the movements. If the patient, for instance, is asked to squeeze your hand as hard as he can, you will see that the muscles of the shoulder and those of the hand flexors and extensors contract simultaneously and unnecessarily, so that the strength is wasted by wrong distribution. These peculiar appearances in manipulation arouse the suspicion of an insincere attempt to make it appear that he is trying to overcome weakness. It is therefore important to re-

member that this form of muscular hindrance is of a pathological character.

"Another interference with voluntary motion consists in tremors, which might seriously interrupt intended acts. With these conditions there exists a general motor debility, which may be overwhelming in one or both lower extremities, or in both extremities of one side. Complete paraplegia seldom occurs. Usually it is a paraparesis, the functional nature of which is shown in the gait, and the weakness is co-extensive with the sensibility disturbance distribution.

"When the patient is examined in the supine position there is often seen a discrepancy between the manner and intensity of the motor disturbances.

"An important consideration is that the form of the paralysis is hemiplegic or monoplegic usually, and we can often decide that these originate from external injuries of the same side of the body. After an arm injury the arm is paralyzed; when the foot has been hurt the leg suffers paresis, and a head injury is followed by a paresis of the same side on which the injury occurred.

"Almost regularly have these forms of paralysis a difference in character from the hemiplegias and hemipareses of organic origin. The cause of the difficulty, the unilateral phenomena, with the absence of facial and hypoglossal nerve affection, determine its functional nature.

"Rarely are there instances in which the glosso-pharyngeal and facial nerves are involved, pulling the mouth to one side, and where the tongue is deviated, such as are described by Brissaud and Marie,* but also the manner of the motility disturbance is different from that of true hemiplegia. The paralysis is never complete, and the leg is oftener more severely affected than the arm, though occasionally it is not so. The incomplete voluntary body control, the unconscious clutching at objects for support, are also peculiar to this disorder.

* De la éviation faciale dans l'hémiplégie hystérique. Progrès Méd., No. 5, 1887.

"One not aware of this would imagine it simulated.

"The partial or complete hemianæsthesia and gait should be regarded as diagnostic, and that the muscle groups paralyzed are not innervated by single nerves.

"In Case XXXII, after arm concussion, all movements of the hand and fingers were simultaneously deranged, and the motility in the rest of the joints of the extremities was somewhat affected.

"It never happens that the extent of motor derangement explains the direct trauma, but oversteps its limits. Almost invariably both upper or both lower extremities are involved, or the difficulty is half-sided in one arm and leg. Muscles are usually relaxed; occasionally contractions are found which may be reflexly caused through pain and in time rendered habitual. If a joint disease alone involves the surrounding muscles the appearances and the use of chloroform can explain it as such. If organic, the contraction remains, and if functional, and due to pain, it disappears. Further, the manner of contracture due to hysteria has been described by Charcôt and his pupils.

"Characteristic of the hysterical contracture accompanying the functional paralyses the following are to be considered:—

"1. The sudden and spontaneous involvement.

"2. The great degree of contraction preventing passive movements, while the hemiplegic contractures of organic cause continued, even after years, and, up to a certain point, might be overcome by passive movement.

"3. The deformities caused by the contractures are commonly greater than those of organic origin.

"Trophic conditions should be regarded. It is not only necessary to inspect, palpate, and measure, but the electrical and histological examination of the muscles must be made.

"In many cases the gross appearances and measurable dwindling are not worth mentioning, and electrical tests and muscle harpooning give normal results. From this there are

many exceptions. Charcôt and Babinsky* have shown that the decrease of muscular volume can precede the functional paralysis.

"A difference of five centimetres has been found between the sound and affected extremities.

"Fibrillary tremors and the electrical reaction of degeneration never occur in the functional trouble, but there is a simple quantitative decrease of electrical irritability.

"Simple muscle dwindling is differentiated from inactivity atrophy through the former being slow to devolop and the latter suddenly appearing.

"Our observations teach that

"The hemiplegia and monoplegia of traumatic neuroses can precede provable change of the affected muscles. At times this change may be evident to sight and measurement, at other times it may be demonstrated only through electrical tests and the examination of excised muscle sections.

"When, as in a few cases, greatly diminished electrical irritability was found there was also severe cyanosis, diminished skin temperature, and increased electrical resistance.

"The anatomical changes of muscle structure consist in a lessened number of fibrils and increase of primitive tissues; in several cases there was an extreme loss of fibrillary bundles, and the cross-sections gave an uneven distribution of fibrils. Sometimes this was in consequence of a lessening of the diameter, as well as an hypertrophy of the connective tissue, and increase in the numbers of nuclei.

"*Gait Disturbances.*—To the most noteworthy and diagnostic symptoms belong the modifications of walking. These are quite distinct from gait disturbances produced by other derangements of the brain and spinal cord, the nearest of which in resemblance is that of the spastic paresis type, in which there is spreading of the legs, with short, slow steps, the leg excursion being limited by the lessened movements of some of the joints. The toes do not strike the floor, but if the foot is dragged it is

* De l'atrophie musculaire dans les paralysies hysteriques. Progrès Méd., 1886, No. 16, etc.

either the entire foot or the heel that is shuffled along the ground. Nor is there muscular resistance to passive motions, particularly forced passive movements.

"The tendon reflexes may be exaggerated, but a foot or patellar clonus is infrequent.

"From the superficial resemblance of the gait to that of spastic paresis we are able to make a differential diagnosis. There is an abnormal position of the body in the fixed spine and forward trunk flexion. Commonly one hand is held in the sacral or hip region.

"One of our patients half rotated his pelvis in walking, putting one hip forward and then the other. He could walk better backward than forward, because flexion was more painful than extension of his legs. Another did not lift his feet from the floor, but shoved himself along intermittently, with inward rotation of his hip-joints. A third held his body so far forward, or flexed, that the trunk was almost horizontal, and with the aid of crutches progressed laboriously. As to the genuineness of the necessity for this there was no doubt, for as soon as he wished to extend his body very severe pains overcame him. Attempts at walking produced dyspnœa and pulse increase.

"An ataxic gait was observed in which the left leg was rotated considerably outward and then the foot was brought down with a stamp; the right step was hitched or halted by three downward strokes before he could lift the other leg. When lying down there was nothing to indicate ataxia, and discrepancies such as this are observable between the upright and supine positions.

"There occur swaying and tottering from side to side, and reeling, as in cerebellar disorders. The patient compares his gait to that of one intoxicated, but between these there are differences.

"The patient sometimes stands frightened, as though before a pit, and often falls backward with efforts to save himself. Soothing influences have decided results, and through them such

disturbances are lessened. Vertiginous sensations may cause, at times, a to-and-fro stagger.

"In other cases trembling is a prominent feature. The tremors of the so-called spinal-spastic paralysis and those of sclerosis differ from this trembling in being more intense and in not being restricted to the lower extremities, for they may affect the trunk, arms, and face-muscles, and finally result in tremor of the whole body. In sclerosis, also, the trunk, or head alone, may be shaken slowly by four to six oscillations per second, but in traumatic neuroses a very quick, marked tremulousness is seen, which may persist for a long time, even after the interruption of a walk.

"In these unilateral pareses the gait disturbance is most often one-sided, and is never the same as in the typical hemiplegias,—an important fact. The patient may support himself with one crutch and a leg be completely motionless, suspended above ground, or the foot touches the ground; the leg is not circumducted but fairly dragged;—phenomena comically, but aptly, described by French authors as comparable to the movements of a child riding astride a cane. One of my private cases maintained an external rotation of the leg so that the inner border of the foot was dragged.

"By no means have all the pathological gaits of this disorder been described. I have only attempted to give the more important kinds. It is quite likely that in any of them there are opportunities for pretense or exaggeration; hence, it is especially requisite to remark that the genuineness of the foregoing instances was proven by the course and duration of the disease as absolutely certain.

"Psychical influences in the production of these disturbances play an important rôle, besides which the muscular contractions caused by pain should be considered.

"The swaying motion of the body when the eyes are closed does not seem to differ from Romberg's symptom of tabes dorsalis.

"*Tendon Reflex Conditions.*—The tendon reflex is not constant, but with some certainty may be said never to be absent. In one case in which it did not appear when the "grip test" was made it was ascertained to be present. Often an increase of the reflex is observable, and a light tap may cause a clonic contraction of the quadriceps. Sometimes, in addition, foot trembling and patellar clonus is caused. Occasionally there may exist a difference between the reflexes of the two knees, a matter of diagnostic value.

"*Tremors.*—These frequently are a symptom of traumatic neuroses, often an intermittent one, reaching such a height that in some cases they may produce shaking spasms. Rapid tremors seem to be the rule, for they are quicker than the shakings of paralysis agitans or sclerosis, which are usually from four to eight in number per second. These tremors, in our traumatic disease, are increased when the patient is observed by the physician, showing the mental causation. During voluntary motions of the body it appears as though the mental irritability, caused by the inability to complete intended movements, exaggerated the tremors. The fact that these lessen when the attention is withdrawn from them, or during rest, is another matter suggesting simulation. I have occasionally seen tremors which closely resembled those of sclerosis. The intimate relation of these shakings to the mental state of the person afford differential points.

"The outbreak of paralysis agitans after general concussion is described by Clever. I have noted paralysis agitans with decided tremor following upon head injury in two cases.

"The tremblings of traumatic neuroses are very seldom limited completely to one extremity, or to the extremities of one side. They usually have a general distribution. Once it appeared stronger in the upper extremity, and in another the lower was more affected; further, a tremor of the head and face is not infrequent.

"When the right arm is the seat of tremor, then the writing

is characteristically changed, and when in the leg the gait is modified accordingly. In attempts to walk or stand it may advance to an appearance of saltatory spasms. If it affect the facial and tongue muscles it induces a peculiar speech difficulty.

"*The Speech.*—Seldom do we find only one cerebral nerve involved, but more often an entire complex of motor head nerves are implicated. Above all, a typical aphasia has never been observed in any one of a vast number of cases. The narrations of the patients concerning speech troubles can be interpreted as meaning that they have at times been transiently affected by an aphonia similar to that observed in hysteria.* In these occurrences all efforts were futile, for awhile, to bring out a single word, until at last a slow, jerky, difficult speech began, or there may have been a simple slowing of the speech. The patient may, at this time, speak as a foreigner does who has not control of the language and has to consider each word, and it appears as though the thread of his talk was lost or he had forgotten what he was about to say, or as though in a state of great fright he desired to tell something and brings out his words jerkingly, slowly, and with panting inspiration. Others speak explosively, or the syllables may be separately enunciated, constituting a difference between this and scanning speech.

"The bulbar speech paralysis does not occur.

"Stuttering, in its different forms, has been observed. Bernhardt has recorded one case in which there were stuttering and hesitancy, and, at times, a modification of the speech through tremulous motions of the lips and tongue.

"While there may be a resemblance to some of the speech defects caused by paralytic conditions, a proper consideration of other accompanying derangements sufficiently distinguish them apart.

"*Additional Cranial-Nerve Disturbances.*—Simple motor activities, or such as are ordinarily combined, are rarely deranged. One of our patients being asked if he were able to put

* Charcôt and his Pupils, in Progrès Méd., 1886, Nos. 7, 9, 42, etc.

out his tongue, opened his mouth widely, contracted the muscles of his lower jaw and neck, while his face reddened and his head began to tremble, but his tongue remained back of his teeth. He acted as though he tried not to protrude the tongue, yet, on another occasion, the tongue was fully extended suddenly, unawares. This was in Case XIX. These and allied peculiarities are recorded in other cases. Facial and hypoglossal paralysis I have not seen. It occasionally occurs that the tongue is deviated to one side during extension, but this is not constant, for, on examination, motion of the organ from one side of the mouth to the other can be made. Such deviation is, in all probability, due to the anæsthesia of the mucous membranes of the mouth and tongue affording no sense of the position in which the latter is placed, for while using the laryngeal mirror the tongue motions may be controlled.

"Mastication and deglutition are never involved. Very seldom were there affections of the ocular muscles. I have referred to the pupillary reflexes. Frequently differences in the sizes of the pupils were observable, to which, unless extreme, no diagnostic importance could be attached. Generally the pupil is dilated on the same side with the pain seat and sensibility disturbance, a fact shown by some authors, but to which there are exceptions. It has previously been mentioned that pupillary differences increase during fright attacks. Typical double ocular-muscle paralyses occur very exceptionally. Not infrequently there may be insufficiency of the internal recti muscles, thereby disabling converging motions of the eyeball. Neither pronounced nystagmus nor ptosis have been observed. Rarely have I seen the monocular diplopia described by Parinaud.

"The results of ophthalmoscopic examinations are few, and they consist in atrophic conditions of the optic nerve, and, as far as I know, only in three cases,—one reported by Walton, two others by Uhthoff. The latter examined the two cases with the author, but they are excluded from neuroses, and in so far as

they have any bearing upon the foregoing will be considered further on.

"*The Cardiac and Vascular Nervous System.*—Disturbances of the heart in this connection cannot be dwelt upon sufficiently. Their most common manifestation is in pulse frequency, which in railway spine (*sic*) is noted by Erichsen. Once the pulse persisted at 120 beats per minute and more, even during mental quietude. In other cases the swiftness of the pulse, owing to abnormal irritability of the heart, would be brought about by trifling causes, such as by others walking about the room, or slight sound disturbances, as when an object was dropped to the floor. When the physician clapped his hands behind the patient's back the pulse-rate sprang to 160 per minute. Physical examination affords no clue to the cause of the rapid cardiac and carotid pulsations, as there are, as a rule, no associated abnormalities of the heart.

"This condition accompanies most often the subjective fright sensations. The palpitations, constriction feeling, and sense of oppression are similar to those observed in ordinary palpitation of the heart. In a small, but not to be undervalued, number decided changes of the heart are proven, viz., a hypertrophy and dilatation of the ventricles, with occasionally heart murmurs. With great interest I watched the development of two such instances. In them, initially, the pulse frequency was the only evidence of heart trouble, but in the course of one or two years hypertrophy followed. In another case, a patient had fallen from a telegraph-pole and struck his left thorax region. (Case XIX.) Besides the great pulse rapidity there were abnormal pulsatory impulses of the thorax; a dilatation of the right ventricle and loud diastolic murmur over the pulmonalis were discovered. The positive connection between this condition and the accident could not be asserted. Fräntzel, Leyden, and others have sufficiently demonstrated the development of these kinds of heart disease from nervous influences, and there can be no doubt of their thus originating, and our observation teaches

that a stage of nervous palpitation of long duration may precede obvious heart disease.

"The etiological significance of severe mind disturbances in Basedow's disease has been noted by olden authors.

"Attention is called to cases wherein several have developed arterial sclerosis, as ascertained by examination, after a few years have passed.

"Exceptionally the pulse may intermit at times.

"Concerning vasomotor conditions the paralyzed extremity is occasionally cyanozed, the skin of the affected part being colored bluish red. It feels colder than the healthier side, and its temperature is lower, as indicated by the thermometer. The œdematous swelling, also, in parts over which will-power is lost, occurs oftener in the lower than in the upper extremities. Associated with this, very often, is a disposition to head congestions. Slight excitement may suffuse the face, neck, and upper part of the chest diffusively, or with splotches of red. Light mechanical skin irritations cause a persistent red streakiness, but this is not of special value, for it can be observed often in healthy persons. As regards hyperidrosis, I agree with Page.

"*Digestion and General Nutrition.*—Even in severe cases ability to eat is not disturbed. Loss of appetite, which may proceed to anorexia, belongs to seldom-observed cases of the kind. Profuse diarrhœa is mentioned by Page, occasional vomiting is not infrequent, but stomach irritability is only occasionally noticeable. The general nutrition is not markedly affected. In but few patients has the emaciation been so considerable, or any appearance of enfeeblement, as to attract attention; but, if we are to believe the statements of patients, decreased weight often does occur. An excessive thirst is sometimes complained of, with profuse urination, but without detectable pathological changes in the urine.

"*Bladder, Rectal, and Sexual Functions.*—In a part of the cases there was difficulty in micturating, but usually this was owing to a morbid frequency of desire to micturate; at times

others stated that strong pressure alone would cause emptying of the bladder, but seldom did this reach the necessity of sitting down or moving the bowels at the same time, though retention may necessitate the use of the catheter. In one case under our observation there was complete anæsthesia of the genito-urinary and anal mucous membranes, with incontinence of urine and fæces. Defecation usually occurs in the normal way, though there is frequently constipation. Bernhardt claimed that a patient of his had to immediately respond to Nature's call or soil himself. No objective proof of sexual impairment can be made. Patients almost invariably state this condition to exist, and where those who have no damage-claim to urge are included support is lent to the strong probability that it does occur. Complete impotency may then be inferred as sometimes occurring, and the loss of sexual desire is particularly found. Richard Schulz writes to me that in patients of this kind spermatorrhœa occurs, with flabby penis. Page notes menorrhagia.

"*Temperature of the Body.*—Only occasionally were temperature ranges taken. The body heat was generally normal, but there is no doubt of occasional febrile conditions, or chilliness with subsequent temperature rise.

"*Theories of the Nature and Genesis of Traumatic Neuroses.*—The olden teachings confined attention to the spinal-cord affections, though the disturbances were distributed elsewhere, as any part may be affected by trauma. The cerebral and psychical effects are mostly noticeable. Of especial value as asserting the functional theory is the absence of patho-anotomical changes, and this view is supported by Page, who shows that the opportunities for making post-mortems in these cases seldom occurred, and that no case was of use, where sections were made, to demonstrate inflammatory or degenerative processes as having taken place in the central nervous organs and their membranes.

"The physical trauma is responsible for the development of only a portion of the disease. The main rôle is that of the

psychical, such as the fright. The mental shock causes the subsequent conditions, which would not generally amount to much were it not that the diseased mind prevented reaction from the bodily derangements, thus setting up permanent disease.

"There are no constant results following injuries, for we saw light and severe forms, extensive dermal extravasations and bone fractures, joint contusions, etc. Further, it is certain that by general concussion of the body, as they principally occur in railway injuries, strained muscles and ligaments may be produced, and thus the back pains may be due to joint, ligament, and muscle stretching, and the circumstances strongly suggest the probability of a bending of the spinal cord and a pull or strain upon the emerging and entering nerves. This would well suffice to account for the pain; at the same time the moment of injury is attended by mental concussion and a permanent mental effect is produced. This finds support in conditions of paralysis based upon mental causes, or the permanent pains and abnormal sensations afford fuel to the psychosis, from whence the pathological state is derived, and gradually all such conditions become the property of the mental state. The presumption of paralysis produces it, for it is stamped with its origination from an idea.

"Paralysis from idea was known to olden authors, but Charcôt more fully described and experimented concerning it. In hysteria, hystero-epilepsy, and hypnosis this phenomenon can be induced, and he has proven that this kind of paralysis and disturbance of sensibility are identical with symptoms that occur after injuries. From this Charcôt draws the conclusion that these paralyses are of mental origin; that the mental shock produces a sort of hypnotic condition, and thus hypnotic autosuggestion induced this paralysis."

I have purposely avoided making but few comments in the course of this translation of Oppenheim's records and observations, for their excellence lifted them above either commendation or detraction. The patience, toil, care, and conscientiousness apparent throughout his work compels the approval of every

scientific delver in his field, and the world owes him a debt of gratitude for his exercise of rare observational powers exerted in the study of his cases, and I hoped to read that Oppenheim had anticipated me in the adoption of a theory that, in my opinion, accounts best for the psychical and physical phenomena of the obscure disorder under discussion. From unusual familiarity with spinal-concussion cases and through a survey of allied nervous conditions I have long held the opinion that the spinal sympathetic nervous system was the main seat of probable organic damage in these cases; a statement of the reasons for believing which may be deferred to another chapter. After a diligent search through the literature of the subject, my priority in making this claim, I think, will be conceded. At many places in Oppenheim's thoughtful work he has touched closely upon this ground. The saying is ascribed to Dr. Sam. Johnson that "only the fool never changed his opinion," and Oppenheim's abandonment of the spinal-cord lesional idea he absorbed from Westphal shows that he followed his scientific convictions; his encounter, however, with the French school headed by Charcôt, in which Oppenheim and his *confrères* came off victorious, led him to make concessions, and, with characteristic German regard for what seems to be proven, he has adopted what Putnam calls the similarities that hysterical conditions present for identities. Observe, for instance, the fact that pareses predominate in concussion cases, while paralyses are foremost in hypnotics, hystero-epileptics, and hysterical persons.

There can be no mistaking Oppenheim's inclination to fasten the cause of the major phenomena exhibited by traumatic neuroses symptoms upon an affection of the brain, and his attempts to do so constitute the weakest part of his book. His observational acumen is great, but he has missed an opportunity to group larger ranges of facts, that are too often ignored, and to make deductions therefrom. Proceeding, he says:—

"One would infer that peripheral injuries, as in Case XXIX, a patient who was caught in a rotating wheel, would

be followed by molecular degenerative changes in the central nervous axis, and it may be that there is such an impairment of the cerebral-cortex centres for movement innervation, producing paralysis. So-called local shock, which precedes motor and sensory paralysis, is commonly of a transient nature. Charcôt reasons that the mental shock lowers the mental status of the person so that auto-suggestion induces a permanent paralysis. The mental disorder induces permanent mind disturbance, and paralytic conditions depend upon this, probably through a direct fading out of the memory ability to perform certain movements.

"There is great danger of the pains instituting depressed, hypochondriacal, and melancholic conditions, centralizing attention upon the suffering, and affording a nucleus for imaginary ailments.

"The later development of paralyses is thus accounted for.

"An explanation of the unilateral sensory and motor loss consists in the opposite cerebrum from the part of the head that received the blow being affected, locating the symptoms upon the opposite side from the brain injury. Concussion of the brain, in the olden sense, cannot be considered as having been occasioned in many such cases.

"From cicatrices irritations may spread to the motor centres, and would naturally be reflected back to the injured part.

"From the absence of post-mortem findings it makes it all the more probable that the brain is the seat of the symptoms.

"This theory would prevent the justice of classifying all these symptoms under hysteria, as the French authors do in speaking of a traumatic hysteria. If all the numerous functional diseases could be squeezed into the term hysteria, then traumatic neuroses symptoms might also be included, but not otherwise.

"Sometimes actual lesions occur as complications of this disorder, but I formerly overestimated their frequency, Of these, atrophy of the optic nerve and pupillary reflex defects, or other disorders, afford the suspicion of a material foundation. When the injury has been particularly severe such complications may

occur, and patho-anatomical dangers develop, which combine with the functional disease. Bernhardt concedes this pathological union of the functional and organic disorders in the same individual as likely to occur.

"It is well known that trauma may originate many organic diseases of the central nervous system, and that insidious changes may follow injuries and cause spinal-cord degeneration, sometimes producing true neuroses, or even fatal results.

"*Predisposition.*—Many of our cases of injury in the male were previously perfectly sound, able to work, and not neurotic. In others, a former injury had been sustained which left no after-effects. In a few illness had preceded the accident, and a neuropathic condition was obvious. The statements of patients were not alone relied upon when it was to their interest to regard the trauma as the main factor of their disease; inquiry was made into their personal characters and the attendant circumstances of the injury. Light accidents suffice to bring on apparently severe symptoms in those predisposed by neuroses,—a fact to which Charcôt alludes. Case XXIII is a clear illustration of this. She was the offspring of the marriage of blood-relations, and before the injury suffered from retinitis pigmentosa. A fall upon even ground sufficed to produce a severe permanent neurosis, upon which followed decided mental alteration. In three other cases nervous disabilities succeeded peripheral injuries, such as femur fracture, hand contusion, etc., in persons who had suffered from mental ailments.

"It will not do to conclude that the blow should be severe to produce permanent injury.

"Alcoholic addiction can cause diseased sensations allied to those of traumatic neuroses, and previous drunkenness may aggravate the symptoms of traumatic cause, and, though there is want of testimony on the similarity of alcoholic and traumatic symptoms, the habit certainly lessens the powers of resistance to disease.

"Rigler thinks that railway officials are predisposed by

their employment to the development of traumatic neuroses, through irritation of the nerve-centres from incessant vibrations. To our regret, recent observations have not touched upon this point, so it lacks corroboration.

"*Course and Prognosis.*—In but few cases does the ailment fully develop soon or immediately after the injury; usually a few months elapse before this takes place. Primarily pains, paræsthesiæ, and mental aberrations appear, and in the course of weeks or months motor and spastic derangements follow. Disturbed speech or epileptic attacks are still longer in appearing. In rare instances there may be a sudden advent of the disorder about the time of the injury, but in these cases swift recovery ensues. Ordinarily, after progressing to a certain stage the derangements are stable, though some symptoms may cease and others become more pronounced. The mental alteration is usually obstinate, and differs in this respect from hysterical states, which are changeable and intermittent or capricious.

"As regards life the prognosis is favorable; exceptions occur when nervous heart disturbances proceed to organic affections. A danger to life exists in an inclination to suicide through mind derangement, but this is seldom realized. Complete recovery seldom takes place, from our observation. Even Page* admits this, for in most of his cases he notes a diseased irritability remaining, which marks the person as a 'damaged man.' At all times these patients are liable to develop a severe hallucinatory bewilderment, or insanity,—a transformation which we have several times had an opportunity to witness.

"Of dubious prognosis are such cases in which epilepsy or dementia is included in the symptoms, as well as where decided cardiac troubles are present. Not uncommonly special *régime* produces a betterment in some cases, but it is especially observable that those who are involved in legal proceedings are retarded in their recovery; and this is a complication to be considered. Often the interest in an expected verdict causes the

* Medical Times and Gazette, i, 1885.

patient not to desire recovery until his suit is decided. The patient thinks it is to his interest to exaggerate the subjective difficulties and to simulate. The law proceedings weigh heavily upon the individual and affect him more because he is mentally altered. So we often see improvement in their symptoms after a favorable issue, but, in my experience, the greater number have, after the termination of the legal quarrel, remained unchanged in their ailments by the event.

"*Therapeusis.*—As in the treatment of all diseases, there is a necessity for the absence of all irritating influences; and noxious circumstances, likely to cause an increase of the mental irritability, must, so far as controllable by the physician, be mitigated; and, with this in view, legal contests should be settled as soon as possible. Often I have known suits to drag along over a year or two, rendering the patient's condition worse. Quick decisions are not always practicable, as the medical opinion cannot be readily framed in all cases at the outset so as to afford a definite prognosis. It is to the interest of the sufferer to recommend settlements and to see that there is no clause left by which new legal matters can be instituted.

"A difficult therapeutical question occurs in determining what occupation the patient should follow. In severe cases, of course, nothing suitable can be found, and in any case railway pursuits, or positions of responsibility, are out of the question. Light work sometimes is attended with marked benefit.

"Tight bandaging is apt to aggravate ailments of this sort, and Charcôt states that in functional paralytics a tendency to contractures may be induced by tight bandages, and sometimes a few turns of the bandage suffice to produce contractures. Rapid atrophy of muscles was brought on in one instance, though the direct connection could not, with certainty, be proven.

"Where there is positive mental disturbance complete quietude is an important requisite to treatment. Most patients feel the need of seclusion, and seek it; and this necessity should

be fulfilled. Its prevention affects healing processes badly. A trip on the sea may be beneficial, but sea-bathing cannot be recommended. Occasionally good effects are reported from a course of bathing at springs. They state that the pains and stiffness are ameliorated thereby. Rubbing with cold water should be tried, though the results are uncertain. The electric current in these neuroses, at times, gives excellent results, the most trustworthy being the galvanic current applied to the head. I have seen such troublesome symptoms as headaches, tinnitus, and insomnia lessened by its application. Other patients are too sensitive to electricity to be able to receive benefit from it, and it is likely that in such cases the mental trouble is at work to resist the effects of treatment. The faradic current is of no use, though the brush may be used for anæsthesia as well as the faradic current for the muscles of the paralyzed extremities. The electric bath I have observed very little in utilization for these cases, but one of my patients had a syncopal attack with its first trial, and its further use was stopped.

"From our present knowledge the main therapeutical measures should be addressed to the mental condition. It lies in the power of the physician to calm the patient with assurances of cure and that his life is not endangered. Such statements affect the condition favorably. The difficulty is increased by allowing the patient to mistrust that you are ignoring the disease, and his loss of confidence renders treatment abortive. Then if anxiety be permitted to develop between the patient and physician it causes inconveniences and begets distrust on both sides. An instance is recalled of a sufferer who went the rounds of several medical men, none of whom believed in the genuineness of his troubles, with the result of a real psychosis being thus created.

"Recent hypnotic measures have been suggested. By Charcôt's hypothesis, conditions that could be produced by auto-suggestion should be relieved by it, but practically it does not avail. I have occasionally succeeded in hypnotizing some of

these patients, but was not able by suggestion to free them from their difficulties.

"Medicaments have but limited usefulness to record. In my experience bromides are best. The 'blues,' the fright conditions, the startlings, insomnia, *pavor nocturnus*, and heart palpitations, under sodium or potassium bromide, have undergone amelioration. Page warns against the persistent use of these remedies. Antifebrin, in half to one gram doses, occasionally relieves pain. From hypodermics of antipyrin I have seen no effects. Against insomnia bromides or paraldehyde can be given, but in severe cases chloral or morphine. Other nervines and tonics may, at times, be administered. Nutrition must be attended to by good diet when the strength is low. There is so great an intolerance of stimulants in these cases that, though beer and wine may be allowed in moderation, the stronger alcoholics, and even coffee and tea, should be forbidden.

"Charcôt regards massage as local hypnotizing, and advises it. In the nervous clinic, at times, setons have been inserted with good results, particularly when headaches, pains in the neck, or spastic conditions existed. Some felt so much improved that they visited the hospital for a reapplication of the setons. In two cases from which I excised small pieces of muscle improvement of motility followed. Lesser operations performed on them without anæsthetics resembled, in the absence of pain reaction and hæmorrhages, operations upon the cadaver. Bergman advises cicatricial excision if the spasm is preceded by an aura starting from that point, and if there is an epileptogenic zone. In Case XXXIII the results from this were not permanent, but cases are known where definite healing has occurred.

"*Forensic Observations.*—The following questions are usually propounded to the physician:—

"Is John Doe sick, and, if so, from what does he suffer?

"Is there a connection between his illness and the accident?

"Is the disease curable, and, if so, in what time can it be cured?

"Does it cause complete, or partial, inability to earn his living?

"If there is only partial disability, what per cent. is it?

"By the terms of the accident-insurance law of July 16, 1884, every workman receives, if totally disabled, $66\frac{2}{3}$ per cent. of his working salary during his sickness, and lesser amounts, *pro rata*, for partial disablements. The method of determining such things must be arbitrary, for there can be no fixed rule in such matters. The scientific deputation to form a medical opinion on the subject, according to Becker,* defined working ability to be that which enabled the performance of bodily and mental activities, in the degree to which the person was accustomed, and the loss of this constitutes working disability. Against this the superior tribunal opposed the declaration that disability to work did not consist in the diminished ability to do customary work, but the disability to do the ordinary bodily acts, which do not require extra strength to perform, and this need not, necessarily, be manual labor. According to von Woetke (Accident-Insurance Law of July 6, 1884, with Berlin, 1885, opinions), it is impossible to estimate the degree of bodily and mental strength, and the actual earnings should be considered.

"Many of the queries are incomplete, and often inapplicable to the case; and the question as to whether there is any disease at all requires a decision as to the whole matter of simulation, which can seldom be made unqualifiedly.

"I have detected impostors, and proven all their symptoms to be false. Other authors claim that simulated symptoms frequently cease in hospital, while under observation. Usually malingerers have erroneous notions as to the nature of the symptoms, and their grouping may be inaccurate, and thus lead to their detection. If the person is seen at a place of amusement, whether recovered or not, the laity is impressed with the idea of there being fraud; and the rigidly stiff walk, such as the military affect, often is taken as evidence of soundness.

* Anleitung zur Bestimmung der Arbeits und Erwerbsunfähigkeit nach Verletzungen. Berlin, 1885.

"Rigler shows that from the instituting of railways up to the law of June, 1871, nineteen collisions and fifteen derailments occurred, and in these only six persons were permanently injured; after that time, to the end of 1876, twelve collisions, seven derailments, and thirty persons with similar troubles, were noted; and when the corporation prosecution law passed, nine times this number of cases were recorded,—a fact that indicates abuse of the law, and that these parties were not hurt so much as they claimed to be. There is a greater disposition to exaggerate symptoms than to manufacture them outright.

"There appears a test of importance in the information the patient is liable to possess of the value of the objective and subjective symptoms.

"No doubt some experts are able to imitate forms of paralysis, but only at times.

"Sufficient weight cannot be given to paralytic conditions, in persons who have no cause to cheat, in estimating the reality of symptoms in those who really have organic trouble, with the requisite knowledge of the value of injury neuroses to enable them to falsify. Further, it is a matter of considerable weightiness, in determining pretense, that seldom do single symptoms exist, and it is their sum that make the characteristic whole. The best-informed simulator would not be able to bring together all the mental, motor, and sensory features. In many cases hospital observation is indispensable, and for long periods, as to whether there may be sleep-walking, spasms, etc., which only occasionally occur, and may not do so at the time of the physician's visit. Heart symptoms require time, also, for the pulsations may be simply temporarily increased at the moment of inspection.

"Exaggeration is difficult to exclude by estimation, as, for example, the pains and abnormal sensations. Expressions of pain in the face and acts which do not depend on the will-power must be judged, and yet there are persons who do not show pain externally.

"Case XXXI had a contused hip-joint, with pain and

fixation of leg. Two prominent physicians claimed that, if he did not simulate, he considerably exaggerated. Observation in hospital proved all the traumatic coxalgia to be present; partial hemianæsthesia, including the face, and slight atrophy of the right-leg muscles were proven by electrical tests, Brodie's symptom, etc.

"Those who are accustomed to treat hypochondriacal, hysterical, and neurasthenic patients know the great trouble there is in differentiating the disorder. Objective disease may be found after repeated examination which had been overlooked at first, and may be of great value.

"Disease may have existed before the accident, and then claimed to have resulted from it. I have had two such cases. But where an accident exaggerates or renders worse pre-existing disease, the claim is valid. This is decided by a law decision of February 4, 1887. Where there is a neuropathic tendency beforehand, it should be proven that the accident aggravated it, or not, as the case may be. Alcoholism is different, however, as it can produce symptoms similar to the disease. The toxic neuroses and psychoses are closely related to trauma.

"No doubt organic spinal disease developed in one case half a year to a year after injury, and a tumor in the disseminated sclerosis appeared after a severe mental concussion. There are a number of such well-attested instances in the literature.

"Opinions as to curability are difficult to form, as well as of the degree of incapacitation. We know that many cases are very stubborn, and have but little chance of permanent and complete healing. The postponement of decisions and the existence of poverty protract the disease. Rigler states that formerly the injured were compelled to resist their diseased tendencies and go to work, when there were no damages to be claimed; but I do not agree with him in this respect, for a mental affection could not be cured by such means.

"As to permanent disability, it is best to be reluctant with an opinion. Where severe forms, such as insanity, existed, or

where there is a positive lowering of the intelligence, such as is produced by epilepsy, a decision may be reached. Atrophy of the optic nerve, pupillary affections, or where irreparable injury accompanies the complaint, some approximate idea of the disability duration is enabled. Where neuroses persist for one or two years, and do not tend to grow better, it is unlikely that complete recovery will occur.

"When the injury has appeared to be light I have advised work to which no responsibility of consequence was attached, such, for example, as a few hours' office work, the position of porter in a private dwelling, and such occupations. Railway work is not to be thought of as at all suitable. It pertains more to the lawyer's duty to ascertain and declare, from the testimony, to what degree the inability from injury requires the undertaking of work of inferior activity."

CHAPTER VI.

Illustrative Cases of Spinal Disease.

PART I.—PERSONAL OBSERVATIONS.

I. *A Case of Concussed Spine causing the Typical Nervous Symptoms known as Spinal Concussion. Incomplete Recovery.*—Isaac W. Holland, æt. 30, a strong, healthy man, weighing one hundred and ninety-seven pounds, a railway conductor, to which place he had been promoted during twelve years' railroad service, was, in February, 1883, in the passenger coach of a train which collided with another, and was thrown upon a cushioned seat and thence to the floor. He complained of having been "shaken up," but remained about the wreck several hours, assisting others, and then walked two miles, resuming his work later in the day, and was on duty eight days, after which he laid off two days, as he "felt badly;" tried two days more on the train, then stopped at home five days, and, though his undefined bad feelings persisted, he continued thereafter twenty-one days more on the road.

He manfully struggled against the depression, the "scared" sensations and "rheumatism" in his back, and, at one time, was inclined to adopt the opinion of a practitioner that it was only a liver disorder. He went from Chicago to Davenport, Iowa, on the train, to visit the road surgeon, who, after an examination, failed to find any evidence of organic disease. Returning to his home, and his disability growing more aggravated, suit was brought against the company; four months after beginning which he enjoyed a remission of his pains and applied for his old place on the road, but was refused, and the same day he took to his bed, where he remained for a year and a half preceding the trial of his claim. The allegations were that he had eaten but one meal a day in this time, and that the light hurt his eyes so that the room had to be kept darkened all the time. His weight had fallen from one hundred and ninety-seven to one hundred and two pounds. He preferred to be alone until he wanted his position in bed changed, for which he required help; he lost strength continually; his back was the principal seat of pain; he suffered continuous headaches, prickling sensations, numbness, and pain in all parts of his body; he had not a good night's sleep for over a year; his eyes were weak and sight was blurred; his appetite and digestion were

Note.—Full names of patients given by their permission or that of their friends.

poor; arms and legs felt constantly cold; he had but little strength in his arms and legs; could not walk without assistance, and every movement caused pain; even piano-playing annoyed him, and the slight noise of a footfall on the carpet, as well as conversations, or trivial, sudden sights or sounds, irritated him out of all proportion to the cause. In December, 1884, at the request of plaintiff's counsel, Kretzinger Brothers, I visited Mr. Holland and found him in bed, with a screen shading a dim light from his eyes, and the windows were darkened. His muscles were relaxed and flabby, and there was plainly seen emaciation in all parts of the face, trunk, and extremities. There was extreme pupillary dilatation, but this may have been due to the darkness, though others in the room did not exhibit the same extent of dilatation. The light reflex was not prompt, and the seeming photophobia caused me to desist from complete tests as to this. He shifted, or hitched, himself in bed, an inch or two at a time, by means of a rope at the head of the bedstead. His back, the entire length, was of a dark hue, the width of a hand, closely resembling, if it was not, hypostatic congestion of the dermis, due doubtless to dorsal decubitus. Fibrillary tremors were every few minutes plainly observable in his arms and hands, and less frequently elsewhere. Grosser tremulousness of the hands also occurred. The temperature was generally subnormal, his feet ranging eight or nine degrees below normal, though wrapped in blankets. Apparently there was universal hyperæsthesia, and the finger-tips were anæsthetic; there was impaired sensation upon the radial sides of both arms; the inner sides of the legs and feet were similarly more affected than the outer sides, but there was generally lessened discrimination of touch. There was a more blunted sensation-appreciation about the lumbo-dorsal junction of the left than upon the right side, and in the middle dorsum this was reversed, the right side being more anæsthetic. Pressure on the spinous processes caused acute pain, less in the cervical and sacral regions, greatest in the lower dorsal region. He complained of an incessant headache, with frequent "thickness of the tongue" in speaking. Sight, hearing, and touch were hyperæsthetic. He was not able to fix his attention upon anything for any length of time, and his friends spoke of his unwonted irritability. His grasp registered on the dynamometer 25 with either hand. Feeble motility was evident, approaching paresis.

The genitals were flaccid, and erectile ability and desire were said to be absent. There were no vesical or rectal difficulties. He was not able to eat much at a time, and felt disinclined to eat at all.

He was not able to sleep more than fifteen minutes at a time, and awoke unrefreshed and perspiring from horrible dreams.

The patellar reflexes were greatly exaggerated, and the tapping

caused excruciating pain in his back and head. His family physician stated that epileptiform convulsions began a year before, and were increasing in severity.

The patient was haggard and cyanotic ; he carried his back in an unyielding, stiff manner, and avoided every movement possible, and such that he found necessary to make were slowly and tremulously performed.

Ordinary faradic and galvanic currents caused too much pain to enable their being increased sufficiently to obtain muscular contractions.

His pulse was slow, but increased upon his attempting motions. Owing to his sufferings and inability to undergo prolonged examination other tests, such as those of his gait, etc., were omitted.

The claim was hotly contested in a Chicago court on the ground of malingering, voluntary starvation, preponderance of subjective over objective conditions, etc., but it became manifest to the jury that Holland's case was genuine, and he was awarded $25,000, which the Supreme Court increased by interest and costs to $31,000.

There was a consistency in the totality of the symptoms he presented, and a harmonious blending of both the objective and subjective troubles, together with their agreement with the classical descriptions of Erichsen. Furthermore, Mr. Holland's good reputation gave strength to his statements (as it should in all cases), and, so far from his feigning disease, he repeatedly denied the existence of difficulties concerning which he was interrogated so often that he knew they would be regarded as favoring his case were they present.

For nearly a year after the trial and verdict his condition remained about the same. In 1886 he was still confined to the house, but sat up more. In 1887 a barn caught on fire near his house and he was greatly prostrated by the excitement for a week or so, but seemed to gain strength thereafter, and in the fall of that year began to go outdoors in a wheel-chair, which at first was pushed, but in a month or so he was able to roll it himself for half a block at a time.

The last convulsion he had was in December, 1887. At the present writing, September, 1889, he is able to walk a few blocks at a time, but is easily fatigued ; has no endurance ; his volition is impaired ; makes up his mind to do anything with difficulty ; his back still aches, and is tender in the cervical and lumbar regions. He walks stiffly and slowly and has to be careful about his movements ; and he feels worse in the mornings, as his sleep is disturbed by pain in his back and by frightful dreams, which awake him. He is forced to lie down often during the day ; appetite is still impaired ; weight one hundred and thirty pounds (a difference of sixty-seven pounds less than his original weight). He is more cheerful recently, but is easily annoyed and suffers from headaches often.

Surface hyperæsthesia at times relieved by walking about, but when irritated he feels better by lying down in a darkened room. Eyesight too much blurred to enable reading or writing except for a few minutes. He has attacks of dizziness and ringing in the ears. When tired the fibrillary tremors appear; he avoids, as far as possible, all draughts of air and annoyances generally; knee reflexes slightly increased; left side slightly anæsthetic, and more impaired motorially than right. Romberg's swaying symptom present. Dynamometer grasp 40, with each hand, and the light still causes pain in his eyes. He is not able to engage in any kind of work.

II. *A Case of Probable Malingering.*—In 1884 a midwife brought suit against a Chicago street-railway company, alleging injuries sustained in a fall from a street-car in motion. She was brought into court in a wheel-chair, and maintained rigidity of the left leg, which she claimed was paralyzed. Dr. A. J. Baxter and I were requested by the company to make an examination of the case, but, by the laws of Illinois, this could only be done by the plaintiff's consent, which she would not grant. (I make it a rule to insist upon the fullest courtesy being extended to the physicians of the defense in all cases of the kind, and no honest reason can be valid for taking advantage of such a law.) The court thereupon selected two surgeons, one of whom was very conscientious, and their report was adverse to her claim. She subsequently figured conspicuously in other lawsuits and seemed to have fully recovered from her "paralysis." How much, if any, real injury existed in her case cannot now be ascertained. It is known that a year after the claim was made she walked the streets and transacted business, and certainly she greatly exaggerated her ailments, if she had any. My regard for the opinion of one of the surgeons who were called by the judge leads me to believe that the plaintiff was shamming, in spite of this opinion being coincided in by the other surgeon, who, though skilled, enjoys the reputation of being a great society intrigant, politician, and facile swearer for the side that engages him. Evidently paralysis and pain constituted the plaintiff's idea of the requisites for spinal concussion, for, as far as ascertained, there were no other conditions alleged as caused by the concussion to her spine.

III. *Fall upon the Feet, Jarring the Spine, followed by Spinal-Concussion Symptoms and Death.*—Dr. E. W. Du Bose, æt. 38, Post Surgeon, U. S. A., at Forts Seward and Lincoln, Dakota, during 1873 to 1878, while in Washington, D. C., in the early part of the latter year, accidentally walked off the pavement into an excavation, some eight or ten feet deep, alighting upon his feet, jarring his spinal column, but with apparently temporary effect. The doctor was tall, with an erect, military carriage, to which latter he probably owes his death, as he did not see the

pitfall when he walked into it. His nobility of character and learning were widely respected and endeared him to me. I first learned of the accident in August, 1878, when I was shocked to find him completely changed. He was thinner and his face exhibited evidences of suffering. He said his head tortured him unceasingly. He was gloomy and reticent and constantly endeavored to restrain his irritability; he walked slightly bent forward, with all his former vigor gone; rotation of the spine was painful and micturition required a long time, from detrusor paresis. His steps were short and slow. There were no paralyses or other organic symptoms observable, no fracture nor dislocations of the spine. His sleep was troubled, appetite poor; paræsthesia, hyperæsthesia, and anæsthesia general. He could not stand with his eyes closed, nor could he read at all, as everything "swam" when he attempted it. He could slowly rotate and flex his vertebræ and head, though it cost him pain to do so. He could stoop only by supporting himself. There were vertiginous sensations, tinnitus aurium, and a tendency to seek seclusion and darkness; the latter to relieve his photophobia. After our parting I was unable to hear from him, as he did not write, and the surgeon-general referred my inquiry to the health officer, who forwarded to me the following information:—

HEALTH DEPARTMENT, DISTRICT OF COLUMBIA,
No. 503 D STREET, N. W., WASHINGTON, D. C.,
April 24, 1889.

[*A Transcript from the Record of Deaths in the District of Columbia.*]

Emory W. Du Bose, died July 4, 1880, aged forty-one years; unmarried; white; physician; birthplace South Carolina; duration of last sickness fifteen months; cause of death organic disease of brain and spinal cord and acute melancholia; place of death, Government Hospital for the Insane; medical attendant, W. W. Godding, M.D.; buried in Glenwood Cemetery; undertaker, Anthony Buckly. (Signed by)

SMITH TOWNSHEND, M.D.,
Health Officer and Registrar.

Even though in this case organic lesions of some kind may have existed, his symptoms were those of spinal concussion with whatsoever complications or consequence.

IV. *Fall upon the Back. Concussion Symptoms Two Years. Recovery.*—Mrs. G. C. Paoli, past middle age, wife of a noted Chicago physician, fell on an icy pavement, striking sacrum and back of head. She was unconscious and vomited later, but rallied. Great emaciation and weakness followed without paralysis or paresis; there were hyperæsthesiæ, especially auditory; tenderness and rigidity of the spine, with depression and general pains, especially in the back; disturbed sleep and headache.

In two years there was gradual but complete recovery, which was brought about by constant exercise of skill and care.

V. *General Concussion to Body and Scalp Wound. Concussion Symptoms at first, and, later, Insanity.*—F., æt. 28, was asleep at the moment of a collision, and, in addition to being violently jarred, received a head wound—a scalp contusion—but was not rendered insensible. He was pinioned by the *débris* and saw his fellow-passengers burned alive within a few feet of him. He was rescued in a dazed condition and months later complained of sleeplessness, pain in the back, headaches, and leg weakness; with inability to attend to work. Next, paretic dementia symptoms set in, such as the delusions of grandeur, mental and physical anæsthesia, drawling speech; but, as is usual in traumatic insanities, these peculiarities were modified, and differed from the genuine paretic dementia. His irritability was extreme, at times, and alternated with the indifference of the paretic. He became a decided paranoiac within a year after the accident, and grew so unmanageable that his attorneys dropped his case. He was, at last accounts, in an asylum for the insane.

VI. *Blow to Head and Cervical Region. Mixed Concussion and Mental Disease Symptoms. Unrecovered.*—L., æt. 48, an industrious, vigorous mechanic, weight one hundred and seventy pounds, member of a military organization, was struck by pieces of stone, which fell from a high building, upon his head in the left parietal region, and also between the scapulæ. In a few weeks he began to fail in health and mind, and in two years his character had completely changed; he had lost memory for recent events, and would tell the same thing over again, unaware that he was doing so; he had lost his previous ability as an amateur musician, had grown very irritable; lost all business aptitude; could not tolerate even small drinks of liquor; appeared very much older than he was; walked feebly, bent, and totteringly; his speech was hesitating; light hurt his eyes, and he was unable to read, though his pupils respond to tests for light and accommodation reflexes; slightly deaf in the left ear, and heard "distant bells ringing" constantly; sleep disturbed; dreams repeatedly of falling; touch, hearing, and sight senses irritable, and anæsthesia in left extremities and in left side of body; the face and head generally anæsthetic; left hemiparesis; costive; knee and elbow reflexes exaggerated on both sides; the cremasteric and abdominal reflexes abolished except upon right abdomen; spine between scapulæ tender to touch; appetite poor; heart action feeble, temperature subnormal; quantitative loss of response to faradic and galvanic currents to an extreme degree; present weight one hundred and twenty pounds, having lost fifty pounds since the accident; muscles

shrunken and flabby; left thigh an inch less in circumference than the right; bladder slightly paretic.

It is noticeable that the hemiparesis was upon the same side as the head injury. Formerly I ascribed this to *contre coup*, supposing that the left head-stroke had injured the right cerebrum and induced left hemiparesis, but a left hemiplegia would have been pathognomonic of the latter, and unilateral pareses are characteristic of spinal concussion, particularly with head blows. He did not lose consciousness after the injury, which is another spinal-concussion characteristic. In a civil action for damages, a physician stated that electricity and scientific instruments, such as the thermometer, æsthesiometer and dynamometer, were valueless as tests, and that bromism (without foul breath or eruptions) and drunkenness (it was proven that L. was temperate) were probably the causes of all the symptoms. Several ignorant doctors testified on both sides, with others who were better informed, and the issue was against the plaintiff. He is now impoverished, helpless, and demented. Responsibility for the accident was not well established by the plaintiff's attorney.

VII. *Blows upon the Head and Back. Spinal-Concussion Symptoms at first, followed by Traumatic Paretic Dementia.*—M., æt. 30, machinist, was struck on the forehead and top of head by conductor's lantern and kicked in the back; soon after developed spinal pain and rigidity; left eye amblyopic; hearing of left ear impaired, which he first noticed when using the telephone; pain in left temple; constant general headaches; very sleepless; bowels fairly regular; sexual power impaired. Dynamometer grasp—right, 100; left, 60. Was formerly very strong in left hand, as well as in the right; left knee-jerk less than the right; forehead numb, especially upon left side; has scrotal pains. Since the accident, which occurred January 27, 1888, he is more easily affected by liquor than formerly, and indulges more freely. My first examination was made April 19, 1888, and at his next visit to my office, March 14, 1889, I found his speech drawling, and that he had occasional delusions of grandeur; that his business was being neglected through unwonted quarrelsomeness and tippling. June 13, 1889, the spinal symptoms seemed to be overshadowed by the mind alteration, as far as could be learned from the statements of relatives and friends. With Dr. O. L. Schmidt, I made an electrical examination of his neuro-muscular condition, and found hypersensitiveness with the faradic current, right side more than left, and, with the galvanic current in the anterior crural region, in milliampères—right side, C C 9, A C 11, A O and C O absent, with 15 milliampères; left side, C C 5, A C 6, A O 7, C O absent, with 15 milliampères. Over the elbow region of the musculo-cutaneous nerve—right side, C C $2\frac{1}{2}$, A C 4, A O 3; left

side, C C 1, A C 2½, A O 2½, and no C O, on either side, with 15 milliampères. The interpretation of which is that the motor and sensory enfeeblements are upon the left side of the body, and the readier response of that side to galvanism, in connection with this, show that so far as organic mischief is concerned the right cerebrum is injured. The somewhat quantitatively lessened reactions of the legs may result from spinal-concussion causes.

The damage suit was tried during the writing of this chapter, and the court appointed two specialists to examine the patient at my office. During this examination it was ascertained, in addition to matters stated above, that there was extreme tenderness in the cervical and lumbar regions, the knee reflexes were normal, the cremasteric was present, but feeble, and the abdominal reflex was absent; his taste was impaired; he could not read, as it made his eyes twitch and caused tears to flow; pupils were dilated, reacting to light, but sluggishly to the test for accommodation; the swaying symptoms were marked; he could not rise without the aid of his arms when lying down, and when he stooped did so by bending his knees, but not his body, maintaining rigidity of his back; and he angrily refused to try to bend his back, as he said the pain was too great. There was no vision contraction nor ophthalmoscopic findings, but with the perimeter a color constriction was found to exist on the nasal side of the left eye; the asthenopia was in both eyes. His appearance was one of fatuity, and his behavior somewhat silly. His friends testified that he had become a changed man in every respect, that he was irritable, there was no consecutiveness to his thought or conversation, that his memory was poor, and he had once talked of committing suicide, and, upon another occasion, had delusions of persecution.

The court experts did not find evidences of insanity; one stated that there were symptoms of spinal irritation, which the other denied. Both acknowledged the great value of electro-diagnosis, though they had not made use of it in this case; and both of these gentlemen had previously, in Case XIV, derided electricity as a means of examination.

VIII. *Fall upon End of Spine. Spinal-Concussion Symptoms Persist after Two Years in a Child. Instance Unique.*—H. S., æt. 9, Christmas, 1887, while skating, slipped and struck buttocks, and since then, while previously perfectly well, has been restless, peevish, sleepless, capricious, with poor appetite; some vesical paresis; compelled to stop schooling owing to incessant headaches; irritable to unendurability, and takes advantage of the consequent indulgence of his parents and relatives generally; is costive; heart- and pulse- beats are rapid and easily accelerated; complains of formication, occasionally, in both arms, and

more frequently of numb feelings and coldness in hands and feet; all his senses, special and general, appear hyperæsthetic; is easily startled; has little endurance, tires out easily; does not seem to have the proper use of his legs. His restlessness, whining, and emotionalism (utterly differing from hysterical conditions), his anger being easily provoked, and even castigation checking him but temporarily, prevented further examination; but the case affords us one of the most satisfactory instances ever recorded of the major symptoms of spinal concussion under conditions excluding simulation. There is nothing neurotic in the ancestry, nor was there any congenital difficulty. I sent him, in his mother's care, to Dr. J. H. McBride, Superintendent of the Milwaukee Sanitarium, but, as that place is intended for quiet patients, he was not accepted. Dr. Henrotin, of Chicago, circumcised the boy for a reflex effect, with temporary benefit, but a relapse soon occurred, and he affords his parents a decided problem as to how far they should go in curbing his disagreeable disposition and at the same time recognize his irresponsibility and suffering. I shall watch this case with great interest, and hope to be able to report its progress in later editions of this book.

IX. *Fall down Elevator-Shaft. Spinal-Concussion Symptoms, with Complications. Result Unknown.*—J. L., æt. 25, fell from second floor to basement through elevator-shaft, August 20, 1888. Was unconscious for half an hour, and then felt cramps and pains in his back. Girdle pain occurs in lower lumbar and in cervical regions; attempts to rotate neck cause pain. Right grasp with dynamometer, 55; left, 40; æsthesiometer tests negative. Tinnitus aurium: "sounds like water running." Left upper occiput struck, and his right lip was sewed up by a surgeon. Is hyperæsthetic, "nervous;" eyesight blurred, and scintillations frequent; "sees stars if the weather is rainy," probably indicative of barometric pressure increasing cerebral congestive tendency in optic as well as in other centres; constipated; no bladder trouble; sexual impairment; sleepless, "jumps in bed" (irritative jactitations); cannot read very long at a time; headaches in occiput upon awakening; hand co-ordinations normal, feet co-ordinations impaired; patellar reflex greater upon right than left side, and the tap causes pain in the back, which is less upon the left side; abdominal reflexes exaggerated upon both sides. No further record of the case, as he was lost sight of.

X. *Fall down Elevator-Shaft. Concussion Symptoms, with Indications of Organic Spinal Disease. Previous Struma and Spinal Curvature. No Improvement.*—Miss S., æt. 25, fell through elevator-shaft in 1885, and was confined to bed a month; did not lose consciousness at the time of the accident. Partially deaf from previous catarrh, and was somewhat cachectic, and had a lateral spinal curvature at the date of examination,

March 22, 1888, which condition probably antedated the fall; scapular protrusion, especially upon the right side. A right sterno-clavicular dislocation exists; suffered from headaches and insomnia, and sensation was impaired in the right arm and leg. Dynamometer—right, 20; left, 35. Breathing difficult at times, heart rapid; facial, lingual, and abdominal anæsthesia of right side. In a few months the anæsthesia in right arm became less, but the right patellar reflex was diminished, and the right leg remained anæsthetic; abdominal reflex greater upon left side; more susceptible to heat upon the left side. The old ailments in her case, which should have been more frankly acknowledged, helped her defeat in a damage suit, though the fall had, undoubtedly, hurt her permanently. Dr. A. J. Baxter was called by the judge, Dr. Norman Bridge by the defense, and I was the plaintiff's physician. We examined the case together, and thoroughly agreed in our testimony.

XI. *Struck by Locomotive. Concussion and other Symptoms. Unrecovered.*—H., æt. 50, hit by engine and tossed some distance. The ordinary spinal-concussion symptoms followed within a week or so, such as sleeplessness, optic and auditory defects, sensory impairment, and, in addition, bladder and rectal weakness; right-knee ankylosis from patellar fracture; mental debility marked. Recovered $5000 in an action against the railway, but the year following had not improved in any particular.

XII. *Train Derailment. Spinal Concussion and Myelitis.*—F., æt. 22. By derailment of train, May 1, 1888, while asleep, he was tossed across the sleeping-car aisle into the opposite berth and was awakened by the crash, and thinks that he fell head first, with arms outspread. Extricated himself and did not feel much hurt at the time, beyond a slight soreness along left side and leg. His left lumbar and cervical regions were painful. October 13, 1888, there was sexual impairment; bladder difficulty at first, disappearing later; cramps occasionally in left hand; no headaches; cannot read or write as he formerly could, owing to difficulty of continuous attention, eye-sight blurring, and some photophobia; cannot stand on left leg, which is anæsthetic, weak, and painful; the left tendon reflex is absent, right normal. Dynamometer—right, 80; left, 35. Fulgurant pains in legs, as in tabes; was constipated, at first, but is not now; oral temperature 99° F.; weight one hundred and forty-one pounds, previous to accident one hundred and fifty pounds; sways with eyes closed and when feet are together; inco-ordinative upper extremities; auditory and tactile hyperæsthesia; taste impaired; abdominal and cremasteric reflexes exaggerated; hot sponge on back causes pain; muscle consistency flabby; shoes, especially left, worn at toes; depression, irritability, insomnia, disturbing dreams; temperature of feet subnormal.

A preliminary examination of the conductivity of the anterior crural,

October 15, 1888, gave for the right leg A C 6 milliampères, but no reaction with the same galvanometric measure in left leg. With 10 milliampères the left afforded A C > C C.

November 19, 1888, pains in the legs and muscle-twitchings worse. Dr. Otto Schmidt found A O > C C.

June 9, 1889, conjointly, Dr. Schmidt and I made another electrical test, with the following result: 14 to 15 milliampères overcame normal resistance and caused tonic contractions upon both sides. Anterior tibial nerve—right, A C 6, C C 8, A O 12; left, C C 3, A C 4, A O 7. Anterior crural—right, A C 9, C C 11; left, A C 5, C C 7. No A O nor C O with 15 milliampères.

Spinous processes of third, fourth, eighth, and ninth dorsal vertebræ are sensitive to pressure. Slight right lateral curvature of spine, with right scapular ridge raised. Left leg one centimetre smaller in circumference than right, at ten centimetres below patellar lower border; at twenty-five centimetres above internal condyle, left leg is two centimetres smaller. Dynamometer—right, 41; left, 40½. He walks with a cane, and drags the left toe. Fibrillary tremors increased over left rectus femoris upper third.

XIII. *Fall upon Back. Remnant of Concussion Symptoms after Thirteen Years.*—H., æt. 48, a watchmaker, fell from step-ladder ten feet upon his back. Felt considerable pain at the time, but in a week was much better, and did not recall having had any trouble until a year later, when his back and head began to ache. Urine was slightly phosphatic, but of normal specific gravity, and physicians failed to find any cause for his depression and pains other than that, in some way, his back had been hurt by the fall. January 23, 1889, thirteen years after the accident, his head still ached, but he either had grown accustomed to this or improvement had occurred. His sleep was not then disturbed; no bladder trouble; bowels costive; sexual power feeble, ejaculates too quickly, and his back pains more after coitus; priapism at times; his overcoat feels uncomfortably heavy, and its pressure hurts his back; walking distresses him there; no photophobia, no aural trouble, a little dizziness, cremasteric and abdominal reflexes absent; patellar reflexes are normal. Spine slightly curved, antero-posteriorly. Vertebral caries cannot be satisfactorily excluded, neither can it be affirmed by position tests. There were no meningeal or myelitic symptoms, no hyperæsthesia nor anæsthesia. The pain in back and head was made worse by motions; the sexual impairment, constipation, and lassitude were the most prominent symptoms, and, as these disabled him from working, he sought relief from one physician after another, who usually diagnosed his trouble as "spinal irritation," consequent upon the fall.

XIV. *Head and Back Struck. Cerebral and Spinal-Concussion Symptoms; Paralysis Agitans and Hemiparesis Two Years afterward. Unrecovered.*—Mrs. V., æt. 63, struck by street-car in upper spinal region and right occiput; was not at once made unconscious, as she handed her card to cabman who drove her home; thinks she lost consciousness and roused again at times on the way. For two weeks could only be partially aroused; right-sided paresis occurred six months later; right pupil dilated, left contracted. Vomiting and other evidences of cerebral concussion occurred during the first two weeks; there were also right paræsthesia, prickling sensations. A year after the accident there was left hemiparesis, with loss of sensation upon the same side, but extreme hyperæsthesia below right patella and about right shoulder, pectoral region, axilla, and scapula. Dynamometer—right, 3; left, 30. Sleep disturbed; headaches upon right side. Two years afterward paralysis agitans, mainly in right arm, fully developed, and is advancing to the body generally. Electrical tests, made with the assistance of Dr. Plymon S. Hayes, June 9, 1889, revealed quantitative and qualitative changes from the normal. To the faradic current the left side responded fairly, as to contractions, though a strong current was required. She complained of the painfulness of this test, but double the current upon the right leg produced neither contractions nor pain. With galvanism of the anterior crural region, right, C C 5, A C 6, C O 8, no A O; left, C C 5, C O 8, no A C nor A O, affording indications of qualitative anomalies in the side opposite the hemiparesis, and that side was less qualitatively than quantitatively affected. C O requires relatively a much stronger current to produce contractions in health, other things considered. The left-arm reactions were normal, and the right musculo-cutaneous region gave C C 6, A C 8, no A O nor C O.

Against her damage claim was brought the charge that two previous claims for other injuries had been settled many years before; college professors swore that she had no paralysis agitans, though her hand tremors numbered one hundred and sixty to the minute, and the surgeon of the road disagreed with the experts and said that paralysis agitans could not be disputed. The plaintiff's attorneys claimed that during her unconsciousness her signature had been forged to a statement by an agent of the road, that detectives, perjured witnesses, complaisant notaries, bribed "physicians" and nurses had been injected into the case (two of the medical personages were wofully ignorant), and that even a shyster lawyer had connived with the road, and compromised her previous cases, without her knowledge. A four weeks' trial ended in a verdict of $10,000, which was appealed.

XV. *Case Undecided as to Whether Former or Recent Accident*

Caused Concussion and Other Symptoms.—C., æt. 46, was in railway accident in 1883, and obtained $8500 for spinal injury, from which, he says, he fully recovered, and in January, 1889, met with a street-car accident. Present symptoms: vertigo, sleeps badly, dreams often, reads with difficulty, and can write but a few minutes at a time; appetite poor, no vesical trouble, swaying with eyes closed not marked; does not hold his back rigidly, stands on one foot with difficulty, was delirious after the accident; tendon reflexes exaggerated; half girdle pains right side at times. Dynamometer—right, 40; left, 45. Scattered general anæsthesia; no atrophy. Left shoe is soled half an inch thicker than the right; the shortness of leg this would indicate is apparently owing to a slight knee contracture. Tremors in right hand; hyperæsthesia of all senses; cremasteric reflex, right side, marked, absent left side; testicular atrophy left side; no gluteal reflexes, abdominal reflexes present; tenderness in cervical and lumbar regions. Dr. Otto L. Schmidt and I made electrical tests, during which the patient exhibited great emotionalism, which his attending physician says sometimes rises to delirium, with frequent heart rapidity and flushed face.

Response was obtained to ordinary faradic excitation, the right leg requiring a trifle more current than the left, which was normal in reaction, but the right afforded peculiar clonic rhythmical tremor response, with the faradic uninterrupted. With the electrode over the rectus femoris the right reactions were C C 7½, A C 7½, no A O nor C O, and the left gave C C 8, A C 8½, A O 13, and no C O. Diagnosis: Both legs show unhealthy state of spinal cord; the right more markedly, but the reactions are those of progress from a worse disorder. There may have been full degeneration reactions formerly, but the tendency seems to be toward function restoration, with a possible slight remnant of previous organic spinal disease. With no opportunities to obtain particulars, other than those afforded by the plaintiff, there remains doubt as to whether the former accident is to blame for all or part of his trouble, or how far the second contributed to his present condition.

XVI. *Struck by Locomotive. Contusions of Leg and General Concussion. Improvement.*—Mrs. S., æt. 40, while crossing a track was run into and tossed by engine, and taken home unconscious. There were a medley of symptoms, at first, from the surgical injuries; a compound tibial fracture and injury to hand, but as these became better she was photophobic, delirious at times, emotional, suffered back pains, and her sleeplessness was extreme; hyperæsthesia and anæsthesia general, with some paresis of the injured leg. The road compromised with her, and she rapidly improved, but how far recovery proceeded it is impossible to satisfactorily ascertain. I think there was both conscious and

unconscious exaggeration of her symptoms. She was always very obese, and lost but little flesh during her illness of about three years.

XVII. *Derailment. Typical Concussion Symptoms. No Improvement after Verdict and Lapse of Two Years.*—A. O. Evarts, æt. 30, postal clerk, at work when his car was thrown down an embankment and dragged three hundred feet. He found himself in the roof of the car, which was lying on its side, and thinks that he was tossed to and fro at the time. He was bewildered, but did not feel much hurt at first. His foot was sprained, and the pain there attracted his notice. The pain in his back was not very obvious for a month, but it increased in severity, and his physician secured thirty days' leave of absence for him; as he continued to grow worse, extensions were granted for ten months, when he returned to the road for a week, but suffered so much, even with an assistant to help him, that he was forced to stay at home. He had been three years in the postal service previous to the accident, and his past faithfulness earned considerations from his superiors in office. January 10, 1889, these symptoms were apparent: Insomnia; nightmares, particularly if lying on back; digestion fair; eye-sight blurred; hyperæsthetic, especially to light and sounds; constant back pains, mostly lumbar, increased with slightest motions, and spine is rigidly held; to-and-fro motions cause pain; cannot stoop without holding to something; exercise exhausts him, but at times the intense aching is partly relieved by walking; feels impelled to walk, even though it tires him; it takes a long time to traverse a given distance; headaches and dizziness are constant; a little reading tires him; his head is seldom clear, and heat makes him feel worse; temperature sense unimpaired; no bladder trouble until he attempted to work on the train, after the injury, and incontinence was thereby induced; no emaciation; at times very emotional, says his memory is impaired, and his sexual ability lost; cannot stand upon one leg, especially the right; sways when standing with eyes closed, and turns very pale during this test; perspiration bursts out on the face, and a few moments of this ordeal nauseates him to vomiting; his power of endurance is feeble; less sensitive to faradism and æsthesiomter tests in left arm than in right; both arms quantitatively reduced in faradic response, left more so, but the right leg was more affected in this respect than the left, which was also more easily influenced by the galvanic current, in the proportion of five milliampères, for the production of contraction in the left leg, to ten in the right,—a strength of current that would induce pain before motion.

Simulation was the defense of the railway company, but Evarts' good standing in the community, for uprightness in all his dealings, went far to support his statements of subjective conditions. Conscien-

tious employés of the road forfeited their positions because they testified for the plaintiff, and those who were willing to distort the truth were rewarded. The effects of such a policy would be to retain untrustworthy servants in preference to the honest ones, and a broader view would show that what might be temporarily gained by such a course would be more than counterbalanced by pernicious consequences in other respects. The jury awarded the highest verdict obtainable under Wisconsin customs,—$5000. At present writing, nearly a year afterward, his condition is about the same and aggravated by attempts to work pending the Supreme Court affirmation.

XVIII. *Fall from Platform. Severe Symptoms of Concussion at first, with Rapid Abatement. Result Unknown.*—A painter about twenty-five years old was under my care at the Alexian Hospital. He had fallen from his staging while at work, and dropped, about a story and a half, upon the lower spine and one side. He did not lose consciousness, grew worse, and was sleepless, emotional, hypochondriacal, and complained of numbness and formications; held his back stiffly; said that motion cost him suffering. Two weeks of rest in bed, drachm doses of fluid extract of ergot, and symptomatic treatment improved his condition so much that he declared himself recovered and left the hospital, when he was lost sight of. Page would have reported this case as cured, but relapses are too frequent to enable any such claim to be made.

XIX. *Fall from Car. Concussion, with Absence of Some Symptoms; Quantitative and Qualitative Electrical Reaction Derangements. Prognosis Uncertain. Health Impaired.*—Miss R., æt. 42, knocked unconscious in street-car accident, by which she was thrown into the street; knows nothing of where she was struck; two weeks confined to bed, with pain in back, head, and right arm; is more emotional since the accident; has a steady, dull pain in her back; sleep was disturbed at first, not so much recently; throbbing pains, at times, in head, but no headaches; appetite fair; sensitive to noises; sight blurs at times. Dynamometer—right, 18; left, 30. Tenderness in cervical and sacro-coccygeal regions; tendon reflexes normal; more numbness on right than left side; unable to work for six months; tries to do so, but fails; feels better in cold than in warm weather; faradic reaction less upon right side; galvanic right forearm flexor surface, C C 35 Barrett's cells, A C 30; right arm, C C = A C 35 cells; right hand, A C 30, C C 35; right crural nerve, C C = A C 30; left crural nerve too sensitive to test; left gastrocnemius gave contractions, C C = A C 30 cells.

XX. *General Concussion. Some Spinal Concussion and Cerebral Symptoms. Improved.*—P., æt. 25, in 1883, while asleep in a Pullman car his train collided with another, and he was with difficulty extricated

from the wreck; the passenger in the berth above him was killed, as well as many others. He was exceedingly emotional, complained of sleeplessness, pains, etc., especially in the back, but before a more thorough examination could be made the company paid him $12,000 and ended the suit. His irritability was excessive, even after the settlement. September, 1889, he is attending to business, but is a "damaged man." He has to exercise great care, and is easily fatigued; otherwise he is fairly well.

PART II.—CASES OF OTHER AUTHORS.

I. *Leyden's Instance of an Unjust Accusation of Simulation.**—The patient, Joseph Hoffmann, was aged about forty, of healthy family, and himself at all times vigorous and of sound physical constitution. On the second of March he was on a train which had an accident near one of the Alsatian forts (Bitsch). The patient was attending to the brakes of one of the wagons, which was thrown from the track and dragged about two hundred yards farther by the engine after derailment. The patient experienced a severe shock to his back, and was knocked about considerably in the brakeman's box. He was also struck on the head in some way unknown to him. He fainted, and some time after awoke, crawled out of the wagon, and made his way with some difficulty to the next station. He felt considerable pain under his left shoulder, which was swollen, and in the small of the back. At this time he noticed no paralysis, nor difficulty with bowels or bladder.

After treatment in the hospital for his external injuries, the patient noticed a weakness of his lower limbs, so great that he could hardly walk even short distances; at the same time there developed belt-like pains about the abdomen. There were other pains of different character, which remained constantly throughout his illness, while the weakness of his legs disappeared. The pain and distress were so great that the patient was compelled to give up his position and remain at home. The severe pain in the small of his back was increased by every movement, so that he could do no work, even within doors. In July, 1874, he was appointed superintendent of a gang of workmen at the building of a bridge, and was drenched through with rain. The following morning he awoke with a stiff neck and pains in the cervical part of the spinal column, which radiated toward his arms and returned in paroxysms of two or three minutes' duration. After some local treatment he improved sufficiently to consider himself capable of resuming his former position

* Ein Fall von Rückenmarkserschütterung durch Eisenbahnunfall (Railway Spine), von Dr. E. Leyden. Archiv f. Psychiatrie, viii, 1. Translation by Spitzka, Journal Neurology and Psychiatry, Aug. and Nov., 1884.

of brakeman, but was compelled to abandon it on account of weakness of his left arm and the aforesaid pains in the small of his back.

Various of the subjective signs of spinal disease now appeared in rapid succession; the paretic weakness of his legs increased to complete paralysis; sensation was not destroyed; there was local pain over the third and fourth dorsal vertebræ, and the well-known authority on spinal diseases, Leyden, diagnosticated a tumor of the cord as the probable trouble, and attributed it to the railroad concussion.

The electrical contractility of his leg-muscles, which at first had been exaggerated, later disappeared almost altogether. He died from exhaustion following the development of bed-sores, diarrhœa, and obstinate vomiting, on the fourth of April, 1876, his sufferings having lasted three years. The railroad physicians had repeatedly questioned the existence of an organic affection of the cord; the poor sufferer was repeatedly denounced as a simulator, subjected to repeated examinations, and even after his death the railroad officials and their medical agents with great reluctance admitted the justness of the claims of his family. In Leyden's book there is a plate showing the appearance of Hoffmann's spinal cord. A so-called perimeningeal neoplasm was found, consisting of a cheesy mass, which united the outer membrane of the cord, the dura mater, to the vertebral column. This new formation was regarded as the result of a chronic inflammation; it was one hundred and ninety millimetres in length, and perforated the dura at a point corresponding to the exit of the sixth dorsal-nerve pair.

Signs of inflammation of the cord itself were found, these being evidently of a secondary occurrence.

II. *From Erichsen. Concussion Symptoms, followed by Organic Disease.*—Case 28. General Shock. Symptoms of Spinal Concussion and Meningitis. Very Slow and Imperfect Recovery.—Mr. C. W. E., aged about fifty years, naturally a stout, very healthy man, weighing nearly seventeen stone, a widower, of very active habits, mentally and bodily, was in a railway collision on February 3, 1865. He was violently shaken to and fro, but received no bruise or any sign whatever of external injury. He was necessarily much alarmed at the time, but was able to proceed on his journey to London, a distance of seventy or eighty miles. On his arrival in town he felt shaken and confused, but went about some business, and did not lay up until a day or two afterward. He was then obliged to seek medical advice, and felt himself unable to attend to his business. He slowly got worse and more out of health; was obliged to have change of air and scene, and gradually, but not uninterruptedly, continued to get worse, until I saw him on March 26, 1866, nearly fourteen months after the accident. During this long period he had been under the care

of various medical men in different parts of the country, and had been most attentively and assiduously treated by Dr. Elkington, of Birmingham, and by several others, as Dr. Bell Fletcher, Dr. Gilchrist, Mr. Gamgee, Mr. Martin, etc. He had been most anxious to resume his business, which was of an important official character, and had made many attempts to do so, but invariably found himself quite unfit for it, and was most reluctantly compelled to relinquish it.

When I saw him at this time he was in the following state :—

He had lost about twenty pounds in weight, was weak, unable to walk a quarter of a mile, or to attend to any business. His friends and family stated that he was, in all respects, "an altered man." His digestion was impaired, and his pulse was never below 96.

He complained of loss of memory, so that he was often obliged to break off in the midst of a sentence, not being able to complete it, or to recollect what he had commenced saying. His thoughts were confused, and he could not concentrate his attention beyond a few minutes upon any one subject. If he attempted to read, he was obliged to lay aside the paper or book in a few minutes, as the letters became blurred and confused. If he tried to write, he often misspelt the commonest words, but he had no difficulty about figures. He was troubled with horrible dreams, and waked up frightened and confused.

His head was habitually hot and often flushed. He complained of a dull, confused sensation within it, and of loud noises, which were constant.

The hearing of the right ear was very dull. He could not hear the tick of an ordinary watch at a distance of six inches from it. The hearing of the left ear was normal; he could hear the tick at a distance of about twenty inches. Noises, especially of a loud, sudden, or clattering character, distressed him greatly. He could not bear the noise of his own children at play.

The vision of the left eye had been weak from childhood; that of the right, which had always been good, had become seriously impaired since the accident. He suffered from muscæ volitantes, and saw a fixed line or bar, vertical in direction, across the field of vision. He complained also of flashes, stars, and colored rings.

Light, even of ordinary day, was especially distressing to him. In fact, the eye was so irritable that he had an abhorrence of light. He habitually sat in a darkened room, and could not bear to look at artificial light, as of gas, candles, or fire. This intolerance of light gave a peculiarly frowning expression to his countenance. He knitted and depressed his brows in order to shade his eyes.

The senses of smell and taste seemed to be somewhat perverted. He

often thought that he smelled fetid odors, which were not appreciable to others, and he had lost his sense of taste to a great degree. He complained of a degree of numbness, and of "pins and needles" in the left arm and leg; also of pains in the left leg, and a feeling of tightness or constriction. All these symptoms were worst on first rising in the morning.

He walked with great difficulty, and seldom without the aid of a stick. Whilst going about a room he supported himself by taking hold of the articles of furniture that came in his way. He did not bring his feet together,—straddled in his gait; drew the left leg slowly behind the right, moved it stiffly, and kept the foot flat in walking, so that the heel caught the ground and the limb appeared to drag. He had much difficulty in going up and down stairs,—could not do so without support.

He could stand on the right leg, but if he attempted to do so on the left it immediately bent and gave way under him, so that he fell.

The spine was tender on pressure and on percussion at these points, viz., at lower cervical, in middle dorsal, and in lumbar regions. The pain in these situations was increased on moving the body in any direction, but especially in the antero-posterior. There was a degree of unnatural rigidity, of want of flexibility, about the spine, so that he could not bend the body: he could not stoop without falling forward.

On testing the irritability of the muscles by galvanism, it was found to be very markedly less in the left than in the right leg.

The genito-urinary organs were not affected. The urine was acid, and the bladder neither atonic nor unduly irritable.

The opinion that I gave in the case was to the effect that the patient had suffered from concussion of the spine; that secondary inflammatory action of a chronic character had been set up in the meninges of the cord; that there was partial paralysis of the left leg, probably dependent on structural disease of the cord itself, and that the presence of cerebral symptoms indicated the existence of an irritability of the brain and its membranes.

I saw the patient again on April 18, 1867, two and a half years after the accident. He then suffered much from pain in the head and in the cervical spine. He was subject to fits of continual depression, was generally nervous, and little fitted for his ordinary business. Memory was defective and ideas unconnected. The head felt hot; face had a somewhat heavy, expressionless look; pulse 96 to 98; digestion bad; urine phosphatic; left leg numb, with occasional darts of pain and sensation of "pins and needles." It was colder than right leg.

III. *From Erichsen. Severe and Somewhat Typical Concussion Symptoms, with Cerebral Complications.*—Case 29. General Shock. Con-

cussion of the Spine; Chronic Meningitis, Severe Symptoms. Slow and Incomplete Recovery.—The following case presents some very remarkable and unusual nervous phenomena, resulting from railway shock, which I will briefly relate to you:—

"March 1, 1865. Mr. D., a man of healthy constitution and active habits, aged thirty-three, was travelling in an 'express' (third class, with divided compartment), and was seated with his back to the engine. When near Doncaster, the train going about thirty miles an hour, ran into an engine standing on the line. He was thrown violently against the opposite side of the carriage, and then fell on the floor.

"*Immediate Effects.*—There was a swelling the size of an egg over the sacrum, severe pain in the lower part of the spine, which, on arriving at Edinburgh the same day, had extended up the whole back and into the head, producing giddiness and dimness of sight. There were tingling feelings in the limbs (particularly the left), great pain in the back and tenderness to the touch, sickness in the mornings, and lameness, continued for the first fortnight.

"The treatment adopted consisted of blisters and hot fomentations to the spine.

"The patient seemed to improve and the pain between the shoulders to lessen after these applications.

"28th. He was seen by an eminent surgeon, who ordered him to go about as much as possible, but to avoid cold. The result of this advice was that he found the whole of the symptoms much increased, with prostration and lameness.

"April 20th. Left for London, breaking journey for a week in Lancashire, greatly fatigued by journey. A discharge came on from the urethra; the lameness was much increased. He could not advance the left leg in front of the right, and there was great prostration."

I saw him, in consultation with Mr. Hewes, May 1, 1865, when I received the above account from the patient. He was then suffering from many of the "subjective" phenomena which are common to persons who have incurred a serious shock to the system. But, in addition to these, he presented the following somewhat peculiar and exceptional symptoms:—

1. An extreme difficulty in articulation, of the nature of a stammer or stutter of the most intense kind, so that it was extremely difficult to hold a continuous conversation with him. Although he had, previously to the accident, some impediment in his speech, this had been aggravated to the degree just mentioned, so as to constitute the most marked stutter that I have ever heard in an adult.

2. A very peculiar condition of the spine and the muscles of the back.

The spine was rigid—had lost its natural flexibility to antero-posterior as well as to lateral movement.

There was an extreme degree of sensibility of the skin of the back from the nape of the neck down to the loins. This sensibility extended for about four inches on either side of the spine. It was most intense between the shoulders.

This sensibility was both superficial and deep. The superficial or cutaneous sensibility was so marked that, on touching the skin lightly or on drawing the finger down it, the patient started forward as if he had been touched with a red-hot iron. There was also deep pain on pressure along the whole length of the spine, and on twisting or bending it in any direction.

Whenever the back was touched at these sensitive parts, the muscles were thrown into violent contraction so as to become rigid, and to be raised in strong relief, their outlines becoming clearly defined.

3. The patient's gait was most peculiar. He did not carry one leg before the other alternately in the ordinary manner of walking, but shuffled sideways, carrying the right leg in advance, and bringing up the left one after it by a series of short steps. He could alternate the action of the legs, but could not bring one leg in front of the other without twisting the whole body and turning, as on a pivot, on the leg that supported him. He could not bend the thigh on the abdomen.

I saw this patient several times during the summer and autumn. In the early part of December his condition was, as nearly as possible, the same as that which has been described in May. No change whatever in pain or in gait having taken place, there was not at this time, nor had there ever been, any signs of paralysis, but he complained of the sensation of a tight cord around the waist.

In addition to Mr. Hewes and myself, this patient was seen at different times by Sir W. Fergusson, Drs. Reynolds and Walshe. We all agreed that the patient was suffering from "concussion of the spine," and that his ultimate recovery was uncertain.

After the trial he was continuously under my care, and I saw him at intervals of about a month. He was treated by perfect rest, lying on a prone couch; by warm salt-water douches to the spine, for which purpose he resided at Brighton, and by full doses of the bromide of potassium. Under this treatment he considerably improved (May, 1866). The extreme sensibility of the back was materially lessened, and he could walk much better than he did. He also stammered less vehemently, but he still had considerable rigidity about the spine, could only walk with the aid of a stick, and retained that peculiar careworn, anxious, and aged look that is so very characteristic of those who have suffered from these injuries.

March 5, 1870, five years after the accident, this patient called on me. He looked pale, haggard, more than his real age. Had done no business since the trial. Still felt nervous when put to anything, however trivial. Still felt a want of power in left leg and hand, as if asleep or dead. Still had tenderness in lower dorsal and lumbar regions. His health was very variable; often he was unfit for any work.

IV. *From Erichsen. Concussion Symptoms; Probable Myelitis Later.*—Case 30. Railway Concussion. Slow Development of Symptoms. Partial Paralysis. Incomplete Recovery.—E. C., aged 47, a gentleman farmer, hale, hearty, athletic, and of active habits, received an injury in a railway collision on July 1, 1865; the carriage in which he was being upset, and he and his fellow-passengers thrown violently about. At the time he did not feel himself hurt, was able to creep out of the window and assist the other passengers, and then went on to Lowestoft, his destination. At night, however, he could not sleep, and this was the first symptom that attracted his attention. The next morning he felt stiff, and complained of creeping sensations up and down the back, and of unpleasant sensations, almost amounting to pain, in the head. By the middle of the day he was forced to recline on a couch, as he could scarcely sit up. He felt very unwell for several days. During this period he had sensations as if electric shocks were passing through the body and limbs. He returned home, continued to feel unpleasant sensations in his head, back, etc., being often giddy, but was still able to take a certain amount of exercise, and even to ride on horseback. He continued in this unsatisfactory state until August 12th, when he became suddenly extremely giddy and scarcely able to stand. His head became very confused, he could not attend to the business on which he was engaged, and seemed to have lost all energy and power. He continued to feel the electric shocks through the body. In November he began to suffer from an increasing difficulty about the lower extremities. He was obliged to leave off riding, as he had entirely lost both his grip and the powers of balancing himself. He also found that he walked with difficulty, and occasionally seemed to lose control over his legs. On November 29th, when getting up in the morning, he suddenly fell, and probably momentarily lost consciousness. He lost all power in his legs, and suffered intense pain in his head. As he was gradually getting worse, he came up to London, when I saw him on January 6th, in consultation with Mr. Calthrope.

At this time he was complaining of various symptoms referable to the head, such as loss of memory, inability to attend to business, difficulty in grasping a subject. There was general debility, incapacity for exertion; he was unable to ride, could scarcely walk, looked haggard and ill, and felt himself a perfect wreck. On examining the body I found

the following objective signs: There was flabbiness and wasting of the muscles of both the lower extremities and of the buttocks, the skin hanging loose. The left lower extremity was more shrunken than the right. The thigh at its middle was one inch smaller in circumference; the leg at the calf was three-fourths of an inch smaller than the right. There was a considerable diminution in the temperature of the limbs, especially of the left, which was very considerably colder than the right and the rest of the body.

The electric irritability of the muscles was very materially diminished in both lower extremities; it was nearly lost in the left leg below the knee. In the upper extremities it was extremely active, the difference being very striking. The pulse was quick, varying from 100 to 110, and weak, the beats intermittent twice in the minute. On January 26th there was no improvement; in fact, he was in more suffering, and had lost all power in the left leg. There was also a good deal of pain in the spine, in the upper dorsal and lumbar regions, more especially on the left side. It gave him pain both to lie and to sit on the left side. He could not rise from a recumbent position without assistance from one or two persons, and could not dress without help. During this period he suffered much from pain in the head and singing in the left ear. On April 27th I again saw him in consultation with Mr. Calthrope and Mr. Buller, when these symptoms were noted as continuing without any change. This state of things continued throughout the summer—the legs being cold and almost powerless; the pain in the head, the electric shocks, and inability to move remaining unaltered. On July 6th the symptoms continued without material change. He went to Yarmouth for change of air, but suffered intensely from the head, and derived no benefit. He continued under my observation for more than a twelve-month, and after the termination of the legal proceedings, on February 18, 1867, he went into the country. No material improvement took place in his condition for a very considerable length of time, and up to the present time there has been no recovery from the more serious symptoms. (Date of book, January, 1882.)

V. *From Erichsen. Concussion Symptoms, followed by Meningitis and Myelitis.*—Case 31. Railway Concussion. Injury to Cervical Spine; Meningitis. Permanent Injury. Paralysis and Irritation of Spinal Accessory, Musculo-Spiral, and Circumflex Nerves.—J. M. was injured in a railway accident on October 29, 1866. He suffered from the usual symptoms of spinal concussion, for which he was treated by Dr. Woodford, of Bow, with whom I saw the patient in consultation on November 30, 1867. At that time he presented three sets of symptoms of a very marked character, referable to the head, to the spine, and to the right arm. The

head symptoms consisted of an inability to concentrate his thoughts, and of loss of memory on many points.

In the course of conversation he "dropped," to use his own word, the thread of the discussion. There was a complete inaptitude for business. The spine was evidently the seat of very considerable mischief. It was rigid, moved as a whole when he was told to stoop, and was extremely painful on pressure and on movement in any direction, namely, in the lower cervical and in the middle and lower dorsal regions. The pain in this situation was described by the patient as being of a hot, burning character. From the seat of pain in the neck he suffered constant spasmodic pain shooting down the right arm and right side of the chest, with frequent cramps in the muscles of the arm. From the seat of pain in the dorsal region he complained of the sensation as of a cord being tightly bound round his body and pressing on his ribs. The right arm and hand had suffered considerably. There was great loss of muscular power in the limb, so that the patient was unable to hold it up in a horizontal position, or to support it extended for more than a few seconds. The grasp of this hand was much weakened, and considerably feebler than that of the left. The limb was wasted, more particularly below the elbow, where it was smaller than the left arm. The hand also was wasted, more especially about the muscles of the thumb. The patient complained of severe twitchings and spasmodic pains shooting down the forefinger and the thumb. The attitude of the patient was very remarkable; he stooped forward, and the right shoulder was raised about two inches higher than the left. This position was never changed. He suffered from severe spasmodic pains through the side of the neck and shoulder, and on examining the parts the trapezius and sterno-mastoid muscles were found extremely tense. The muscles that were chiefly wasted in the right arm were those which were supplied by the musculo-spiral nerve. These muscles had lost their electric irritability. The raising of the right shoulder was evidently due to irritation of the spinal accessory nerve, in consequence of which the trapezius was kept contracted, and the spasms that passed through it were due to this irritation.

The conclusions arrived at in connection with this case were that at the time of the accident there had been some concussion of the brain and of the spinal cord; that the brain was still suffering from the consequences of that concussion, but only to a slight degree; that the spinal cord had been severely injured; that there was evidence of chronic inflammation and irritation of it, these changes being seated in the meninges of the cord; that partial paralysis of the musculo-spiral nerve had already taken place; that the wasting of the limb and arm was dependent on the paralysis of this nerve; that in addition to the paralysis the

nerves of the brachial plexus were probably much irritated, as shown by the painful cramps that manifested themselves in the arm. The condition of the shoulder was due to spasm of the muscles supplied by the spinal accessory nerve. I saw the patient on February 12, 1868. In many respects he was then worse than when I had seen him in the previous December. He looked very ill; he suffered more than previously from twitchings in the neck and right arm. I found the paralysis of the right arm was more complete than it had been. He could not move the arm from the side, and the paralysis extended to the muscles about the shoulder, to those, in fact, that were supplied by the circumflex nerve. There was an utter absence of all electric irritability of the muscles supplied by the musculo-spiral and circumflex nerves. I saw him again on January 18, 1869, with Dr. Woodford. We found that he still suffered from irritation of the brain and spinal cord, the spine continuing to be rigid and painful; that the right shoulder was drawn up and displaced forward; that the right arm and hand were paralyzed so as to be absolutely useless for all practical purposes, and that the right leg had gradually become to a great extent powerless. By order of the Court of Queen's Bench he was seen on May 28, 1869, by Mr., now Sir James, Paget, who found that J. M. complained of constant pain in his back, extending across the shoulder and to the back of his head; of pains passing through his chest, and of pain round the chest as if he were being compressed; of aching down the right thigh as far as the heel. The right shoulder was always slightly raised, and he had occasionally involuntary twitchings of its muscles. The muscular power of the right shoulder and forearm was much decreased, and he was subject to frequent twitchings of the right lower limbs, which prevented his walking more than very short distances, or taking any active exercise. The manner of walking was slow and feeble. During the last two years he had wasted very much, and his skin and muscles felt soft and weak. The pulse varied from 40 to 50. His bowels and lower limbs felt unnaturally cold. He said that his appetite and digestion were always bad, that he never slept well, and that his memory was impaired.

On reference to these symptoms of injury which Mr. M. had suffered since October, 1866, it was the opinion of Sir James Paget, in which Dr. Woodford and I fully concurred, that there was no reason to think that his sufferings on the whole were materially decreasing, and there was no doubt that they were the consequence of severe injury to the spinal cord. We were further of opinion that he would never recover health as he had had it before the injury, or be again fit for the active business in which he had been engaged. On February 15, 1871, four and a half years after the accident, J. M. wrote to say that he still suffered

greatly. His arm was partially paralyzed; the thumb useless; his spine tender, and ached on movement or after exertion of any kind; his nights sleepless, and he was quite unfit for the ordinary business of life.

VI. *From Page. Concussion Symptoms. Unrecovered Four Years After the Injury.*—Case 1. S. W., æt. 46, a tall, somewhat powerful man, was in a very severe and destructive collision. He received bruises over both arms and legs, and also a blow upon the face which abraded the skin over, and fractured the bones of, his nose. He was not stunned. He lay for several days after the accident in a state of great nervous depression, with feeble and rapid pulse and inability to eat or sleep. He suffered at the same time much distress from the fact that a friend sitting beside him in a carriage had been killed; and this seemed to prey constantly upon his mind. The bodily injuries progressed rapidly toward recovery, and in seventeen days after the accident he was able to be moved home. Nine weeks after the accident he had fairly well recovered from his injuries, and made no complaint of bodily sufferings. The ordinary functions of the body were natural, but his mental condition showed extreme emotional disturbance. He complained that he had suffered continuously from depression of spirits, as if some great trouble were impending. He feels very upset at our visit and begins to cry. He says he used to cry whenever he spoke to any one, but that now he has rather more control. He has been out of doors for a few yards, but was stopped by a sudden sensation as if his breathing was very short. His voice is very weak and indistinct, and occasionally he says it is almost inaudible. There is no disease of the larynx or adjoining parts. He sleeps very badly, waking frequently, and being constantly troubled by distressing dreams. His pulse is weak, 104. He occupies himself by a little reading and by occasionally going out, but he feels so shaken and weak that he is unable to do anything more. In many respects, however, he is improving. The weight he lost is being regained. He can walk rather farther, is not so prone to cry, and his voice is stronger. Examination discovered no structural disease, but he was evidently in a most depressed and feeble state. Words, in fact, fail adequately to portray the distressing picture which this otherwise strong and healthy man presented. He remained in much the same condition for several months, though with undoubted tendency toward improvement. Fifteen months after the accident, several months, that is, after his claim had been settled, we learned that he was better, though yet very far from right, and he was considered wholly unfit for work. His history, given four years after the accident by his medical attendant, is as follows: "In my opinion he will never be anything like the same man again. His appearance is much altered. He looks much older, haggard, and has become very bald. His

voice is very weak, almost gone at times. For some time he went about in search of health, but improved very slowly, if at all. Lately he has obtained two posts, the work at which is of a very light nature. I just jotted down the following symptoms as he mentioned them, and I feel sure he would not wilfully exaggerate them. Very depressed spirits, sometimes palpitation, loss of sleep, bad dreams, very easily tired, can't walk more than two miles, then gets very tired and quite loses his voice. Did nothing for two years after the accident. Has lost all his energy. Sometimes has a great dread of impending evil. He *can* travel by railway without feeling nervous, but can't drive without feeling frightened all the time. I may add that his heart-sounds are rather feeble, but not otherwise abnormal. Pulse 72. No special spinal symptoms; no paralysis; no bladder symptoms; always gets much upset if dining in company or if many people are talking near him. I knew him well before the accident and he was a very energetic and very honorable man."

VII. *From Page. Concussion Symptoms. Not Fully Recovered, but Improved.*—Case 2. B. J., æt. 44, a thick-set, somewhat robust-looking man, was in a carriage which ran off the line when the train had just left a station, and which, after jolting along off the rails for a few yards, was turned over on its side. He says he was far more shaken—"terribly shaken" was his phrase—by the previous jolting than by the overthrowing of the carriage; and when he had got out his condition was that mentioned in the official report. On the following day he travelled home alone, presenting on arrival so dazed an appearance that his doctor was immediately sent for. When we saw him, ten days afterward, he was suffering from muscular pains, increased by movement, in various parts of the body, and due, no doubt, either to bruising or straining when the carriage had been jolted and overturned. He can hardly get any sleep, having before his mind a constant *fear* of the railway accident, and he becomes occasionally "light-headed" at night. He is lying in bed with his eyes closed and the blinds down, complaining that he dreads the light. He gets very low-spirited, and frets about his business, the thought of which pains his head. He is much alarmed at the pains which he suffers, says he is afraid to move on account of them, and that he fears he has received internal injury. The bowels are confined. His temperature is 99° F., and his pulse is 102. Notwithstanding his expressions of fear, he was able to sit up in bed without sign of suffering, and in talking he moved his head naturally from side to side. He very soon also seemed quite content to have the blind drawn up, and gradually opened his eyes. There was no evidence of his having received any bodily injury other than muscular bruising and strain, and his condition was regarded by all who saw him essentially as one of general nervous

shock likely to pass away after a time. We saw him again in two months. He had then a somewhat worn and anxious expression, but said he was better, his "nervousness" being not so great as it was. He complains of being easily upset and startled, and that, when thus startled and upset, there comes on a sharp pain in the head. The muscular pains are better, that which still troubles him most being a pain in the muscles of the left side of the neck. He sleeps better, though he occasionally has disturbed nights. He could walk two or three miles perhaps, but would be very fatigued. His pulse is 100. He had evidently much improved, and it was advised that after further change he should begin his work. Several weeks more elapsed, and we then found him neither looking nor feeling so well as before. He was very nervous about himself, feeling unable to do his work, depressed and melancholy, and losing heart from the thought that he would never get well. He had been attending to his business for two or three hours a day, and the anxieties of it were very distressing to him. He was, moreover, very anxious to arrange his pecuniary claims for compensation, as both he and his doctors felt that that was now beginning to prey upon his mind. In bodily health he seemed well. Eighteen months after his claim was settled, we again had the opportunity of seeing him. He was then in perfect bodily health, able to follow his occupation as usual, and to endure as much physical exertion without fatigue as before the accident. He could not, however, remain so long at his desk without feeling worried, and from his wife we learned that he was more irritable than he used to be. In these respects, nevertheless, he was admittedly improving, and he himself felt confident that before long he would be absolutely well.

VIII. *From Page. Collision. General Concussion. Death on Thirty-seventh Day. No Lesions Found Post-mortem.*—A man forty years of age, of exceedingly delicate physique, who was in a collision at night. The accident was a slight one, and he was the only passenger injured. He was said, in the official report, to be "violently shaken," but he was able to go on home. The next day he was delirious, and on the third day he was still talking somewhat incoherently. He complained of being much shaken and of feeling seriously injured, but there was no evidence discoverable of bodily hurt. He improved for a time, and his condition was not thought to be serious. He never seemed, however, to make any marked progress, and four weeks after the accident he became more prostrate, and greater anxiety was felt about him. From this time he gradually got weaker and weaker, and died on the thirty-seventh day. No organic disease whatever was found on post-mortem examination in any of the viscera. The lungs were greatly congested and the cavities of the heart were distended with blood, as if death had occurred from failure of respiration and circulation.

IX. *From Putnam.* Railway Accident. Spinal Injury, with Concussion Symptoms. Unrecovered.*—Case 1. The patient, who was a man of between fifty and sixty, of previously good health in all essential respects, and formerly an officer in the army, was travelling at the time of the accident on a railway in Massachusetts. When near a certain station, the engine with one or more cars, in one of which the patient sat, was, as usual, uncoupled from the rest and allowed to run ahead in order that the rear half of the train might be switched on to another track.

Unfortunately, the brakeman failed to disconnect the bell-rope, and by the time the two parts of the train had separated to the extent of ten or twelve feet the rope was stretched taut, giving the proper signal for stopping the engine, which the engineer at once obeyed. The rear part of the train continued its course, and struck the fore part with sufficient momentum to damage the platforms and break some of the glass in the cars.

The patient, who was sitting with his face to the engine, was jerked forward, then back, and finally slid down between the seats, striking and scraping his back with some force against the edge of his own seat, the cushion of which had been displaced.

He was helped out by a bystander, who said to him, "Friend, are you hurt?" to which he replied that his back hurt him very much.

He was, however, able to complete his journey, under some distress, performed some business, and returned in the evening to his home, near Boston, but in the course of the afternoon was nauseated and vomited.

For nearly three weeks he kept about his work, but from the day of the accident he was a changed man.

From being cheerful and active, he became listless, gloomy, dispirited, and emotional, bursting frequently into tears, and at night he was restless and delirious.

The secretion of urine was greatly diminished, and it was passed often but once a day. The hands and feet were perpetually cold, and his physician, Dr. Blood, of Charlestown, through whose kindness I was able to examine the patient later, found his pulse habitually about 60, and his temperature ranging from 97° F. to 98° F.

Before the end of three weeks his distress had increased so much that he was obliged to take to his bed, and when I saw him, a few days later, he was the very picture of prostration and misery,—pale, nervous, excited, with large and almost irresponsive pupils and drooping lids, the skin cool, and the heart's action feeble. He whispered to me that he had not had an erection since his illness began, and there is good reason to

* American Journal of Neurology and Psychiatry, August and November, 1884.

think that this condition has remained unchanged up to the present time, —an interval of a year and a half.

The sensibility of the skin was found notably diminished at that time over all four extremities, and, in fact, everywhere that it was tested. Pain and distressing sensations in the back were constantly present. The patient was seen soon afterward by Drs. S. G. Webber and C. B. Porter, and by all of us, subsequently, a number of times.

It is unnecessary to describe in detail the further progress of the case; suffice it to say that the patient became at first paraplegic; then, after some months, hemiparaplegic, the motions of the right leg remaining absolutely abolished, even those at the hip-joint.

It was also soon discovered that the loss of sensation had shown the same tendency with the loss of motion to concentrate itself upon one-half of the body, and the case assumed in this respect the appearance of a typical hemianæsthesia.

The special senses were all involved in this impairment, and the hearing was diminished for bone-conduction as well as for air-conduction (*vide* above). All these symptoms, even including some degree of impairment of emotional self-control, remained nearly unchanged up to the time of the trial, *i.e.*, through an interval of nearly a year and a half.

X. *From Putnam. Concussion Symptoms in a Neurotic Person following upon a Railway Accident.*—Case 2 is, in outline, as follows: The patient, who was highly neurotic by temperament and by inheritance, was thrown forward, in consequence of a moderate shock of the railway-car in which he was riding, so as to strike the right side of the abdomen upon the seat in front. No symptoms showed themselves for two weeks, when the legs became suddenly paretic. After a few weeks more the left leg had improved very much, while the right became suddenly entirely helpless, even at the hip-joint. Patient came to the Massachusetts General Hospital, Out-Patient Department, several months later, complaining, besides the paralysis, of abnormal sensations throughout the entire right side.

There was diminished sensibility to deep pricking over the right leg and thigh, but not over the rest of the right side. The field of vision of the right eye was materially contracted, and the hearing of the right ear diminished to both air- and bone- conduction. The deep and superficial reflexes seemed less on the right side than the left. The mental condition and general nutrition appeared to be normal.

XI. *From Putnam. Crushing of Body, with Nervous Impairment resulting.*—Case 3. An Irish laborer was crushed, seven months before applying at the Massachusetts General Hospital, between a cart and a post, getting several ribs broken and receiving various bruises. Is easily

fatigued by slight exertion, and annoyed by trembling of hands. The examination made was not thorough, partly because of want of intelligence on the patient's part, but it is evident that sensibility to deep pricking is diminished over the entire left half of the body.

XII. *From Knapp.** *Fall on Back. Concussion Symptoms. Some Improvement.*—I. Jeremiah C., 37, M., railway employé, consulted me in March, 1887. A year and a half before he was knocked off a cable-car, striking his back and losing consciousness. On return of consciousness he went back to work, and kept at it for an hour or two, but afterward he was laid up for seven weeks. Now he has pain in the back, especially on motion, with rigidity of the spine and lumbar tenderness. His arms feel helpless; he has numbness and tingling in the hands, and at times in the legs; the legs are not as strong, and he has had cramps in them. Occasional vertigo and rush of blood to the head. Nervous, fretful, low-spirited, and poor memory; some vesical tenesmus and loss of sexual power. Some improvement under faradism and the actual cautery.

XIII. *From Knapp. Fall down Stairs. Concussion Symptoms.*—II. John D., 30, M., organ-finisher, consulted me in February, 1888. Fell down stairs a month ago, striking small of back and buttocks. Great pain in the back. Diminished power in left leg. He cannot bend his spine, and has great tenderness in the lumbar region. He has a desire to empty his bladder most of the time, and when he passes water he thinks he is through before he really is, occasionally wetting himself. No sexual power since the accident. Quite nervous and rather alarmed as to his condition. Knee-jerks rather quickened, a tap setting up a general shrinking, as if from pain.

XIV. *Fall from a Mast. Concussion Symptoms.*—III. Martin H., 46, M., draw-tender. Referred to me at the Boston Dispensary in August, 1886. Two years ago fell from a mast, thirty-six feet, striking back. Since then has had sharp pains in the back and abdomen, shooting down the legs. The legs are easily fatigued, feel numb and prickly, and as if a pad were between them and the floor. "Drawing" girdle sensation. Twisting or bending the spine or riding in the cars is painful. Faint spells and vertigo. Severe headache at times. Nervous, low-spirited, and a poor sleeper. Short breath, palpitation, and a "drawing" feeling in the stomach. Poor appetite and digestion. Arms feel numb, and fingers feel as if asleep. Diminished sensation in arms and legs, and some tenderness of nerve-trunks in legs. Lumbar spine flat, slight lateral curvature to the right; tender below tenth dorsal vertebra, the tenderness being greater by the sides of the spinous processes. Reflexes and electrical reactions normal. No ataxia.

* Boston Medical and Surgical Journal, November 1st and 8th, 1888.

XV. *From Knapp. Fall from Ladder. Concussion Symptoms. Improvement.*—IV. Bateman C., 59, M., electrician. January, 1886. Some months before he fell from a ladder, striking on his buttocks. No loss of consciousness. Nausea and vomiting till two months ago. Costive. Since accident, loss of power and prickly throbbing in legs, worse in right leg, which has wasted. Legs at times feel hot or cold, both subjectively and objectively. No distinct pain in legs. Water had to be drawn for a week after his fall. A month ago fell, rupturing a vessel in his knee, and the knee had to be aspirated. Right leg two inches smaller; marked diminution of sensibility. Muscles of thigh do not react to either current on right and very feebly to strong galvanic current on left. Much fibrillary contraction of right quadriceps. Distinct gain under galvanism, with improvement in strength and sensation in legs; has decided pain in them.

XVI. *From Knapp. Nervous Symptoms, resembling those of Concussion, after a Stab in Abdomen and Peritonitis.*—V. Jeremiah O'D., 50, M., carpenter, consulted me in August, 1885, being anxious to get a pension on account of his disability. Was stabbed in the abdomen in 1865, and had peritonitis after it. In 1870 the Pension Board rejected his application, thinking his hemiparesis was the result of apoplexy, but he denies any history of apoplexy. On recovery from the peritonitis the left leg began to be weak, and he had pain and stiffness in the left hip. He could not walk without staggering and getting exhausted. Hard to lift left leg up stairs. Severe pain in left side and abdomen and left side of head. Depressed, poor memory, slight mental impairment, vertigo, and diplopia; some tinnitus. Numbness gradually developed over his entire left side, less marked in the hands and feet, but amounting in some places to absolute anæsthesia and analgesia. Tingling and prickling on left side. Smell impaired. Poor vision in left eye from cataract; field not contracted. Taste poor on left; hearing worse on left. Diminished tactile sensibility over entire left side; left arm a little smaller and weaker. Cannot put left leg into a chair without great effort. Sways with eyes shut. Knee-jerk and cremaster reflex most marked on right; knee-jerk weak. Speech rather indistinct. Slight tenderness over left posterior tibial. March, 1888, question of pension still pending. Has not improved since 1885. Symptoms much the same. Still has anæsthesia, which is most marked on the left, although tactile sensibility is blunted on the right. Considerable difficulty in walking; drags left foot. Trouble in locomotion increased on trying to make any quick movement.

XVII. *From Knapp. Fall on Ice. Previously Neurotic. Concussion Symptoms.*—VI. Susan W., 46, M. December, 1886. Neurotic taint. Fell on the ice last winter, striking left hip and elbow, and causing hernia.

Now the slightest effort causes pain across the chest and in the back. Lifting causes a "hot water" feeling in the hernia. Very severe headache, impaired vision, and increase of deafness in left ear. Tinnitus. Short breath and pleuritic stitch. Weak stomach; very costive; frequent micturition. Considerable pain in the arms. Numb feeling on left side; the left hand and foot get cold readily. Staggers on walking, and the left leg gives out. Cramps in the legs; numbness, prickling, and pain in the left leg. Great spinal tenderness; tender over stomach and lower ribs on each side; tender over left ulnar, sciatic, and posterior tibial nerves. Diminished sensibility in left ulnar region, over left chest, and on outer side of left leg. Electrical reactions normal. Knee-jerks exaggerated; front-tap contraction. Eyes and ears not examined. March, 1888, worse since last seen. Pain in left side and back; prickly feeling all over body. Much vertigo. Pain in right foot. Poor vision. Very nervous. At times has much trouble in passing water. Troubled greatly with leucorrhœa and piles. Field of vision good; *von*, 20–50. Fundus normal. Cannot hear watch with either ear or through bone. Marked opacity of membrana tympani. Cannot stand with eyes shut. Slight tremor of hands. Extreme spinal tenderness.

XVIII. *From Knapp. Fall down Embankment. Concussion Symptoms. Some Improvement.*—VII. Annie S., 45, M. Seen in consultation, February, 1886, with Dr. E. S. Boland, who has reported the case in full.* Not neurotic. Two years before she was thrown down an embankment by the sudden starting of a train, and had recovered damages, although the case was still in dispute. Much pain in head and lumbar region, and considerable vertigo. Sleeps poorly, and has a poor memory. Poor appetite; very costive. Has had jaundice since the accident. At one time had xanthopsia, at another melanopsia. Menses irregular and painful. Urine scanty. Wets and soils herself at times. Very marked anæsthesia over whole body, with analgesia. Some sensation in tip of nose, left ulnar region, and right cheek. All muscular efforts slow and weak. Cannot stand without support. Muscles do not react well to faradism. Knee-jerks weak. Field of vision contracted, especially in right eye; *vod*, can count fingers; *vos*, 2–20; monocular diplopia, *od*. Pupils react sluggishly to light. Loss of smell and taste. Hearing to watch, contact *ad*, four inches *ar*. Gained under treatment for three months. Later, right ankle became weak. When last heard from, in December, 1887, she was still far from well, being quite lame, and having much pain in her back.

XIX. *From Knapp. Fall on Head, with some Spinal Involvement.*

* E. S. Boland, Symptoms following Injury to the Head and Back. Boston Medical and Surgical Journal, November 10, 1887.

Not a Typical Case of Spinal Concussion.—VIII. Charles L., 14, S., school-boy. Referred to me by Dr. Cutter, of Leominster, in May, 1886. Nervous heredity. Posthumous child. Always nervous and irritable. Had convulsions in infancy. Six years ago fell from a bridge, striking forehead. Signs of shock after it. "Shoulders drew up and spine got crooked." Delirious after fall and very nervous since. Said to have lateral curvature, but it was not detected. Three years ago eyes began to trouble him, with dim vision and pain. Much headache; irritable, surly, and heedless. Poor appetite; chronic diarrhœa. Palpitation. Passes much urine. Rheumatic fever a year ago. Muscles weak. Pain in legs, with numbness and prickling in hands and arms. Fell again last fall, striking head. Worse since then, and has had two attacks; in one, unconscious, rigid, trembled, and screamed; sleepy after it. Two attacks of aphonia. Left leg said to draw up at times. Very fat. Field of vision normal: *vod*, 20–20; *vos*, 20–100; astigmatism of 4 D, *os*. Quite tender over spine and more or less tender all over. Smell, taste, and hearing normal. Slight diminution of electrical sensibility on left. Knee-jerks only on reinforcement. In June, 1888, reported to have had chorea, and after that to have had an increase of all his symptoms, with one or two more attacks.

XX. *From Knapp. Thrown from Wagon. Concussion Symptoms.*—X. Charles C., 61, W., machinist. June, 1887. No special taint. Eighteen months ago he was thrown from a wagon, and was unconscious for six hours and a half after it. No external injury or fracture. Hot-water bottles were put to his feet, burning them so badly that he was kept in bed for four months. On getting about, his shoulders and right leg began to feel heavy, and his arms ached. His head has felt sore, and he has had sharp pains in it. Discouraged, low-spirited, and irritable, but mental power is not impaired. Short breath, poor appetite, constipation. Prickly aching and burning in the arms, which feel weak and heavy. The right leg feels numb and prickly, and both legs ache. He has pain and a hollow feeling in the back, which hinder his walking; says he is growing worse. Marked myopic astigmatism; field of vision normal. Fibrillary tremor of tongue. It hurts him in the lower dorsal region to bend his spine, but it is not tender. Some inco-ordination of the left arm, and a little tremor of the hands. Speech a little thick. Epigastric reflex present only on left. Triceps, radial, ulnar, and patellar reflexes exaggerated. Slight patellar clonus; front-tap contraction.

March, 1888. Condition not improved. Complains greatly of his back, and of inability to use his arms well; numbness of both legs. No inco-ordination of hand. Reflexes exaggerated. No consciousness of events immediately preceding accident. Was thrown from a carriage

fifteen years ago, and after that had some stiffness of left arm, which recovered. A year before his last accident, however, this arm had been rather weak.

XXI. *From Knapp. Struck by Machinery. Concussion Symptoms. Death in a Year afterward.*—XI. Dennis B., 37, M., printer. Referred to me by Dr. Post, in August, 1885. In January, 1885, was struck by shafting, the right side being most injured. Right instep and right little finger broken; right thigh and leg much bruised. Laid up until May. Two weeks ago tried to go to work on a hot day, worked an hour and a half, and had to go to bed. Memory began to fail after injury, and he has had constant, severe headache ever since. Has vertigo so badly that his wife is afraid to let him go out alone. Forgetful since his injury. Very restless at night; much more irritable and excitable. Considerable diplopia. Slight palpitation and shortness of breath. Poor appetite, some vomiting. At times has to wait before he can pass water, and at times the stream stops. Cannot close right hand as well. Frequent and severe pain in right leg after using it, and constant numbness and prickling. Right leg weaker, somewhat wasted, and is easily fatigued. After his attempt to go to work, was in bed for a week; headache and vertigo much worse, felt dazed, and has been more or less confused; had constant nausea and vomiting for a week. Field of vision good: *vod*, 20–20; *vos*, 20–30; left disk paler. Some weakness of external recti, with nystagmus on excursion outward. Other senses and tactile sensibility unimpaired. Arms strong, no inco-ordination, some tremor of hands. Right leg smaller than left, vastus internus does not react to faradism, lower leg-muscles require a stronger current than on left. Nerve-trunks in right leg rather tender. Reflexes normal. About a year later the man died. There was no autopsy.

(This preceding case and another which Knapp describes, where peripheral injuries occurred, the arm and thigh being broken, and a nervous, unstable disposition followed, are cited to show that Erichsen's claim, of the nervous system escaping, as a rule, where bone fractures occur, is not without exceptions.)

XXII. *Outlines of Oppenheim's Cases.*—I. Derailment.—Headaches, insomnia, vertigo, fainting-spells, pain in left side and back, considerable concentric-vision contraction; analgesia general except tips of fingers, and also a zone in lower part of back which was hyperæsthetic; girdle pains, speech disturbance, general motor weakness, impotence.

Improved in several symptoms, but general condition worse. Death from unknown causes.

XXIII.—II. Derailment. Struck against Back.—Back pain lumbar and left head regions, flickering sight, vision-field contracted left eye;

hearing diminished left ear; mental disturbance, emotional, irritable; constriction feeling in chest; peculiar walk disturbance; could walk backward better than forward; general motor debility, especially in left leg; tremors, inco-ordination, swaying symptom; anæsthesia outer thigh surfaces. Improved.

XXIV.—III. Derailment.—Back pain, and in sacral region, tenderness of spine, rigidity of spine in all movements, walking disturbance considerable, micturition difficult; excitement and walking increased difficulties, would tremble when making motions or when excited; pulse increased, irritable heart; emotional.

No improvement.

XXV.—IV. Derailment. Struck Head and Sacral Region. Emotional Shock.—Mental derangement, very hypochondriacal, great irritability, peculiar speech disturbance, tremulous and unable to write owing to tremor, hyperæsthesia in dorsal region, tenderness of spine, pulse increase, pseudo-spastic walk disturbance, scalp analgesia, contraction of color vision.

Chronic condition, with very few remissions. Treatment unavailing.

XXVI.—V. Railway Collision.—Pain in back, chest, and back of head, tender spine, ill-humored, in a constant state of fright, irritable, myosis, and no light reflex left eye, rigid trunk during motion, motions difficult, tremors, increased tendon reflex, decreased skin reflexes, frequent micturition and small quantities voided; anæsthesia, left half of body, with inconstant anæsthesia of the right side; considerable concentric-vision contraction, decreased central sight, achromatopsia, impaired special senses.

Condition chronic and progressive.

XXVII.—VI. Derailment.—Despondency, easily frightened, pain in head and back, concentric-vision contraction and decreased central contraction; impaired hearing, smelling, and tasting, both sides; anæsthesia of entire body except small, distinctly outlined areas, tremors, walk difficulty.

No improvement while in hospital. Considerable improvement after the settlement of the damage claim.

XXVIII.—VII. Railway Accident. No Injury, but a Terrible Fright.—Despondency, terrors, insomnia, loss of mental continuity, epilepsy, sensibility and special senses impaired, pulse-range from 120 to 140 continuously, and, in the course of the disease, heart enlargement; trouble evidently increased by the legal proceedings. Predisposed by arterial sclerosis.

(There are no exclusively spinal-concussion symptoms in this case. —S. V. C.).

XXIX.—VIII. Railway Collision. Slight External Bruise.—Headache, vertigo, girdle constriction, despondency, nervousness, insomnia, fright tendency, decreased intelligence, mental debility, micturition difficult, hyperæsthesia in lower part of back; motor defects, especially in right extremities; sensibility diminished, special senses right side impaired.

No improvement after claim settlement and years of observation.

XXX.—IX. Railway Accident. Blow to Back and Head.—Headache, vertigo, pain in back, tinnitus aurium, cries easily, terror spells and emotional disturbance, impotency, urine retention, pupil contraction-reflex lost, inequality of pupillary sizes, concentric-vision decrease, taste diminished, hearing impaired, wide-spread sensibility disturbance with peculiar distribution, general activity lessened, walks with difficulty, increased tendon reflexes.

Better in some symptoms, otherwise the condition is stationary.

XXXI.—X. Railway Accident. Contusion to Back of Head.—Despondency, frights frequent, decreased intelligence, vertigo, fainting attacks, concentric right-eye vision contraction and atrophy of the optic nerve of the same eye, left contraction color-field vision, sensibility disturbance over large body area, speech difficulty, tremors, activity lessened, impotency.

Gradually grew worse, sight difficulty increased.

XXXII.—XI. Railway Collision.—Mental derangement, vertigo, peculiar speech and motor disturbances, scalp anæsthesia, febrile attacks.

Improved in hospital. Remissions later.

XXXIII.—XII. Derailment.—Pain in lumbar region, increased pulse, fright condition, pupillary differences, anomalies of sensation.

No improvement.

XXXIV.—XIII. Fall from Locomotive in Motion.—Despondency, irritability, fright, dreams much, insomnia, pain in right thorax, light functional disturbances of the special senses, anæsthetic zone in right thoracic region, vertiginous attacks, abnormal irritability of heart and nervous system, nervous heart palpitations.

No improvement.

XXXV.—XIV. Fall from Train, Striking Head and Right Side of Body.—Mental disturbance and weakness, vertigo, right hemiparesis not involving cranial nerves, right extremities decreased in size of muscles, right hemianæsthesia, also including special senses (but not continuously distributed).

Chronic stationary condition.

XXXVI.—XV. Fall upon Head from a Horse.—Attacks of unconsciousness with aura, preceded by hallucinations and paroxysms of

bewilderment and fright; sensibility disturbance widespread, also special senses impaired, headache, and vomiting.

Unimproved when discharged from the hospital, and but very little improvement afterward.

XXXVII.—XVI. Hit on Head with a Club.—Timidity, startlings, easily frightened, peculiar gait, anæsthesia and sensory disturbances, memory failure.

Worse at first, two years stationary, and subsequently improved.

XXXVIII.—XVII. Bruise of Left Half of Head and Shoulder through Fall of a Beam.—Stupidity of a few weeks' duration, loss of energy, vertigo, attacks of loss of consciousness, weakness, and tremors, chiefly in the left extremities; loss of sensation, indisposition, left hemiparesis, without involving facial and hypoglossal nerves; tremors, speech disturbance, difficult micturition, left hemianæsthesia, including special senses; photophobia, blepharoclonus.

Under observation but a short while.

XXXIX.—XVIII. Hurt by Machine Belt; Thrown against Ceiling; Considerable Fright.—Progressive dementia, epileptic attacks, headache, dizziness.

Discharged from hospital unimproved.

XL.—XIX. Fall upon Left Side from a Telegraph Post.—Mental disturbance; left hemiparesis, leg more affected, facial and hypoglossal not included; left hemianæsthesia, including special senses; left pupil larger than right, diminished skin reflexes left side, vasomotor disturbances involving affected muscle-substance, tremors, heart enlargement, pulse increase.

Improvement in several symptoms, others worse. At present no improvement.

XLI.—XX. Right Side of Head and Face Burned through Gas Explosion.—Headache, disturbance of hearing, fright condition, insomnia, paræsthesia in right half of body, sudden paralysis of right side, excluding facial and hypoglossal nerves; right hemianæsthesia, double-sided sensory disturbances.

Improved.

(From such instances it appears that *some* of the symptoms pertaining to spinal concussion may be induced by fright or by other causes.—S. V. C.)

XLII.—XXI. Body Squeezed between Car-buffers.—Hypochondriacal, hysterical attacks; difficult walk, girdle sensation, frequent desire to micturate, peculiar anæsthetic distribution, vision contraction, light hypnotic condition when eyes are closed.

Improvement. No damage claim.

XLIII.—XXII. Struck in Back by Rotating Machine.—Mental alteration, persistent tenseness of lumbar muscles, difficulty in walking, tremors of extremities increased to shaking spasms; difficult passive movements in lower extremities and increased tendon reflexes, a peculiar condition of patient when he rises from the floor; scalp analgesia, abnormal heart irritability, speech difficulty.

No improvement.

XLIV.—XXIII. Fall upon Left Side on Even Ground. Parents were Cousins. Pigmented Retinitis.—Mental alterations, apathy, depression, irritability, easily frightened, analgesia of entire body, left side total hemianæsthesia, left optic amaurosis, right decided vision contraction; both sides sensory functions involved; left hemiparesis, more evident in leg; peculiar walk disturbance, left paradox phenomena; anorexia, not continuous; hypnotic conditions.

Improvement of paralysis after excision of small portion of muscle from left extremities, considerable spread of anæsthesia, incontinence of urine and fæces; mental alteration, ending in paranoia. Phthisis and death. No damage claim.

Post-mortem: Gross appearances of nervous system afforded negative results.

XLV.—XXIV. Fall of Brick upon the Back. Contusion.—Hypochondria, melancholic, emaciation, tenderness over several dorsal spines, extremities weak, increased tendon reflexes, sensibility disturbances, persistent pulse rapidity.

Difficulties increased. Arterial sclerosis and cardiac hypertrophy.

XLVI.—XXV. Fall on Back of Head from a Ladder.—Vertigo, insomnia, headaches, depression, palpitation and fright conditions, pulse increase constant, heart action rapid, diastolic heart-murmur and friction sounds.

No marked improvement.

XLVII.—XXVI. Head and Face Injury from Fall of a Lantern.—Fright condition, night terrors, severe tremors, vertiginous sensations, swaying symptom.

Under observation but a short time.

XLVIII.—XXVII. Injury of Right Foot caused by Falling of Rail. External Wound and Swelling of Joints.—Constant pain, most severe when moving; cyanosis of skin up to and involving leg, œdema; weakness and tremor of right leg and arm, but less severe in the latter; right-sided hyperæsthesia without special sense inclusion, walk disturbance.

Slight improvement.

XLIX.—XXVIII. Severe Injury of Left Hand by Machinery.—

After half a year there was pain in the ulnar-nerve distribution; flickering in sight of left eye; hyperæsthesia in the vicinity of the scar; slight contractions of the third, fourth, and fifth fingers of the left hand; vasomotor disturbances, mental disturbances, increased reflexes, especially in left extremities.

Improvement through local bathing and resection of peripheral nerves, with subsequent increase of nervousness.

L.—XXIX. Machine Injury. Concussion of Right Arm, and Fright.—Flabby paresis and anæsthesia of right arm; mental anomalies, probably pre-existent; vasomotor disturbances and right-pupil dilatation.

No marked improvement. Case not followed.

LI.—XXX. Injury which caused Fracture of the Left Arm.—Epileptic mental condition prior to injury; pain, swelling, and weakness of left leg; attacks of unconsciousness and fright; insomnia; cramp in left arm; paræsthesia left side, excluding the f. and h. nerves, probably of cerebral origin; œdema of left leg; hyperæsthesia of left side, including the special senses.

Improvement. No claim made.

LII.—XXXI. Contusion of Right Hip.—Pains in joints and vicinity; hyperæsthesia of skin around joint; sensation loss in right leg, extending to abdomen; coxalgic difficulty in walking; right pupil larger than left; right vision contracted; slight atrophy of right leg and decreased electrical contractility.

Not heard from after discharge from hospital.

LIII.—XXXII. Factory Injury. Severe Concussion of Left Arm.—At first there was severe pain, especially in the left arm and fingers; later, contractions of left hand and fingers, cyanosis of skin, subnormal temperature; increase of electrical resistance of the skin; left-arm weakness; paralysis of left hand and fingers; glove-shaped anæsthesia; decrease of electrical response; microscopic proof of change of muscle-substance; left pupil larger than right; headache, left-sided.

Very little improvement at present.

LIV.—XXXIII. Severe Injury of Right Hand by a Millstone.—After healing of the wound in seven months, there were paræsthesia in the right side of the body, general nervous prostration, an epileptogenic zone, and aura starting from the scar, with spasms, absence of pupil reflexes, speech disturbance, right hemiparesis, right vision contraction.

Improved by compression of arm and extirpation of scar, but following this a psychosis developed. Healing was attended by a remission of all the symptoms.

CHAPTER VII.

TRAUMATIC INSANITY.

THE frequent allusion, in the German literature, to mental derangements following upon injuries leads me to reproduce here an article on the subject of insanity, caused by more direct and uncomplicated injury to the brain, which I published in the *Alienist and Neurologist*, July, 1888. The grosser and undisputable paralyses, or other bodily disabilities consequent upon head hurts, described in the average surgical works, need not be dwelt upon here, as tyros in both medicine and law are familiar with them; but, as in American colleges of medicine very little attention has been paid to mental diseases, in spite of the strides study in this field has made in Europe in the past twenty years, this review of the present *status* of head-injury insanity appears to be particularly necessary in determining differences between primary and secondary brain involvement, or the mind alterations peculiar to spinal-concussion cases, and how far direct brain injury may differ from the indirect.

Head injuries do not invariably produce mental disease, but when insanity results there are, in most cases, peculiar symptoms constant enough to justify the designation of Skae,* "Traumatic Insanity," which has been adopted by Krafft-Ebing,† Spitzka,‡ and the other leading psychiatrical authors.

There are important medico-legal bearings that should induce the scientific physician to accord the traumatic etiology a just consideration, even where the malady did not, upon superficial observation, appear to otherwise differ from the ordinary epilepsies, paranoias, paretic dementias, etc., which, as sequelæ, are often prominent, but which are, as a rule, modified by the traumatism markedly.

* London Journal of Mental Science, vol. xx.
† Lehrbuch der Psychiatrie.
‡ Insanity, its Diagnosis and Treatment.

Closer attention to such cases will reveal the impure nature of insanity improperly classified under other than the traumatic name when head injury figures as the cause. Many of the perplexing "mixed cases" in asylums can thus be satisfactorily accounted for, such as present first one fairly-defined psychosis and then another, or blend two or more forms, aside from katatonia and circular insanity.

The mental ailment being apt to develop long after the receipt of the injury, surgeons do not ordinarily encounter or recognize the disorder, as is evident in the bare mention by Agnew* and Bryant† that insanity may follow head injury and there be no external evidence, upon the head, of the injury.

In hospitals and private practice cranial injuries are seldom followed, from lack of opportunity. Even military surgeons are debarred from a satisfactory study, for in the field such cases are sent to the rear, discharged as disabled, or otherwise escape observation, after the wound, if any, has healed.

From various causes even insane asylums differ widely in their statistical records. Thus, Clouston‡ encountered but 12 cases in 9 years at the Royal Edinburgh Asylum, and infers that "accidents to the head do not loom largely, therefore, in the production of the insanity of the world." On the other hand, Schläger§ found 49 out of 500 cases of insanity to be traumatic. Sankey is silent on the subject, as his cases were females in the Hanwell Asylum principally. Pritchard‖ quotes from Esquirol¶ traumatic cases in private practice, 8 in 120; Salpêtrière, 26 in 361; Charenton, 11 in 256; total, 45 in 737, of which 22 were from head blows or falls and 23 *coup de soleil*. Worcester** cites (J. Crichton Browne's "West Riding Asylum Reports") that from April 1, 1870, to the same date in 1872 there were admitted 42 such cases,—fifteen times more numerous annually than in

* Agnew's Surgery, p. 304. † Bryant's Surgery, p. 200.
‡ Mental Diseases, p. 300.
§ Zeitschrift der K. K. gesellschaft der Aerzte zu Wien, xiii, p. 454. 1857.
‖ Insanity, p. 136 *et seq.*
¶ Art. Folie, Dict. des Sci. Méd. ** Insanity and its Treatment, p. 90.

Edinburgh. Kiernan* found 45 in 2200 at Ward's Island Asylum, New York. While pathologist at the Chicago county asylum I ascertained 49 cases wherein traumatism was operative among 610 patients, and my report† divides them as follows: Causes ascertained, 357; unascertained, 253. Of these, 24 males, 3 females, had head injuries; 3 males, 1 female, were sun-struck; 3 males had been subjected to intense heat; 1 male had become insane after a lightning-stroke upon the head. In these the traumatism appeared to be the only cause, but in 2 male cases typhoid fever, in 1 male a fright, in 1 male and 1 female a tendency to hebephrenia, and in 2 males and 3 females heredity were associated; 3 males were epileptic; 1 male had been sun-struck in addition to having a head injury.

Mickle‡ states that in 1221 cases of paretic dementia, tabulated in the 1878 "Lunacy Blue Book" for England and Wales, 3.1 per cent. was caused by sun-stroke and 4.6 per cent. by cranial injury.

The proportion of insanity due to blows and falls upon the head, overheating, and sun-stroke, from various authors, approximates, from among all other forms of mental disease:—

6.	per cent.	Bucknill and Tuke (*Psych. Med.*, p. 97).
10.	"	Schläger (*Wien Zeitschrift, loc. cit.*).
6.	"	Esquirol (*Dict. des Sci. Méd.*).
.33	"	Clouston (*Mental Diseases*, p. 300).
2.	"	Kiernan (*Journ. Nerv. and Mental Diseases*, July, 1881).
8.	"	Clevenger (*Med. Journ. and Exam., loc. cit.*).

The average proportion of traumatically caused to other forms of insanity is thus 5.4 per cent., ranging with different asylums from less than 1 up to 10 per cent. of the admissions; but, for reasons to appear, this is not the proportion of traumatic insanity.

It is in many cases difficult, if not impossible, to determine whether the traumatism acts as the predisposing or the exciting

* Detroit Lancet, June, 1883, p. 539.
† Chicago Med. Journ. and Examiner, April, 1884, p. 388.
‡ General Paralysis of the Insane.

cause of insanity. Heredity would undoubtedly precipitate matters after an injury, and, we should think, subject such predisposed persons to a greater liability to injury where the neurotic or mental taint had developed enough to lead them into danger; but the recorded cases show that heredity is not necessary to the establishment of this form of insanity, and, *a priori*, a maimed brain would be quite sufficient to institute a mental ailment without preceding causes.

Kiernan* found inherited taint in twenty-eight of his forty-five cases. My records furnish five males and three females predisposed by heredity in fifty-nine cases. Ten of the total were in private practice after leaving the asylum four years ago.

Bucknill and Tuke† report a case resembling paretic dementia, whose father died insane. Verity‡ a similar instance with an insane maternal grandmother and uncle. Brower§ gives three cases, in two of which there was heredity; a paternal uncle, three paternal cousins, and a brother insane in one of the instances, and a grandmother, two uncles, and two cousins, all paternal, in the other case.

About the best deduction we can make from the cases cited is that *while heredity renders the individual with a head injury more liable to insanity than one with the same injury would be without the heredity, and while this predisposition plays a very important part in a large but undetermined number of traumatic cases, the psychosis may exist without any previous insane tendency, inherited or acquired.*

Plainly any constitutional vice, however obtained, that would enfeeble the resisting powers could act as a predisposing cause in this as in other divisions of mental derangement. Winslow‖ believes "that the importance of head injury as a cause of insanity cannot be exaggerated," and further states: "In some instances accidents of the kind may not be followed by serious

* Jour. Nerv. and Mental Dis., July, 1881, p. 450, Table 11.
† Psychological Medicine, p. 311
‡ Amer. Jour. Neurology and Psychiatry, May, 1882.
§ Alienist and Neurologist, Oct., 1883.
‖ On the Brain and Mind, p. 440.

results, but in certain temperaments, or conditions of bodily health, and in particular predispositions, we may safely predicate the development of chronic disease of the brain as the result of neglected blows on the head. Injuries of this character occurring to persons of a strumous habit, or suffering long-continued debilitating diseases, impaired nutrition, overwrought and anxious minds, or a constitutional liability to mental or cerebral disease, are frequently followed by serious and often fatal results."

Before arriving at what traumatic insanity is, it will be as well to dwell upon what it is not, owing to the confused idea conveyed by almost all writers except Spitzka.* He states that "it does not accurately correspond to the ordinary psychoses, has distinct clinical characters, and is always, when found, referable to traumatism or to analogous causes." He allots only two pages to the subject, but tersely and effectively. Directly or by implication, in many works, every form, from melancholia to senile dementia, has been ambiguously included as traumatic; but Kiernan† incautiously criticises Crichton Browne‡ for this, when that observer merely noted that traumatism had preceded or complicated the development of cases of hypochondriacal melancholia three, dementia nine, epileptic dementia nine, senile dementia five, dementia with general paralysis three, general mania two, and one case each of acute, puerperal, recurrent and *a potu* mania, and a case of "amentia." The classification of the English does not enable us to know whether delirium tremens or alcoholic insanity was meant, and as the traumatism in the "amentia" case was doubtless post-natal the list may probably be translated into imbecility, alcoholic, puerperal, recurrent insanity one each, dementia nine, senile dementia five, epileptic insanity nine, paretic dementia three, hy. melancholia (paranoia?) three.

I referred to two hebephrenia cases complicated by head injuries. These, with many in Browne's list, would be atypical,

* Manual of Insanity, p. 370. † *Op. cit.*
‡ West Riding Lunatic Asylum Reports, vol. ii.

for, aside from the fact that some psychoses may develop one upon another and an epileptic, puerperal, or other case may be also traumatic, the traumatism may predispose to other forms, precisely as any other brain malady may. If the pubescent insane tendency pre-existed the injury could be the exciting cause, the hebephrenia could be modified or aggravated by the trauma, traumatic insanity might co-exist with or be overwhelmed by the hebephrenia; so that the case might be one of simple hebephrenia with traumatism, traumatic insanity with hebephrenia, one or the other or even both well marked, *according to the clinical symptoms.* This is the advantage of Spitzka's classification; there is something tangible about it; a prominent group of phenomena characterizes each mental disease. We cannot be bound to an etiological *ignis-fatuus.* There is no justification for other than a clinical classification in the present unripe stage of mental science.

The puerperal case might or might not have become such with or without the head injury: heredity has more to do with that trouble. A well-marked case of melancholia, mania, or any other mind alienation should not be included as traumatic insanity, even though the injury were the cause, *unless the clinical features of that disease are apparent.* A cerebral malformation may induce epilepsy, idiocy, or paranoia, according to circumstances. It would be absurd to neglect the palpable result for the obscure etiology; so all insanity following a head wound is not traumatic insanity, and the conclusions may be made that

Traumatism may precede insanity and have no relation to the insanity, just as head injury is compatible with sanity.

Traumatism may predispose to traumatic or other forms of insanity, especially alcoholic and syphilitic.

Traumatism may be the exciting cause of traumatic or other forms of insanity in the predisposed, as hebephrenia and paranoia.

Traumatism may modify, complicate, or aggravate other

forms without the clinical symptoms of traumatic insanity appearing. The latter may co-exist with other forms of insanity.

Traumatism may act as predisposing and exciting cause, producing traumatic insanity by itself (Dickson, Luys, and Schläger), *but hereditary or other taint causes greater liability.*

Instances of head injury during youth developing epilepsy at puberty and insanity at fifty are noted by Calmeil* and Lasegue.† Esquirol‡ mentions a three-year-old boy who fell upon his head and became insane at seventeen, with headaches in the interim; Rush§ one at fifteen, who fell from a horse, sustained contusion, and died insane a few years later. Voisin‖ and many others recite similar instances. Savage cites a slight head hurt in a lad causing insanity, but he was strongly predisposed by heredity.

From Kiernan's researches it appears that slight head injuries, from the insidious nature of the changes they set up, are as much to be dreaded, if not more, than the grave injuries. Winslow takes strong views as to the severity of apparently slight head injuries.

Duret,¶ Rush,** and others note the slowness with which cerebral injuries manifest themselves; some observers mention four to ten years, and later Griesinger†† says that traumatism may produce insanity at once or several years afterward, that it predisposes even without visible cerebral lesion. Savage, Winslow, and Krafft-Ebing call attention to the same fact, and the latter divides traumatic insanity into kinds produced immediately or later, sometimes many years. In nineteen of Schläger's forty-nine cases insanity began within a year of the accident, in the remainder in from four to ten years afterward.

Insanity may develop at any interval after a head injury, but usually several years intervene.

* La Paralysie chez les Aliénés.
† Paralysie Générales des Aliénés, Voisin.
‡ Maladies Mentales.
§ Medical Inquiries and Observations, p. 28.
‖ *Op. cit.*
¶ Etudes exp. et clin. sur les Trau. Cerebraux, p. 137.
** *Op. cit.*
†† Mental Pathology and Therapeutics.

Under head trauma that affect the brain, with or without demonstrable cranial or cerebral lesion, may be included contusions, compressions, incisions, punctures, concussions, the effects of transmitted or direct violence (such as could be imparted by a jar of the spinal column), lightning-stroke, sun-stroke, overheating, exposure to sudden alterations of intense heat and cold. Neck wounds through probable injury to the cervical sympathetic* and injuries to the limb or trunk may occasion insanity.

Skae, Worcester, Dickson, Savage, Spitzka, Bucknill and Tuke, Clouston, and the alienists of continental Europe uniformly include sun-stroke as a cause, and later works, such as Spitzka's "Manual," properly add general overheating, while Kraft-Ebing,† Reich,‡ Brush,§ and Schwartzer‖ report a transitory insanity from exposure to alternations of great temperature ranges. I treated one such case whose delusions were grandiose. There was considerable cerebral hyperæmia. He improved within two months of the inception, but after two years a remnant of his insanity remains, and a recent furibund attack compelled his incarceration in the Northern Wisconsin State Asylum.

Schläger observes that the injuries were followed by immediate loss of consciousness, by dull pain in the head, or by simple mental confusion; but these are the customary accompaniments of all head hurts. Savage speaks of the nervous instability that sometimes follows with an increased liability to become affected by other exciting causes of insanity, and thinks that bone depression with membrane inflammation may often be the cause of the disorder, but acknowledges that altered conditions of brain nutrition may suffice.

Duret's "*Etudes*" form a handsome contribution to the subject. He explains *contre coup* and other effects of head

* Brower, Bannister, and I published separately, and at several years' intervals, accounts of the progress of a case of this kind: one side of his face was flushed and delusions of persecution and suspicion were prominent, in Jour. Nerv. and Mental Dis., 1879, and Med. Jour. and Exam., May, 1884.

† Lehrbuch der Psychiatrie.

‡ Berliner Klin. Wochenschrift, No. 8, 1881.

§ Amer. Jour. of Insanity, 1882-83.

‖ Die Transitorische Tobsucht.

injuries, especially concussion, by the sudden propulsion of cerebro-spinal fluids from the point struck to opposite parts, often the fourth ventricle. The strain upon ventricles and blood-vessels could cause effusion and extravasation. As a valuable addition to cerebral pathology Duret's work has not had even decent treatment by the English writers.

The pathology of the subject cannot be simplified, for the results will vary widely between post-mortem findings and ante-mortem symptoms according to skull and brain structure, vascular peculiarities, age, habit, education, environment, nationality (the Irish develop greatest irascibility after head injury), and especially, what has been least considered, *the location of injury*.

To facilitate study of these cases the record should note the seat of the hurt, the manner in which it was sustained, and other information likely to impart clues as to the portion of the brain injured. The statement "head injury" is too broad to enable judgment of cause and effect relation. My observation leads me to believe that frontal head-wounds are apt to induce the paranoia form of traumatic insanity; more diffused injuries, such as concussions, insolation, overheating, the paretic dementia.

Among the troubles which Spitzka, Clouston, Marce,* and others describe as *sometimes* occurring are speech difficulties, vertigo, irregular alternations of stupor, agitation and imperfect lucidity, tinnitus aurium, photopsia, eye scotoma and scintillation, paresis of muscular groups, particularly those of the eye-ball, anæsthesiæ and hyperæsthesiæ. These are probably the least constant, but some are usual accompaniments of different forms of brain derangement, and hence need not be dwelt upon in connection with the typical cases except as subsidiary evidences.

Epilepsy may supervene either in the form of *petit* or *grand mal*, with or without epileptic insanity, and, as Kiernan says, not differing from the ordinary except that some ended in

* Maladies Mentales.

paretic dementia (a traumatic modification). He had a larger percentage of epileptics from traumatism than other observers, who do not note so many. Ecchevaria* states that thirty-five in three hundred and twenty-one epileptic insane were such from traumatism, and Gowers† found ninety-two cases in fourteen hundred and fifty due to head injury. One of the most violent and dangerous epileptic maniacs I ever knew had a fractured skull.

Mania from traumatism is likely to be the recurrent furious phase characteristic of the occasional outbreak of traumatic insanity.

Hebephrenia has been disposed of *supra*.

Melancholia admittedly rarely complicates or succeeds traumatism. Kiernan had but one case, the *attonita* form. This horrible derangement we can readily imagine could be caused by head injury.

Katatonia.—I found one case with a head injury, but doubt its relationship beyond its having caused alcohol addiction. Kiernan found four head injuries among thirty katatoniacs.

Stuporous insanity being a recoverable form, dementia would more properly include cases of traumatism resembling it.

Senile Dementia.—Traumatism could have but a problematical association. It never could cause the disease unless it precipitated impending senile brain involution.

Syphilitic dementia could occur through the injured brain or membranes affording a nidus for the post- or pre- syphilitic poison.

Alcoholic insanity may co-exist with, precede or follow upon traumatism, and be associated with it in every conceivable manner, for reasons given *infra*, under alcoholic complications.

Imbecility may result from traumatism, for obvious reasons.

Recurrent Mania.—A case was reported by Crichton Browne, but the attacks may have been only the episodical furies of traumatic insanity. I observed one, a German, aged

* Epilepsy. † Epilepsy, p. 26.

40, with a large scaphoid depression of the top of his skull from fracture. When overheated he became volubly maniacal, but at other times *appeared* to be rational. (The "boodler gang" of county commissioners, part of which is now in the penitentiary, interfered with my means of studying this and other cases—a side comment to indicate the difficulties of the American non-political alienist.)

The prognosis of traumatically-induced insanity is unfavorable. Schläger attests this. Spitzka says: "As a rule progressive deterioration sets in and dementia terminates the history of the case." Marce also states that the "patient becomes progressively demented." All writers coincide in this. Where dementia follows swiftly, death does also; but other terminal dements from traumatism may linger an ordinary life-time.

To this point in the subject we have regarded many phenomena (but not all) that could be included as occurring in traumatically-induced insanity or that have some association with traumatism, leaving the insanity of traumatism for separate inspection. Owing to authors not having fully differentiated this from other head-injury forms, we have but little data for percentage calculation.

It is probably related to other insanity in the proportion of 1 to 2 per cent.,—about one-fifth of all head-injury insane cases.

I would designate as traumatic insanity that which exhibited the constant phases that characterize it. The pathological term traumatic being used *in a clinical sense*, and justified by the sufficient invariability of symptoms following demonstrable brain injury; nor would it be unreasonable to include under that head all cases presenting the characteristics, whether head injury could be demonstrated or not. It would be as correct to infer the trauma or its equivalent from the symptoms as it would be to assert cerebral deficiency in idiocy regardless of the external cranial appearance.

Skae held that the symptoms, progress, and termination are sufficiently distinctive and characteristic to enable it to be

considered as a distinct type of disease. Spitzka fully recognizes this, but places it, nevertheless, among his second or complicating, when it should be under the first or pure insanities. Proper acknowledgment that the brain changes are not *always* demonstrable would assign it to sub-group A, class first; but supposing this to be debatable, then it may properly fall into the second class as associated *with* demonstrable changes in the brain, especially where the form was that of paretic dementia, paranoia, or dementia. But that author solves its location for his third class, sub-group B (constitutional insanity, essentially the expression of a continuous neurotic condition) by stating (p. 371) that it developed upon the "traumatic neurosis."

The objection to including traumatic in the pure group, when it manifests paretic dementia symptoms, can be met by the further observation that such forms are impure, and were we to absorb a case under, say, paretic dementia, there would likely develop other co-existing symptoms, or the paresis would be too feebly marked, while the peculiarities due to traumatism were strongly marked. *Traumatic insanity is pure in the impurity of the psychoses it simulates.*

The maniacal excitement with which Skae stated that it usually began is most likely the fury which often calls attention to the disease which may have been previously apparent to an expert, for Schläger and others do not mention this kind of onset. Skae's further observations are well sustained: "A chronic condition, often lasting many years, when the patient is irritable, suspicious, and dangerous to others; in many such cases distinct homicidal impulses exist; this form is rarely recovered from, and has a tendency to pass into dementia and terminate fatally by brain disease." The "characteristic delusions" he additionally enumerated as "those of pride, self-esteem and suspicion" are best separated into those allied to paranoia and paretic dementia.

Schläger speaks of "self-conceit, prodigality, disquiet, and restlessness." These and other aspects of the subject may now

be detailed *seriatim*. The first thing to occur as a symptom usually is

Change of character. This is very often only ascertainable by a comparison of the behavior before and after the injury, upon testimony of relatives and acquaintances. Commonly the traumatic lunatic is described as "not being the man he was." These changes are often radical, and consist of

Lapses of memory, as in epilepsy, more prominently than a general failure of that faculty. The memory cannot be said to be as acute as previously, and forgetfulness of names, persons, places, and transactions are occasional to frequent, but the most notable are the memory *gaps*. As Spitzka says, entire periods of life may be obliterated from the mind, but in my cases these *lacunæ* were, so far as I could determine, limited to the epileptic-like, automatic furies, and to other occasions when insane acts were committed during a few minutes, or extending sometimes over many hours or days. As in other insanities, juvenile or olden events are more readily remembered than the recent occurrences.

Headaches and sleeplessness are noticeable, especially as preceding or accompanying the most troublesome periods of the disorder. Both conditions are apt to be hyperæmic and aggravated by constipation, liquor imbibing, business or domestic worry, etc.

Irritability, varying from occasional irascibility provoked by trifling affairs, an explosion of anger, a passionate manner, to the most violent outbursts of temper. Schläger found these to exist in twenty of his forty-nine cases. Usually the head is flushed at such periods, and there is a swagger and bullyism differing from the epileptic irascibility or "*petit mal intellectuel*," which is attended with pallor, a cynical, sarcastic, or sneering "hatefulness," rather than boisterousness. But the epileptic, unconscious automatism, it is readily understood, may also appear, as any peculiarity of epilepsy may develop from head injury. The usual sun-stroke or traumatic irascibility, to a lesser

degree, can be observed in many cooks who are "hard to get along with." Its cause is in cerebral turgescence from heat.

It would seem as though many peculiarities such as these were exactly epileptic, and this probability should be borne in mind and studied.

Suspiciousness is a frequent feature, as in phthisical insanity. In the neck-wound case, I reported with Brower and Bannister, every delusion the patient, Kelly, had was accusatory. Being a policeman, he imagined every one a thief. Meyer* reports a case which manifested delusions of suspicion after being struck on the head by a large weight; later he became paretic.

Long, apparently lucid intervals. It is not best to omit the "apparently," for there is no telling at what moment the insanity may explode in an outrageous act, and while hallucinations and other features of insanity exist, even though the patient may talk and act rationally, the insanity is not absent. Personal inspection of the patient may reveal nothing beyond a slight peculiarity of manner, or not even this. The speech may or may not be affected; the pupils may be dilated, contracted, or normal, and respond to accommodation tests and to light. There may or may not be paresis of muscles or other determinable physical impairment, and such cases in asylums are often capable of doing routine work in an intelligent manner, but they should be always looked upon as dangerous.

Homicidal and suicidal impulses, as frequent and characteristic occurrences in traumatic cases, are recorded by Spitzka† and Clouston,‡ who cites a case.§ Many of Bucknill and Tuke's‖ descriptions of homicidal impulse read like traumatic cases, but epilepsy (which may have had the traumatic origin) is discussed in their connection.

Verity¶ narrates a case where the pain and heat appeared upon the side of the head opposite to the part struck, with mental degrada-

* Archiv für Psychiatrie, Band II.
† Manual of Insanity, p. 370.
‡ Mental Diseases, p. 298.
§ *Op. cit.*, p. 244.
‖ Psychological Medicine, p. 254 *et seq.*
¶ Amer. Jour. Neurology and Psychiatry, May, 1882, p. 196.

tion, drunkenness, hallucinations of hearing, disagreeable in character. Three years after the hurt he struck and threatened to kill his wife; at this time he was sober. Two days later he committed suicide by hanging. Brower* observed three cases. One was an army captain, æt. 23, wounded in right parietal region, suffered from headaches and insomnia, and four years later became irritable, resentful, quarrelsome, and dissolute. His wife abandoned him on account of his conduct. He went to France, and became conspicuous for his outrages as a leader of the Commune. He committed a murder and mail robbery. "The immorality was obviously pathological, and the case has in it the evidences of logical perversion." The second case, with heredity, hurt in the army, upon the head, underwent character change, was quarrelsome and subject to fits of ungovernable fury, and suspected his family of a desire to poison him. After an attack of epileptic convulsions, his delusions of conspiracy and suicide increased. He carried a knife and pistol for self-defense. The Catholic Church and clergy, to which he had been devoted, he especially regarded as persecuting him. He had attacks of fury, in one of which he killed his wife and then attempted suicide. The Illinois prosecution claimed the man's irregularities to be due to whisky. The judge instructed that if the insanity was the result of inebriety it was no defense, which resulted in the following verdict: "We, the jury, find the defendant guilty in the manner and form charged in the indictment, and fix his punishment at death by hanging. We also find the defendant insane at the present time." The prisoner committed suicide the next day. The third case, æt. 50, strong insane heredity, known as "silly" and "crazy" among his companions, sustained a concussion at forty-two years of age, and a year later another. He squandered his property, had paretic delusions of great wealth, boasted of being the third son of God, and in June, 1878, in a public place, in the presence of several persons, without warning or evidence of passion or excitement, he shot and killed his wife. Upon examination by Drs. Brower and Lyman, he had pupillary inequality, nystagmus, fibrillary twitchings of muscles of face, back, thorax, and legs; the jail attendants stated that he slept scarcely at all, feared his food was poisoned, and refused it. E. P. Weber, the prosecuting attorney, conscientiously abandoned the case, and the jury found the prisoner insane.

In fourteen of Schläger's forty-nine cases "there were suicidal attempts, with loss of memory and confusion." Pritchard† declares "the propensity to suicide is very often combined with the impulse to homicide," and that "acts of suicide, like

* Alienist and Neurologist, Oct., 1883, p. 650. † On Insanity, p. 284.

those of homicide, are generally preceded by a morbid change of character and habits. Individuals who have been cheerful, active, animated, taking a lively interest in the pursuits of life, in the society of their friends, in their families, become melancholy, torpid, morose, and feel an aversion to their relatives or most intimate associates, become listless and indifferent. These appearances have often been observed to be the preludes of some attempts at suicide, and have sometimes put the relatives on their guard, and have led to the prevention of the catastrophe."

And Savage* very justifiably writes: "I would say that in considering a murder the first question to be asked is, What was the assigned cause for the crime; was it the natural development of surroundings and habits? To my mind certain crimes are themselves sufficient evidence of mental unsoundness. If a person, with or without a sudden shock, become completely changed in his domestic relations—if a man who is a good husband and a kind father kills wife or child without any established delusion, I think the crime itself is sufficient to cause a *prima facie* belief in the existence of mental unsoundness. The chief points, then, are the apparent causelessness of the crime, the utter want of relationship between the crime and the supposed end to be attained, the relationship between the crime and any delusions, the establishment of any insane or nervous inheritance, or the proof that the patient himself at one time or another has been of unsound mind or epileptic. Next after the consideration of the causation of the crime itself and its surroundings, it is important to obtain evidence as to acts immediately preceding and immediately following the deed, as well as to find out the details."

In many cases of traumatic-insanity murders, the previous insane predisposition is emphasized by a number of immediate relatives having been insane.

Alcoholic complications are very numerous, and where one exists, a murder, especially a wife murder, may be the result of

* On Insanity, p. 469.

this, as alcoholic lunatics, influenced by their marital-infidelity delusions and hallucinations, commit peculiarly horrible crimes of this kind. A drunken katatoniac disemboweled his wife in Chicago, running into the street in his nightgown. He was sent to the penitentiary, after puzzling the doctors with the alternations of that disease. (Periodically the daily papers recount the acts of an ordinary katatoniac as a "wonderful case baffling all physicians").

Spitzka (p. 254) mentions Lennon, a New York alcoholic, who cut his wife up in regular checker-board pattern.

That both alcoholic and traumatic insanity are murderous might raise the quibble in court as to which the crime was attributable. As the head injury impels to the alcoholic lunacy it should not matter, but there is a psychological interest in the disentanglement. The delusion of the wife's unfaithfulness might shift the homicide upon the liquor lunacy.

1. Alcoholism may in the ancestry predispose through transmitted nervous or mental instability, so that traumatism will more likely induce insanity in a descendant.

2. It renders the individual liable to accidents, despite the old saying that drunkards escape injury.

3. Previous alcoholic habit complicates and aggravates traumatic cases as it does pneumonia, and may be the determining factor of insanity, where the abstemious, with the same injury, would survive and may remain sane. It retards recovery; and alcohol, after a head wound or sun-stroke, readily congests the brain,—a condition especially to be avoided.

4. A proneness to alcoholic addiction is observed as remarkably frequent after a head injury, sun-stroke, or overheating.

5. Traumatic cases are quickly, readily, and badly affected by small amounts of liquor, which, previous to the injury, would have had little if any effect. "A little will always make them maniacal and often very dangerous and homicidal," says Clouston.*

* *Op. cit.*, pp. 298, 299.

6. Alcoholic insanity may be superimposed upon traumatic, and many degrees of these two psychoses combined are observable.

7. The delusions peculiar to the alcoholic insane are sometimes found in traumatic cases complicated with alcohol, even though the alcoholic insanity may not fully exist. This is an important observation.

8. As a probable majority of head-injury cases are addicted to liquor, the relations of alcoholism to this insanity should be clearly understood as of medico-legal importance, for the law makes a distinction between acts done through insanity from liquor continuously used and those occasioned by liquor "voluntarily" taken. Fearing that advantage may be taken of the plea if drunkenness secured acquittal, the legal fiction remains, to be swept away by further advance in civilization, that every drunkard is responsible for his crime. Since this is in the statutes there should be careful discrimination of the effects of alcohol in criminal cases. It should be known that injury predisposes to alcoholism, and that one or the other psychosis may predominate in the same individual.

Frequently we have to combat the error of an effect or product of insanity being mistaken for the cause, and nowhere is so much injustice exhibited as in these instances.

I knew an officer of the regular army whose eye was shot out and fore-brain injured during the late war. He was jovial, dissipated, and occasionally irascible, especially when marching. He was thrice court-martialed for acts committed under liquor influence and threatened with cashiering. He had no sympathy from his brother officers, who were harsh in their condemnations. His previous brilliant record for bravery stood him in good stead, whereas the pathological condition should have been recognized in mitigation or excuse. A fireman is in an Illinois asylum with a battered head received in the course of duty. He was previously temperate, and as he drank heavily afterward this was blamed as the cause of the insanity, and his wife is refused the customary pension.

If we adopt the Earl of Shaftesbury's dictum (he was in a position to make such an affirmation, being the head of the

English Lunacy Commission for fifty years) that 50 per cent. of all insanity is due to alcohol, I think that careful tabulation will show much of this alcoholism to be induced or precipitated by cranial injury, which latter becomes the real and the former the apparent cause.

Delusions, illusions, and hallucinations are those of being persecuted, and are often hypochondriacal, as in paranoia; those of grandeur, as in paretic dementia; those of poisoning and marital infidelity, as in alcoholic insanity.

The divisions of traumatic insanity, I would suggest, are as follow:—

Traumatic dementia, which usually runs a rapid course to death, and follows upon severe injuries.

Traumatic Paretic Dementia.—This is not the ordinary paresis, but a mixed form, blending the peculiarities of the traumatic with those of a shifting, ill-defined paresis, and often linked to a prominent enough paranoia, but the latter is modified by the paresis which governs the prognosis. Mickle* says: "In the cases which have come under my observation where cranial injury has conduced to general paralysis, it has, in the majority, served to play the part of a predisposing rather than an exciting cause." Closer study of these with other traumatic patients would enable him to see the injury alone sufficient in the majority, for it is too frequent to be otherwise. Sankey† tells of a patient injured by a fall, who was a week insensible, recovered, and two years later paretic dementia set in. In Burman's statistics‡ 103 paretic dements were such through sunstroke in 7, and head injury in 12 cases. In 1221 cases of paresis, stated by the English "Lunacy Blue Book" for 1878, 3.1 per cent. was caused by sun-stroke, 4.6 per cent. by head injury.§ Mickle‖ discusses the influence of cranial injuries and heat as predisposing and exciting causes. Calmeil¶ speaks of similar results from exposure to the great furnace-heat. Brierre de

* Jour. of Mental Science, Jan., 1883.
† Lectures on Mental Disease, 2d ed., p. 287.
‡ Bucknill and Tuke, Psych. Med., p. 329.
§ Mickle, Gen. Paral. of Insane, p. 102.
‖ *Op. cit.*, pp. 98, 108.
¶ Mickle, *loc. cit.*

Boismont* affirms that paretic dementia may be preceded two or three years by great irritability or menace of suicide, or character change and memory failure. It would be useful to know whether such cases were not traumatic, but the author cited gives us no clue to this. Burman and Calmeil† unite in calling attention to the frequency of paretic dementia in the army and navy. The hypochondriacal, suicidal, and homicidal paretics of Mickle, with delusions of persecution, it is noteworthy, were military, a class particularly subject to head hurts and heat exposure. Careful inspection of Mickle's cases shows a likelihood of a much larger undiscovered number of traumatic patients. While several of his soldiers were sun-struck and one was hit by a poker, the evident traumatic symptoms detailed were not referred to as such, and these same symptoms existed in several other cases in which there was no mention as to whether there had or had not been head injury. The precedent eccentricity, suicidal attempts, irritability, passion, insomnia, and alcohol addiction point to a probability of traumatism in his Cases X, XII, XIII, XV, and XVI. Case XIII had early epileptic convulsions and XV epilepsy eight years before.

While an idiopathic epilepsy may become paretic, and neither ailment be attributable to trauma, the epileptiform seizures of paresis should be studied with regard to traumatism, especially if the fits occurred early in the disease, or heralded it, as affording a possibility of traumatism. At least, as traumatism causes epilepsy and paretic dementia, it would be well to determine to which of the three conditions the spasms were due, and whether in traumatic paretics the epileptiform phenomena, from *petit* to *grand mal* or their similitudes, did not occur more frequently or sooner than in other paretics.

Parchappe,‡ Calmeil,§ and Burlureaux‖ assign epilepsy as a cause of paretic dementia. Let us next ascertain the cause of the epilepsy.

* Annales d'Hygiene pub. et de Méd. Legale, 1860.
† Bucknill and Tuke, Psych. Med., p. 329.
‡ Traité de la Folie.
§ Traité des Malad. Inflam. du Cerveau.
‖ Folie Paralytique.

I have observed loquacity, prodigality, and expansive ideation develop in a case six months after a head injury, without headaches, insomnia or intemperance, with decided *petit mal* about weekly. He fell thirty feet, causing stellate fracture of right occipito-parietal and post-occipital regions. He was maniacal immediately after the fall and semi-comatose two months. He was treated by Drs. A. J. Baxter, Otto Schmidt, J. C. Oswald, and myself during the year that has elapsed since the accident. Irritability does not occur often. His abstemious life has aided him greatly.

Traumatic paranoia may occur with or without the paretic symptoms simultaneously or successively thereto. I should judge from the accounts of the "American crowbar case" that paranoia was the prominent, if not the sole, manifestation in that instance. Left frontal hurts or heredity appear to determine the appearance of this logical perversion.

There are cases wherein paranoia, epilepsy and paretic, dementia are united, where one predominates or persists to the exclusion of the other form.

Analysis of Mickle's cases yields the remarkable fact that Cases X, XII, XIII, group 3, paranoia with paresis, post-mortem proved the left cerebrum most diseased; in Case XV, group 4, with epilepsy, the paresis predominated, and in the paretic and alcoholic Case XVI, group 4, the right cerebrum was most diseased in both.

It must not be expected that these divisions into the paretic, paranoia, and dementia forms will be found to persist in the same individual, for often the peculiarities of one kind of insanity may shift to those of another, or all three, or two, of the forms may unite, and this constitutes a justification for the term Traumatic Insanity.

Traumatic insanity without the paresis, paranoia, or dementia might exist and be evident in furious outbreaks, but I have not seen a case nor can I find any record of the absence of features allied to the psychoses mentioned.

The treatment is to avoid sun or other extreme heat, liquor, costiveness, irregularity of habits, irritating influences, business

aggravations or close application to any pursuit, and to combat with ergot, bromides, antipyrine, phenacetine, and derivatives generally, the insomnia and other products of cerebral congestion. Massage from the shoulders downward and hot baths, to diffuse the circulation, prove useful. Hydrotherapy is very helpful.

I. *Traumatic Dementia.*—W., æt. 40, depressed contused wound left upper frontal region from a falling brick, in two years became crochety, irritable, intolerant to liquor, sleepless. Memory and business ability suffered impairment. Without warning one day broke up furniture and raved about his house. Mentally deteriorating.

II. Reported in Chapter VI.

III. *Traumatic Dementia.*—A railroad official named Murphy was brought to me three years ago, after being pounded upon the top of his head with a large rock. He soon after became stupid, could not describe his feelings or condition, had forgotten nearly all he knew, was sleepless and troublesome at home, but too demented to be furious. At an early stage of his insanity he had faint paretic ideas. He died, I was told, in an asylum last year.

IV. *Traumatic Dementia.*—John G., American, machinist, lightning marks along forehead, neck, and left side. Was struck in 1880, suffered mainly pain in head and stomach, but was conscious and talked rationally till the third day, when left hemiplegia occurred and lasted a year. The paralysis included facial with ptosis. Tongue and vocal organs first to recover in 1881, when insanity became evident. Irritable, homicidal, suicidal, destructive, noisy, suspicious, erotic, jealous of wife. In 1883, a terminal dement.

V. *Traumatic Paretic Dementia.*—D. S., negro, teamster, æt. 54, scar on right forehead; arrested for larceny, but found to be insane; well behaved between furibundal attacks, during which he had paretic delusions of great wealth and hallucinations of sight and hearing. Saw God in a chariot once, who commanded him to escape. It required six men to subdue him, as he had unusual strength. Died of pneumonia a year after insanity began. Medulla small. Isthmus cerebri, left Rolandic, frontal, parietal, and temporal regions, arterial engorgement, extreme in occipital portion. Capillary extravasations in course of superior longitudinal sinus, streaking the dura with the rusty color often found in alcoholic insanity. Veins of left side cerebrum fuller than right.

VI. Reported in Chapter VI.

VII. *Petit Mal and Paranoia following Traumatism.*—B., æt. 25,

clerk, paranoiac father beat him over the head repeatedly when he was young, had attacks of *petit mal*, was temperate, but irritable (except to wife and mother), suspicious, had memory lapses and delusions of persecution for which a direction and basis was afforded by some abusive anonymous letters he claimed to have traced to two women in his office. He purchased a revolver and deliberately shot both of them in their heads, but they made fair recoveries. The extreme penalty would have been twenty-eight years, but he was sentenced to six years in the penitentiary after the State and defense attorneys conferred with the judge. Public feeling ran high, and as I testified to the insanity I received some newspaper criticism, such as this:—

"The doctor testified that *petit mal* was more dangerous to the intellect than the convulsions of epilepsy. *Petit* means little: how can the less include the greater danger?

"Why do not these experts prevent crime by timely warning instead of waiting till it is done?"

That is precisely what every expert does when he can, and what I have repeatedly done when the opportunity presented, but people seldom seek medical advice in such cases until crime is committed by their insane friends.

VIII. Reported in Chapter VI.

IX. *Traumatic Paranoia.*—C., æt. 30, butcher, energetic, habits regular; was struck by locomotive, small scalp wound on head healed completely; unconscious, delirious, and vomited several days. Within six months his memory became impaired, lost his business ability. Sleepless and restless at night, headaches persisted; suffered from dizziness, dimness of eyesight, photophobia, tinnitus aurium, and defective hearing. Extremely irritable and suspicious, feeble, stupid, sullen, with lapses of memory, forgetful of faces and places; the least liquor "goes to his head" and makes him worse. His bed-fellow stated that he several times rose in the night with hallucinations of burglars breaking in. Twice he fired through the door at imaginary persons he claimed to have heard. He married a girl whose language he did not understand and who could not understand his, while unable to provide for a wife. Beyond a few frontal rugæ, there was nothing in his appearance to indicate insanity. Dr. Edmund Andrews was called by the judge and I by the patient in a civil action against the railroad company. Dr. Andrews agreed with my statement of the case and C. was awarded $5000 damages.

X. *Epilepsy and Dementia from Traumatism. Recovered.*—K., æt. 26, Irish, when thirteen was struck upon left side of head with a club. Epileptic convulsions every three to six weeks since; irritable, stupid,

could not learn to read or write, progressing to dementia. An osteal node protruded an inch behind top of left ear. At my request Dr. A. J. Baxter removed this exostosis by trephining and I kept the patient under treatment thereafter to avert the headaches which gave warning of the attacks. Since this operation in 1885 he has fully recovered mentally and from the epilepsy.

XI. *Occipital Injury with Optic Hallucinations and without Insanity.*—J. H., æt. 42, merchant, had fallen upon occiput when a boy of twelve and suffered frequent pain about the nuchal location, growing worse with age. He drank wine, but not excessively. No mental impairment evident aside from peculiar optic hallucinations, interesting from the cuneus gyrus in the occipital brain being the psychic optic centre. He had been treated for tremens, which he resented in passionate outbreaks. I induced him to go to the Alexian Hospital and lessened the vascular stasis in the back of his head by derivatives, and he was soon attending to business after having lost several months' time. His room would be filled with apparitions of his friends and he repeatedly asked me how often I had called to see him during the day when it was my first visit in the morning. He was annoyed by being unable to distinguish the hallucinations from the real personages. As he had no auditory hallucinations I taught him to compel all whom he saw in his room to speak and he was pleased with the result, for the apparitions would not answer him, and his reason aided this discrimination.

XII. *Traumatic Predisposition to but without Insanity.*—A. W., æt. 45, builder, was sun-struck during late war, and often irritable and sleepless with headaches, but not insane. In 1881 was very much reduced by neglected remittent fever, and I gave him ten grains of quinine, which developed a maniacal attack; a second dose brought on a similar fury, but by combining with hydrobromic acid I was enabled to increase the quinine even more. Kiernan * first called attention to insanity induced by quinine. This instance might explain it as occurring in persons with some abnormality of cerebral circulation to whom congestion would be dangerous.

XIII. *Paranoia with Traumatic Insanity and Alcoholism.*—Peter Deegan, æt. 60, farmer, had lived in Ozaukee County, Wisconsin, about thirty years, an Irishman, surrounded by Luxemburgers, with whom he was incessantly at war. He had been beaten over the head with a club and had fallen out of wagons upon his head during drunken bouts, and, to use his own words, "swam in whisky." He turned his family out of doors and was cruel to his children in many ways. There was evidence that his sister and himself were primary paranoiacs. She was hemi-

* Alienist and Neurologist, 1883.

paretic and passing into dementia. Both of them saw and talked to the fairies or "good people," left food out of doors for them, and had delusions concerning the dead not compatible with their professed religion. Deegan, in a dispute over a trivial matter (a wagon-load of straw) brought two guns from the house, one of which he discharged into the thigh of a neighbor, from the effects of which he died. On a change of venue he was tried at Sheboygan, Wis. The evidence was overwhelming as to the traumatic and alcoholic nature of his insanity, but there was great popular prejudice against him, and he received a twenty years' sentence.

A medical politician swore that there was no such thing as alcoholic insanity, it was only drunkenness; that there were no American authorities on insanity; that the Germans had never added to our knowledge of the subject; that he would not use deceit in examining a prisoner suspected of simulation, he would inform him that he was a physician and tell him what he expected to elicit by tests; that it was unfair to spy upon a prisoner to this end. He defined insanity as a "disease of the brain affecting the mind, causing the person to act, think, and feel differently from usual," and acknowledged, when asked, that insanity was not always a disease of the brain, but claimed, in answer to another question, that he would not "think, act, and feel differently from usual" if he were set down unexpectedly in the middle of China, or were he to sit down upon an upright pin-point.

The trial lasted more than a week, one day of which I spent upon the stand detailing the essentials of traumatic and alcoholic insanity. I am indebted to the medical fraternity of Sheboygan County for a kind reception. Nor is it for this that I affirm the high-grade intelligence and education of these "country doctors." They are better equipped in this regard than the average city medical man.

XIV. *Traumatic Paranoia with Alcoholism.*—Mathias Busch, æt. 32, German, brewery-beer vender. Grandmother threw herself in a well while insane, father "eccentric," a paternal uncle John insane and confined in a cell in his own house. A son, Henry, of this uncle is in the Jacksonville Asylum, insane; another paternal uncle, Fritz, was insane, who had two daughters, one of whom died in epileptic convulsions and the other gave birth to two idiots.

Busch had been struck on the left forehead when a boy; the scar is still visible; had also a punctured wound in left temple at outer angle of eye from a pitchfork thrust. He had twice been sun-struck in addition. He had been industrious and kind to his family up to the date of his first sun-stroke, six years ago, when stupid and depressed attacks followed with occasional irritability, and drink affected him more than formerly.

His occupation led him to drink considerably. He suspected his wife of being unfaithful at times. These troubles with headaches and sleeplessness increased after the second attack, but he transacted his business as usual with occasional moroseness and accusations against his wife. Three years ago he attempted to commit suicide with a pistol.

A week before the murder of his wife his insanity was noticed by Mr. McAvoy, president, and Mr. Ortseifen, manager, of the brewery. Busch wildly told them that he was being persecuted by the brewer's union (of which he was not a member, but thought he was). He told others that his wife had tried him twelve times in the brewery and at other times in the lodge (an insurance organization, the benefits accruing only to his wife upon his death). These statements of trials were proven to be absurdly unfounded. He bungled the beer books of his customers, refused to talk to any one, as he had some hypochondriacal delusions concerning his throat, but occasionally forgot this and spoke. Customers complained to the brewery and an agent accompained him on his rounds, after which he was suspended; but he refused to work anyway, as he said, "Every one is against me."

February 2, 1888, he talked of committing suicide, and accused his wife of "being in a corner with men before his eyes," and said that her hair was mussed and clothes disarranged; all of which was an hallucination. His wife appealed to friends about this time, saying, "Mat is going crazy, he acts foolish, and does not sleep at all." His manner became more insane until the afternoon of February 6th, when he came into the house, helped his wife to prepare dinner, kissed her and the baby, and arose from his chair, went to his wife, laid her head on his shoulder, as though to caress her, and drew a butcher-knife across her throat, severing the carotid. Mrs. Schenk, an aunt of the wife, cried out to Busch, "Look out, the knife is sharp!" He answered, as though surprised at her interference, "Let me!" Mrs. S. cut her fingers in trying to interpose her hand. When arrested he was bending over the corpse, looking into the gash, in which he had his fingers. Some said he had thrust a handkerchief into the wound, and that he grinned when asked why he did the horrible deed.

He did not sleep well in jail, talked and acted "queerly." Had an illusion of his cell-mate being "Katy," his wife, and addressed him as such, trying to kiss him. Twice he attempted suicide in prison, once with his suspenders, and the second and nearly successful time with his bedsheet, torn and knotted for the occasion. Artificial respiration and an hour's hard work restored him. He had tinnitus aurium and, hallucinations of sight and hearing. He told me that some said his wife was dead,

but that, as he heard her talking and singing to him, he was puzzled and did not know what to believe. Evidently, at times, he would accept the statements of others, for he wrote to a friend to bury him next to his wife. At one time in jail he complained of a bone in his throat, and because there was none there the newspapers brandished this as evidence of his pretending to be insane. He talked rationally when spoken to and made no attempt to feign. Incarceration improved him, through cutting off his drink and regulating his habits. He was watchful of the court proceedings, and at times stolidity gave way to evident interest, just as any other traumatic or paranoiac might. He did not seem to be able to recall the events of his crime. His pupils were dilated, but responded to the usual tests as normal. Hearing was not impaired. Heart-sounds feeble and its action was sluggish.

The fact that he was capable of being controlled to some extent in jail by threats was urged as evidence of pretense on his part, when every asylum attendant, with or without warrant, uses this method effectually with troublesome patients, and some political asylum superintendents bluff their cases by swaggering through the corridors with jack-boots, long hair, and pistols.

Busch was said not to be insane, because he had not the appearance of an insane person (the lay idea of the genuine article, derived from novels, being one with bristling hair, protruding eyes, and startling behavior). Apropos of this, a grand juryman doubted the insanity of a quiet, sensible-spoken woman in the county asylum, but remodeled his opinion when she returned to him with tinsel crown and other gew-gaws, introducing herself as the queen of song and tragedy. A negress was being sympathized with by another visitor as unjustly incarcerated, owing to her modest and rational behavior, when she launched a murderous kick which nearly ruptured his perineum.

An "expert" for the State swore that Busch was feigning traumatic insanity, but could not describe how that was when the prisoner appeared to be rational. He was further unable to enumerate any of the different forms of insanity, and when asked the difference between monomania and mania, said that the first was "off on one subject, while the other was off on several;" that the maniac's memory was always impaired. He had never heard of katatonia or hebephrenia, and claimed that the murder was the product of an ordinary beer drunk. This alienist defined an insane delusion as a faulty idea having no foundation in fact, and a hallucination was one that had such foundation. Walker and Furthman, former assistant State attorneys, defended the case, and the former asked, "If a child believes the moon to be made of green cheese, is not that belief a faulty idea not founded on fact, and is the child therefore insane?"

The trial lasted two weeks, and was ably conducted by the attorneys, extraordinary diligence being used to procure testimony of Busch's antecedents and behavior before the murder. Less energetic and astute charge of the case would have left the insanity badly sustained.

The jury found Busch guilty, but sentenced him to the penitentiary for life,—a most illogical verdict; for were he sane, under the law wording he should hang; and if insane, the asylum, and not the penitentiary, is the proper place for him. He should not have been liberated under any circumstances, if sent to an asylum. It was doubtless the expectation that he might escape from an institution for insane that inspired the verdict.

Soon after this he was taken to the penitentiary, and was sent by the prison officials to the Kankakee Asylum for the insane, where he has remained ever since.

In some States there is provision made for insane criminals in special asylums. Juries usurp the functions of legislatures and perjure themselves when they endeavor to compromise between public clamor and their disinclination to condemn the insane to death. The abolition of the death penalty and provision for insane criminals will solve the question, as, except among savages, the intent of the law is not vengeance, but the protection of society.

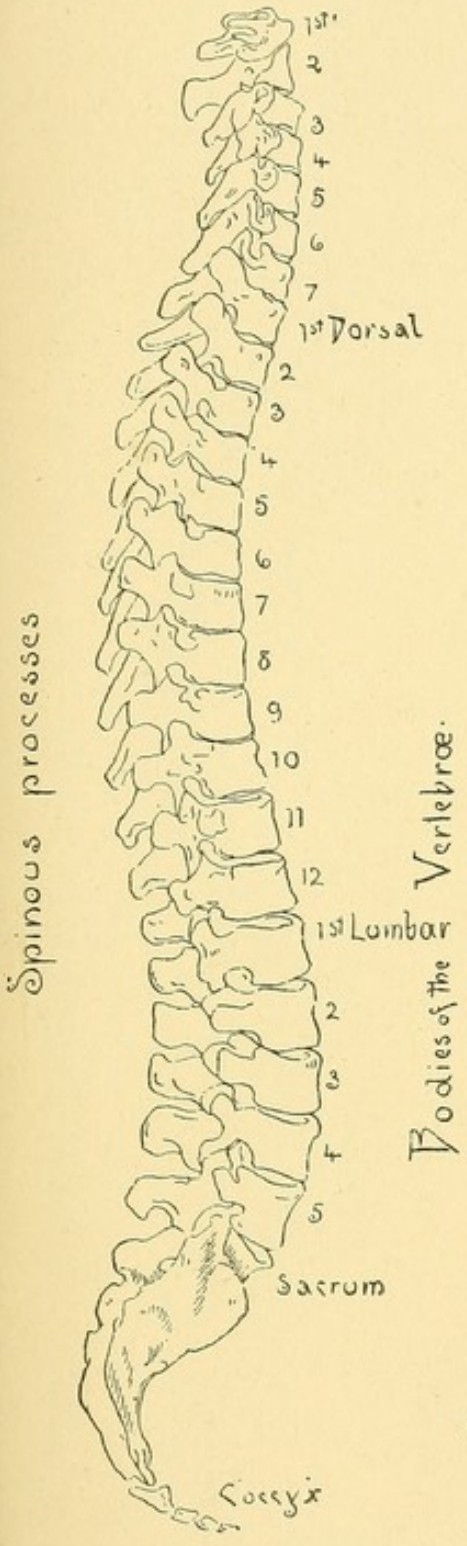

Spinous processes
1st
2
3
4
5
6
7
1st Dorsal
2
3
4
5
6
7
8
9
10
11
12
1st Lumbar
2
3
4
5
Sacrum
Coccyx
Bodies of the Vertebræ.

FIG. 1.

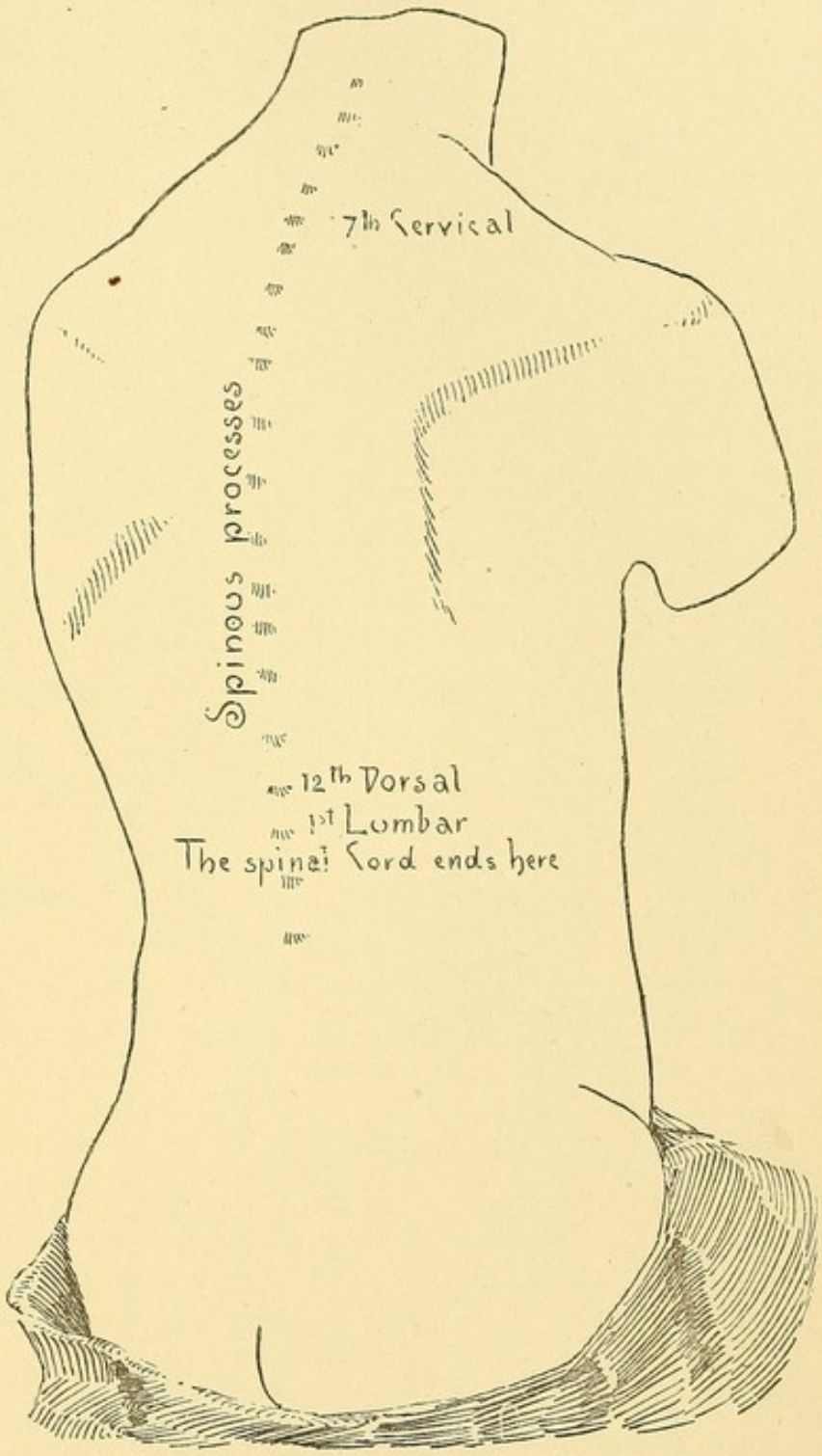

7th Cervical
Spinous processes
12th Dorsal
1st Lumbar
The spinal Cord ends here

FIG. 2.

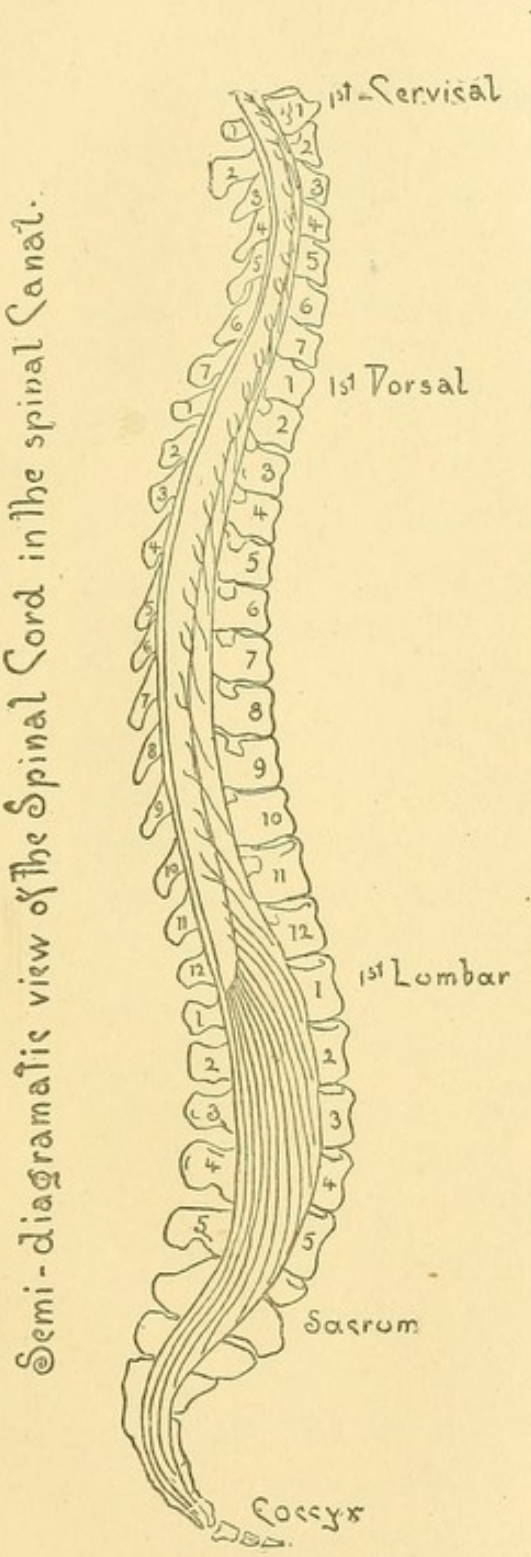

Semi-diagramatic view of the Spinal Cord in the spinal Canal.
1st Cervical
1st Dorsal
1st Lumbar
Sacrum
Coccyx

FIG. 3.

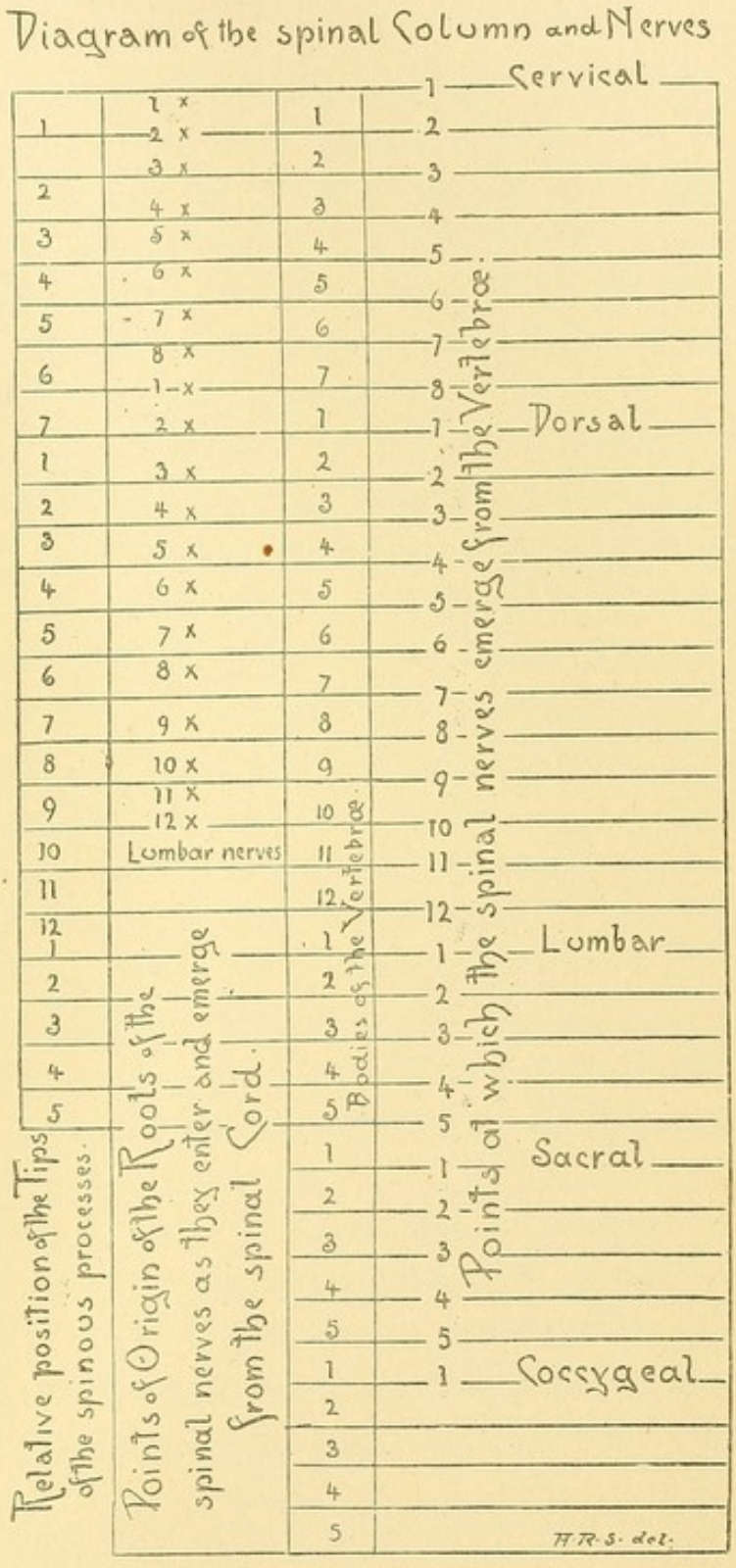


Diagram of the spinal Column and Nerves
Relative position of the Tips of the spinous processes.
Points of Origin of the Roots of the spinal nerves as they enter and emerge from the spinal Cord.
Lumbar nerves
Bodies of the Vertebrae.
Points at which the spinal nerves emerge from the Vertebrae.
Cervical
Dorsal
Lumbar
Sacral
Coccygeal
H.R.S. del.

FIG. 4.

CHAPTER VIII.

THE SPINAL COLUMN.

THE vertebral column is made up of bone-segments separated by cushions of cartilage, and the entire "backbone," as it is popularly called, is perforated by a canal in which is suspended the spinal cord and its membranes, extending from the brain to the "small of the back" (see Fig. 3). Holden's* description of the bones is the best and easiest understood of all works on the subject in the English language.

Three slight curves are described by the spinal column; forward in the neck and loins, and backward from the chest. Deviations from these, in various directions and degrees, constitute pathological curvatures. Muscles are attached to the projecting and other parts of the vertebræ, as the bone-segments are called, and bundles of nerves pass through apertures in the column to and from the spinal cord and body in general. No adequate description of these nerves could be made here without using space and time unnecessarily. The general reader, not versed in medical matters, is referred to anatomical or physiological books† for full information, but there are important facts in connection with our subject to which special attention must be called, many of which cannot be found in the older works, as the past ten or fifteen years have developed great advances in our knowledge of the nervous system.

The spinal canal is lined with a sheathing of periosteum, and between this and the cord there is connective or areolar tissue, filled with fat-cells and blood-vessels, surrounding the cord and its membranes. The outermost membrane is the dura mater, a dense, tough skin, loosely attached to the bony canal

* Luther Holden, F.R.C.S., Human Osteology, London, 1857. At one time this excellent work was allowed to go out of print, but recent editions have been published and are in good demand.

† Henle's Nervenlehre; Quain's, Gray's, Allen's, Leidy's, or other Anatomies; Dalton's, Carpenter's, or Foster's Physiologies.

sides by the connective tissue, and enveloping the arachnoid membrane sac, which contains the cerebro-spinal fluid. This sac is very delicate and filmy. Closely attached to the surface of the cord is the pia mater, a membrane made up of fine blood-vessels and interlacing fibrils.

The pia mater covered cord floats in the subarachnoid space with its fluid, and is held to the arachnoid behind by the *septum posticum*, a thin membranous partition, between the layers of which run the larger blood-vessels of the cord. The *liaamentum denticulatum* is a narrow fibrous band, resembling

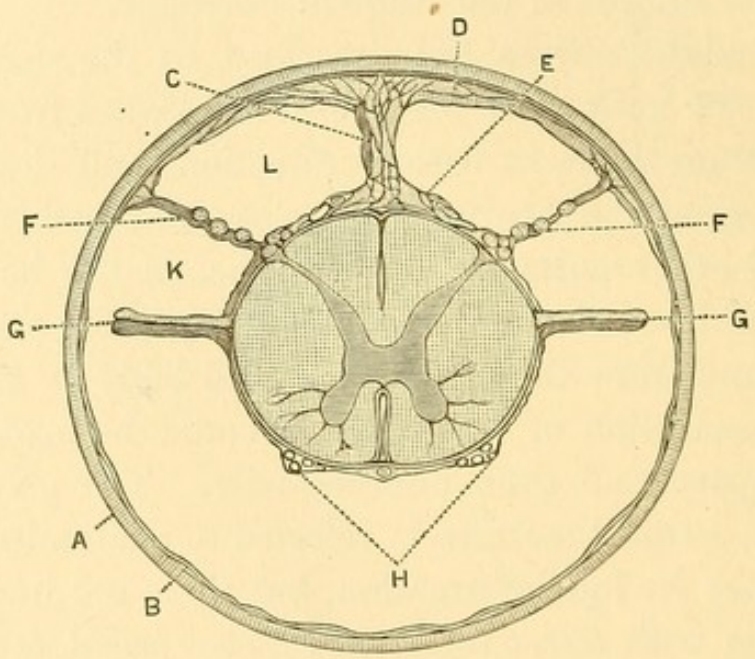


FIG. 5.—SECTION THROUGH THE SPINAL CORD AND ITS MEMBRANES IN THE UPPER DORSAL REGION. (AFTER KEY AND RETZIUS.) MAGNIFIED.

A, dura mater; B, arachnoid; C, septum posticum; D, E, F, subarachnoid trabeculæ, those at F, F supporting bundles of a posterior nerve-root; G, ligamentum denticulatum; H, sections of bundles of an anterior nerve-root; K, L, subarachnoid space.

saw-teeth, the points of which pass to the dura mater and thus support the cord on each side and assist in holding it in the middle of the cavity. There are about twenty-one of these "saw-teeth" ligamentous points. The spinal nerve-roots pass between the cord and bones, and are covered by a continuation of the spinal dura and arachnoid membranes; these nerve-roots also hold the cord, more or less rigidly, within the spinal canal. (Relationship of the cord and membranes is sketched in Fig. 5.)

In the centre of the spinal cord is an H-shaped prolongation of gray matter, surrounded by nerve-fibres which pass up and down, to and from the brain. For convenience the cord,

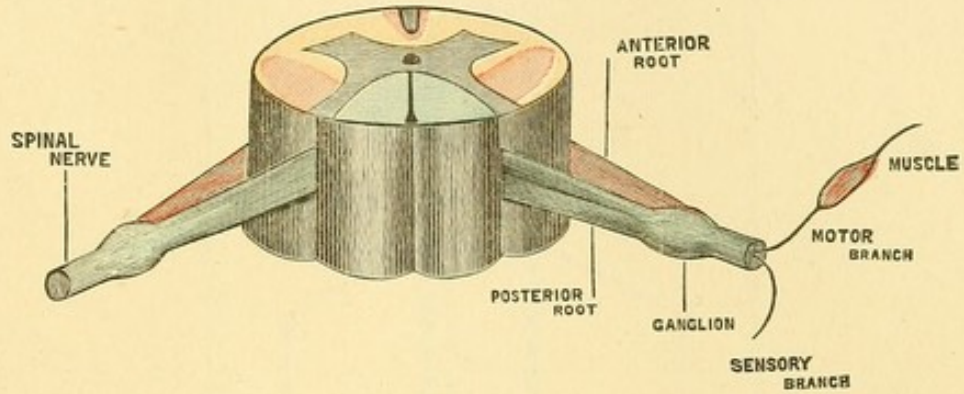


FIG. 6.—A SPINAL SEGMENT. (MODIFIED FROM SHARPEY AND QUAIN.)

though continuous, may be considered as divisible into segments joined together, each segment representing a centre for particular parts of the body and limbs, and, to quote from Bramwell, "the essence of the clinical examination of the spinal cord con-

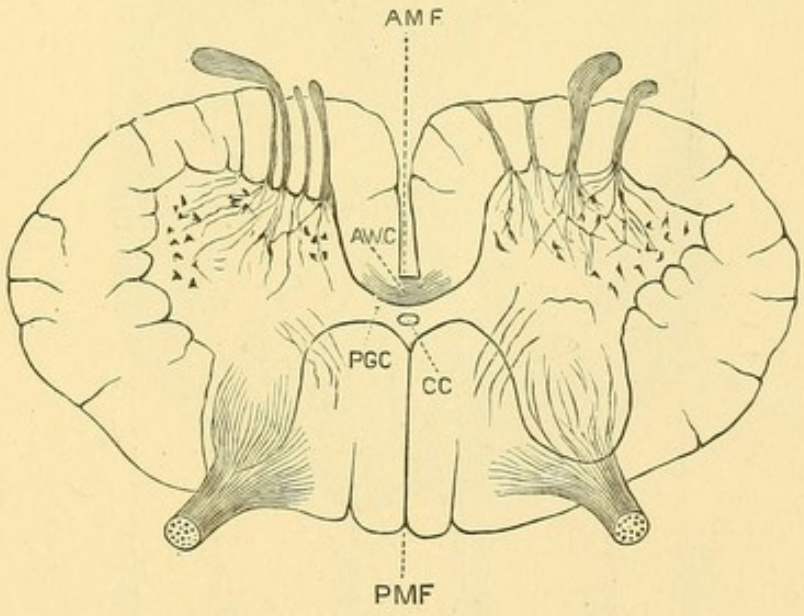


FIG. 7.—TRANSVERSE SECTION OF A SPINAL SEGMENT IN THE CERVICAL REGION. (BRAMWELL.)

AMF, anterior median fissure; PMF, posterior median fissure, or septum; AWC, anterior, or white, commissure; PGC, posterior, or gray, commissure; CC, central canal.

sists in the systematic and separate examination of each spinal segment by observing the motor, sensory, reflex, vasomotor, and trophic conditions of its body area; and the comprehension of

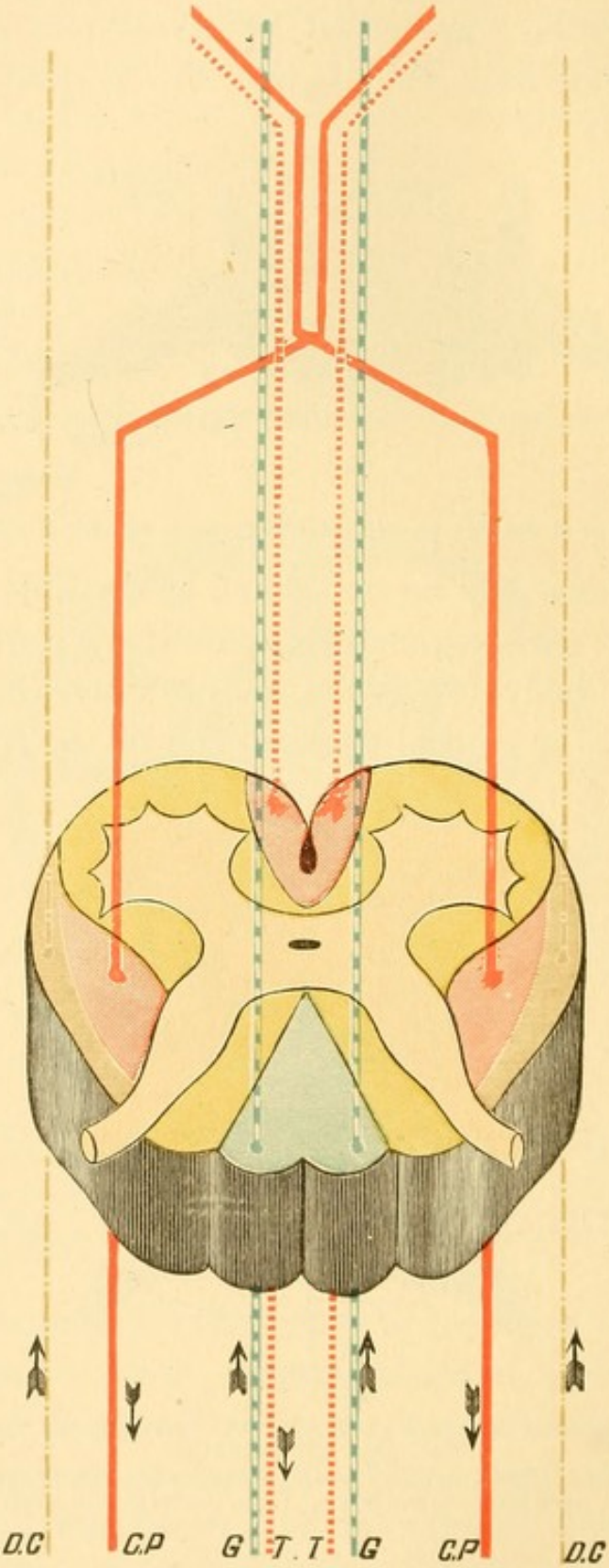


FIG. 8.—A DIAGRAMMATIC REPRESENTATION OF THE CONDUCTING TRACTS OF THE SPINAL CORD. (MODIFIED FROM BRAMWELL.)

T, fibres of Türck's column (direct pyramidal bundle); *C. P.*, "crossed pyramidal fibres;" *G*, fibres of the column of Goll (postero-median column); *D. C.*, fibres of the "direct cerebellar column." Note that the arrows show the direction of the impulses carried by each tract of fibres. Also that the motor fibres of the lateral column decussate at the *lower part of the medulla*. Each of the "anterior pyramids" of the medulla is composed of the motor fibres (direct and decussating) above the lower limits of the medulla.

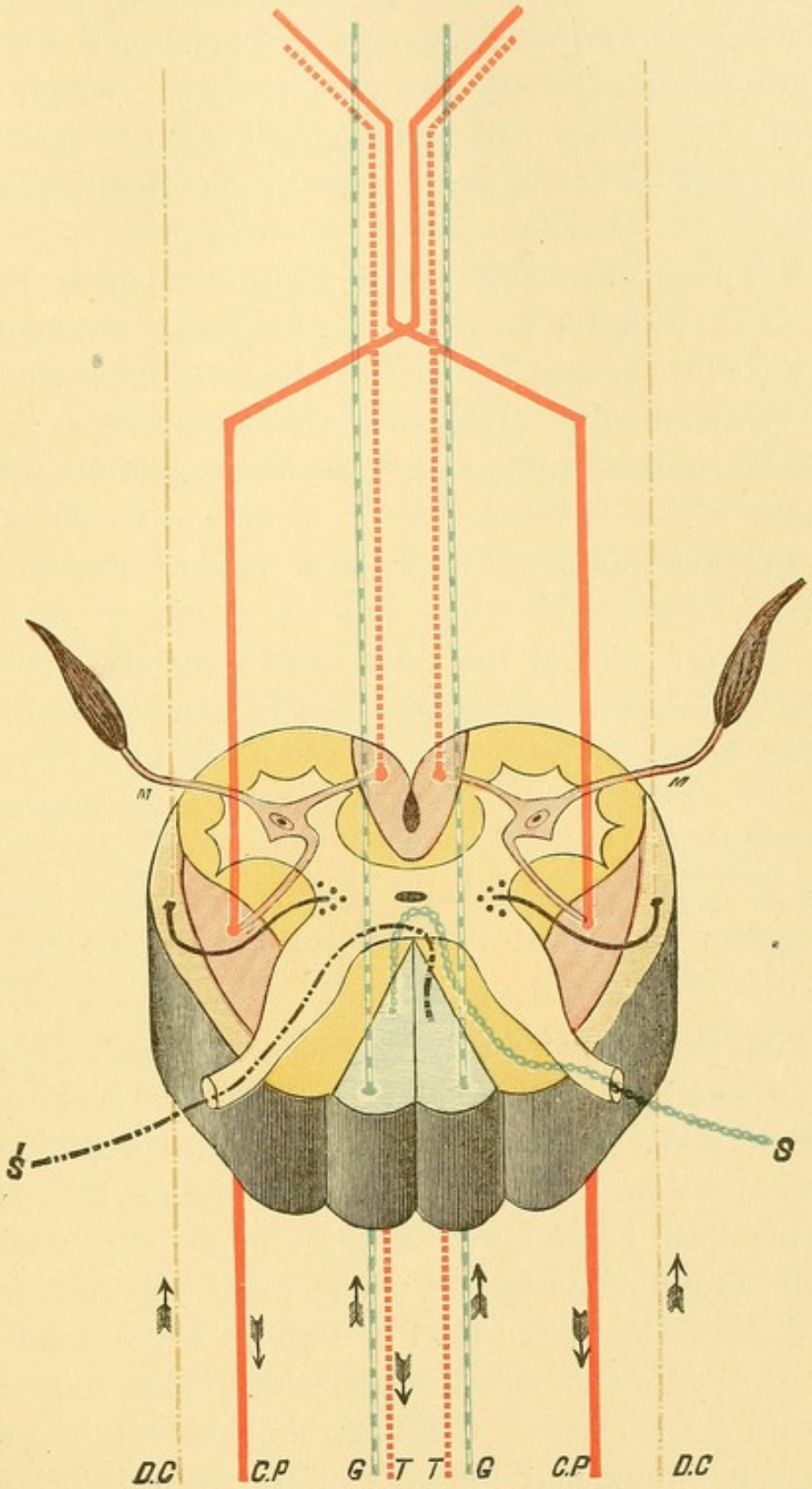


FIG. 9.—A DIAGRAM DESIGNED TO ILLUSTRATE THE CONNECTIONS OF THE MOTOR AND SENSORY CONDUCTING TRACTS OF THE CORD WITH THE SPINAL NERVES. (MODIFIED FROM BRAMWELL.)

M, motor fibres of the anterior root of a spinal nerve; *S*, *S'*, sensory fibres of the posterior root. Note that the course of *S* and *S'* are not the same. Some sensory fibres pass directly through the posterior horn of the spinal gray substance and others through Burdach's column to reach the gray substance. The direct cerebellar column is composed of fibres which start in Clark's column of cells. The fibres of the two pyramidal tracts become united to the motor cells in the anterior horns of the spinal gray substance.

the diseases of the spinal cord consists essentially in the correct understanding of the structure and functions of the individual parts of these spinal units; of the manner in which they are related to each other; of the pathological changes to which they are liable, and of the derangements in function which result therefrom."

The cut on page 189 (Fig. 6) illustrates one of these segmental disks with its incoming sensory and outgoing motor nerves, the "fore-and-aft" anterior and posterior median fissures, and the perpendicular columns of nerve-strands, passing to and from the brain, surrounding the gray matter which contains the nerve-cells.

A less diagrammatic picture of a cord section appears in Fig. 7.

To give an idea of the fineness of structure of the brain, cord, and nervous system generally, a few microscopical measurements may be cited:—

	Millimetres.		Inch Fractions.
Capillaries,* . . .	.15 to .007	=	.006 to .0003
Lymph-spaces,† . . .	.01 to .003	=	.0004 to .00012
Nerve-cells, ...	.04 to .0056	=	.0016 to .0002
Nuclei, ...	.0131 to .0045	=	.0005 to 00017
Axis Cylinders,‡ . . .	.01 to .001	=	.0004 to .00004

Taking Schmidt's§ measurements of the granules of some of the nerve-cells as an average for most of the nervous system structure, at seven hundred and fifty to the square millimetre, there would be forty millions in a cubic millimetre. It would, to a microscopist, be an absurdly gross reduction to estimate the nerve-cells and fibres, capillaries, and other important constituents of the brain or spinal cord to number a thousand millions to the cubic inch; and when we consider that a most intimate relationship exists between these minute tissues, to the end that there may be functional integrity of the bodily workings over

* Ch. Robin, Journal de la Physiologie, October, 1859.
† J. Hoffman, Journal of Neurology and Psychiatry, August, 1883.
‡ Schmidt, Journal of Nervous and Mental Disease, January, 1879.
§ *Ibid.*

which these organs preside, health becomes more wonderful than disease, and the folly of otherwise than tentatively designating any disorder as functional, in contradistinction to organic, becomes apparent. Health depends upon the proper interaction of these and other microscopic and ultra-microscopic organs, such as blood-corpuscles and their contents, so that the misplacement, in time or space, of usual relations between these structures makes an "organic" disease if apparent to the eye, or a "functional" disease if not. There can be no doubt but that *all* disease is organic, ultimately. The terms "functional" and "organic" have, however, a certain convenience, though they are sadly abused at times. There should, therefore, be due regard for these and other such facts as that a pin-point prick in the floor of the fourth ventricle of the brain and cord may cause diabetes mellitus and death.

The sensations of touch, pain, and temperature are conveyed to the cord and brain by the posterior sensory nerves, and when these nerves are destroyed, in any part of their course, those sensations are cut off. Impairment of those sensations indicates interference with their conducting tracts. The posterior columns of the cord convey touch sensations, but pain and temperature sensations reside in the gray matter of the cord, as touch may be interfered with when the posterior columns are affected, but not the other sensations, unless the gray matter is deranged. The columns of Goll and Burdach, if injured, cause anæsthesia at the level of or below the lesion.

Abnormal sensations, such as anæsthesia, hyperæsthesia, heat and cold sense aberrations, and paræsthesia, indicate interference with the sensory-tract conduction. Pain in the spinal region may be caused by disease of the vertebræ or meninges.

Girdle pains indicate interference with the spinal posterior gray or conducting tracts, and often indicate the level of a lesion.

As sensory fibres cross to the opposite side of the cord, a lesion may be in that part of the gray matter or ascending

columns opposite to the side of the body affected, or in the roots of the nerve of the same side.

Destructive lesions of the sensory tracts of the cord have a tendency to ascend; those of the motor tracts similarly descend.

Paralyses or atrophy indicate lesions upon the same side of the cord.

Lesions in the anterior gray horns produce motor and trophic disturbances.

Contractures are produced by injury to the crossed pyramidal tracts in the lateral columns of the cord.

Dilated pupils sometimes are due to irritation of the cervical gray matter and contracted pupils to degeneration in the same region.

The skin reflexes are controlled by nerve integrity at their respective levels of cord centres, and decrease with lateral column degeneration.

Alterations in the meninges induce sudden pains and jactitations.

Inco-ordinations of movements may be caused by any tract or centre being involved to the extent of interfering with prompt sensory or muscular action. The posterior columns of the cord or the lateral tracts may originate, by disease, inco-ordinated motions.

Priapism may be caused by an irritative lesion in the cervical or upper dorsal segments. Sexual impairment may follow upon injury to the reflex centre in the lumbar part of the cord.

Satyriasis is sometimes a feature of locomotor ataxia, and may be due to irritation of the sensory nerve-filaments in the lumbar region of the cord.

The reflex levels are:—

Interscapular, in the lower cervical and upper dorsal cord; epigastric, fourth to seventh dorsal; abdominal, eighth to twelfth dorsal; cremasteric, first and second lumbar; gluteal, fourth and fifth lumbar; patellar tendon, entire lumbar; plantar, vesical, rectal, and sexual, in lumbar enlargement end of cord.

Moxon,* quoted by Page (p. 228), and also by Bramwell (p. 243), describes the precariousness of the blood-supply to the spinal cord thus:—

"Here I must take the liberty of drawing your attention to some very well known anatomical points by which the curious fact that only the legs suffer in the caisson disease is, I think, quite clearly explained. I need scarcely remind you that, whilst the spinal canal extends down into the sacrum, the spinal cord does not extend below the lower border of the first lumbar vertebra; but the spinal cord gives off nerves all the way down on each side, and the spinal canal on its part is pierced on each side with a series of openings all the way down, even to the lowest part of it, at pretty even intervals, the openings serving to let out the nerves that arise from the cord. The consequence of this arrangement is, of course, that the distance between the place of origin of the nerves of the cord and their place of exit from the canal is short, as to the upper nerves, but increases much as to the lower nerves, so that the nerves run nearly horizontally to the neck and upper limbs; whereas to the loins and legs they run a long way down before reaching the dura mater, extending, indeed, for many inches, and forming a bunch of long, loose threads something like a horse's tail, and known as the cauda equina. Now, the spinal cord *is* suspended within the spinal canal in subarachnoid fluid, which entirely insulates it, and, meantime, surrounded by this liquid, and insulated by it, the spinal cord itself is out of reach of any blood-supply, except such as can come to it from the brain above, or else along the nerve-roots at the sides. And, in fact, the supply of this important part becomes, if I may so speak, one of Nature's difficulties. Let us see how the difficulty is met. The blood-supply to the spinal cord is carried out by slender vessels which come from the vertebral arteries within the cranium. There are three of these arteries,—one on the front and two on the back of the cord; they are very slender, and

* Croonian Lectures, Royal College of Physicians, Lancet, vol. i, 1881, p. 530 *et seq.*

yet have to run along its whole length. No arteries so small as these run so great a length elsewhere in the body, and pressure falls rapidly in minute arteries as the length of pipe increases, so that it becomes necessary to re-inforce these slender vessels wherever possible, and advantage is taken of the nerve-roots to send up little re-inforcing arteries along these. In the part of the cord corresponding to the neck, upper extremities, and trunk, where the nerve-roots are short, the re-inforcing arteries are also short, and they reach and join and furnish blood to the spinal arteries, so that in this part of the cord every segment of it is supplied with blood from two directions, the anterior spinal artery bringing blood from above and the re-inforcing artery from below. But when you approach the tip of the cord the supply from below becomes exceedingly precarious, and even apt to fail entirely, because upon the long strands of the cauda equina the small arteries are too narrow and too long to re-inforce the cord with any certainty. But, at the same time, the supply from above has to be furnished with greater difficulty than in the upper regions of the cord, because the original anterior spinal artery is very far away, and the re-inforcing arteries, even in the lumbar region, have to run considerably longer courses than they had in the cervical region.

"Thus the tip of the cord has its blood-supply only from above, and deficiently even there, whilst the upper parts of the cord have a better-sustained supply both from above and below, and this becomes especially the case upon the cauda equina itself, for here the arteries are exceedingly minute and uncertain in size on the several nerves. Hence we see that the tip of the spinal cord, corresponding to the lower limbs and sphincters, is much more weakly organized as to its circulation than are the upper parts of the cord. . . . . I believe it is by impediment to the exceedingly and peculiarly difficult blood-supply of the caudal end of the spinal cord that all these various conditions lead to paralytic weakness of the lower limbs, and they are to be met by conditions improving the circulation, if possible."

The blood-supply to the cord is often easily influenced by external applications to the spine, and derivation may be obtained by lying upon the face. Sudden cold affusions also produce quick reactions. Furthermore, John Hilton's remarks* concerning the peculiar sensations of "pins and needles" are applicable to other and greater pathological states:—

"What has happened," he asks, "when they occur, for example, when a man has fallen with his back upon the ground? It is possible that the spinal marrow, obeying the law of gravitation, may, as the body falls, precipitate itself in the same direction, fall back toward the arches of the vertebræ, and be itself concussed in that way. Or the little filaments of the sensitive and motor nerves, which are delicately attached to the spinal marrow, may, for a moment, be put in a state of extreme tension, because, as they pass through the intervertebral foramina, they are fixed there by the dura mater; and, if the spinal marrow be dragged from them, the intermediate parts must necessarily be put upon the stretch, producing at the same time the 'pins and needles' sensation, and also explaining the symptoms felt on the following day. It is impossible that these symptoms could be the result of anything but some structural disturbance; and they are, to my mind, the evidence of decided injury to the nerves or marrow, although what that injury may be is not ascertainable."

These views of Hilton's are capable of extension to wrenches, etc., of the vertebræ, not only disturbing the precarious circulation of the cord, but by strains inducing more or less permanent irritation of the nerve-roots and meninges, and, *what seems to have been wholly lost sight of by all writers, lesions of the soft and poorly-protected spinal sympathetic communicating fibrils.*

Relegating further consideration of the pathology, thus hinted at, to an appropriate, later chapter, the anatomical and physiological matters of this intimate connection of the cord with

* Rest and Pain, p. 49, quoted by Page, p. 125.

the sympathetic nervous system can be well illustrated by quotations from Edward Long Fox's recent work.* He says:—

"If it be allowable to hazard a conjecture, founded more upon pathological and clinical observation than upon anatomical proof, the gangliated cords that run the length of the trunk of the body are united with some of the cells of the anterior horns, and probably with the cells of second and third dimensions.

"The twofold connection of the sympathetic ganglia with the spinal cord by means of the double set of fibres from each ganglion to the spinal nerve above it; the fact that of these fibres one, medullated, seems to have its exit from the cord with the anterior root of the spinal nerve, the other, non-medullated, to enter the spinal cord and to be distributed to its vessels; the connection of each ganglion with the one below it by similar medullated and non-medullated fibres,—all speak, on the one hand, of the close dependence of this great chain of ganglia with the cerebro-spinal centres, whilst, on the other, they point, under certain circumstances, to their independent action."

I have long held the impression that the entire vasomotor sympathetic nervous system was intimately bound up with every cerebro-spinal act, and thus expressed myself†:—

"Dilatation is a nutrient reflex. Upon muscular excitation there is reparative demand. If a muscle be stimulated to contraction, it would seem proper that means of repairing the waste involved in the contraction should be provided. The osmotic power of the vessels is drawn upon with muscular action, occasioning a secondarily induced rush of blood to the part being nourished. This being the established action of the entire nerve distribution in the parts under consideration, that mode of action would adjust both cerebro-spinal and vasomotor systems to its repetitions, and it must be borne in mind that vaso-dilator fibres run chiefly in the cerebro-spinal and vaso-constrictor in the sympathetic nerves; but, even admitting the dictum of Dastre and

* The Influence of the Sympathetic on Disease. London, 1885.

† Comparative Physiology and Psychology, p. 153. Chicago, 1884.

Morat that vaso-dilator fibres exist in the vago-sympathetic trunk, concomitant phenomena, such as dilatation following exercise of a part, could develop the molecular susceptibilities of a nerve constantly associated with definite workings of other nerves as to render the dilatation constant whether the motor or the sympathetic branch was irritated. Associated serviceable habit, as Darwin has shown, develops the most extraordinary capabilities throughout organic life, especially evident in the emotions.

"Blood conditions in a centre can become associated with distant movements, calculated to alter the nutrition of the irritated point for the better, and, whether through paralysis of a strand or through stimulation, the adjustment of the nerve to its function may result in diametrically opposite modes of working. The apparently erratic conversion of constrictors into dilators, and *vice versâ*, is best accounted for by Lepine's* experiments on the frog's sciatic, the conclusion from which is that the same fibre may act as dilator or constrictor, *according to the condition of the peripheral mechanism.* Foster† suggests that the paths along which the impulses of afferent or central origin issue as efferent impulses are determined, in part, by the condition of the cord and character of the afferent impulses, or of the central disturbance.

"The vasomotor phenomena attending *every* reflex, whether cerebro-spinal or sympathetic, are of more importance than could be judged from their little consideration by writers. The assumption of a vasomotor accompaniment to every act of the nervous system involves an explanation of much hitherto considered inexplicable. No blood, no action; plus blood, plus action. Every vital act incurs expenditure, sensation as well as motion. The irritation of every cell causes waste and necessitates repair. If the reparative (vasomotor) power be annulled, the function ceases with death of the part. Regeneration of nerve-areas must be regarded as identical with that of any other

* Comp. Rend. Soc. Biol., March 4, 1876. † Physiology, p. 284.

tissue. The brain is nourished precisely as are other organs, reflexly through irritation at the point needing restoration. Molecular change, depletion, expenditure is the irritant. The amœba moves more rapidly when hungry than after being fed. The vasomotor is the reparative system, and its reflexes must be considered with reference to that function, regardless of but little else. Such visceral parts as use blood most rapidly are in the greatest condition of vasomotor irritation. Habit fixes the quantity of blood and regulates its afflux. The vasomotor connections with the cerebro-spinal system have the same significance as their connection with other organs. Splenetic, gastric, uterine, hepatic, muscular, etc., irritation, through want of blood, starts the reflux, and, no matter whether sensory or motor nerve needs restoration, the irritation of either will start vasomotor action as readily as impulses to abdominal viscera.

"The connection of sympathetic fibres with both sensory and motor cerebro-spinal nerves has no other value than that the vasomotor system recks of molecular motion without discrimination as to whether those motions produce sensations or muscular actions. In healthy conditions of the body mere friction induces the suffusion of the surface with blood. If a sensation pass over a spinal nerve, molecular motions are set up in that nerve and stimulate vasomotor action; if a motor nerve be engaged, both nerve and muscle thereby excite vasomotor afflux of blood to them. But due regard must be paid to the blood conveyance in the entire animal, for a disturbance at a distance may render stimulation of other parts inoperative. Hence, the variable nature of sympathetic workings may be represented by the active points A, B, C, D, E, having a tonus of 10 along their vasomotor filaments. A, being stimulated to contractile effect 20, B, C, D, E vessels at first are surcharged and dilated by the blood-pressure, but by diffusion the general tonus is distributed as 12 to all points. Let E demand repair through exhaustion, lowering the tonus of that point to zero, then the remaining tonus of all falls to 9.6. Now let C and E

require blood before the vessels at E have been restored to their usual calibre, A, B, D will be in tone, C dilated, and E will be extremely dilated. It is plain that a strand, ordinarily acting as a constrictor at A, could not thus act at this stage, but would appear to act as a dilator, through its stimulation having aided in raising the tone of C and E, the general distribution causing the tone at A to fall.

"The vascular tonus being normal generally in the indifferent regions, there will follow dilatation if other vascular regions are dilated, through the diffusion acting first to re-establish tonicity, the dilatation being compensatory in the region apparently stimulated. The most important thing to remember is that the *nutrient reflex* occurs with every cerebro-spinal irritation, the vasomotor flash of supply to the points irritated."

These and allied considerations, showing the interaction of the cerebro-spinal and sympathetic nervous systems, I detailed in the work mentioned, but, while they are fascinatingly simple to tyros in physics and chemistry, the general want of knowledge of those branches by many medical persons leads them to regard such matters as theoretical. A few feet of rubber pipe filled with water and marked at intervals with the letters A to D, as above, and pressed at one or more of those intervals, will sufficiently demonstrate the "common sense" of my "nutrient-reflex theory," which has been commended very thoroughly by savants. But, turning again to Fox, he describes the numerous sympathetic ganglia of the cranium and cervical region, which regulate the blood-supply of the brain and head generally, and, in speaking of the inferior cervical ganglion between the neck of the first rib and the transverse process of the last cervical vertebra, beneath the vertebral artery, he says: "It is connected with two and sometimes with three lowest cervical nerves, and may be considered a simple ganglion, like one of the thoracic chain. Its important branch is the lower cardiac nerve, which communicates with the middle cardiac and the recurrent laryngeal, and terminates in the deep cardiac plexus. It also sends

branches round the subclavian artery, and a more important branch along the vertebral artery, and this branch communicates with the sixth, seventh, and eighth nerves, *so bringing the phenomena of tinnitus and vertigo into relation with lesions of very various parts of the system.*" (Italics mine.)

"The connection of the sympathetic with the cranial nerves is as follows:—

"With the first nerve, only indirectly through the nasal branch of the ophthalmic nerve (of the first division of the fifth), which nerve is joined by filaments from the cavernous plexus of the sympathetic.

"With the second nerve, the optic, perhaps by a small branch from Meckel's ganglion, perhaps by a small filament from the ciliary nerve; from the lenticular ganglion, *penetrating the optic nerve with the arteria centralis retinæ.*" (Again emphasized by me, for its important bearing upon our subject in accounting for visual aberrations of a "functional" nature.)

"With the third nerve, the motor oculi, by filaments from the cavernous plexus; with the fourth nerve, the pathetic, by filaments from the same in the outer wall of the cavernous sinus.

"With the fifth nerve, the trifacial:—

"1. The Gasserian ganglion, by filaments from the carotid plexus.

"2. The ophthalmic nerve, by filaments from the cavernous plexus, the ganglionic branch of the nasal branch of the ophthalmic nerve by cavernous plexus filaments.

"3. Meckel's ganglion, by filaments from the carotid plexus, through the Vidian nerve.

"4. Ophthalmic ganglion, by filaments from the cavernous plexus.

"5. Otic ganglion, by filaments from the plexus round the middle meningeal artery.

"6. Submaxillary ganglion, by filaments from the plexus round the facial artery.

"With the sixth nerve, the abducens, in the cavernous sinus, by filaments from the carotid and cavernous plexuses.

"With the seventh, the facial; in the aquæductus Fallopii, by the external petrous connected with filaments accompanying the middle meningeal artery; and at its exit from the stylo-mastoid foramen, by filaments from the carotid plexus.

"With the seventh, the auditory, it is doubtful if there is any direct connection; but perhaps sympathetic fibres join it from the internal auditory branch of the vertebral artery.

"With the eighth, the glosso-pharyngeal. The petrous ganglion of this branch is joined by one from the superior cervical ganglion; the carotid branches of the tympanic branch are joined by filaments from the carotid plexus.

"With the eighth, the pneumogastric. The root ganglion, by a branch from the superior cervical ganglion; that of the trunk, by a branch from the superior cervical ganglion; the pharyngeal branch, by filaments of the pharyngeal plexus.

"The external laryngeal branch, by a communication with the superior cardiac nerve; the recurrent, by cardiac branches; the anterior and posterior pulmonary branches, by filaments from the third and fourth thoracic ganglia; the gastric branches, by fibres from the solar plexus.

"With the eighth, the spinal accessory, at the ganglion of the pneumogastric root.

"With the ninth nerve, the hypoglossal, opposite the atlas, by branches derived from the superior cervical ganglion.

"All three cervical ganglia in some sense rule the heart; all in various degrees supply vasomotor power to the vessels of the spinal cord; the superior cervical ganglion, by its connection with the lenticular, has much to do with the movements of the iris." Detailing further the extensive blood-vessel regulation of the brain, he mentions that "after ablation of the superior cervical ganglion, vasomotor influence may gradually be supplied by nerves from the cervical plexus, by fibres from the pons, medulla, and upper part of the cord." (Accounting for partial

restoration of function after injury, as in the policeman mentioned in my Chapter VII, who was injured in the cervical sympathetic, but in after years the flushing of one side ceased. These partial functional restorations may also account for the incomplete recoveries from traumatic neuroses.)

Observe that no sympathetic fibres are found in the brain or cord substance, nor in the lungs, and this has puzzled histologists; but upon the nutrient reflex theory it suffices that the propinquity of blood-vessels to *uninsulated* nerve-substance would, through the direct molecular action of the nerve-cell or neuroglia, provoke nutrition from the vessels lying nearest, without the necessity of regulating nerve-strands, and the constant, regular supply of blood in the lungs sufficiently nourishes the ultimate structures; so that in both gray matter and lungs sympathetic fibres are not needed, but the larger vessels passing to those structures are supplied with vasomotor regulating apparatus for obvious general equilibrating purposes.

"In the thorax, on each side of the spinal column, lying over the heads of the ribs, and covered by the pleura, is placed a ganglion corresponding to each dorsal vertebra, connected with the spinal nerve of the same region by two branches, one a branch of the nerve itself, the other composed of sympathetic filaments. The disturbances that occur in the circulation of the spinal column on the destruction of this sympathetic branch render it more than probable that it has its origin in the ganglion, although the oculo-pupillary phenomena, and the vasomotor, that arise on sections of various regions of the upper cord, prove that each segment of the cord may contain a sympathetic centre. The first thoracic ganglion is small, and is sometimes united with the inferior cervical ganglion. Each ganglion is connected by one or more branches with the ganglion above and below it; the second and third send branches to the thoracic aorta, the vertebræ, the œsophagus; the fourth ganglion sends important branches to the posterior pulmonary plexus. The lower thoracic ganglia are the centres of origin for the splanchnic

nerves. Of these, the great splanchnic, the most important sympathetic root in the body, is generally formed by roots from the fifth, sixth, seventh, eighth, and ninth thoracic ganglia. Its origin varies in different individuals."

It terminates in the semilunar ganglion, and spinal nerves preponderate in its composition.

The smaller splanchnic goes to the cœliac plexus, and the smallest ends in the renal plexus.

"In the lumbar region the ganglia are nearer to each other. They lie along the inner edge of the psoas muscle. Most usually there are four, but the number may be three or five. They send branches to form the lumbo-aortic plexus over the lower part of the aorta, and thence supply branches to the superior mesenteric plexus, which has but few ganglia, and to the spermatic or ovarian plexus, a prolongation at once of the renal, solar, and lumbo-aortic plexuses."

The complex pelvic ramifications of the sacral part of the gangliated cord are then described, and "the abdominal plexuses seem all to find their centre of origin in the solar plexus. Connected as it is with almost every organ of the body, with a vast influence on the circulation, with direct power over all the secretions of the abdominal and pelvic viscera, with a reflex reaction on the heart that under certain conditions may lead to fatal syncope, it is scarcely to be wondered at that some physiologists have considered it the very centre of life itself."

Pflüger thinks that each hepatic cell has a sympathetic fibril ending in it.

"The prostatic plexus is between the prostate and levator ani; a branch passes to the vesiculæ seminales. It is then continued forward to form the cavernous nerves of the penis.

"The pelvic plexus also sends nerves to some of the branches of the internal iliac artery that do not go to viscera. These branches are the obturator, the ileo-lumbar, part of the sciatic, the lateral sacral, and the gluteus."

Further discussion of the sympathetic system, in health

and disease, is deferred until we come to symptomatology and pathology. Enough has been stated to show that this visceral and vascular nervous system is a constituent part of the spinal column most exposed to injury, and that lesions therein have never been mentioned as likely to occur in concussion accidents.

The absence of fibres of Remak from the spinal cord and the known pathological connection of Clark's vesicular column with nutrition are at once explained by recognizing the medullated anterior spinal nerve-root branch to the spinal sympathetic ganglion as a true motor cerebro-spinal nerve communicating with the vasomotor system from the "trophic cells" in the anterior gray horn of the cord. The sympathetic fibrils run to the sensory posterior nerve, but the spinal motor nerve runs to the sympathetic ganglion.

CHAPTER IX.

SYMPTOMS OF ERICHSEN'S DISEASE (SPINAL CONCUSSION).

To John Eric Erichsen, of London, belongs the credit of being the first to describe a group of symptoms, mainly nervous, that frequently occurred after a concussion of the spine, even though no demonstrable lesion was inferable ante-mortem, or discoverable post-mortem. The progress of a quarter of a century in medicine has justified Erichsen, and, though neurologists have eliminated minor errors and built upon his discoveries, the major part of the symptom-group stands to-day as he first announced it. There will be mere justice in attaching the name of Erichsen to the disorders he disentangled from so many others, and we shall have, by so doing, the very great advantage of being able, henceforth, to separate the cause and the effect, the manner of the accident and the disablements produced. Thus, without fear of being misunderstood, we may say that many kinds of direct and indirect concussions of the spine may be induced; that such spinal concussions *may be accompanied by, result in, or consist of*, vertebral or other fractures and dislocations, inflammations, degenerations, crushings, compressions, extravasations, paralyses, insanities, etc., *with or without Erichsen's disease*, which is the particular kind of spinal concussion, the especial traumatic neurosis under discussion.

Another justification for the designation, Erichsen's disease, I predict will more fully appear when the pathology of the sympathetic nervous system, particularly the spinal, shall be better understood. Knapp's Case V, of many related symptoms occurring after an abdominal wound, may be instanced, and there is added significance in Seguin's remarks*:—

"The reader who carefully peruses Knapp's able summaries

* Annual of the Universal Medical Sciences, vol. iii. Philadelphia, 1889.

of the symptom-groups usually presented by concussion cases (pp. 28–34), if he has had much experience in neurological practice, will recognize an astonishing similarity, if not identity, with a large group of *non-traumatic* cases which annoy the physician so much by their vagueness, their subjectivity, and by the condition so much insisted on by the writers cited, viz., their incurability. We acknowledge that we do not fully understand the pathology of these cases, which we classify as hypochondriacal, hysterical, or even delusional, and which we sometimes see twenty years after the beginning of symptoms sometimes much worse, but usually not so in reality. It seems to me that this striking resemblance, in all but etiology, between concussion or traumatic general neuroses and psychoses, and those just referred to, is worthy of more consideration than it has received."

Erichsen's spinal-concussion disease may be caused by falls, blows, jars, direct or indirect, such as are especially met with in railway collisions and derailments. Fright or wounds may cause *a few* similar symptoms, but by no means all of the phenomena that enable us to separate Erichsen's disease from other traumatic, psychical, or non-traumatic ailments. Cases 50 to 53 in Erichsen's work, with the similar peripheral injury cases of Oppenheim, and, indeed, those in the experience of any surgeon, satisfactorily set apart Erichsen's disease from other traumatic neuroses in which epilepsy, localized pain, and paralyses are the prominent features. Therefore *Erichsen's disease is a group of mainly subjective symptoms, of a nervous and mental nature, sufficiently characteristic to enable it to be recognized as a traumatic neurosis, distinct from other traumatic neuroses, with which it may or may not be associated. The most common cause of Erichsen's disease is a concussion of the spinal column, including its contents and nearest appendages.*

Every surgeon and neurologist, with any experience in spinal-concussion cases, will agree with Erichsen in this statement:—

"One of the most remarkable phenomena attendant upon

this class of cases is, that at the time of the occurrence of the injury the sufferer is usually quite unconscious that any serious accident has happened to him. He feels that he has been violently jolted and shaken, he is perhaps somewhat giddy and confused, but he finds no bones broken, merely some superficial bruises or cuts on the head or legs, perhaps even no evidence whatever of external injury. He congratulates himself upon his escape from the imminent peril to which he has been exposed. He becomes unusually calm and self-possessed, assists his less fortunate fellow-sufferers, occupies himself perhaps actively in this way for several hours, and then proceeds on his journey."

There is much truth in the claim that fractures of bones and other such grosser injuries tend to break the force of the spinal concussion. I knew a painter who, in falling from a scaffolding three stories high, sustained a compound fracture of every bone in his arms and legs, and subsequently, with the exception of a tibial comminution, which necessitated resection and artificial bracing, appeared to be as well as before the accident. Erichsen's watchmaker's statement is often quoted in this connection: "That if the glass is broken the works were rarely damaged; if the glass escape unbroken the jar of the fall will usually be found to have stopped the movement." There is a mechanical explanation of this in the vibrations which would have been transmitted to the spine having been broken up and arrested at the points of limb fracture, but this is not invariably the case, for Oppenheim and others note exceptions.

The patient is not apt to be very definite in his statements of illness until the symptoms fairly develop.

Symptoms are slow in their development, and often are not well recognized until weeks or months after the accident; meantime, there is disability, to a greater or less degree, evident to the patient, if to no one else, though some days he may feel better than others. Some of the victims try to shake off their indisposition, and

Endeavor to return to work,—a fact which should be

allowed to their credit where simulation is suspected. I knew of a genuine case of Erichsen's disease in which the sufferer attempted a game of football, in the hope of being able to thereby dispel some of his despondency; great aggravation of his trouble followed, and the lawyers of the other side did not fail to urge the event as evidence of his good health. Open, manly behavior is so often capable of misinterpretation that mankind in general is strongly tempted to hypocrisy.

When one has a family depending on his exertions he may feel that he has the strongest incentive to suppress bodily and mental anguish, particularly when a position is in danger of being forfeited by absence from work. The break-down comes, however, with an increase in many of the symptoms, the most prominent and invariable one of which is

Pain in the back, especially upon moving. This may be diffused up and down the spine, but felt more particularly in one part than another in attempting position-changes. Sometimes it is described as a dull, sickening ache, with or without throbbings and hot and cold feelings; often the occiput is complained of as being painful, especially in the mornings. The most painful part need not necessarily be the one that was struck, and it is not reasonable to suppose that the exact location of injured parts may be made, either through appeals to the patient's recollection as to where he was struck or inferences that the most painful part was the site of injury origination.

Tenderness of the spine upon pressure is most frequently found over the interscapular and lumbar regions. The entire spine may be very "touchy," or here and there may be particularly irritable spinous processes. Leaning back against the chair, lying down face upward, the pressure of heavy clothing, produce discomfort in varying degrees; in some cases this leads to frequent position-changes in bed and general restlessness.

Sleeplessness is one of the earliest and most persistent symptoms, and is doubtless mainly due to the incessant suffering. Nightmares when lying on the back, sensations of falling, hor-

rible dreams, terrified feelings, disturbed sleep, sudden awakenings, with rapid heart action and in a cold perspiration; hearing the clock strike every hour of the night, and so on, are the usual complaints of patients; and, if under observation, their nightly behavior verifies their statements.

Dull, steady headaches, sometimes worse, but seldom if ever absent, persist, and are located in the occipital or frontal region more often than elsewhere, or upon that side of the head that corresponds to the part of the body supposed to have been struck, or that presents the greater part of the symptoms. It is worth noting that sharp, neuralgic, or lightning-like pains are seldom complained of, and these, we shall find, belong more frequently to the better-understood nerve disorders.

Anæsthesia.—The discussions of Putnam and Oppenheim, to be found on pages 44 to 46 and 89 to 93 of this book, merit particular regard. Loss of sensation co-extensive with enfeeblement of parts is oftenest observed, and may or may not include one-half of the body. There may be more or less deadened sensibility upon both sides, and instrumental tests may be needed to make it at all apparent, or it may be so extreme as to cause the hallucination of an absence of the part affected. Restricted portions of the head, body, or limbs may be anæsthetic.

Hemianæsthesia is, as a rule, upon the same side of the body as the motor loss.

Analgesia and hyperalgesia are not often found independently of the tactile-sense conditions. Excess of anæsthesia would constitute pain-sensation absence, and the tenderness of the spine is either hyperæsthesia or hyperalgesia.

Hyperæsthesia, or extreme "touchiness," may be general or it may be limited to certain areas, even upon the anæsthetic side, and in such portions the reflexes are increased.

Paræsthesia, or aberrant sensations, as tricklings, crawlings, creepings, "pins and needles," hot and cold flashes, numbness indicative of irregular nerve conduction, which may be centric in cause, are sometimes mentioned.

The girdle or half-girdle sensation, as of a band or rope tightly pressing the abdomen or chest, less frequently the head, is a paræsthesia of importance occasionally complained of, and indicative of the level of the spinal column affected.

Pains elsewhere, as in the abdomen, arms, or legs, are more apt to be a sense of heaviness, weariness, or mentioned as a tired feeling, or an aching. If sharp, shooting, darting, or lightning pains are felt, the suspicion of demonstrable cord injury may be aroused.

To the foregoing sensory derangements may be added what are called by the patients weakness in the back and limbs, nervousness, general debility,—conditions too frequently recorded by the vague title, neurasthenia.

General motor enfeeblement is, as Oppenheim has so well demonstrated, largely due to the fact that pain is aggravated by exercise, and the motions are accordingly restricted, but other causes co-operate.

The rigidly-upright or forward-bent back, the avoidance of spinal flexion or rotation, and the general unwillingness to shift positions except slowly, evidence the irritated state of the sensory nerves in the spinal vicinity.

The gait disturbances, detailed on pages 97 and 98, may exist; the most frequent being the straddling walk.

Pareses, or diminished motor power, upon one side, or in one or two arms, or legs, may be the cause of defects in gait, grasp, or other voluntary motions. These pareses—hemipareses, parapareses, or monopareses—are usually associated with sensory derangements in the same portions of the body or limbs. Paralytic conditions are loosely used by authors to include pareses and paralyses, but there should be a clear distinction between a paralysis, which is a total loss of muscular power (rarely, if ever, observed in the primary stages of Erichsen's disease, unless complicated by some other spinal derangement), and a paresis, which is sometimes called a partial paralysis, but which should with much more propriety be regarded as a motor impairment.

Paralyses and pareses are very improperly used interchangeably, by some writers, with confusing results.

The unilateral head, body, and extremity motor and sensory derangements are especially symptomatic.

The irregularities of muscular movements, as in pressing the dynamometer, Oppenheim affords us on page 94 *et seq.* of this book.

General or localized tremors, tremulousness, or tremblings, are inconstantly present, more frequently if the patient is startled or overexerted.

Fibrillary twitchings or tremulous motions of small portions of individual muscles may often be observed, usually upon the most affected part of the person, and irrespective of other conditions, as often when passive as when in motion.

Inco-ordinations are most marked during Romberg's test, which consists in placing the patient upright with heels and toes together and eyes closed; from slight swayings side to side, or to and fro, induced in a few seconds to the extreme condition of great pallor, staggering, profuse perspiration, nausea, and even vomiting. Standing upon one leg, with or without closed eyes, may be difficult or impossible. Hand co-ordinations are usually less impaired.

The tendon reflex may be exaggerated, in which case pain is complained of as induced by the raps, not only in the knee region, but in the spine, and sometimes in the back of the head. This reflex may be normal, or slightly differ on the two sides. The absence of the reflex is of little consequence, by itself, as this condition has been observed in health.

The cremasteric, abdominal, and other reflexes are usually diminished.

The faradic and galvanic responses are generally quantitatively, but not qualitatively, lessened.

The convulsions that occasionally occur in Erichsen's disease may be associated with hysteria, epilepsy, tetanus or tetany, or may be more closely related to the other symptoms as hysteroid,

epileptoid, tetanoid, or apoplectiform. There remains much to be done in this field of observation. In the absence of descriptions of clear epileptoid attacks it may be right to infer that the weakened nervous system may admit of hysteroid or hysterical convulsions without thereby discrediting the genuineness of any of the other symptoms, or regarding the fit itself as other than a product of the disease.

The heart and pulse rates may be but slightly above normal and accelerated at times, or constantly rapid.

Bedridden cases are not frequent, at least in the beginning stages of the disorder.

Sexual impairment is almost invariably claimed.

Bladder and rectal difficulties occur in only a small percentage of cases.

Constipation is frequent, diarrhœa rare.

The appetite may be lessened, but digestion is fair, though not much is usually eaten at a time.

Increased perspiration has been observed by some authors, though I have not observed this to any great extent in my cases.

Cold extremities, with a generally subnormal temperature, are common.

Intolerance of alcohol, and stimulants generally, is noticeable. A very little suffices to cause uncomfortable sensations, flushings, and oppression; but the disposition to overindulge is less than in head-wound cases.

The appearance, in some cases, may give no indication whatever to the uninstructed observer; the complexion may be florid, or healthful, and the sufferings of the patient may be absurdly out of proportion to any external evidence thereof; but this is by no means frequent. Most often there is a haggard expression; the drawn features and corrugated forehead, knit brows, sallow complexion, stiff or bent movements performed slowly and carefully, and indisposition to lean back in the chair indicate the pained and sick man.

The demeanor is generally under restraint to avoid exhi-

bitions of fretfulness, irritability, petulence, fright, anger, and emotionalism generally.

The disposition is one of depression, low-spiritedness, timidity, hypochondriasis. He manifests constant anxiety and broods over the events of the accident, which he appears to remember acutely, even though other mental traits may be impaired. Will-power is defective; it takes time to arrive at a conclusion. There is incapacity to make sustained efforts in reading, writing, or conversing, or at least without an aggravation of his troubles. He is easily startled, and manifests, at times, many of the mental peculiarities recorded by Oppenheim, and which, among other things, led that author to erroneously ascribe nearly all the symptom origin to mental shock.

Insanity, properly so called, does not belong to the primary stages of Erichsen's disease. It may exist as a complication, or an outcome of the later stages, just as demonstrable cord-lesions may ensue with myelitis or meningitis. As paralysis may follow paresis, so may a psychosis develop from the cerebral symptoms of Erichsen's disease. Then, again, a true melancholia does not belong to the cerebral traumas; and if the suicidal and homicidal tendencies of traumatic insanity appear, with suspicious, persecutory, or grand delusions, a head injury may be reasonably inferred. Bucknill and Tuke mention spinal injuries as a cause of insanity, but this I believe will be of the melancholic type, and as a secondary result of the suffering, as in my Dr. Du Bose case, rather than the furious or demented kinds characteristic of brain-lesions.

In this mental-influence connection, since, admittedly, in a great number of cases fractures of the bones secure immunity from the major symptoms of spinal concussion, *what becomes of the fright element which Page and Oppenheim dwell upon as etiological?* Surely, the bone breaking does not dispose of the terror of the situation.

Suffering of various kinds may distract or weaken mentality, and any one may notice in himself an increase in emotionalism

during physical weakness. When recovering from an illness you are more easily affected to tears or laughter; nor are you capable of putting forth mental effort any more than physical during the existence of debility. Just as the pain restricts the motility in Erichsen's disease, so, in my opinion, it and its cause co-operate to produce the emotionalism, irritability, despondency, and other mental derangements common to the disease, which symptoms disappear *pari passu* with the spinal troubles, and never beforehand.

Ear difficulties may exist in the shape of impaired hearing, tinnitus aurium, or extreme sensitiveness to sounds.

Eye disorders consist of asthenopia, most prominently, with photophobia, and the causes are not objectively visible, as a rule, even with the ophthalmoscope. In many cases the perimeter and color-tests disclose a contraction of the visual or color-field.

Taste may be dulled. The smell is not perceptibly impaired.

The touch sense about the face, tongue, or head may be deranged.

When any of the special or general senses are disordered their distribution is generally the same as that of the motor derangements.

Speech disturbances are not aphasic, amnesic, nor aphonic. They partake of the other motor debilities, and may be classed mainly as hesitant and slow.

Vertigo occasionally occurs, fainting spells seldom.

Flushings sometimes occasion disagreeable feelings.

Emaciation, either general or localized, I think, occurs in about one-half the cases, by rough estimation. Atrophic conditions doubtless exist in all, though more or less marked, and discoverable only by histological methods.

The irregular and crossed sensory and motor phenomena Oppenheim has well recorded, as well as many other matters not necessary to repeat here beyond the bare mention that in

my opinion the following topics have no *direct* relation to the subject, or, at least, none that has been sufficiently well established: Nystagmus, amaurosis, blepharoclonus, ptosis, ocular-muscle pareses, diplopia, contractures, paralysis agitans, chorea, menstrual derangements, nausea or vomiting, except rarely; the age of the patient, diabetes, except theoretically and incidentally; fever at any stage, clonus, and as to whether the left side is not the oftener affected.

The more obvious vasomotor derangements are in occasional œdemas, cyanoses, congestions, flushings, pallor, hyperidrosis, nutritive disturbances, atrophies, etc.

Conscious and unconscious exaggeration of symptoms should be looked for, as well as downright lying, or simulation.

The effect of litigation upon the patient should be estimated, if practicable. Law proceedings worry and depress most cases, and when a result is reached sometimes, not always, the disorder takes a favorable course.

When insanity occurs the physical conditions are not so easily ascertainable, as the mental condition overwhelms the other subjective, and sometimes objective, symptoms.

There may be an abatement of some symptoms, an increase in others, during the progress of the case.

Secondary organic disorders, as myelitis or meningitis, may appear, or an unsuspected fracture, or caries, may institute Pott's disease of the spine. Compression or other such symptoms may become apparent.

Intermissions may occur, but not to the extent of even apparent recovery.

Recoveries may occur, but it is not known what proportion of these are complete or incomplete; the latter marking the individual, to the extent that Page admits, as a "damaged man."

Chronic invalidism and death are known to result.

The existence of prior disabilities should be ascertained in justice to both sides, as the defense should not be held responsible for sicknesses dating before the accident, nor should the

plaintiff forego his claim for damages where a latent syphilis or locomotor ataxia were restarted, or a hernia was aggravated.

A predisposition may exist in a neurotic condition, such as Oppenheim describes. The liability of railroads damaging these egg-shell nervous systems and precipitating a traumatic neurosis may be compensated by the equal liability of escaping such risk in encounters with rickety-boned persons, who are quite as numerous. Their bone-breaking will save their nervous systems, and, according to Page, prevent the occurrence of "fright or nervous shock."

As to prognosis, it is apparent that every case will have to be considered by itself, for in the revision of the entire subject it is seen that olden classifications and descriptions included and omitted too much. Heavy and light blows may either of them cause slight or grave symptoms, and, in time, either of these may end in recovery or death.

A new classification is needed, based upon more correct knowledge and recognition of what is and is not Erichsen's disease. In a private letter to me Dr. Knapp says: "The present state of our knowledge makes it hard to differentiate the forms of disease, although I think we are beginning to recognize various more or less distinct types,—some organic, others functional, but many of them severe and incurable."

CHAPTER X.

DIAGNOSIS.

THE more or less subjective symptoms of Erichsen's disease are:—

1. Pain in the back, especially on moving.
2. Tenderness of spine upon pressure.
3. Sleeplessness.
4. Headaches.
5. Anæsthesia.
6. Analgesia.
7. Hyperalgesia.
8. Hyperæsthesia.
9. Paræsthesia.
10. Girdle sensation.
11. Pains elsewhere.
12. General motor enfeeblement.
13. Rigidity of spine.
14. Gait disturbance.
15. Pareses.
16. Coarse tremors.
17. Inco-ordination.
18. Vertigo.
19. Speech disturbances.
20. Ear difficulties.
21. Eye difficulties.
22. Taste or smell impairment.
23. Bedfast condition.
24. Sexual impairment.
25. Bowel or bladder trouble.
26. Condition of appetite.
27. Intolerance of alcohol.
28. Disposition.
29. Demeanor.
30. Business-ability loss.
31. Some mental peculiarities, as extreme emotionalism and memory impairment.

For the genuineness of these symptoms we are compelled to rely very largely upon the statements of the patient, and were it not for their occurrence in cases where no damage claims are made, and in persons who are absolutely ignorant of medical matters in general and spinal-concussion symptoms in particular, much doubt of the reality of the suffering could be well entertained.

It must not be supposed that *all* of these symptoms need be present to constitute the group or case of concussion. A few may be absent or not very evident, but the pain characteristics are indispensable. Further, there is a "harmony of the symptom-grouping" with the objective appearance, if any, scarcely possible to simulate. I doubt the ability of Erichsen, Oppenheim,

Page, or any other person as well instructed, to be able to maintain the objective manifestations of those symptoms, or even a number of them, for a few hours, to say nothing of months.

These outward manifestations of subjective conditions are the pained expression, the frown, the stiff postures, the gait peculiarities, the flinching when the back is touched, particularly unawares; inability to stand on one foot, and the general behavior and appearance. The sleep disturbances may be observed by friends or relatives, or attested by the hospital attendants, and the subjectivity of this symptom may thus be lessened.

The objective signs of Erichsen's disease may consist in:—

1. Emaciation, which differs from that induced by starvation by the waste being more in the muscular than adipose tissues, the latter being notably the first to be absorbed in starvation, affording the sunken-eyed condition from loss of subocular fat, which is never produced by concussion of the spine, pure and simple.

2. Fibrillary twitchings, or tremors of individual muscular bundles, impossible to simulate.

3. Flushings,—a sudden suffusion of the head or other, usually superior, parts of the body, which, if not existing before the accident, denote a consequently deranged vascular supply.

4. The heart and pulse conditions, if abnormal and not existing before the accident, may reasonably be referred to the injury.

5. Hyperidrosis appearing after injury indicates a depraved nervous condition, which the accident may have produced.

6. Cold extremities make a symptom not possible to feign, but that this did not precede the injury should be reasonably established, if possible.

7. Cyanosis.

8. Pupillary dilatation, indicating nervous irritation, may be caused by belladonna, but this can be readily excluded by

holding a light close to the eyes, which is apt to cause contraction of the pupils unless atropine, or its base, has been recently taken by the patient, or there is a centric destructive lesion.

9. The reflexes are purely objective.

If the urine is retained very long it becomes ammoniacal, and a test for ammonia can be made where this detrusor paresis is alleged; but there is no way of readily ascertaining whether the retention is voluntary or not.

The examination of the patient by the physician should be conducted by avoiding leading questions. The symptoms should be described with as little suggestion as possible. Many persons are so unaccustomed to analyzing their ailments that, even though perfectly honest, descriptions cannot be satisfactorily obtained unless fairly dragged from them; but they should be warned that suggestive questions from the physician are improper under the circumstances. A consistent statement or a fraudulent narration may thus be quickly obtained.

The previous character of the patient as to credibility forms a very important part of the corroborative testimony, and should be obtained if possible.

The patient should be asked if he has read any medical works or received any instruction concerning disease, particularly on the subject of what he imagines his trouble to be. The extent and sources of such knowledge, if any, should be learned.

If the physician believes the case to be an honest one, and he cares to continue further connection therewith, he should counsel the patient to avoid medical publications or seeking any knowledge on the subject, for the present, beyond what may avail for treatment.

But the matter of auto-suggestion, I think, will not stand very close inspection, for it is beyond the bounds of possibility that there should be such uniformity in a great group of symptoms, utterly unlike so many other disorders, occurring in persons in all stations in life, regardless of their intelligence, temperaments, or opportunities of information.

Observe the manner of walking of the patient; his method of ascending and descending stairs; whether he can walk straight with eyes closed. Test the leg movements, standing and lying; of abduction, adduction, flexion, extension, rotation; also similar movements of the feet, hands, and arms.

Notice if he can pick up articles from the floor in a natural manner. A little management can justifiably avert suspicion of your intention.

Test his ability to stand with toes and heels close together and eyes closed, and whether he stands equally well on either leg or imperfectly on one or both.

Quantitative and qualitative differences in motor ability should be sought for, as, whether the limbs of one side are weaker than the other, and if compensatory aid is obtained from other, usually higher, muscle-groups; for a kick can be delivered by thigh-swinging, even when the lower-leg muscles are weak; or supination and pronation or flexion and extension may be performed by gravitation means, even when the lower arm is paralyzed.

Have him rise from his chair without the aid of his hands or arms, and, similarly, from a supine to a sitting posture. The latter is a severe test. Also, ask him to extend his leg stiffly and raise it, without bending the knee, while lying down.

The soles of the shoes habitually worn should be examined to see if any and what part of the foot is dragged. Foot-clonus may be tested by tapping the calf when tense. A great degree of this is sometimes observable when the patient is seated and rests his toes on the floor, with the heel lifted.

The "front-tap contraction" can be elicited by the tense calf-muscle contractions following a tap on the tibia, or, to a greater extent, the front lower-leg muscles.

The tendon reflex is obtained by tapping just below the knee-cap, when the leg swings unrestrained. Differences between the two sides are especially to be noted. Reflex cutaneous action should be tested by tickling the soles of the feet for the

plantar reflex; stimulating the gluteal muscle for the gluteal reflex; passing a light touch along the inner thigh to obtain retraction of the testicle,—the cremaster reflex; stroking the abdomen for the abdominal, the upper portion for the epigastric, the back for the dorsal, and the upper part of the back for the scapular, reflexes.

Other tests are for the conjunctival reflex, the contraction of the iris to light, and, to accommodation tests, its dilatation on stimulation of the skin of the neck or when light is excluded.

A perimeter and color-gauges are used by oculists in determining the visual-contraction field and loss of color appreciation. The ophthalmoscope has given negative results in Erichsen's disease.

The tuning-fork and watch are used in testing the hearing and bone conduction.

Bitter or sweet substances placed on the sides of the tongue, alternately, assist in ascertaining taste deficiency.

Tender parts of the body should be sought out, as well as those portions insensitive to pain, by pinching, pricking, and handling unexpectedly.

A test of the vasomotor condition consists in drawing the finger-nail over the chest, abdomen, back, and limbs in such a manner as to cause streaks of variable width, and note the result in the white, blue, or red streaks that suddenly or sluggishly follow. These are the so-called "meningitic streaks," or *taches cérébrales.*

Tests of co-ordination, besides "Romberg's swaying" method for the lower part of the body, may be used for the hands and arms, in directing the patient to extend the arm outward from the person and suddenly touch the lower lobe of the ear with the pointed finger, and, with eyes closed, bring the index fingers together. When inco-ordination is extreme the writing is badly affected, and even a straight line cannot be drawn; the limbs often cannot be held in fixed positions.

To measure muscular power the dynamometer is used. The

scales are arbitrary and no two are alike, but the relative strength of the two hands are determinable by its means. To some extent this subjective test may be rendered objective by the physician placing his hand over that of the patient, during the test, to ascertain if there is honest tenseness of the intrinsic muscles, but, where these are atrophic or paralytic, tenseness cannot be expected. In paresis a fluctuating grasp is apparent, but its extent is properly recorded on the instrument.

Opposing movements of the patient's is another method, in recording the results of which the relative strength of the two sides should be allowed for, as usually three or four to five between the left and right; and it should be ascertained whether the patient is not left-handed or ambidextrous. Some mechanics are equally strong in both hands unless disease renders them otherwise.

Lifting weights attached to the feet or hands further test the strength differences of the sides, and the so-called muscular sense may be examined by small weights placed simultaneously upon both sides of the body or extremities. An ounce may feel heavier on one side than six ounces or more on the other. The different weights should be of one size, or attached to the hands, etc., by strings to avoid other means of discrimination. In extreme cases the blindfolded patient cannot tell where his limbs are. Muscular sense may be but slightly impaired in Erichsen's disease.

The consistency and relative sizes of corresponding muscles should be observed, bearing in mind that the right side of the body is slightly the larger.

Notwithstanding the fact that heat and cold are but relative terms, the paradoxical conclusion has been reached that there seem to be two sets of nerves for the appreciation of heat absorption and abstraction; sensitiveness to cold or heat, one or the other, or both, may, independently, be deranged; hence, the temperature sense should be determined by damp, hot, and cold sponges. The back exhibits most decided appreciation of these

differences, as any one can attest who has taken a cold douching of the spine.

The clinical thermometer affords degrees of bodily heat, and measurements of this may be taken in the mouth, axillæ, anus, hands, and toes.

Richert's normals are 36° C. (96.8° F.) to 38° C. (100.4° F.), axillary; oral, 0.25° C. to 1.5° C. higher; rectal, 0.9° C. higher than mouth; infantile higher than adult temperature, and exercise, food, and habits cause 1.0° C. variability.

Sensation impairment in the fingers sometimes causes an inability to discriminate the sizes of coins without the aid of eye-sight. A dollar may be mistaken for a dime, and so on; or the clothes cannot be buttoned by the patient, as he does not know whether the buttons and holes are together or not. The æsthesiometer is the instrument for the determination of sensation defects, and where the patient's statements may be relied upon it is indispensable. The patient's eyes must be closed or averted during the examination of parts that he can observe; and, to avoid the heat and cold senses assisting the judgment, the instrument, or the fingers of the physician, if they are used, should be approximately of the same temperature as the part examined.

The patient should be asked what part of the body was touched, and at times this question can be asked when no touch is made. The points of the instrument, a mere compass, are spread apart, and one or both ends applied to the person, with the query, "How many points do you feel?" The answer may be, correctly or incorrectly, one, two, three, or more.

Relative measurements only are necessary, and the practice of some physicians in taking minute memoranda of the precise number of millimetres spread during a rapid examination partakes not only of pedantry, but asininity. The only value such exact records could have would be in comparing the results of several very long examinations taken on different days. The relative of the two sides, and seldom the absolute spread, alone

is worth noting. The greater the degree of sensibility, the nearer the points can be placed and told as two. Weber's *averages* are:—

Tip of tongue,	1.5 millimetres.
Finger-tips,	2 to 3 "
Lips,	4 to 5 "
Tip of nose,	6 "
Cheeks and back of fingers,	12 "
Forehead,	22 "
Neck,	34 "
Forearm, lower leg, and back of foot,	40 "
Chest,	45 "
Back,	60 "
Upper arm and thigh,	75 "

The intelligence of the patient modifies the results, and practice enables better discrimination.

Putnam, in his article on Hemianæsthesia, page 45 of this book, gives useful hints in this regard as to the constancy of an anæsthetic spot indicating a truthful person under examination, as it would be impossible for him to persistently lie about the sensations successively produced in an identical region on different days.

A simple test for the relative torpidity of tactile conduction upon the two sides, that I have habitually used, and have not found described by the other authors, consists in touching simultaneously two symmetrical parts and asking which contact was felt soonest. This should be preceded by actual differences in touch, such as these: Right leg first, then left leg a half second later; longer intervals if the contacts were felt simultaneously; then reverse the order in which the sides were touched. Sometimes where the tracts are diseased, and the gray matter of the cord conducts the sensation, the side first touched may be the last to feel it, and a very long interval of delay may occur.

Nearly all the preceding expedients are beyond the control of the physician as to his ability to affirm that correct answers were given by the patient when the tests were applied, the thermometer being the main exception; for the following events may interpose:—

1. A malingerer may give false answers.

2. The patient may, through stupidity, not understand the questions asked.

3. Widely different results may be obtained upon a subsequent examination.

Upon bare, uncorrelated findings, such as are described, no reliance, *alone*, can be placed; *but the intelligent physician has a right, and it is his duty, to interpret the information thus elicited; to detail, on the witness-stand, his methods of examination; to place his estimate upon the value of the tests made in individual instances, and to give his opinion as to whether the patient was truthful, was lying, or exaggerated, consciously or unconsciously.*

The necessity for this emphasis is occasioned by attempts to exclude anything that the patient said at the time of the examination by the physician, on the presumption that the patient's mere narration was valueless. But the expert has reasons, through his special education, for believing or not believing the statements of the patient, which, be it remembered, are elicited by means of which the plaintiff is supposed to be ignorant, and the probability of that ignorance is, or should be, duly considered. Judge Gary, formerly of the Circuit, now of the Appellate Chicago Court, ruled that all statements made by the plaintiff during his medical examination were admissible, and another *nisi prius* judge ruled directly the opposite. Obviously many forms of insanity and functional ailments could never be discussed in court were this latter ruling to generally obtain.

As to the malingerer's false answers, I have the first one to see who could successfully pass the fusilades of opposed physicians, lawyers, and the court where anything is properly known about the subject. That any one should possess the amount of medical education, training, and skill of an actor, and the assurance required to maintain simulation of a consistent group of symptoms, such as Erichsen's disease presents, is preposterous,

to say nothing of the objective evidences of the subjective symptoms and the objective signs that can be found, if properly sought for, when the disease really exists. Allowance must similarly be made for the stupidity of the patient, and defective answers should be weighed as probably indicating want of ability to simulate in other matters. The changes in symptoms, especially sensory, may occur within certain ranges without rousing the suspicion of pretense necessarily. The *tout ensemble* is to be considered. The survey of the aggregated testimony must be made from several stand-points.

It was mentioned that until a new classification can be reached, through more complete observation and study, prognoses will have to be individually adjudged. In the main, the prognosis is grave, for the "damaged man," that even Page admits, is often found below the surface of the alleged "recoveries." Apropos of the declaration of cases having "recovered" and yet being useless to themselves and families, while pathologist at the County Insane Asylum I was repeatedly informed by attendants that certain cases were "much better;" they had "improved;" were "nearly well," and the like, when the only justification for the statement was that the unfortunates had become less noisy, less obtrusive and troublesome; they were more easily managed, because their intellects were sinking into that blackest of mental nights, terminal dementia. Head-injury cases are frequently discharged from hospital as "cured" and find their way to insane asylums later. We need more careful following of cases than Page was enabled to exercise through "the migratory habits of persons in the poorer walks of life."

Much confusion has been occasioned by what was, at one stage, a case of Erichsen's disease, eventuating as a genuine myelo-meningitis, or some other equally grave organic disorder. If observed in the first stages Page would doubt its genuineness, and if in the later stages it was triumphantly proclaimed to be an organic derangement without concussion symptoms.

At any stage, from beginning to end, there may be complications as well as sequelæ of an organic nature pre-existing, simultaneous, or eventuating. Among these are syphilitic, tabetic, neurotic, mental, myelitic, meningitic, rheumatic, cardiac, hepatic, intestinal, renal, cerebral, ocular, aural, hernial, and many other derangements. Often the head is injured at the same time, complicating Erichsen's disease with cerebral symptoms; fractures and dislocations may induce palpable lesion-complications, or may exist and only be discovered post-mortem. Erb recognizes that concussion symptoms may be present in the severer cord-lesions, and want of proper consideration of this has obscured proper understanding of the subject. Certainly a co-existing pleurisy does not render the pneumonia impossible, and so a myelitis or meningitis, or both, may complicate a case of Erichsen's disease; the concussion symptoms may predominate, or the myelitic; or the meningitis may diffuse itself in the concussion phenomena; or either of the organic troubles may focalize as the Erichsen's symptoms abate.

External evidences of injury, such as wounds, bruises, contusions, etc., are no more necessary in Erichsen's disease than in any other disturbance of the nervous system, many of which, such as the hæmorrhagic, end in death, and may be caused by a fall, without wounds exteriorly.

No single symptom, nor any two symptoms, can constitute the disorder, but the clinical picture is made by a group of symptoms, many of which may separately be found, differently grouped, in other diseases. It is the peculiar arrangement and combination of colors on the canvas that create the landscape, and the legal trick of trying to secure an admission from the expert that first one symptom and then another is not peculiar alone to Erichsen's disease can be met with the comparison that by taking away certain pigments and breaking up their arrangement the landscape may be destroyed. If, on cross-examination, the attorney pushes this exuviation process by insisting upon your answering as to whether separate symptoms are

not found in other diseases, and not absolutely necessary to this particular complaint, ask him if he can tell you what can similarly be spared from a picture to allow it to remain such, or how many and what bricks, stones, etc., you can take from a certain house without destroying it as that particular house.

The foundation, frame, and roof of Erichsen's disease is the back pain and rigidity, the insomnia and emotional disturbance, subjective, and unapparent to the untrained observer though they be. The roof, frame, and foundation of the house may be out of sight, but they nevertheless exist; at least, you can generally safely infer that they exist, even though unable to directly demonstrate the fact.

CHAPTER XI.

ELECTRO-DIAGNOSIS.

ELECTRO-DIAGNOSIS *affords an infallible means of converting many subjective into objective phenomena.* But, as Bramwell and many others observe, there are very few physicians competent to undertake an electrical examination. The mere using of electricity in practice for treatment does not entail electro-diagnostic skill. The five-cents-a-shock fakir and five-dollar electric-bath man "treat" diseases, and too many physicians in general practice either have no batteries at all or could not tell the difference between the faradic and galvanic currents, simply because electro-therapeusis and electro-diagnosis are but barely mentioned in American medical schools. While electricity in diagnosis has been in use on the European continent nearly twenty years, it is only within the last five years that any attention was paid to the subject in the United States. Its value is incontestable, and if a "professor" or other expert claims a knowledge of it that he does not possess he will be chagrined when a rigid cross-examination exposes him.

There is but one course for the honest physician not versed in electro-diagnosis to pursue, and that is to frankly confess that he has not posted himself on this subject. I have seen some pretentious experts come to grief through adopting a different course. One was led into most absurd admissions concerning the test by an adroit lawyer and then exposed. He stated that cerebral paralyses, as well as spinal, gave reactions of degeneration immediately after the injury. Two others scoffed at the idea of there being anything worth noticing in electro-diagnosis, one of whom stated that he always found C O, in his experience, in health invariably following C C; both united in denouncing the milliampèremeter as unreliable, and gave pseudo-

scientific discourses to an amused jury, a member of which happened to be well posted in electrical engineering. In a subsequent trial these two gentlemen escaped a repetition of the former humiliating cross-examination by admitting that electrodiagnosis was all-potent, but that they had not used it.

J. Russell Reynolds* published an excellent little work for beginners in the study of medical electricity, and his chapter on the diagnostic uses of electricity is very lucid, though great progress has been made in this field since it was written. The recent work of G. Betton Massey† is a valuable treatise on a special application of this great but ill-understood therapeutic agent. The older writers were Duchenne, Remak, Benedikt, Moritz Meyer, von Ziemssen, Brenner, Erb, De Watteville, whose works sadly need revision and adaptation to the recent instrumental and other advances that have been made within ten or even five years past.

A distinction is necessary between the words contractility and irritability. Muscles may have either, but nerves only the latter. When a nerve is stimulated or irritated by electricity, a paralyzed muscle, to which such nerve is distributed, may respond more feebly than its fellow of the opposite side, and yet percussion may provoke a readier contraction than in health, especially when there is some rigidity of the muscle. Readiness of contraction should not be confused with the force of contraction.

If with three milliampères you induce a little flicker in a healthy muscle and none at all in one that is paralyzed, you have tested the relative irritabilities of such muscles with a low power. If Muscle A will react to three milliampères, and it requires six milliampères to move Muscle B, then the latter is the less irritable muscle.

In making such or other tests identical means must be

* Lectures on the Clinical Uses of Electricity, delivered in University College Hospital, London. Second American edition. Lindsay & Blakiston, publishers, 1874.

† Electricity in the Diseases of Women, with Special Reference to the Application of Strong Currents. F. A. Davis, publisher, 1889.

resorted to for different muscles. The same size electrodes must be used over corresponding places and the current direction must be the same.

With strong currents, say ten or twenty milliampères, a healthy muscle in some cases acts more vigorously than one that is paralyzed. This does not, as in the former instance with weak currents, indicate that the strong contractions evidence irritability also; they are often less irritable through having more contractile strength. To test irritability the current must be reduced to the lowest point that will produce action; with more powerful currents the relative differences in strength are exhibited. Sometimes one milliampère will cause a quick response on a paralyzed side, while five milliampères may be needed to produce similar quivers upon the healthy side. If, when this exists, the current strength be increased to ten or fifteen milliampères, or, by the use of a strong faradic current, the paralyzed muscle may give but a feeble jerk, while the healthy muscle may be tetanized.

The most general diagnostic use of electricity is to ascertain whether loss of motion depends upon some condition that shuts off from muscles the influence of the spinal cord.

Marshall Hall applied the term "spinal paralysis" to the separation of a muscle from the spinal cord. This may occur with or without spinal disease.

The Germans designate as "peripheral paralyses" everything of the kind having other than a cerebral origin.

A muscle may be paralyzed by some cause existing in the muscle itself, by failure of nerve conduction to the muscle, or injury of that part of the cord from which the nerve arises; or the brain control of the muscle—volition—may be destroyed by a cord- or brain- lesion that interrupts the conduction from above the nerve origins.

There may be thus a loss of voluntary power, a paralysis from lesion in the cord or brain, and yet the case may not be one of "spinal paralysis."

A division of the nerve between the cord and muscle may

cause a "traumatic paralysis." Neuromatous or other tumors, or an accidental injury, may separate the muscle, so far as electrical conduction is concerned, from the cord, and place it in the same position as when the cord is destroyed at the nerve-roots for that muscle.

When a muscle is separated in these ways from the cord influence there is a speedy loss of irritability to all forms of electrical stimulation. The amount of diminution may vary, but it is in proportion to the damage.

When the damage is above the point of cord influence toward or in the brain there may be a distinct increase.

Spinal-cord disease of that portion directly related to the muscles diminishes the electrical reflexes in such muscles, and nerve-section produces a similar result.

Irritative cord or nerve-trunk lesions cause loss of faradic contractility and increased response to slowly interrupted galvanism.

In Erichsen's concussion disease a difference in the motility of the two sides may be objectively demonstrated by strong faradization convulsing the muscles of the healthy side and having no effect whatever or in causing but feeble movements of the paretic portions. Simulation can be disproved by this means. Pain will, by such a test, be caused in healthy nerves, and may or may not be in the injured side.

In hysterical paralyses of recent date the muscular electrical contractibility is unimpaired, even though a strong faradic current may not be felt; but in old cases of the kind, where disuse has rendered the muscles flabby, there is usually some diminution of their irritability and strength; however, this speedily disappears after a few applications of moderately strong currents.

When a paralyzed muscle gives a normal contraction its relation to the cord is undisturbed, even though the cord or brain may be diseased, so that the will-control over muscles may be lost.

If a paralyzed muscle reacts to feebler currents than the

corresponding healthier muscle the same condition as the preceding may be inferred, or that there is increased irritability of the nerve, cord, or brain. Diminished response to the faradic and increased to the slowly interrupted galvanic may be induced by similar conditions. In a brain-hæmorrhage, for instance, there may at once be universal loss of muscular irritability from shock or collapse. In the first week there may be no differences between the two sides, but about the end of that time the paralyzed side reacts to a lower current than the other; there is more irritability. This condition may exist at any period after a brain-lesion until the secondary atrophic cord-lesions afford a "spinal paralysis," if they ever do; and it does not matter whether there is complete cerebral paralysis or not, nor does it depend upon the extent of the paralysis, for cerebral monoplegias and hemiplegias are alike in this matter of readier response of the paralyzed muscles; nor does it matter whether there is or is not sensation in the parts, or whether spastic contractions are present or not.

In hæmorrhage, inflammation, sclerosis, tumor, or other destructive diseases of the spinal cord there may be complete loss of contractility in the muscles connected with that part, but increased irritability lower down, to other, as well as electrical, reflexes, as, for instance, upon tickling the soles of the feet or tapping the patellar tendon.

If, as sometimes occurs, the degenerations in the cord extend downward an extinction of these reflexes may follow.

In the earlier periods of paralysis agitans or locomotor ataxia, and other diseases that induce weakness through pain, there is often an exaggeration of electric contractility. In hysterical paralysis the reactions may be either normal or increased.

Toxic blood conditions, as well as the secondary descending degenerations from brain diseases, may set up diminished electrical reflexes, or similarly alterations in the nutrition of the cord or muscles from local or general causes may induce the same reduction.

When from a brain injury the muscular irritability is reduced the muscle has lost its irritability from disuse or the secondary involvement mentioned; if from disuse alone, a few electrizations put the muscles in the same electrical reflex condition as the healthy ones, but no improvement in the paralysis will be occasioned.

In spinal paralysis similar treatment with galvanism will produce no such improved reaction unless the lesion influence is removable, as it sometimes may be by electrical and other means, in which case all the symptoms may disappear. A few repeated electrical applications may thus determine how far disuse is a factor in the paralysis.

When there is a nerve-section or its equivalent, as in facial paralysis, there may be the "spinal-paralysis" symptoms of the muscles supplied by that nerve. There may be diminution or loss of function, according to the state of the damage. Sometimes there is loss of faradic and increase to slowly interrupted galvanic currents, as when the lesion is irritative.

In certain temporal-bone diseases electrical treatment may improve the palsy up to a certain point and no further, but where there are resorbable exudates pressing upon the nerve the paralytic condition may disappear.

Colds, rheumatism, etc., induce paralyses that have no reference to any particular nerve or branch of nerve, with diminished electrical contractility in general, though often there is an increased irritability to the slowly interrupted galvanic current, but to quick interruptions the response is less than in the healthy parts and the faradic reaction may be extinct. In Bell's palsy from a cold and in lead paralysis this may be observed.

The sensations produced by galvanism are: a feeling of burning, especially at the negative electrode; heat tension and thrill between the poles. Faradization stings or burns in proportion to the intensity of the induction, the rapidity of interruption, and dryness of the conductors. Disease may change

these sensations by increase, decrease, or their entire extinction.

Increased sensitiveness occurs in hyperæsthetic individuals who are such either normally, as in hysterical persons, or through disease.

Hypersensitiveness may be found with increased irritability of reaction, and the skin of one side may be more sensitive than that of the other. Diminished sensitiveness may follow the shock of recently induced paralysis, with, at the same time, impaired touch and temperature sense. It may exist in hysteria or as a chronic condition in rare central diseases unassociated with paralyses. When muscles are made to contract by electricity the contractions are felt in health, and may amount to a pain if cramp is induced. This sensation is in direct proportion to the force of contraction, but in disease this relationship is not always found.

Increased electro-muscular sensibility sometimes exists alone as a morbid condition. Pain is occasioned by the contractions that would not be noticed in health, and this may be general or local. Paræsthetic or dysæsthetic states, as in neuralgias or myalgias, often accompany this derangement.

Sensibility and contractility may be increased together to electrical reactions.

When the increase is local comparisons should be made with the other side; and the significance of differences would be related to those of augmented contractility.

Muscular sensibility and contractility are usually reduced together, but parallel deviations are not invariable, for contractility may persist and sensibility be diminished or lost, as in hysterical paralysis; but it is found in other diseases also. In some lead-poisoning cases the sensibility has remained when contractility was diminished. When both sensibility and contractility are diminished in a limb or one-half the body there may be an extensive cerebro-spinal lesion.

When electrodes are close together the nerve-trunks are

not much influenced, but when separated widely some nerve-trunk may be involved in the circuit and induce burning or stinging, tingling, or "pins-and-needles" sensations. Breaking the circuit may cause pain. Wide separation of the faradic electrodes causes pain which, when they are brought closer together over the surface, is not apparent.

In cerebral disease, blood-poisoning, and destructive lesions of the spinal cord only do we find decided lessening of electric sensibility. There are great differences of endurance of currents between individuals, and it must especially be remembered that there is a general lessening of electrical reactions of all kinds in old age.

In testing with the galvanic current, one electrode, called the indifferent, is placed on the sternum or back of the neck; a large, flat, moist sponge, buckskin, or cotton-covered plate is better than one of small size. The other is called the testing electrode, and should be small. This is placed on the region to be tested. Since the terms direct and indirect stimulation have been confused by writers they need not be referred to beyond stating that Erb called stimulation of the muscle from the nerve indirect, and direct when the muscle was more directly stimulated. Others held that nerve excitation was the only direct method. The motor points or places nearest the surface where the nerve may be reached are shown in the plates at the end of this book. All such plates are founded upon Erb's originals.

In medical electricity the positive pole is called the anode, and the negative is the cathode. German and English scientific symbols are struggling for supremacy, and both should be mentioned, though in this work only the latter will be used.

		German Symbol.	English Symbol.
Positive pole, . . .	Anode	An	Anode, An or A
Negative pole, . . .	Kathode	Ka	Cathode, Ca or C
Opening of circuit, .	Oeffnung	O	Opening, O
Closing of circuit, .	Schleissung	S	Closing, C
Weak contraction, .	Zuckung	Z or z	. . . C or c
Stronger contraction.	Starke Zuckung	Z′ or Z″	. . . C′ or C
Tetanic contraction, .	Sehr Starke Zuckung	Te or Z‴ or Z″	C‴, C″, C′ or Te

The puzzling array of combinations, such as Ka S Te and An OZ, etc., have done as much as anything to deter physicians from studying this most important subject. The invention of the absolute galvanometer enables us to use easily-comprehended figures in simplifying the entire matter. I omit the useless c or C in denoting contraction, for, when it is recollected that the first figure indicates the lowest number of milliampères that will produce a contraction, it follows that the strength of contraction can be expressed far better in such absolute degrees than in relative terms.

The normal reaction is in this definite order:—

1, C C C; 2, A C C; 3, A O C; 4, C O C.

Very feeble currents cause no contraction either on opening or closing with either pole.

Weak current, . . .	C C C
Stronger current, . .	C C C′ + A C C
Still stronger current, .	C C C″ + A C C′ + A O C
Very strong current, . .	C C C‴ + A C C″ + A O C′ + C O C

In health the constant galvanic current of moderate strength produces contractions when the current strength is suddenly altered by reducing or increasing the current, or making or breaking the circuit.

Some distinctions are made between stimulating the nerves and muscles, such as quantitative, and an occasional change of place between A C C and A O C, or their simultaneous disappearance. De Watteville claims that the time the current has been flowing through the nerve before it is broken, as well as the current strength, determine the position or occurrence of A O C, as to whether the order shall be C C C, A O C, A C C, C O C, or, as first stated, with A C C second and A O C third.

For practical purposes these finer points need not be discussed here; it will answer to remember that the relative positions of A C C and A O C with regard to precedence of one

another need not be regarded in ordinary tests of either muscles or nerves, but *departures from the arrangement of the other symbols constitute degeneration reactions.* That arrangement is the definite normal polar-reaction order, the cathodal-closing contraction being the first, and the cathodal-opening contraction being the last, to be manifested.

My simplification consists in dropping the contraction symbol and substituting the milliampère degrees, thus:—

1, C C 3	or	C C 5
2, A C 6	or	A C 7
3, A O 8	or	A O 8
4, C O 15	or	C O 20

I have endeavored to discover something like a mean normal at which average reactions occur in milliampère terms, but something as above is the approximation, and should be considered only such, and more with regard to the relative distances between the number of milliampères required to produce the first and third reactions rather than between the second and third (which were just stated to be somewhat convertible), or particularly the fourth, for often in health cathodal opening cannot be induced without increasing the current to a too painful degree. For clearness and brevity's sake *we may generally neglect consideration of C O in health, but it becomes an important polar reaction in disease.*

We are reduced, then, to this formula for health, though it is only approximate:—

1, C C, ...	2 to 5
2, A C or A O, ...	6 to 8
3, A O or C O, ...	6 to 8
4, C O, ...	15+, or undemonstrable.

Remembering that the stronger current produces not only all that the weaker does, but additional reactions, the primes, seconds, and thirds, to designate the force of contractions, can be dispensed with, as well as the useless symbol for contraction; for it stands to reason that if C C is produced by two milliam-

pères, and does not cause the A C, which may require eight milliampères, then eight, or the stronger current, will cause C C C′, and so on.

We are now prepared to discuss the diseased reactions.

Strümpell* gives a concise review of the subject:—

"The variations from the normal state seen under pathological conditions consist of quantitative and qualitative changes in the law of contraction. We term the simple increase or diminution of the electrical excitability in nerves or muscles, without simultaneous changes in the quality and order of the occurrence of muscular contractions, quantitative changes. The discovery of increased or diminished irritability of nerve and muscle can be made most easily in unilateral diseases, where we can compare the strengths of current required to obtain the minimal contraction on the diseased and healthy side with each other. If we are dealing with bilateral or general diseases this is much harder to make out. We must, then, draw our comparisons from the conditions of excitability in normal individuals, where the different obstacles to conduction can be carefully estimated by the aid of a galvanometer or by comparing the excitability of the nerve-trunks in the different parts of the body with one another. For this purpose we are usually content (following Erb's example) with comparing the superficial nerves, like the frontal, accessory, ulnar, and peroneal, which are easily excited. An increase of electrical excitability is found in many fresh peripheral paralyses, and also in tetany. A diminution of electrical excitability is found quite frequently in bulbar and spinal paralyses, in progressive muscular atrophy, etc.

"Much more important, however, than the simple quantitative changes of electrical excitability are those not merely quantitative but also qualitative deviations from the normal law of contraction, which were first discovered in certain forms of paralyses by Baierlacher in 1859, and were soon generally

* A Text-Book of Medicine. By Adolph Strümpell, Erlangen Medical Clinique Director and Professor. Translation by Vickery and Knapp, with notes by Shattuck. New York, 1888.

confirmed. Erb has given these the name of the 'reaction of degeneration,' because they are closely connected with the progress of certain anatomical changes in the paralyzed muscles and nerves.

"In order to make the relations of the reaction of degeneration clear, let us select as an example any fresh peripheral paralysis, and follow the changes in excitability to the two currents in the nerves and muscles. In a short time (two or three days) after the onset of the paralysis a gradually increasing decline in the faradic current and galvanic excitability in the nerve begins. After one or two weeks the excitability is completely lost, so that from the nerve we can no longer provoke any trace of muscular contraction with the strongest faradic or constant current. During this time the excitability of the paralyzed muscles to the faradic current has also rapidly diminished, and finally has wholly disappeared. The case is quite different with direct galvanic excitement of the muscles. Here we find at first a slight diminution, which in the second week passes to a decided increase of the galvanic muscular excitability. We now obtain marked muscular contractions with relatively weak currents. Besides that two other very important peculiarities are to be noted: 1. The muscular contractions are not short and lightning-like, as under normal conditions, but they seem quite sluggish, protracted, 'worm-like,' and often persist during the whole duration of the closure of the current. 2. The muscular contractions occur not only chiefly at cathodal closure, as under normal conditions, but the anodal-closure contractions are as strong as the cathodal-closure contractions, or even plainly exceed them. The cathodal-opening contraction is also frequently stronger. It may also be mentioned here that the mechanical irritability of the muscles in such cases is usually increased.

"This second degree of reaction of degeneration lasts from four to eight weeks. If the paralysis be severe and long-continued, or incurable, at the end of this period comes a decline of the galvanic muscular excitability. The contractions become

weaker, the strength of current necessary to produce them greater, and, finally, in incurable cases, even with the strongest currents, we can obtain only a little, slow, anodal-closure contraction or none at all. It is different, however, in the milder curable cases. In these the passage to the normal condition gradually follows either the increase of the galvanic muscular excitability or, in more protracted cases, its secondary decline. The contractions become more vigorous and shorter, the cathodal-closing contraction again predominates, the faradic muscular excitability and the faradic and galvanic excitability of the nerves finally return, and with them the old normal conditions are restored. A fact to be observed in these cases is of great interest, namely, that the voluntary motion in such cases often returns decidedly earlier than the electrical excitability of the peripheral nerves. We see, then, that a diseased nerve may be capable of conducting irritations coming from the brain, while the taking up of irritation, its direct excitability, is still completely lost. Reaction of degeneration can sometimes be made out in lesions of peripheral nerves, and perhaps also in spinal diseases in those muscles which show no essential limitation of their voluntary mobility. In such cases we can obtain a muscular reaction by electrical irritation of the nerve above the point of lesion.

"Besides the complete reaction of degeneration, just described, there is also a so-called partial reaction of degeneration, which is not infrequent in milder cases. This is when the diminution of the faradic and galvanic excitability in the nerves and the diminution of faradic excitability in the muscles are only of slight degree, while the characteristic changes in the direct galvanic excitement of the muscles—increased excitability, slow contractions, and predominance of anodal-closure contractions—are fully developed. In some cases the occurrence of slow contractions on faradic excitement of nerves and muscles has lately been observed—'faradic reaction of degeneration.'

"All paralyses may be divided into two great groups,—into

atrophic paralyses, and paralyses without marked atrophy of the affected muscles. We have learned to recognize the necessary hypothesis of the 'trophic' influence of the ganglion-cells in the anterior cornua of the spinal cord as the foundation of this distinction. In all cases where the disease affects these ganglion-cells, or is situated in the peripheral nerves, so that the trophic influence of the ganglion-cells on the muscles can no longer exist, we have a degenerative atrophy of the peripheral portion of the nerve and of the muscle belonging to it. This degenerative atrophy is the anatomical cause of the symptoms of the electrical reaction of degeneration.

"If we have to do with a peripheral paralysis, such as a traumatic lesion of a nerve-trunk, the portion of the nerve peripheral to the point of lesion is separated from its 'trophic centre' in the cord and begins to undergo secondary degeneration. The first anatomical sign of the degeneration is a breaking down of the medullary sheath into large and small flakes and drops. The axis-cylinder is also soon destroyed, so that the sheath of Schwann finally incloses only homogeneous fluid contents, which are in great part rapidly absorbed. At the same time there is an increase of the nuclei in the sheath, and this increase, when the process is long-continued, leads to a decided increase of the interstitial connective tissue in the nerve. The diminution and final loss of electrical irritability in the nerve are perfectly parallel to these anatomical changes, as we can easily understand.

"The degeneration of the nerve involves its finest terminal branches in the muscles, but the muscle itself does not remain unchanged. The muscular fibres undergo a marked atrophy. They become much smaller, their transverse striation is less distinct, and they show in part a fatty and 'granular' degeneration of their contents. Some fibres show that peculiar, yellow, homogeneous character which we call waxy degeneration. In addition to this there is considerable increase of the muscular nuclei, and in the later stages a great new growth of interstitial

connective tissue, often associated with a marked deposit of fat. These muscles, thus altered, now react only to the galvanic current and in the manner above described. The particular cause of this remarkable fact is, of course, still completely unknown to us.

"In the incurable cases the processes of degeneration just described gradually advance, but in the cases that recover a number of processes of regeneration begin sooner or later. We cannot here go into the finer details, which are still, in many respects, the subject of controversy; but it is certain that new nervous and muscular fibres are formed, and that, hand in hand with the anatomical processes of regeneration, first the voluntary motion and later the electrical excitability of the paralyzed parts gradually return again.

"The same anatomical changes, which we have just described as a secondary degeneration in lesions of the peripheral motor nerves, also develop if the primary disease has its seat in the anterior cornua of the gray matter of the spinal cord,— that is, in the trophic centres themselves. In these cases, of course, the form of the disease has nothing to do with it. Both in the different forms of the inflammation and primary atrophy, and also in new growths which affect the anterior gray matter of the cord, a secondary degeneration, with pronounced reaction of degeneration, develops from the anterior roots of that portion of the cord affected to the ends of the peripheral nerves, and even to the corresponding muscles. We shall also learn to recognize a number of primary degenerations of the peripheral nerves, like primary neuritis, diphtheritic and toxic paralyses, etc., which likewise show the anatomical changes, and likewise give, as a result of these, electrical reaction of degeneration. In all cerebral paralyses, however, and in those spinal paralyses where the cause of the paralysis is situated above the part of anterior gray cornua concerned, the degenerative atrophy, and also the reaction of degeneration, are entirely wanting.

"We thus see that the reaction of degeneration, in regard

to diagnosis, at once permits us to decide that the disease is situated in the gray matter of the cord or in the peripheral nerves. It does not permit any further distinction. In regard to prognosis, it teaches us that anatomical changes have taken place in the nerves and muscles, from which a restoration is still very possible, but at all events it can take place only after the lapse of a longer time,—at least, two or three months. We will soon learn to recognize a number of mild peripheral paralyses in which there is generally no reaction of degeneration. From the absence of reaction of degeneration we can then draw the conclusion, with certainty, that no coarse anatomical changes are present in the nerve, and that we may expect after the trouble a much more rapid recovery, perhaps in three or four weeks. The partial reaction of degeneration, above mentioned, is also an important symptom in regard to prognosis. It shows that severe anatomical changes have taken place in the muscles but not in the nerves, and hence it always permits a more favorable prognosis as to time than in the cases with complete reaction of degeneration."

From Bramwell, page 109 *et seq.*, we may advantageously take the following:—

"In testing the condition of either the paralyzed muscles or nerves with the faradic or interrupted current, the following points must be noted:—

"1. *Whether a muscular contraction is produced or not.*

"2. *If a contraction is produced, what is the minimum strength of current required to produce it, and whether the character of the contraction is in any way altered from the normal.*"

He then alludes to the necessity of testing opposite corresponding muscle-groups to ascertain if there are any differences of reaction between them.

"3. *The strength of current and the rapidity (whether slow or quick) of the interruptions required to produce the maximum amount of muscular contraction.*"

With the galvanic current:—

"1. *Whether a muscular contraction is produced or not.*

"2. *If a contraction is produced* (a) *what is the minimum strength of current required to produce it;* (b) *the order of the polar reactions;* (c) *the character of the contractions, whether healthy or not;* (d) *the strength of the current required to produce tetanus;* (e) *whether the contractions are more easily excited by slow or quick interruptions of the current.*"

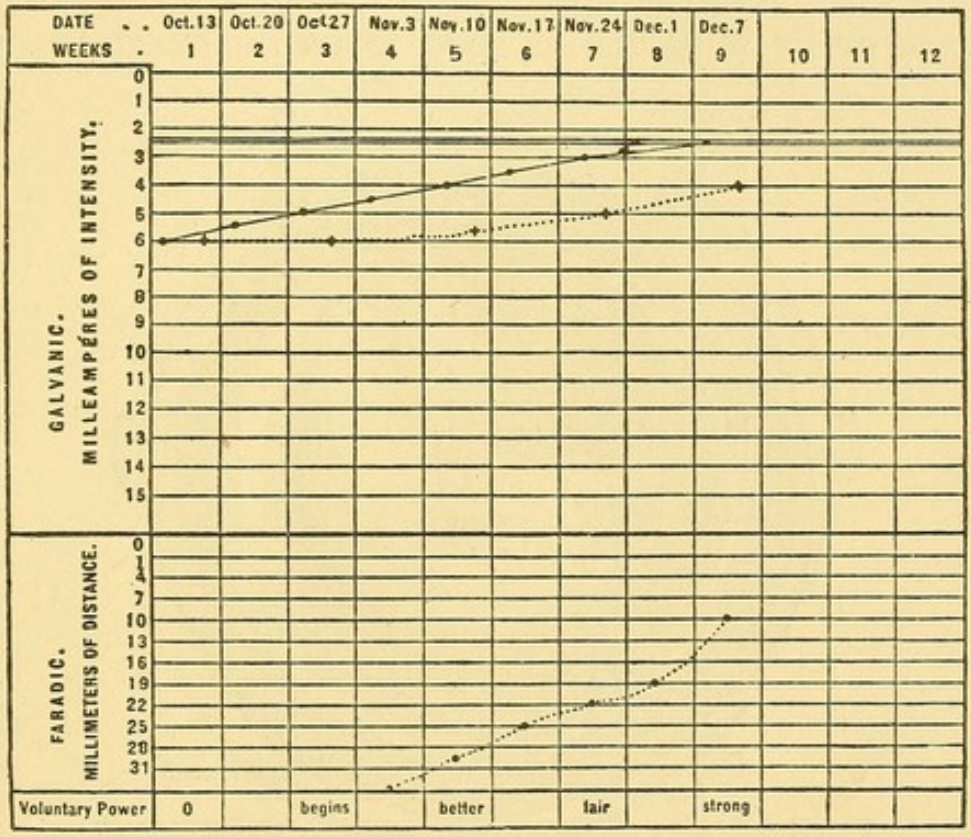


FIG. 10.—STARR'S ELECTRIC CHART.

Name: C. E. K C C ————
Muscle: Ext. Com. Digit. Sinister. An C C .....

Erb gives a number of charts that graphically illustrate the curves of the faradic and galvanic currents during successive examinations of paralytic conditions, but since the advent of the milliampèremeter a new system of records has come in vogue.

M. Allen Starr,* in a paper on "Electrical Charts," makes excellent suggestions to the effect that the curves from examinations at different times can be more readily noted with a new form

* Journal of Nervous and Mental Diseases, February, 1887.

of chart (reproduced on preceding page), and that a prognosis line can be projected from the points when united by a line, either downward or horizontally, in case of chronicity, or upward toward the normal line, which he places at two and a half milliampères.

As a rule, the older treatises on medical electricity were filled with pedantic and uninteresting, scarcely pertinent, apparatus descriptions and essays on primary physics. Some information on this branch must be presupposed for the reader of this book, or its bulk would have to be increased beyond all

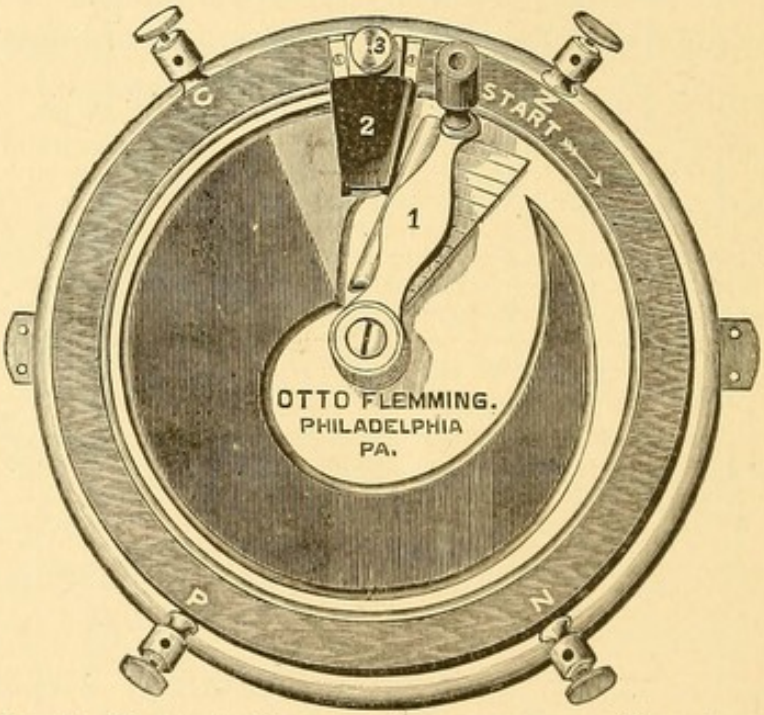


FIG. 11.—MASSEY'S CURRENT-CONTROLLER, OR RHEOSTAT.

reasonable bounds. For one of the most beautifully written and arranged recent text-books on physics, the student can find nothing to surpass "Gage's Physics." Old toilers in what used to be called "Natural Philosophy" wish that Gage's book could have been possible twenty years ago. When such studies are now so clearly presented, whereas in former days the matters of which they treated were so obscure and speculative, it is a disgrace to the rising generations of physicians that they have profited so little by what is now so readily learned; and Massey may well say (page 5 of his recent work): "I have more than

once been simply astounded at the lack of acquaintance with elementary physics on the part of graduates of our best medical schools."

To assist him in increasing knowledge of such matters I shall quote liberally from his second and third chapters. He

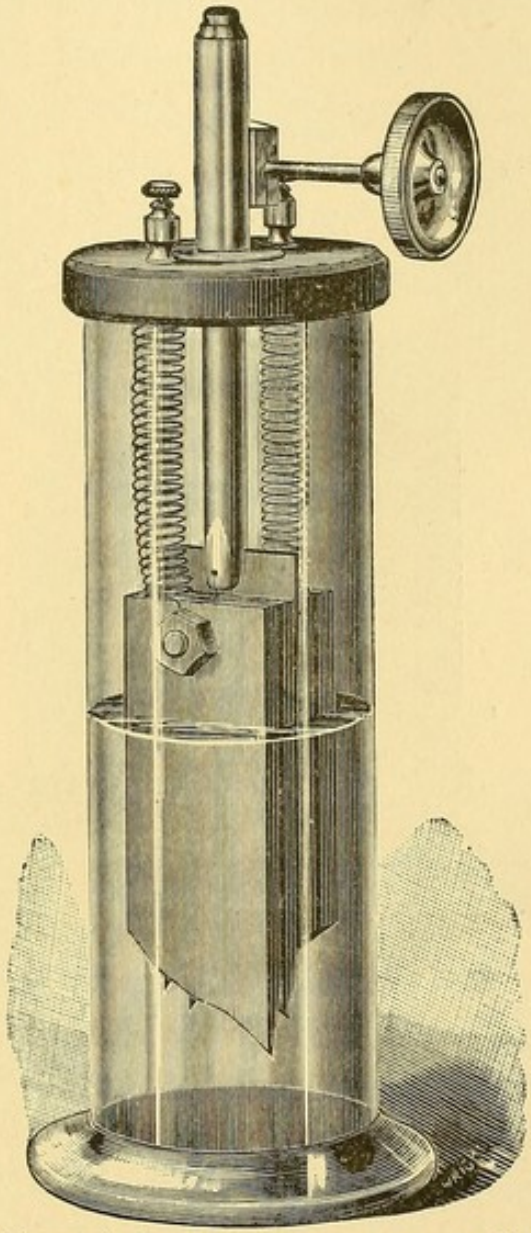


FIG. 12.—BAILEY'S CURRENT-CONTROLLER, OR RHEOSTAT.

describes what he calls current-controllers, but which are generally known as rheostats. One that he invented does not vary the current from a fraction of a milliampère to the full battery strength without shock. "When the crank (1, Fig. 11) is placed to the right of the hard-rubber stop, 2, the contact

rests entirely on the glass and the circuit is broken. Moving it slightly in the direction of the arrow, it soon touches the graphite mark and permits the least amount of current to pass through, since the current must pass through the whole length of the graphite,—a poorly conducting medium. As the crank is slowly brought down from the point of rest and up to the other side, there is a progressive, gradual increase of current, until, finally, the thick graphite and the lead at the left of the rubber button are reached, when the whole power of the battery is turned on, there being no resistance in the controller. A reverse action turns the current off."

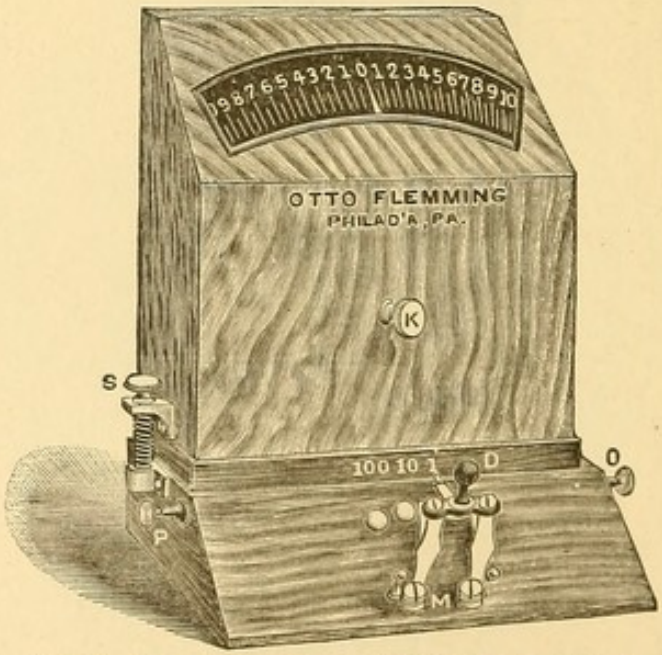


FIG. 13.—THE FLEMMING MILLIAMPÈREMETER.

Another rheostat, of which there are some modifications in the market, is Bailey's, which was "made by the Law Telephone Company, of New York, to control the strength of currents used in telephone-exchanges, and is a development of the water-tube and rod, the rod being replaced by four broad carbon plates, giving immense surface-contact with the water when fully immersed. The plates taper to points below, and by means of a ratchet and pinion may be gradually immersed into the water and raised out of it, giving an exceedingly wide range of resistance and enabling the current to be varied without

the possibility of shock from zero to any desired number of milliampères." (See Fig. 12.)

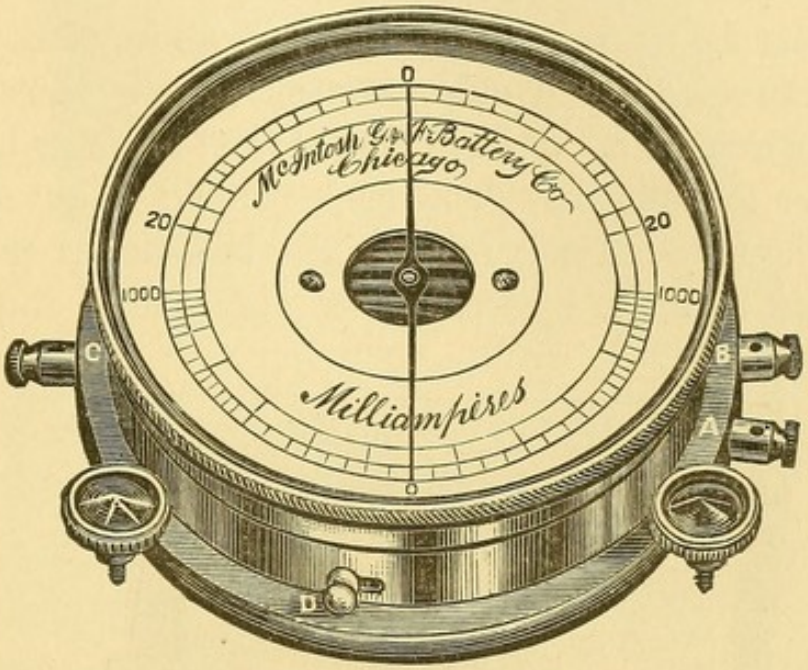


FIG. 14.—THE MCINTOSH MILLIAMPÈREMETER.

Massey describes two forms of milliampèremeters,—the Flemming and McIntosh,—illustrations of which are taken from his book. (Figs. 13 and 14.)

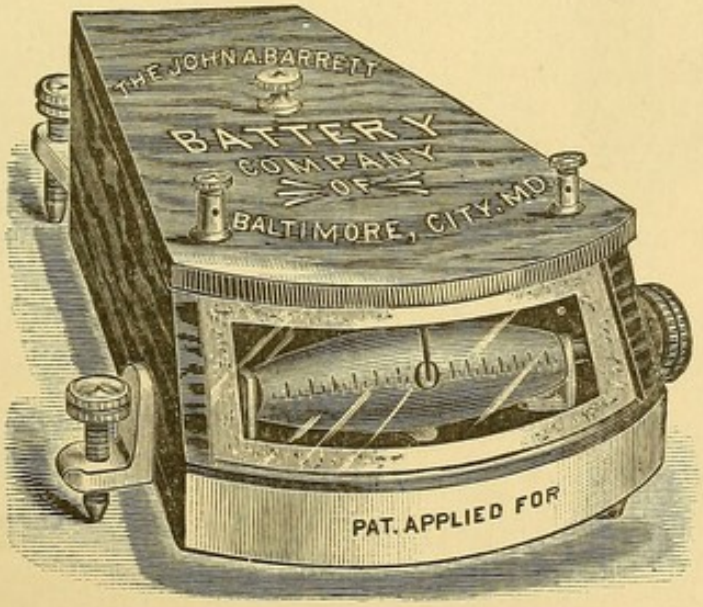


FIG. 15.—THE BARRETT MILLIAMPÈREMETER.

I add to this another form made by the John A. Barrett Battery Company, of Baltimore, Maryland. (Fig. 15.) Ingenious

devices for admitting increased scale-reading are attached to some of these meters.

There are many excellent stationary batteries with appurtenances, but for neurological purposes I know of nothing that surpasses Barrett's sealed chloride-of-silver cells, illustrations of which are given here. I have had several of these batteries in constant use for four years, and their voltage is but slightly reduced. The fifty-cell galvanic weighs but eleven pounds and measures six by seven by ten inches. Renewal of the cells may

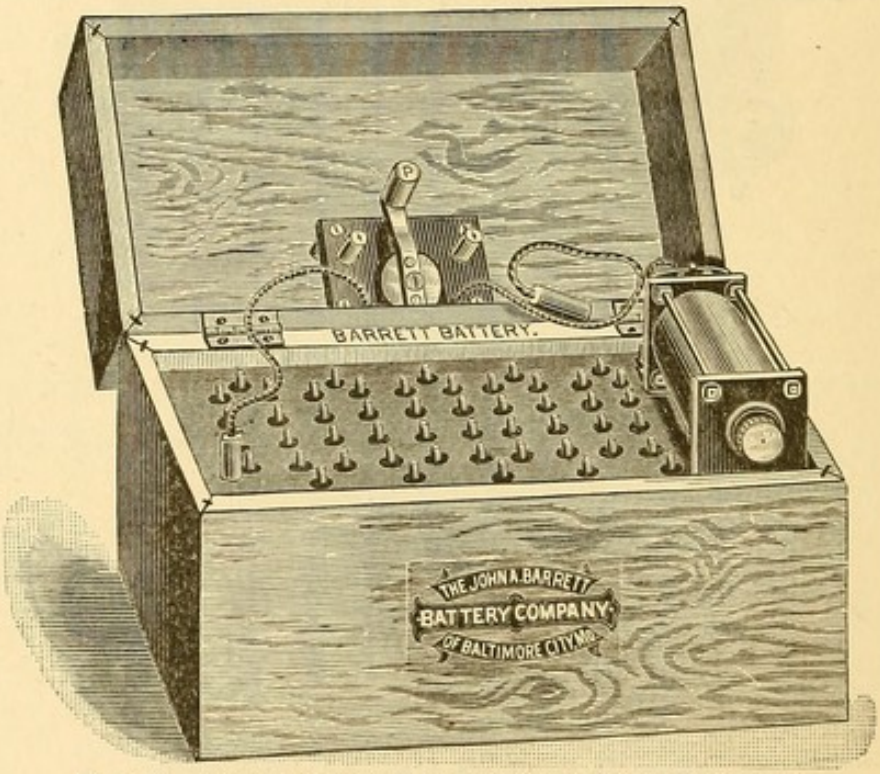


FIG. 16.—COMBINATION FARADIC AND NO. 2 BATTERY.

not be needed for years. Its portability and cleanliness, together with other good features, make it *the* medical battery of the age. A faradic attachment or separate faradic batteries may be used in connection with the galvanic.

Massey, page 34, says: "Exactness of record is amply attained if the number of milliampères is given, together with the name and dimensions of the active pole and the duration of the application.

"Such experiments will also show the thoughtful student

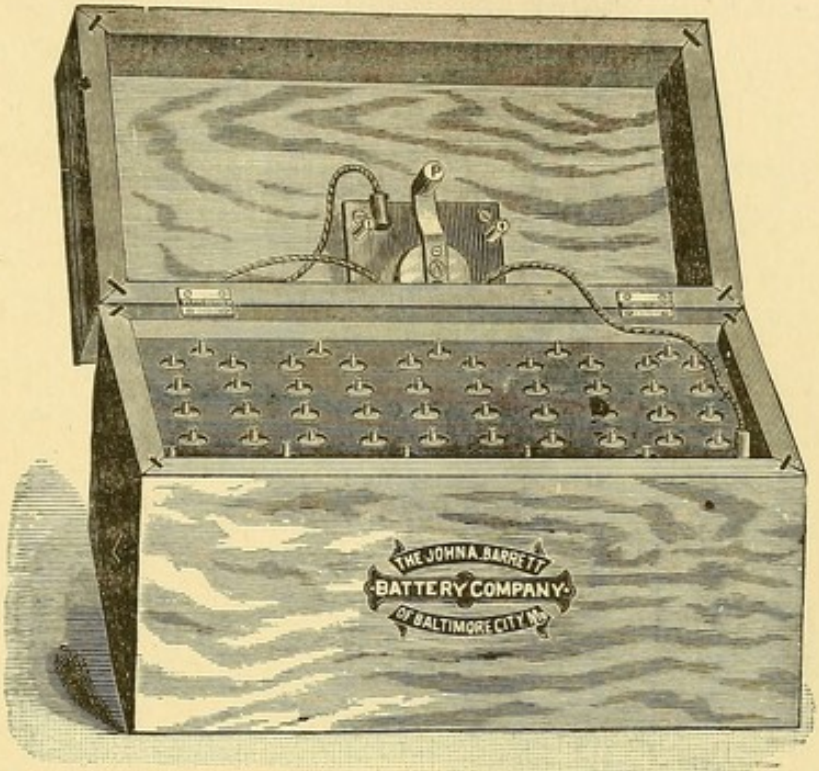


FIG 17.—FIFTY-CELL (No. 1) GALVANIC BATTERY. (Case open, ready for work.)

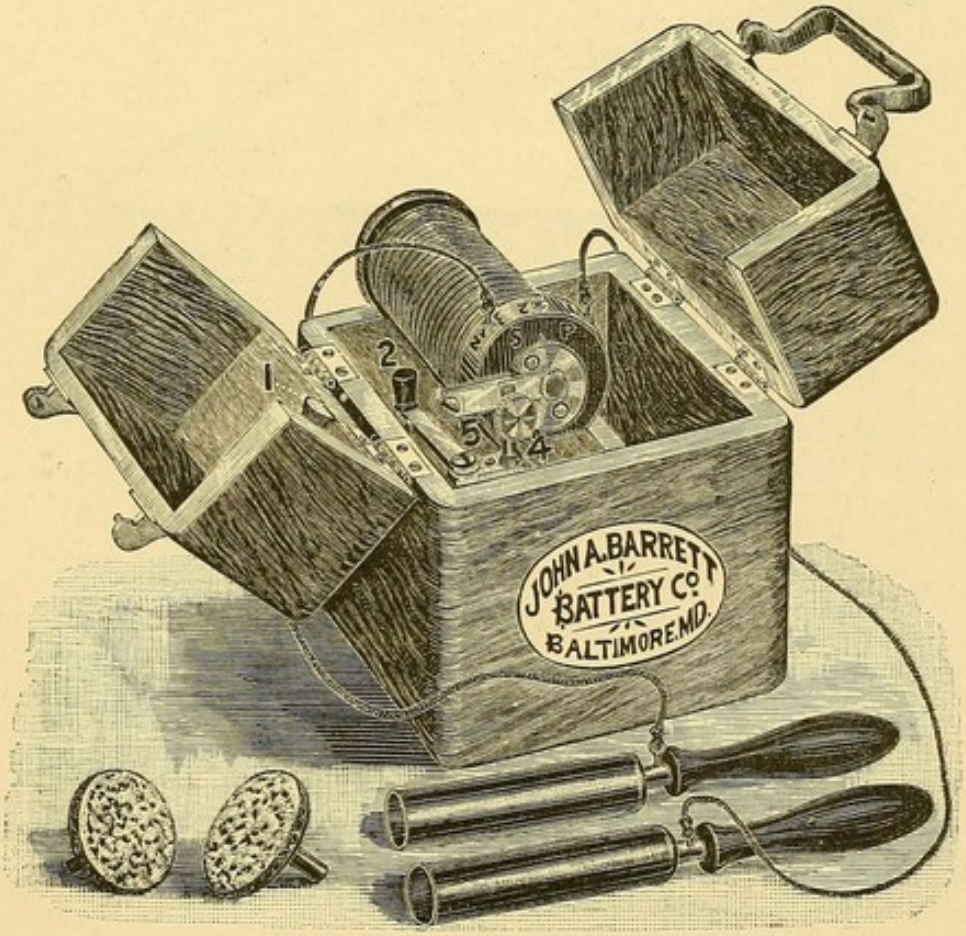


FIG. 18.—SPLIT-TOP FARADIC BATTERY.

that a galvanic battery, or any other source of ampères or milli-ampères of current, is a reservoir of this peculiar form of energy, and in giving it out obeys laws singularly analogous to those of the force stored in a reservoir of water. If we examine a stream of water issuing from a reservoir (Fig. 19) we will find two qualities in it which it will be somewhat difficult to separate in the mind,—pressure and volume. The former is the force by which water transports itself, and depends on the height of the water in the reservoir. It is the same in all pipes issuing from

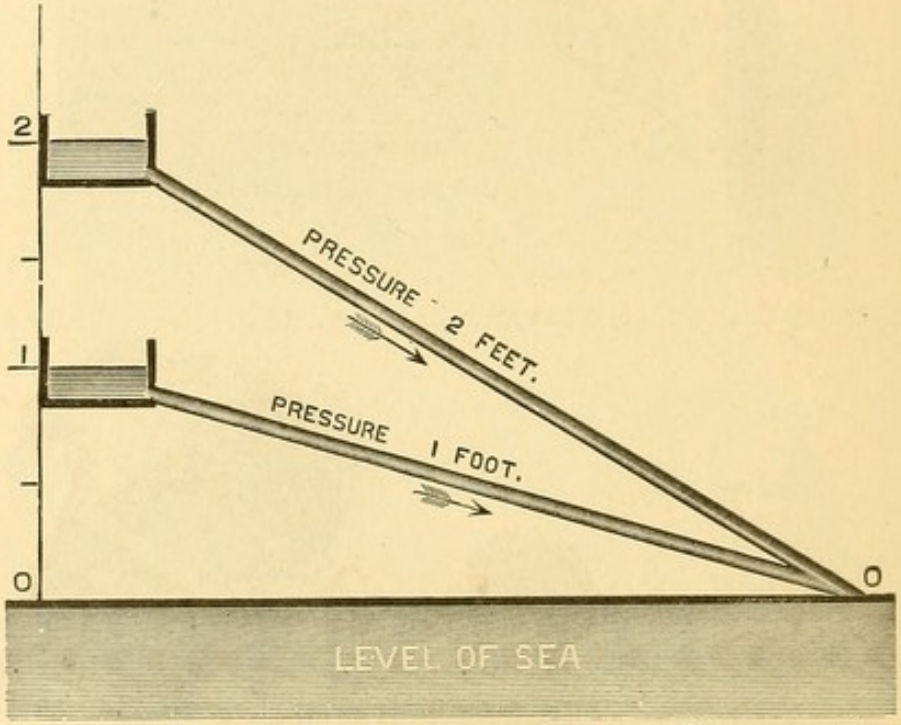


FIG. 19.—DIAGRAMMATIC REPRESENTATION OF THE CAUSE OF FLOW IN HYDRAULIC CURRENTS.

The pressure, measured by a vertical scale of feet, is due to the elevation of the source or reservoir. The amount of water delivered will depend on the calibre of the pipe as well as on the height of this pressure.

it, whether large or small. The volume of water carried by a pipe, on the other hand, depends on the size and length as well as on the pressure. In electricity (Fig. 20) the peculiar force by which it transports itself is called electro-motive force, and is likewise independent of the size of the wire or excellence of the conductor. It is measured in volts. In galvanic batteries the number of volts of this 'pressure' depends on the number and volt-power of the cells when serially arranged (placed one after another).

"The 'volume' of the electric current is equally analogous to that of the water current, for it depends jointly on the height of the pressure (the number of the volts) and the size of the conductor (the diameter and length of a wire, if a metal, and the conductivity, breadth, etc., if a living compound). It is this result of the pressure through the resistance—this volume of the current—that is indicated by a meter. For medical purposes it is measured in milliampères, or thousandths of the commercial ampère, a unit adopted in 1881 for the measurement of current-volume.

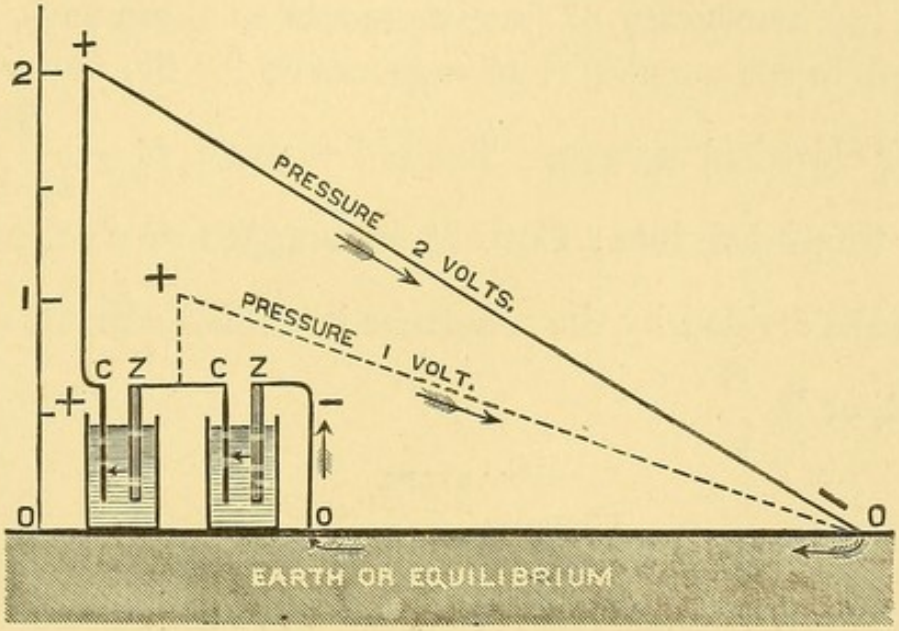


FIG. 20.—DIAGRAMMATIC REPRESENTATION OF THE CAUSE OF FLOW IN ELECTRIC CURRENTS.

The pressure (or electro-motive force), measured by a scale of volts, is due to the elevation of the electric level of the positive end of the conductor by the particular generator in use. The amount of current delivered will depend on the size and conductivity of the wire as well as on the height of this pressure.

"*The Milliampère.*—It follows, from these facts, that the milliampère is the medical unit of electricity itself in transit, just as the gallon per minute is the unit of a water current. The exact number of these units passing through a patient at a given time will always be shown if we have a good meter *placed in circuit with the patient.*

"*The volt*, on the other hand, is merely a unit of measurement of the pressure at which a current is delivered. Its use is to overcome the resistance; hence, the number required and the

resistance to be overcome. The number of these units possessed by a current has no medical value unless the interruption action of the current is desired.

"*The ohm* is the unit of measurement of the resistance that a current meets in a circuit. In the medical use of electricity it is an important factor, since there is so much resistance to be overcome; but it is, after all, but the measure of a negation, so far as actual working results go."

Ten years ago, at the meetings of the Chicago Electrical Society, of which I was vice-president, the electrical engineers deplored the inaccuracy of measurements in those days, but we have lived to see wonderful changes made for the better in this and other electrical matters. The old formula, $C = \frac{E}{R + r}$, can now be translated into: Current in ampères = electro-motive force in volts divided by the resistance in ohms, so that $C = \frac{E}{R} =$ $E = C\ R$, or $R\ \frac{E}{C}$.

EXAMPLES.

$$C = \frac{60 \text{ volts}}{5 \text{ ohms}} = 12 \text{ ampères.}$$

$$E = 2 \text{ ampères} \times 25 \text{ ohms} = 50 \text{ volts.}$$

$$R = \frac{800 \text{ volts}}{10 \text{ ampères}} = 80 \text{ ohms.}$$

The use of the absolute galvanometer has explained apparent discrepancies in the resistance the human body offers to the passage of the galvanic current. De Watteville* had remarked variations between the galvanometer records and the number of cells used, and, in common with many others, blamed the galvanometer with inaccuracy, but he, Waller, and Stone, independently, ascertained that the explanation lay in the changes of resistance in the patients. For instance, with four Leclanché groups, of three cells each, a current-strength of two milliampères was obtained from each group. After joining the

* Neurolog. Centralblätt, No. 9, 1886.

groups in succession with 3, 6, 9, 12 elements, Ohm's law should have afforded 2, 4, 6, 8 milliampères; but in practice there was an increase from 2 to 5, 8.5 and 11.8 milliampères. De Watteville concludes that in the usual medical uses of electricity the body resistance diminishes with the increase of the electro-motive force. Sudden reversal of current temporarily increases the recorded current-strength, but the needle soon returns to an equivalent indication as before the reversal.

CHAPTER XII.

DIFFERENTIAL DIAGNOSIS.

ACUTE MYELITIS may be caused by a concussion to the spine, by exposure to cold and wet, by general inflammatory conditions, by diseases such as small-pox, diphtheria, typhoid, syphilis, and cord compression, or by diseased bones, tumors, or thickened membranes. It may accompany Erichsen's disease, but it is observed that in such cases the acute or chronic myelitic symptoms preponderate, and thus there is afforded another disproof of the fright causation of concussion symptoms *in toto*. Acute myelitis may be general, central, transverse, unilateral, or disseminated; and a further division may be made into traumatic, syphilitic, and idiopathic. The bulbar is an important form of central myelitis. There is great variability in the symptoms, due particularly to the different degrees of acuteness and the location of the inflammatory process.

In the premonitory stage there are in some cases derangements of sensation, as numbness, tingling, or slight pain in the limbs and back, and mild fever and malaise; in others a chill is followed by rapid temperature increase. Sometimes paralysis, anæsthesia, etc., develop so rapidly as to suggest cord hæmorrhage, or the premonitory symptoms may be lacking.

The stage of irritation is attended with both motor and sensory symptoms, such as painful sensations, hyperæsthesia, myalgic pains, *and sometimes pain in the back, which is not increased by movements of the spine*, and this pain is never very prominent unless complicated with meningitis. In this ability to move the spine without increasing the pain, and in the absence of rigidity of the back, we have a means of separating myelitis from Erichsen's disease, *unless the two conditions co-exist.*

Shooting pains occur sometimes in myelitis and are absent in Erichsen's disease, when uncomplicated.

The girdle sensation occurs more frequently in myelitis than it does in Erichsen's disease. It is an early and very persistent symptom in the former. It indicates irritation of the posterior nerve-root fibres in both complaints.

Twitchings, tremors, cramps, and spasms, and, in some cases, bladder symptoms occur, such as increased frequency of micturition, spasm of the detrusor, or loss of expulsive power.

The destructive stage develops paretic increase, or paralysis may quickly follow with analgesia and anæsthesia, often of the "dolorosa" sort, which was described by Charcôt as attended with a diffused sensation of vibration and pain in the whole of the affected extremity. Many cases exhibit serious impairment of the bladder and rectal functions; constipation is common, and sphincter paralysis may ensue. Bed-sores often appear on the anæsthetic side, which is opposite to that of the cord-lesion. Cerebral symptoms are rare.

The reflexes are not impaired unless the reflex arc of the part is involved, and may be increased in inferior parts if secondary descending degeneration involve the pyramidal tracts, arresting cerebral control.

When the cervical region is affected the upper and lower limbs may be paralyzed; priapism, hyperpyrexia, heart and pulse rapidity or irregularity, with, at times, præcordial pains, may exist.

Respiratory derangements may be caused when the lesion is in the upper cord, with dyspnœa, asphyxia, and bronchial obstruction, with cough, difficulty in breathing, and expectoration.

The acute stage may terminate in death or a chronic myelitis. Improvement may follow with re-establishment of general health, lessened sensory derangements; rarely is there a perfect cure, as paraparesis, paraplegia, or monoplegia, with spastic rigidity may persist or increase, necessitating the use of crutches or cane.

Chronic myelitis is induced by the same causes and often follows upon the acute attack. Divisions may be made into transverse, disseminated, annular (when on the cord surface), focal, or general; further classified as syphilitic, compression, traumatic, and idiopathic chronic myelitis.

It may appear gradually with the same sensory derangements, as in the acute form, as numbness, "pins and needles," and with motor troubles, such as leg weakness, bladder difficulty, and obstinate constipation.

The paralysis is usually paraplegic; most cases of chronic paraplegia depend upon chronic myelitis, or an acute myelitis that has become chronic. The trophic condition of the muscles, the state of the reflexes, and, indeed, all the symptoms depend upon the precise location and extent of the lesion. Often rigidity of the muscles is combined with loss of motor power, and myelitis is the most frequent cause of spastic paraplegia,—a circumstance which Bramwell emphasizes as necessary to keep in view in the diagnosis of supposed cases of primary lateral sclerosis.

"The general health is usually well preserved, and the other organs and systems are, as a rule, healthy;" a state of things noted by that author (page 258) and attested by the experience of others. But the paralysis, nevertheless, may eventually become complete, to the extent of confining the patient to his bed; sloughs, cystitis, kidney, lung, or bladder complications may develop as direct consequences. When the myelitis is caused by compression and the membranes are involved, the symptoms become complex and partake of those characteristic of extra-medullary lesions.

The course is usually very protracted; death is frequent by extension of the disorganization, occasional arrest of the process occurs, and very exceptionally a cure is complete.

Acute leptomeningitis spinalis is most frequently caused by exposure to wet and cold, and, in some cases, by blows upon the spine, or by other traumatic influences. The onset is with

headache, irritability, vomiting, slight fever, and maybe a rigor or convulsion. The spinal symptoms are more of an irritating than destructive character.

Pain in the back is increased by the slightest movement, *but not usually aggravated by pressure or taps on the spine*, which signify irritation of the sensory filaments in the membranes, and afford a resemblance to symptoms of Erichsen's disease, in which, in addition to the spinal-root irritation, there are evidences of external, but adjacent, inflammatory or irritative conditions existing in the spinal, osseous, and ligamentous structures.

Shooting pains (hyperæsthesia) exist, with spasms and muscle tenseness, and, in consequence of the muscular contractions, there is spinal rigidity, often with retracted head or other cramped positions. There is a tendency to draw the legs up to the body in bed, and, in fact, an apparent endeavor to ease by flexion the irritated muscular areas. Constipation is frequent and bladder troubles are occasional. Paralyses and sensory aberrations may follow. The fever is irregular and may reach 104° F.; there is intense suffering and sleeplessness, and emaciation may rapidly take place. When the membranes of the cord are alone affected cerebral symptoms are absent. Death may occur in a few days, but in traumatic and tubercular cases the tendency is to become chronic.

Chronic leptomeningitis spinalis may result from the acute attack or gradually be induced by the same causes. There is no fever in the gradual cases. The prominent symptoms are: pain in the back, "increased by movement, sometimes, however, amounting only to heavy, dull discomfort, and accompanied by some stiffness of the back, and, when in the cervical region, by some retraction of the head. The pain is increased by pressure on the spine, and its increase by movement may cause a fixation of mobile parts, as the neck, in some abnormal position. The pain is apparently due to the irritation of the meningeal nerves, and the rigidity is to be regarded as a reflex

effect of this irritation."* The back may be very sensitive to heat or cold, and a hot or cold sponge applied to parts of the back may reveal the chief seat of the disease.

Motor weakness may proceed to paralysis of limited parts. Wasting, with diminished or abolished reflexes, may supervene, and other symptoms of chronic myelitis be also present. The prognosis is uncertain, depending usually upon complications.

Meningo-myelitis, frequently mentioned by Erichsen, is a combination of the two inflammatory conditions often found co-existing, but not necessarily, with Erichsen's disease, except as a frequent consequence thereof.

Some major symptoms of spinal concussion, or of that particular kind we denominate Erichsen's disease, closely resemble, if they are not identical with, those found in meningitis and myelitis of a chronic career, and, indeed, those inflammatory disorders may be merged with concussion symptoms inextricably; but, while meningo-myelitis may complicate, it can be readily separated from Erichsen's disease by the former not necessarily being attended with insomnia, headaches, inco-ordination, the peculiarities of appearance, the demeanor, the disposition, particularly the emotionalism and special-sense alterations; memory defects, vertigo, flushings, sexual impairment, appetite lessened, business-ability loss, hyperidrosis, cold extremities, and *particularly* the electrical-reflex quantitative, with absence of qualitative, change. Myelitis affords the reactions of degeneration which are not present in Erichsen's disease, and priapism occurs at times, which is more a myelitic than concussion symptom.

Pachymeningitis externa symptoms are mainly those of Pott's disease of the spine, which is frequently a cause; and, even when it is dependent on a thickened dura, from extensive exudates, the compression symptoms are so localized that errors of diagnosis should not occur, the main seat of symptoms being below the level of the lesion.

Pachymeningitis interna hæmorrhagica is usually both

* Gowers' Diseases of the Nervous System, vol. i, p. 199.

cerebral and spinal, and the symptoms are those of a chronic and ill-defined meningitis, such as back pains, rigid spine, slight motor and sensory irritation, and impairment. Meningeal hæmorrhages are likely to occur with symptoms of cerebral hæmatoma.

Pachymeningitis interna hypertrophica is a chronic thickening of the internal surface of the dura mater confined to the cervical cord, producing such characteristic sensory, motor, and atrophic conditions, with contractures and deformities, as are not to be confused with the peculiarities of Erichsen's disease.

Polio-myelitis anterior acuta is mainly a disease of infants, being rare in the adult. It is an inflammation of the anterior cornua of gray matter and exhibits characteristic paralytic symptoms, which appear at once, and not later, as in other disorders. One or more limbs may be involved, or even part of a limb. Remak describes an upper- and fore- arm type. The presence of degeneration reactions, with absence of sensory disturbances, sufficiently characterize this disease, apart from other spinal ailments; and it should not be confused with ordinary acute or chronic myelitis occurring in the anterior spinal gray, particularly when associated with sensory disturbances indicating posterior cornua involvement in addition.

Polio-myelitis anterior subacuta is a rare disorder, with myelitic symptoms, caused by disease restricted to the anterior cornua of the spinal cord. In the ascending type the lower leg is first affected by a paralysis which extends upward, and next the finger extensor muscles are attacked, with arm paralysis occurring later. In the descending type the upper extremities are the first and the lower the last to suffer. Though there may be some aching in the back, other sensory derangements are not marked, and there are no cerebral symptoms.

Progressive muscular atrophy is a gradual "drying up" of one set of muscles after another, with some myalgia, but no other disturbance of sensibility. The patient is often

unaware of the presence of the disease until advanced atrophy has occurred. The "skeleton-men" of the museums are victims of this spinal disorder, which is due to a localized disease of a portion of the anterior gray cornua.

Primary lateral sclerosis is a rare disease, of unknown origin, located in the crossed pyramidal tracts of the spinal cord, causing spastic paraplegia, without pain, but with exaggerated reflexes and ankle-clonus. The staggering gait of this disease resembles that of a badly-intoxicated person, and is its most noticeable peculiarity.

Secondary lateral sclerosis is similarly attended with motor weakness in the legs, rigidity, spasms, and increase of the deep reflexes; but sensory disturbances, due to posterior nerve-root pressure, accompany this form. Its origin is in a transverse myelitis or slow compression of the cord. One side may be affected by a descending degeneration of the crossed pyramidal tract from the brain. As in chronic myelitis, of other types, the major concussion symptoms are absent, such as back pains, rigidity, insomnia, headaches, emotionalism, etc.

Amyotrophic lateral sclerosis is an affection of the pyramidal tracts and anterior cornua, in which the symptoms of progressive muscular atrophy, primary lateral sclerosis, and pachymeningitis cervicalis hypertrophica are united. It is invariably fatal and not likely to be confused with other spinal disorders.

Locomotor ataxia, or tabes dorsalis, from disease of the posterior columns of the cord, is characterized by inco-ordination, walking being difficult unless the patient can see the motions of his feet; lightning pains, often abolition of the tendon reflexes, visible ocular troubles, decided general anæsthesia of both sides, retarded sensation conduction, girdle pains, and skin hyperæsthesia. The disorder is chronic and may last twenty years. Long remissions may occur, during which there may be decided improvement or an arrest of the symptoms at any stage; but often some accident or intercurrent sickness may restart the disorder upon its course, or such renewal of symptoms

may occur without assignable cause. The form of insanity known as paretic dementia is sometimes associated with or follows from locomotor ataxia. Vertigo and headache are uncommon. Sleep, appetite, and digestion are apt to be good, and when insomnia exists it is usually from the persistence of sharp pains, and their cessation enables the patient to fall into a sound slumber,—a condition markedly different from that of Erichsen's disease, where the sleep is constantly disturbed. It is now well established that tabes may be caused by a spinal concussion.

Cerebro-spinal sclerosis may be induced by a blow on the head or spine, and consists in disseminated nodules or patches of degeneration scattered through the nerve-centres, and sometimes in peripheral nerves. Visible jerking tremors, advancing to general shakiness on attempting voluntary movements, with comparatively insignificant sensory disturbances, are the essentials; and, in the absence of back pains, rigidity, sleeplessness, and other symptoms, it differs decidedly from Erichsen's disease.

Paralysis ascendens acuta, or Landry's ascending paralysis, is a formidable disorder, of which the morbid anatomy is unknown, with an average duration of from eight to twelve days. Some cases end fatally in three days up to three weeks. Only a few recoveries are known. There are no sensory derangements, no degeneration reaction, nor atrophy. The disease begins by paralysis in the toes, with an upward paralytic tendency, until there is general paralysis and the medulla is involved, and death occurs from asphyxiation.

The compression disorders, such as proceed from tumors, hæmorrhages, effusions, bone dislocations, etc., are sufficiently localized and distinct in their symptoms to require but bare mention here.

Hysterical paraplegia is essentially a disease of the female, and occurs oftenest in young and hysterical women. It may come on gradually or suddenly, and be incomplete or complete. The legs may be flaccid or rigid, ankle-clonus may be present,

and there may be a close resemblance to spastic paraplegia. The reaction of degeneration is never present; all forms of skin sensibility may be abolished, together or separately; retention of urine is common; after a fit of emotional disturbance the *urina spastica*, or great quantities of limpid urine, may be passed. The previous hysterical character of the person, with the *facies hysterica* of Todd and the usual uterine or ovarian disturbance, should be duly regarded. But organic disease may exist in an hysterical person, and a paraplegia be due to that instead of to a functional derangement.

Hysteria in general has been discussed by Putnam, Charcôt, Oppenheim, Erichsen, and others, in its relation to spinal concussion, with the result of establishing the fact that the emotional, sensory, and motor troubles of a genuine case of Erichsen's disease are not hysterical, and have but a superficial resemblance to hysteria. Furthermore, it should be borne in mind that hysteria itself is a genuine enough complaint, sometimes a fatal one, and indicates a depraved nervous control which may, particularly in a female, with or without predisposition, have its origin in traumatism or fright. I have known the latter to cause hysterical insanity, which is as real and as "functional" a disorder as melancholia. Sickness or injuries notably have some, if not many, hysterical symptoms as a complication. There are some hysterical persons who are such by reason of faulty training, congenital defects, or other lack of proper organization; nevertheless, their condition is a pitiable and often irremediable one, and may be as much so as that of an epileptic or idiot.

Page's use of the term hysteria to indicate "loss of control and will-enfeeblement," under the heading of "Functional or Neuro-mimetic Disorders," may as properly be extended to include most forms of insanity and bodily diseases. Moral treatment alone *may* benefit hysteria, and so it may also insanity, and even organic bodily diseases, within certain limits.

Erichsen well says that the term hysteria has been used

"to hide our ignorance of what this condition really consists. To me, I confess, the sight of a man of middle age, previously strong and healthy, active in his business and in all the relations of life, suddenly rendered 'hysterical,' not merely for a few hours or days, by some sudden and overwhelming calamity that may for the time being break down his mental vigor, but continuously so, for months or years, is a most melancholy spectacle, and is a condition that certainly, to my mind, is an evidence of the infliction, in some way, of a serious, and for the time being, disorganizing injury of the nervous system, though, happily, that injury is not in general of a permanent nature or attended by organic changes."

The liability of hysteria complicating or being caused by spinal concussion should be placed upon the same plane as that of other disorders, such as tabes, syphilis, etc. A predisposition may exist in an hysterical person to render the emotional and some sensory and motor symptoms more pronounced, but that hysteria alone may cause Erichsen's disease, or anything resembling it, except very superficially, has been fully disproven by Knapp, Putnam, Oppenheim, and the admissions of Charcôt; the latter was doubtless led into error at first by the well-known impressionability of the French, who afford more hypnotics, hysterical persons, and excitable neurotics than most other people. Charcôt and his school could experiment with auto-suggestion many years, with far less results, upon the English, Germans, Scandinavians, and especially Hollanders. Essentially this is the method of the "Christian Scientists," and other such ignorami. Undoubtedly many "cures" are effected by such people, where little or nothing was the matter, by solemnly insisting that there is nothing the matter; but when the ailment is genuine, beyond doubt, it can no more be cured by such means than auto-suggestion can institute a real Erichsen disease, or anything that closely resembles it, in a previously healthy person.

When there is such wide-spread ignorance of the nature of Erichsen's disease, even among physicians, it is not probable

that the symptoms are due to suggestion from medical attendants, for with such misinformation paralyses and rigid legs would predominate, as in my Case II of probable malingering, those features being the most likely to pass current among the laity and poorly-educated medical men as evidences of concussion symptoms.

There is no doubt but that many cases of imposture, absurdly apparent as such to the informed, have succeeded in securing damages, through want of knowledge on the part of the lawyers of the defense as to what constituted concussion symptoms.

The matter of nervous mimicry of organic diseases in general was discussed by Sir James Paget, whom Page quotes extensively. The entire ground has been more carefully and recently traversed, as mentioned in other parts of this book. Buzzard * discusses the "Differential Diagnosis between Certain Hysterical Conditions and Myelitis," in which he found that electrical tests, as a rule, sufficed to tell them apart.

Conscious and unconscious exaggeration of symptoms may complicate genuine cases or constitute a large element of fraud. About the most laughable instance of downright shamming I ever met was in a fairly well-to-do butcher, who desired an increase of pension from the government for alleged injuries sustained in the late war. Throwing him upon his own resources for symptom descriptions, he said that he was "diseased in his nerves," but, as he could not tell in what way, a few suggestions of absurd troubles were promptly acknowledged:—

His neck felt as though it were a yard long.

He slept only by alternate hours.

He dreamed the same thing every night for a year.

One leg felt as though it were burning up and the other as though frozen.

He said his sense of smell was lost, and he pretended not to be able to recognize strong ammonia, though it made him

* Diseases of the Nervous System. London, 1882.

gulp and his eyes water when a bottle of it was applied to his nose.

When I asked him if he did not see a cross constantly present before one eye and a circle before the other he gave rather a faint assent, as it dawned on his fraudulent and stupid intellect that there were such things as tests for imposture.

A perfectly honest plaintiff may, through emotional disturbance, exaggerate his symptoms without knowing it; or many litigants, with the silly idea that they are helping the lawyers, may lie about their symptoms. They should be repeatedly and sternly warned against any such attempts to deceive, either the lawyer or physician, as dangerous to their interests.

Litigation symptoms, so called, are not a necessary part of Erichsen's disease, and hence should be differentiated from the other troubles as too frequently superimposed upon concussion derangements. The essential element is *worry-aggravation* of the disease. All the facts as to the amount of damages claimed and the prospects of a settlement or the suit dragging along for years should be considered in the light of business annoyances, which we know are often alone sufficient to destroy health and mental peace in previously healthy persons. The effect of litigation of any kind, other than damage suits, is to disturb mental and bodily equilibrium; it debilitates and irritates. In damage suits it is to be considered as aggravating, but not as productive of the symptoms of Erichsen's disease.

Malingering.—In Dunglison's "Medical Dictionary" and Ogsten's "Medical Jurisprudence," as well as elsewhere, classifications of feigned diseases are made, Ogsten's being—

"1. Feigned diseases strictly so called, or those which are altogether fictitious.

"2. Factitious diseases, or those which are wholly produced by the patient, or, at least, with his connivance; and to these have been added, by some writers,

"3. Exaggerated diseases, or those which, existing in some

degree or form, are pretended by the party to exist in a greater degree or different form.

"4. Aggravated diseases, or those which, originating in the first instance without the person's concurrence, are intentionally increased by artificial means."

The disposition to sham, to defraud, to play the hypocrite, to delude, to pretend, is an all too universal trait, but one that has been legitimately inherited from our most remote and beastliest of ancestors. It is essentially a trait most conspicuous in the fox, opossum, snake, and other animals that are compelled to resort to strategy or stealth to procure a living or to escape enemies. The human exhibition of the propensity, as exhibited most frequently in politics, in the church, in society, and in business, has the identical animal origin, and the doctrine of evolution teaches us that the "manliest man" is he who despises intrigue, subterfuge, falsehood, and prevarications, and pursues a straightforward, frank, fearlessly honest course in life, even though it entail *apparent* disadvantage. The real advantage comes in preservation of self-respect and freedom from manifold "carking cares," which latter the atavistic sneak, however wealthy, cannot escape.

This moralizing is pertinent in connection with my claim that the previous good character of the plaintiff entitles his assertions to respect if not to full credence. If the man is a politician and a low character generally his claims should be regarded with suspicion.

Malingerers, as a rule, are of this low type, possessed of a species of low cunning that links them to animals; and they are as truly reversionary to a primitive animal disposition as are the other monstrosities, mentally and physically arrested in development, that Rokitansky preceded the evolutionists in properly classifying. This trickiness is very apt to be associated with other mental defects, such as stupidity or a craftiness that overreaches itself. All these matters should be properly considered by the physician, and if he knows what constitutes Erichsen's

disease it is next to impossible to impose upon him with any medley of nonsensical symptoms such as the ignorant assume, and almost invariably the malingerer is ignorant; for the mental breadth necessary to successfully feign this disorder would certainly deter the possessor of that intelligence from so doing.

Tidy and other authors on medical jurisprudence may be referred to, especially for starvation tests in suspected simulation. The well-known symptoms of bromism in the fetid breath, the eruptions, the mental hebetude should be remembered where the excessive use of the bromides is alleged or suspected, and the great value of electrical tests, when properly used, should also be recalled.

An ignorant or a skilled malingerer may easily impose upon an ignorant physician, exactly as the uninformed in every department of life may be taken advantage of in business. Neither an ignorant nor skilled malingerer can impose upon the educated physician who has proper opportunities for investigating the alleged complaint. Of course it is to be taken for granted that this is exclusive of the honesty or dishonesty of the physician, who may possess either, whether he is unlearned or highly skilled, for it is conceivable that a medical man may lend himself to fraud; but I think the tendency of a scientific education is to inculcate truthfulness in all things, though in no instance must skill and honesty be considered inseparable, and, on the other hand, very stupid persons may be perfectly reliable.

The physician familiar with a certain disease does not need rules for the detection of simulation, as feigned symptoms unfailingly strike him as grotesque. The bank-teller need not be told how to distinguish counterfeit coins.

Paraplegia Depending upon Idea.—Under this term Dr. Russell Reynolds described certain cases of paralysis depending upon imagination in which there was no intention to deceive, and the patients thought they really were afflicted with some organic disease. Some of these were doubtless hysterical, others hypochondriacal, and still others differed from either. They

were of nervous temperaments, exhibited in twitchings, startings, and fibrillary tremors; myalgic pains were common; the heart was easily excited; fatigue was readily produced by exertion or excitement; in short, they were neuropathic. They were sleepless and restless, rising early and unrefreshed; the stomach was deranged and constipation common; reflexes exaggerated, muscles soft and flabby; there was general but not localized wasting; sensibility was not affected, and no bladder trouble existed. "The loss of motor power is seldom, if ever, complete, and often presents anomalous characters; for example, a patient who can neither stand nor walk will move the legs in any direction when in bed. 'Ideal paraplegia' often lasts a long time, it may be years, and it is sometimes most difficult to cure," says Reynolds. The absence of the peculiar, constant insomnia, the back symptoms, the emotional disturbances, and any of the sensory observations of Erichsen's disease distinguish this mainly hypochondriacal disorder apart.

Malarial paraplegia, rare even in malarial districts; intermittent in character; organic symptoms are absent, and it has nothing in common with Erichsen's disease.

Anæmic paraplegia, from cessation of blood-supply to the lower end of the cord. Bramwell states that weakness of lower extremities may follow in some cases of aortic regurgitation.

Alcoholic Paraplegia.—Broadbent, Wilks, Buzzard, and others have shown that in this there is a close resemblance to acute ascending paralysis in the order of development, the degeneration reaction, and myalgic pains. Abstinence from alcohol causes recovery.

Aneurismal Paraparesis.—I have had a few cases of abdominal aneurism, where, in addition to the solar-plexus pressure and other symptoms of aneurism, there was a marked leg paresis, a giving out of the ability to perambulate. I corresponded with Dr. Roberts Bartholow concerning one such case, in which he diagnosed the aneurism and cured it. The case had been pronounced one of ataxia by other physicians.

Neurasthenia spinalis is common in males between the ages of twenty-five and forty, and is characterized by leg weakness and general fatigue. The back and legs ache, and there may be spinal tenderness, some paræsthesia, but no anæsthesia, and the tendon reflexes are exaggerated. Sleep is unrefreshing. Sexual excess is the most frequent cause.

There is no fixation of the spine, disturbed sleep, pain on moving the back, emotionalism, etc., as in Erichsen's disease.

Spinal irritation occurs between the fifteenth and thirty-fifth year, oftener in women than men, with pain in the back, tenderness of the vertebral spines, the pain being "dull, sickening" between the shoulder-blades or lower dorsal region, and sometimes down the sciatic nerves. The motor functions of the cord are intact, and in this particular, as well as in many others, it totally differs from Erichsen's disease. The origination can usually be traced to nervous exhaustion. I knew one case to be caused by overstudy in a young lady of eighteen.

Cerebral concussion may have occurred with the spinal concussion, but the loss of consciousness, vomiting, irritative phenomena, and sometimes *paralytic*, not paretic, consequences of cerebral concussion are notoriously absent in spinal concussion, *in which there is no loss of consciousness* nor other stages of the cerebral disturbance. Further, the cerebral injury often produces opposite hemiplegia, and the paresis of spinal concussion is unilateral. It is worth remembering that a blow upon the head *may* produce spinal, and one upon the spine cerebral, symptoms by transmission.

Traumatic insanities from head wounds are usually characterized by either profound dementia (great stupidity) or grand delusions, extreme suspiciousness, great irritability, epilepsy, logical perversion, and passionate outbursts. As Krafft-Ebing has shown, the spinal-concussion type differs utterly from these symptoms in the dejection, self-concentration, the dwelling upon the accident, the anxiety, etc., and I incline to the belief that melancholia is the more frequent mental derangement, when it

does occur, attending spinal injuries, while this depressed psychosis is plainly not observed in mental disorders following head wounds.

Spinal anæmia is not now regarded as properly designating any set of symptoms. It was a hypothetical, unproved disorder at the time Erichsen wrote, and has been abandoned through its supposed symptoms being absorbed into other ailments.

Syphilis may cause a great array of spinal disorders, mainly such as are induced by neoplastic growths in general, such as membrane thickening, pressure symptoms, interferences with cord functions at various levels through disseminated or focalized gummata, but there is no tenderness of the back nor inability to rotate or flex the spinal column; the insomnia does not exist, and syphilis cannot cause Erichsen's disease nor a sufficient portion of its symptom-grouping not to be distinguished apart. Fleeting and excruciating pain and paralyses characterize syphilis, and there is a syphilitic insanity recognizable by alienists.

Rheumatism could never be seriously urged as resembling Erichsen's disease in symptomatology.

Sprains, strains, and wrenches of the spinal region, *such as ordinarily occur* without involving important structures, do not set up the persistent, agonized, enduring Erichsen's disease; but when the deeper nerve-structures are injured, sprains, strains, and wrenches are as potent as blows upon the back or general concussion in instituting concussion symptoms.

Surgical shock is often confused with the "nervous shock" of Page. The former is a transient condition and the latter a mere fabrication.

PLATE III

A DIAGRAM OF THE SPINAL SYMPATHETIC NERVOUS SYSTEM AND CONNECTIONS.

CHAPTER XIII.

PATHOLOGY.

SPINAL injury, with or without bone fracture or dislocation, has caused myelitis, meningitis, and, more often, meningo-myelitis for the two pathological conditions generally exist together, particularly when chronic. Ollivier, Abercrombie, and Erichsen were certainly justified by the pathological knowledge of their periods in referring the symptoms to inflammatory cord conditions. Chronic meningitis with less myelitic influence more closely resembles Erichsen's disease in symptomatology than any other disorder. The mention of spinal anæmia as co-existing with hyperæmia of the cord was an acknowledgment by Erichsen of vascular irregularities that account best for many phenomena. But spinal anæmia has not been accepted by the profession as presenting any definite set of troubles that could not be caused by other influences. Cerebral anæmia can be recognized, but not the corresponding spinal anæmia, and there are physical and anatomical reasons for the two parts not participating equally in the effects of a lessened blood-supply. In the upright position the heart forces the blood to the brain against the gravitating tendency,—a condition for which there is no parallel in the cord, even with the reasonableness of Moxon's ideas of the precariousness of the spinal blood-supply. The very reverse is true of the cord, for the blood actually gravitates from above. This fact was not sufficiently dwelt upon by Moxon as a compensating factor in his "precariousness" essay, and much, if not most, of the weaknesses he refers to this apparent defectiveness, I think, can be accounted for in other ways. With this dropping of blood from above the whole length of the cord, and the free anastomoses between the anterior and posterior spinal arteries, it would seem as though

engorgement were more likely to occur, and clinically hyperæmia and irregular blood-supply seem to be most frequent. There may be local ischæmiæ, but the symptoms would be lesional and focal. Were there general anæmia the cord would but participate in the prostrating effects, and if there is anything approximating such a condition as spinal anæmia it is what is known as spinal irritation. But Ollivier, and, to some extent, Stilling, regarded spinal irritation as due to a hyperæmic state of the cord. Hammond suggested the anæmia origin of spinal irritation. Rigler and Spitzka look upon Erichsen's disease as, in the main, due to a spinal irritation, and with very good reason: for, although it is a disorder more frequently occurring in youth and females, especially those of a neuropathic tendency, it has many symptoms in common with those produced by a spinal concussion, and undoubtedly there is an irritated condition of the spine in Erichsen's disease. The designation merely states a fact, however, and leaves us no nearer the cause of the irritation. A condensation from Erb's article * on the subject will be of advantage here:—

"Among the direct causes it is usual to enumerate everything which excites and weakens the nervous system and depresses its powers of action. This includes strong psychical impressions, great excitement of the feelings, fright, grief, care, unfortunate love, violent passions, etc.; also excessive bodily exertions, severe marches, watching by night, work by night, etc.; in like manner great sexual excitement and excesses, onanism in excess, continued and frequent sexual excitement without gratification; and, finally, bad food, imperfect formation of blood, exhausting diseases, losses of blood and fluids. All these things may produce spinal irritation. Intoxication with alcohol or opium, traumatic agencies, cold, etc., are also named as occasional causes.

"At the time when every patient with pain and tenderness of the spine was considered to have spinal irritation, numberless

* Ziemssen's Cyclopædia, vol. xiii, p. 360.

diseases of the peripheral organs, and especially those of the intestine and uterus, were considered as giving rise to a symptomatic form of spinal irritation, as it was called. Such a thing is now no longer spoken of.

"As we do not yet know what takes place in the cord in cases of spinal irritation, and as the pathological anatomy of the disease does not at present exist, it is hard to form a reasonable idea of the nature of the action of all these causes. We gladly omit all statements of the pathogenesis of the disease.

"The development is usually gradual. Slight pain and discomfort in the back appear, especially between the shoulder blades,—at first only upon unusual occasions, during excitement or fatigue; by degrees they become more permanent and require less and less to produce them. To these are added all kinds of eccentric pains, increased nervous irritability, loss of general power, etc., and all this increases until the disease is fully developed.

"Often, however, the development occurs quickly,—in a few days,—especially when very powerful influences have acted upon predisposed persons. The disease then presents the following general aspect:—

"The patient is oppressed by a more or less troublesome sense of illness; a general malaise, increased psychical irritability, has seized upon her. In most cases she complains especially of *pain in the back*, situated in various spots, but most frequently between the shoulder-blades, next in the back of the neck, less frequently in the loins. It grows more severe when any movement or exertion is made and in the exacerbations of the disease.

"An examination usually discovers at the spot mentioned a *great sensitiveness* to pressure, tapping, the passage of a hot sponge, electricity, and other irritations. This sensitiveness may be so great that the lightest touch calls forth loud expressions of pain; the weight of the clothes becomes intolerable, and leaning the back against anything impossible. The skin of the

affected portions of the back is usually very hyperæsthetic, but the spinous processes themselves are usually very sensitive to pressure. The degree and character of the pain differ greatly in individual cases; the pain is commonly described as a more or less severe sense of aching, which often lasts a considerable time beyond the effect of the irritation. Hammond describes a deep-seated pain of the back, which, he says, is produced by pressure on vertebræ which are not sensitive, by movements of the spinal column, by standing, etc.

"To this are added a crowd of other symptoms; but what most troubles the patient is the *pain* felt in various parts of the body,—neuralgiform pains,—now in the upper extremities, or the occiput or face; now in the trunk or viscera, assuming the form of various visceral neuralgiæ; again in the lower extremities, pelvic region, bladder, or genitals; pain often of great violence and severity, sometimes fleeting, sometimes more permanent, and often brought back by slight causes.

"With these pains paræsthesiæ are often connected; tingling, formication, a sense of burning and heat, often of cold also; but these are less prominent. The same is true in a still greater degree of actual anæsthesia; it seems to be very seldom observed.

"Marked disturbances of motility are regularly observed; above all, great weariness and exhaustion upon slight efforts. The patient has lost all endurance in walking; can walk but a little way, and presently not at all, on account of the intolerable pain the act occasions. Most patients, therefore, find it agreeable to lie on the back, and usually continue thus. Manual occupations, such as knitting, sewing, piano-playing, writing, etc., are more and more restricted, and at last are quite suspended, chiefly owing to the pain produced in the back and limbs. No real paralysis usually exists; all movements are possible, but provoke violent pains, and there is no power of endurance. The nearest approach to palsy consists in a moderate general paresis, occurring in but few cases; proper paralysis is not one of the symptoms of spinal irritation.

"On the other hand, much is said of *spasmodic* symptoms; fibrillary twitchings, spasms of some muscles, choreic movements, singultus, etc., are often observed. Even permanent contractures, epileptic attacks, etc., are said (probably without truth) to have been observed as consequences of spinal irritation.

"*Vasomotor disturbances* are also very frequent. Most patients exhibit an abnormal irritability of the vessels, and easily turn red or pale; most of them suffer from marked coldness of the hands and feet, which are often of a bluish, cyanotic color.

"*Functional disturbances of the vegetative organs*, of a great variety of forms, are also very common; eructations, nausea, even vomiting occur; palpitation of the heart are very frequent; disturbances of breathing, spasmodic cough, etc., are less common; while vesical spasm, increased desire to urinate, and abundant discharge of pale, clear urine are more frequent, but actual palsy of the bladder and rectum does not seem to occur.

"Finally, a symptom, which seems quite a regular one, is that of *increased psychical irritability* and depression, with more or less *sleeplessness;* there is often some dizziness, noise in the ears, and inability to read continuously, owing to the appearance of muscæ and disturbances of vision, etc.

"The physiognomy of the disease is thus seen to be very complex. In fact, individual cases also differ greatly. We may try to divide them into three classes, according as the symptoms point to the upper, the middle, or the lower parts of the cord as the chief seat of the suffering.

"If the *upper portions* are principally affected, the pain of the back and spinal tenderness are chiefly localized in the cervical vertebræ. The prominent symptoms are those referred to the head,—giddiness, sleeplessness, disturbances of the senses, pains in the occiput, and pains in the district of the brachial plexus; nausea, vomiting, palpitation, hiccough, etc., are not rare; motility in the upper extremities is usually impaired.

"If the *dorsal portion* is affected the chief symptoms, in addition to those in the spine, are intercostal neuralgia,

gastralgia, nausea, dyspepsia, etc.; the lower extremities usually take a large part in the disturbances of motility and sensibility.

"If the *lumbar portion* is chiefly affected, the leading symptoms are neuralgia in the lower extremities and the pelvic organs, spasm and weakness of the bladder, cold feet, weakness of the legs, etc.

"A certain *generalization* of the disease is not uncommon when the spine is painful in several places, often quite generally, and the disease is complicated by all kinds of peripheral symptoms.

"*Course, Duration, Termination.*—We have already described the way in which the disease begins. Its *course* is usually very fluctuating. Improvement and relapses alternate in the most irregular way; the chief symptoms and the spinal tenderness are sometimes felt in one place, sometimes in another; a relapse often occurs without any visible cause, and so does improvement; it is here we must be most on our guard against illusive successes.

"Many cases run a comparatively acute course, grow rapidly worse, and as rapidly improve and recover.

"In most cases, however, the disease is extremely slow and chronic, and its *duration* is stated in months and years; there are some patients who suffer more or less from occasional attacks all their life, and who are exposed to a relapse on the slightest occasion.

"Nevertheless a *cure* may be regarded as the rule; if the proper measures are taken and the causes avoided, this may be expected in the majority of cases. Much patience will doubtless be required, and the many relapses may often prolong recovery.

"Whether spinal irritation may in bad cases result in the development of severe spinal diseases does not seem to us sufficiently ascertained. The observations are almost all of an older date, and give no sufficient guaranty against the confusion of the first stages of severe spinal lesion with functional irritation of

the cord. This question can only be decided by further careful observations. The entire doctrine of spinal irritation requires a renewed revision by means of careful and critically-sifted clinical observations.

"Until this is done, we shall not be in a position to entertain a better-founded opinion upon the *nature of spinal irritation* than we now possess. We can scarcely doubt, it is true, that the structures within the spinal canal are the proper seat of the disease, and the entire list of symptoms makes it most probable that the cord itself is in a condition in which it performs its functions badly. The assumption that the meninges are the first to be affected, and the nerve-roots and the cord suffer secondarily, has little support."

Comparisons made between the symptoms of Erichsen's disease and those of spinal irritation present many striking similarities and total unlikenesses. The resemblances are in the psychical irritability, sleeplessness, slow onset, back pains, tenderness of spine, paræsthesiæ, motor defects, vasomotor disturbances, and cardiac rapidity. The differences consist in the presence in spinal irritation of the capability of division into the three areas affected in different cases; its predominance in females and the young; the neuralgiform pains; the greater acuteness of the pains at times, partaking of the tabetic likeness, as though deep areas of the posterior sensory gray and the meninges in that portion were more at fault than in Erichsen's disease; the visceral neuralgia; the violent, fleeting, and sometimes permanent pains in the legs, resembling those of chronic meningitis or tabes; the paræsthesiæ differ somewhat; the spastic symptoms are more frequent. There is a vacillating severity in the spinal irritation-symptoms that differs from what is usual in Erichsen's disease, the pains and aches of which are of a dulled, persistent character, and in the latter the characteristic headache is present; anæsthesiæ are more marked. The girdle pain is not recorded as encountered in spinal irritation; sexual impairment, hyperidrosis, emaciation, secondary organic disorders,

are peculiar to Erichsen's disease and absent from spinal irritation.

Hammond's reasoning in favor of the anæmia theory is good, and he does not confine the cause of the anæmia to a cord condition necessarily, but calls attention to all these cases being generally debilitated in some way, and to the fact that the sympathetic nervous system may be at fault.

Scattered here and there through manuscripts of the early centuries were hints of the circulation of the blood. Aristotle even suggested that the earth might be round, but advanced reasons against it the next moment. There is a miserable old saw to the effect that there is nothing new under the sun, which, so far as intelligent experience and recorded observation go, is, like the majority of old sayings, untrue. When a new idea is advanced, with enough reasons to entitle it to respectable consideration, it is at first fought, usually most strenuously by those who have not examined the reasons. If in the course of time the theory becomes established and admitted as true, then disparagement is shifted to the claim that the matter is not new. Nor do I expect any better fate for my nutrient reflex and sympathetic lesional hypotheses.

That *some* kind of trouble with the vasomotor system occurred as a probability in spinal concussion has been suggested, doubtless, by several authors, for the vasomotor derangements were too obvious to be overlooked; but that they were the main factor in the disorder *no one has more than hinted at.* H. Fischer* favored the idea of surgical shock being a traumatic reflex *paralysis* of the vascular nerves, concussion of the brain being simply a shock localized in the brain,—a traumatic reflex paralysis of the cerebral vessels. Scholz adapts this to explain spinal concussion, but Erb† says: "We cannot see that Fischer's argument is convincing. It is hard to understand why, in so severe a shock, the vascular nerves alone should be para-

*Volkmann's Samml. Klin. Vortr., Nos. 10, 27.
†Ziemssen's Cyclopædia, vol. xiii, p. 347.

lyzed, to the exclusion of the other nervous elements; we rather believe that the latter are affected to at least as great a degree. This, of course, shakes the foundation of Scholz's application of Fischer's hypothesis to the cord." Then the element of time is a complete bar to Scholz's shock-theory, which is essentially Page's in another form, for with a paralytic shock to the sympathetic nervous system *all the symptoms should appear at once*, which is far from being the case, as weeks or months may elapse.

In rather a lengthy discussion of the spinal-anæmia theory and its applicability to the pathology of the disease, Erichsen incidentally remarks (page 193): "Whether it is by a concussion or vibratory jar, in consequence of which its molecular condition is so disturbed that its functions become for a time perverted or suspended, or whether, as may not improbably be the case, the primary lesion has been inflicted upon the sympathetic system of nerves, in consequence of which the vascular supply to the cord may have become interfered with, and the symptoms that have just been described have actually resulted from a diminution of arterial blood transmitted to it, as the result of the disturbance of the vasomotor action of the sympathetic, is uncertain. That the sympathetic is disturbed in many of these cases would appear to be probable, from the fact that this so-called spinal anæmia is frequently associated with derangement of function of the abdominal or thoracic organs, as shown by palpitations, vomitings, etc."

If at the time Erichsen wrote our present knowledge of the sympathetic nervous system had been extant, he would not have failed to dwell upon its influence in the origination of symptoms, to the exclusion of many of his anæmia and meningomyelitis speculations.

Let us glance again at the sympathetic, and its relations to the spinal cord, before considering the diseases to which this great distribution of nerves is subject.

Gaskell calls the ganglia on each side and in front of the

vertebral bodies *the prevertebral ganglia;* these are the three cervical, twelve dorsal, four lumbar, five sacral, one coccygeal. The four cephalic are classed with these. *Lateral chains* unite these ganglia on each side of the length of the spinal column. *Transverse commissures* connect the ganglia and *rami communicantes* connect the cerebro-spinal nerves with the ganglia. These are divided into *rami afferentes* and *efferentes.*

As an evidence of the importance of the sympathetic system being better recognized in recent works on pathology, Hamilton* says:—

"Since it is now known that the sympathetic is, morphologically, simply a spinal nerve, the spinal nerves are described as compounded of three elements—the *posterior root*, the *anterior root*, and the *visceral*, or *sympathetic root.* The importance of regarding the sympathetic as essentially a spinal nerve cannot be overestimated from a pathological point of view."

The branches issuing from the prevertebral ganglia are distributed to the various organs and to terminal ganglia.

The rami communicantes pass from the spinal nerve-roots forward (ventrad) to join the prevertebral ganglia or lateral chains, which lie closer to the vertebral bodies in the thoracic portion in connection with the dorsal nerves. The cervical chains and ganglia have the longest rami, and are midway between the upper vertebræ and superior blood-vessel system. Branches pass from the superior cervical ganglion connecting with the four cephalic ganglia—the carotid plexus, the cavernous plexus, and their ramifications to all the cerebral nerves, and the four upper spinal nerves. From the middle cervical ganglion branches pass to the fifth and sixth cervical nerves, and to the thyroid vessels.

The inferior cervical ganglion is connected to the seventh and eighth cervical nerves,—the vertebral-artery plexus,—and communicating fibrils run up as far as the fourth cervical nerve.

The other and lower ganglia correspond more closely in

*Text-Book of Pathology, D. J. Hamilton, p. 559. London, 1889.

number with the spinal nerves, to which they are connected, and *filaments pass from them to the adjacent blood-vessels, bodies of the vertebræ, and the ligaments connecting them.*

Quoting from Sigmund Mayer*: "In the free interchange of fibres between the sympathetic and the cerebro-spinal system of nerves it is obvious that the most intimate connection exists between the two organs. Both systems, moreover, may be regarded as together constituting an organization with the same functional attributes, except that in the cerebro-spinal system the nerve-cells are accumulated into large masses, and the connections between the several segments are effected by fibrils which do not stray from the region of the central organ, and which preserve the character of the central fibres, whilst in the sympathetic the cells are more separated, and their connections, both amongst themselves and with the cells of the cerebro-spinal system, are established by peripheric nerve-fibres. In the cerebro-spinal medullary system, the principle of the centralization of the elements is represented, whilst in the sympathetic system it is rather decentralization which is the essential feature.

"The nerve-knots or ganglia of the sympathetic are provided with an investing sheath of connective tissue, which gives off processes that penetrate between the several cells, and form, as it were, a separate capsule to each. The connective tissue consequently constitutes a trellis-work, the interspaces of which contain the nerve-cells; it at the same time supports the blood-vessels."

In the first volume of the same work Rollett describes (page 63) connective-tissue plexuses and trabeculæ as characterized by succulency and ready compressibility, and on section, in consequence of the escape of fluid, the tissue easily collapses. It is extensible within limits and easily torn into shreds, though the masses of interlaced fibrils possess considerable strength.

There is no investing bony or membranous protection to

*Human and Comparative Histology, Stricker, vol. ii, p. 538. New Sydenham Society Translation, 1872.

the spongy semi-fluid sympathetic ganglia and plexuses. The connective-tissue capsules and trellis-like attachments to the viscera, blood-vessels, muscular sheaths, ligaments, and bones admit of a slight swinging elasticity, but at best this cannot by estimation surpass in most cases a quarter of an inch to, at the very outside, half an inch in the most favorably situated spinal-ganglionic connections. The visceral attachments admit of a much wider range to accommodate the intestinal movements.

The thoracic and sacral prevertebral rami are in the greatest danger from concussion jars owing to their closer connection with the bodies of the vertebræ and their shortness. Their elastic range is less than that of the cervical rami especially. The neck and psoas muscles afford *some* extra protection to the cervical and lumbar ganglia and rami.

The cardiac nerves—superior, middle, and inferior—pass forward to the heart from the corresponding cervical ganglia.

The great, lesser, and smallest splanchnic nerves arise from the sixth to tenth dorsal ganglion for the upper, which terminates in the semi-lunar ganglion; the tenth and eleventh for the middle, which ends in the cœliac plexus; the twelfth affords the lowermost or renal splanchnic nerve, distributed to the renal plexus.

The pelvic portion of the sympathetic, in front of the sacrum, has *particularly short ramal connections with the spinal nerve-roots*, and, through the maze of filaments passing to the pelvic plexus, the middle, sacral, and hypogastric plexuses, and further ramifications to the inferior hypogastric, hæmorrhoidal, vesical, prostatic, and vaginal plexuses, the cavernous and uterine nerves, *the blood-supply of the lower viscera and extremities, as well as the functions of the lower abdominal organs themselves, are in especial danger of derangement through irritations or lesions in that vicinity.*

The physiology of the sympathetic has largely been determined by its pathology and through vivisection. Turning again to Fox, who was quoted in a previous chapter of this

book, beginning at his page 37, and making appropriate extracts therefrom :—

"The sympathetic system is largely made up of, or mingled with, fibres from the cerebro-spinal nerves, even in the nerve-supply afforded to the viscera. It seems, therefore, impossible anatomically to dissociate the one from the other. They are as united, as mutually dependent on each other, as are the classes of the individuals in a well-ordered State. But as in the latter case each class has duties and conditions in which, though touching other classes at many points, and being more or less associated with and dependent on them, it yet retains a certain independence of action, so in the exquisitely-ordered and balanced human frame the sympathetic nervous system, though depending much for some of its usefulness and power on its relations with the cerebro-spinal axis, has in its influence on the circulation and on the viscera connected with organic life a certain independence of function : it generates action of itself. It is continually not merely a nerve, a conductor, a humble handmaid of the cerebro-spinal axis, but in all essential points a nerve-centre.

"The truth lies, as it so often does, in the middle line. The associated dependence of one system of nerves on the other, whilst to each is assigned its own peculiar functions, is only in analogy with the arrangements of all the structures of the body, each of which has its own special purpose, and yet is unable to perform its full function except in relation with other tissues.

"Most of the rami communicantes have their trophic centres in the spinal cord.

"Many of the vasomotors of the arm arise with the roots of the brachial plexus, and many of the vasomotors of the leg arise with the sciatic and crural nerves without any origin from the sympathetic ganglia.

"Lesions of the cervical cord may cause the same oculo-pupillary phenomena as lesions of the superior cervical ganglia.

"Lesions of the cervical cord (seventh cervical and first

dorsal) may cause the same vasomotor paralysis, *evidenced by unilateral vascular dilatation of the face, ear, and head*, as is seen in lesion of the cervical sympathetic ganglia." [Here, as well as hereafter, I shall italicize when there are passages especially bearing upon our subject.]

"Hemisection of the lower third of the dorsal region of the cord produces vascular dilatation in the lower limb of the corresponding side, and so increase of temperature.

"Hemisection of the middle of the dorsal region of the cord, or at the superior portion of it, produces greater dilatation of vessels in the lower limb because *the vasomotors of the lower limb have multiple origins*, one being from the abdominal plexuses, and these are, therefore, not cut in a section of the lower dorsal. But this experiment also proves that the vasomotors of the lower limb that arise from the abdominal plexuses are indirectly also derived from the spinal cord.

"All lesions of the spinal cord, and pressure on it, *may enfeeble the vascular tone of the parts in relation by their vasomotor nerves with the region of the cord below the lesion.*

"But with the full appreciation of this mutual dependence of the sympathetic and the cerebro-spinal axis there are certain phenomena which show that the sympathetic ganglia may manifest a partial independence.

"The fœtus has been expelled from the uterus at, or almost at, full time, showing, therefore, a normal capacity of absorbing nutrition and a healthy circulation, without any trace of a cerebro-spinal nervous system, owning only the sympathetic system as the nerve-element in its composition. Parkes states that nutrition is properly carried on with complete destruction of the cerebro-spinal centres. This fact renders probable the dictum of Golz, that the tone of the arteries is maintained by local centres situated in their own immediate vicinity.

"Reflex irritation of vasomotor nerves can be entirely limited to the particular organ or tissue supplied. Thus, in Vulpian's experiment, some days after the transverse section of

the sciatic nerve, or brachial plexus, when the corresponding pulp of the paws of the animals had become quite pale and anæmic, he was able by slight rubbing of these pulps to cause a reflex congestion.

"The not unusual fact of compression-myelitis (especially, strange to say, in the cervical region) being unattended with oculo-pupillary phenomena, or with symptoms of vasomotor paralysis. This has been noted by the writer in two cases of malignant tumor pressing on the cervical cord, and also in several instances of cervical pachymeningitis. Many of the phenomena of blushing, of eruptions, of local congestions, point to the same idea. Perhaps myxœdema and the early stages of scleroderma are associated with functional independence of the sympathetic ganglia; the fact of the continuance of the heart's action for a time in some mammals, after its separation from the body; the peristaltic action of the intestines; the reflex action of the stimulus of the blood upon vascular tone; the phenomena of vasomotor neuroses of the extremities.

"Irritation of the peripheral end of the cervical sympathetic nerves causes protrusion of the eyeball; section of it causes sinking of the eyeball and a slight flattening of the cornea. In the lids are sets of smooth muscular fibres innervated by the sympathetic, and by these the contraction of the lids is opened, and so the eyeball is uncovered.

"From the cervical sympathetic some portion of the secretion of the parotid and of the submaxillary gland is excited, and that on both sides.

"Hermann looks upon the independence of the sympathetic as almost impossible, yet states that automatic and reflex co-ordinate movements, and secretions also, can be the outcome of the faculty of sympathetic ganglion-cells, quite independent of the large nervous centres.

"In the frog, after destruction of the medulla and brain, irritation will cause congestion of the limbs.

"In mammals, after section of the cord at the mid-dorsal

region, sensory excitation of one posterior limb will cause reflex-heat phenomena in the other. The phenomena of pigmentation in the frog, when the brain and cord are destroyed, show the same thing. There is a richness of the sympathetic in central elements like those of the brain and cord, and a wealth of the branches of distribution, gaining force the wider the distribution, and not the opposite.

"It may, perhaps, seem somewhat fanciful to say that it seems necessary that the nervous system of the viscera should be more or less shut off from perturbation of our intellectual being. That this is only partially the case is due to the union and association of the two systems in so many ways.

"It has been well said that the use of the central cord of the sympathetic is to make the animal and the vegetative worlds known to each other, *so that revictualing shall be proportionate to waste.*

"For coarse stimuli, the spinal cord and medulla are the chief centres for vasomotor reflex action; but the heart is more or less independent of the great nervous centres; a reflex arc exists in its own substance. Reflex movements are excited from all sensory nerves, not only spinal but sympathetic.

"As long as a limb is attached to the body by means of its main artery there will always be a vasomotor connection with the trunk, some part of which nerve connection will have its origin from the spinal cord." [*This would explain why a local sympathetic lesion does not wholly interfere with the vasomotor action of parts.*]

"Vertigo attending indigestion may be associated with mottling of the hands and forearms, due to congestion of the superficial arterioles.

"The reflexes, of which the sympathetic ganglia, especially some of the abdominal, are centres, are too numerous to mention. The syncope induced by a blow over the solar plexus, the palpitation and even faintness consequent on indigestion, the vomiting and depression of spirits set up by the passage of a

gall-stone, the transient hemicrania produced in some people by the presence of ice in the stomach, the flux from the intestinal vessels as a sequence of the irritation of some foreign body in the canal, some, at least, of the phenomena of renal calculus, the peculiar phase of peritonitis, the collapse in perforating ulcer of the stomach and intestine, perhaps the increased circulation of blood in the liver and the augmented secretion of bile following injury to the solar plexus, are all instances of this. That in this region of reflex activity the great nerve-centres play a most important part, will be seen in the consideration of *the neuroses and of all emotional phenomena.*

"In those forms of hysteria *that depend on definite uterine or ovarian lesion*, the deep-seated sense of pelvic uneasiness, nearly similar in position and sometimes equalling in intensity the sacro-coccygeal pain attending piles, the pareses of intestine evinced by meteorismus, the increased flow of limpid urine, the vomiting, the hiccough, the frequent diarrhœa, the palpitation, the faintness, the sighing respiration, the globus, the difficulty in deglutition, the blushing, the dilated pupil, the tears, the tinnitus, the excitation of the emotional area, the occasional epilepsy, melancholia, mania, to which such patients are liable, are all examples of afferent irritation carried to the solar plexus, and thence, from ganglion to ganglion of the sympathetic chain, to the three cervical ganglia; thence to the eye, the cerebral vessels, and the medulla oblongata.

"Certain kidney lesions may, perhaps, be reflexly irritative and cause paraplegia. According to Jaccoud this paraplegia is a paralysis of the sympathetic, whilst Weir Mitchell thinks it is due to paralysis of peripheral origin. The latter observer has seen a wound of the nerves of the lower limb determine a paralysis of the upper limb.

"Brown-Séquard showed that *the vaso-constrictors can be set in action in the spinal pia mater*, and, therefore, probably in the spinal cord itself by reflex irritation. He obtained these results by ligature of the renal nerves, and that, too, on the

corresponding side of the spinal pia mater. This constriction of spinal vessels causes anæmia of the cord, and thereby paralysis. He gives instances of paraplegia caused by uterine lesions, by enteritis, colitis, and especially the ulcerative colitis of dysentery, by worms in the intestines, by pulmonary and pleuritic affections, by leg-erysipelas, by knee-joint injuries, by neuralgia, dentition, and diphtheria. Stanley drew attention to this form of paraplegia following bladder diseases. These results are, however, exceptional. Ligature of the renal or suprarenal nerves will cause temporary constriction of many vessels, and might even, by its effect on the spinal vessels, induce a certain amount of anæmic paralysis. A somewhat similar condition is frequently met with in the obstinate constipation consequent on the irritation of a renal calculus, particularly of the left kidney; but it is certainly against all analogy, with what is usually seen, to suppose that vascular contracture to the extent of causing paraplegia will be persistent. And it has been proved, in cases similar to those mentioned by Stanley, that the paralysis was due not to reflex irritation, but to a definite abnormal condition of the peripheral nerves that affected the cord by lines of anatomical transmission.

"*That the irritation in one organ can be reflected through a sympathetic ganglia as a centre of a reflex arc is a fact that is the very essence of the pathology of the sympathetic nervous system.* It is seen in irritation of the stomach as a result of pulmonary lesion, in the influence on the heart of irritation of the solar plexus and almost any of its secondary ganglia, in the innumerable morbid phenomena that own uterine or ovarian lesions as their cause.

"In general, if the sensory nerves in any part of the body are irritated there results a contraction of vessels, more or less generally, throughout the body; but there may be also, in certain cases, dilated reflex as well as constrictor reflex. According to Vulpian, *any sensory irritation, besides causing a general contraction of vessels, causes a dilatation of vessels in close prox-*

imity to the seat of irritation. Thus, we get redness of the skin wherever we apply an electrode, a marked degree of heat or cold, or any other form of local irritation. We may even get a local dilatation and evanescent erythema from the action of intense light, as that produced by the carbon points of an electric light, even when too distant for heat to affect the part. So we constantly find throughout the alimentary and genito-urinary tracts, as well as in the superficial parts, variations in the circulation due to reflex action.

"All arteries do not contract with equal power; those of the brain, spinal cord, and glands are most contractile.

"*It is through the nervi erigentes of Eckhard, which spring from the sacral plexuses and pudic nerve, that normally the centripetal excitations pass that inhibit or provoke erection. These nerves probably act by contracting and dilating the arterioles.*

"It seems probable that the sympathetic vasomotors are constrictors, and that the vasodilators come from the cerebro-spinal axis.

"It seems certain that the physiological state of the vessels is that of mean contraction,—in other words, vascular tone; and the preservation of this tone is one of the chief offices of this system of nerves.

"The vasomotor apparatus is in a state of permanent activity,—never in repose, never inert. The muscular tunic of the vessels is in a state of semi-contraction. Variation in this tone will be the necessary sequence of various modifications of the nervous apparatus. This tone is modified by alterations in the vessels themselves, atheroma, sclerosis; fatty, calcareous, and amyloid degenerations; senile changes, syphilis, scrofula, alcoholism, etc.

"The reflex mechanism of vascular tone is best seen in the heart and arteries. Let there be from any cause a constriction of most of the small arteries of the body, and there is, as a consequence, increase in the arterial tension. The heart strives to

overcome this excess of tension; its contractions become more vigorous, more rapid. The effect is not purely mechanical, but is under reflex influence.

"Anything that causes paralysis or paresis of the vaso-constrictors of a vessel increases the blood-pressure in it. Anything that unduly stimulates the vasodilators increases the blood-pressure. In a word, healthy vascular tone is antagonistic to great blood-pressure.

"Thus, local arterial blood-pressure is augmented in that enfeeblement or even abolition of vascular tone after destruction of a part of the spinal cord, also in that diminution of tone seen in disease of vessels,—senile changes,—under the influence of certain toxic agents, as belladonna. Arterial pressure may be increased if the sympathetic ganglia are abnormally stimulated, even when vascular tone is healthy. The palpitation induced may be so great as partially to overcome the normal vaso-constriction. Palpitation ensues when the cardiac nerves are paralyzed, causing such dilatation of the coronary arteries of the heart as to stimulate the cardiac ganglia. Palpitation from terror would be by paresis of the cardiac branches of the vagus from indigestion, by way of stimulation of the sympathetic cardiac nerves.

"Most of the conditions of arterial tension are attended with accumulations of imperfectly oxidized nitrogenous waste.

"Among the effects of arterial tension are arterial atheroma, aneurism, *the arterioles becoming thickened and tortuous, and sometimes affected with senile cretaceous deposit.*

"Uræmic convulsions are not due to the presence of urea, but to derangements of the cerebral circulation from high arterial tension in kidney disease. Venesection is useful in uræmic convulsions by modification of the cerebral circulation. *Convulsions may occur in arterial tension without kidney disease* and be cured by bleeding.

"Sometimes this tension produces *sleeplessness*, dyspnœa, *depression, loss of energy, of resolution, of memory*, etc., with

giddiness, fullness of head, pains, and *oppression in the chest*, neuralgia, etc.

"*The accelerator nerve of the heart comes as the third filament from the inferior cervical ganglion. It is by this nerve only that the spinal cord can act directly on the heart.*

"It is probable that the acceleration of the heart's action following irritation of brain-centres must be regarded as the result of an arterial pressure. Baxt, Stricker, and Wagner believe the centres to be in the cervical portion of the cord, and that the fibres leave the cord by the rami communicantes as far down as the sixth dorsal vertebra.

"All glands receive vessels and are in relation with nerves. Under the influence of emotion the secretion of glands is increased. All are under the joint influence of cerebro-spinal and sympathetic nerves. The secretion of sweat is presided over by a distinct set of nerves. It is most probable, as Bernard suggested, that the spinal nerves contain the secreting fibres of the sweat-glands, and that the sympathetic contains moderator or inhibitory fibres, being possibly only vaso-constrictor nerves. Luchsinger locates the nerve origins for perspiration in the abdominal sympathetic connections with the first four lumbar and three lower dorsal, and for the upper extremity in the spinal roots of the superior thoracic ganglion.

"*Section of the cervical sympathetic causes an increase of sweat on the side of the lesion.* It is certain that one of the functions of the sympathetic is that of inhibiting overaction in the sweat-glands, and that *hyperidrosis depends on secreting fibres from the cord through the rami communicantes to the sympathetic ganglia.*

"That the irritation which excites hyperidrosis may be reflex is seen in those cases of extreme perspiration of the palms of the hands, induced by indigestion, and instances of perspiring feet, not only hyperidrosis but osmidrosis, are not wanting in which the exciting cause is to be sought in abdominal and pelvic irritation.

"Traumatic alterations of the cord have the same influence on the nutrition of muscles as nerve section. Sir Charles Bell thought that the sympathetic was concerned in progressive muscular atrophy. In this disease, besides lesion of the anterior cornua, the cervical ganglia of the sympathetic may be converted into fat, but many observers have found them healthy. Jaccoud, however, thinks that the cervical ganglia are first affected, and Schneevogt and Jaccoud have recorded a case of progressive muscular atrophy with degeneration of the sympathetic.

"Reflex congestion is generally due to suspension of tonic activity of the vasomotor centres under the influence of irritation at the periphery of the centripetal nerves. An interesting form of congestion is seen from the effects of lightning on the human body. The markings, so like fern-fronds or branches of trees, are caused by the direct action of the electric fluid in paralyzing the nervous system, by causing congestion and redness in the capillary vessels.

"*Determination of blood is a frequent precursor of inflammation, but it is not part of it. Reflex congestion produced by stimulation of sensory nerves is not the same as inflammation.*

"The physiological history of inflammation is briefly this:—

"1. Some source of irritation,—cold, a blow, a burn, or a septic focus.

"2. The centripetal nerves, whether sensory or not, which are within reach of this irritation, are excited more or less violently.

"3. These nerves transmit to the vasomotor centres of the region the excitation which they have undergone.

"4. The tonic activity of these centres is disturbed and suspended more or less completely.

"5. Hence follows cessation or diminution of the tone of vessels that are subordinate to these centres.

"6. Consequently more or less considerable dilatation of these vessels occur.

"7. *But this vasomotor disturbance can only be considered as favoring the development of inflammation.* It is only secondary in importance, and does not of itself suffice to make up the phenomena called inflammation. It places the vessels in a condition for easily and necessarily receiving more blood; it offers facilities for the emigration of leucocytes; but the initial phenomena of inflammation consist in the disturbance of the intimate nutrition produced in the organized living tissue. The vital condition of the tissues having been gradually altered by the previous state of its nutrition, and the peripheral resistance in the capillaries having been induced, the part is placed in a condition of vulnerability, and is ready at any moment to respond to morbid impressions. They may be reflex, as the impress of cold, or direct, as from the presence of germs; and the vasomotor action on the vessels, which without the previous alteration of the cell-nutrition would stop short at non-inflammatory congestion, is of enormous importance in determining the various stages and symptoms of the progress of inflammation, although independent, and unconnected directly with the initial phenomena.

"Some of the capillaries are blocked by thrombi, others that are permeable are dilated; and the course of the blood, instead of being continuous, as in the normal state, becomes jerky, as in the arteries, and thence is caused, partly at least, the sensation of pulsation experienced in an inflamed region under certain circumstances.

"As to the mechanism by which the vasomotor centres of the bulbo-spinal axis, or, at least, of the vasomotor ganglia, induce, under the influence of the irritation transmitted to them, a dilatation of vessels in the inflamed region, it probably consists in a suspension of the tonic activity of these centres; hence the advantage of cold as a therapeutic agent in constricting the vessels.

"A congested part became gradually of necessity a part in which nutrition is badly performed. The affected spot, becoming

less and less perfectly nourished, is *ipso facto* more or less vulnerable to influences external to itself; in other words, it is predisposed to inflammation. *The modification of nutrition by the exciting cause and the vasomotor paresis make up the necessary factors in the causation of inflammation.*

"Dr. Handfield Jones goes much further than this in attributing inflammation to paralysis of the vasal nerves. The grounds for his belief are:—

"Purulent ophthalmia may be produced by division of the neck sympathetic. Sympathetic paralysis in pernicious malarial fever produces extreme local determination of blood and inflammation."

Ranvier found that œdematous conditions followed upon section of nerves supplying ligated vessels, but not before such sections.

A very evident derangement of the sympathetic system may exist—indeed, very many different kinds of such derangements—without any corresponding lesion being discovered in the nerves or ganglia. Coarse lesions of the sympathetic are known, however, to produce morbid symptoms. Another remarkable feature should be emphasized as having direct reference to Erichsen's disease. Many of the sympathetic nerves and ganglia, the latter especially, have been found in various stages of degeneration, sclerosed, pigmented, with connective-tissue proliferation, etc., *without producing symptoms of such degeneration during the patient's life-time.* Fox suggests that the explanation is probably *in the amount of ganglion left healthy.*

"The sympathetic system may be said to possess a very special pathology, but by no means in all cases a recognized pathological anatomy. The important part it plays in so many morbid states is owing to the fact of its being so constantly affected by reflex irritations."

In locomotor ataxia and in tetanus redness of the semilunar ganglia has been noted. The same ganglia have been found to be inflamed in hypochondriasis and marasmus, and in-

flammation of the left portion of the solar plexus was associated with pertussis, spasmodic vomiting, and convulsions; of the ninth and tenth dorsal or thoracic ganglia, with opisthotonus; vascularity of the chest and semi-lunar ganglia, with tetanus; great increase in the size of the lower cervical ganglia has been observed in cretinism and in all the ganglia in idiocy, diabetes, tuberculosis, and cancer. "One of the semi-lunar ganglia was of the size of a filbert and cartilaginous in a case of madness. The abdominal ganglia have been found large, lobulated, yellowish, and of firm consistency in chronic peritonitis. Cholera has sometimes been associated with inflammation of the solar plexus and semi-lunar ganglia."

Pio Foà * states that lesions are most commonly seen in the cervical and the abdominal ganglia, and consist of simple and fibrous atrophy, hyperæmia, sclerosis, fatty and pigmentary infiltration, amyloid degeneration, accumulation of leucocytes, and aggregations of micrococci in the gangliar blood-vessels. These changes are well marked in syphilis, leukæmia, cachexia, pellagra, tuberculosis, cardiac disorders, and infectious diseases.

Morselli † found fatty degeneration and atrophy of the ganglion-cells with thrombotic obliteration of the vessels of the cervical ganglia, and in a case of unilateral sweating Ebstein ‡ has seen very dilated and varicose blood-vessels in the ganglia of the affected side.

The semi-lunar ganglion may be enlarged and diseased following a blow upon the abdomen, and may give rise to liver- and kidney- lesion.

After sun-stroke hæmorrhage has been found in the upper cervical ganglion.

In exophthalmos Dr. Shingleton Smith § found an atrophy of the nerve-cells and calcareous mass in the inferior cervical ganglion.

While the changes in the ganglia and surrounding con-

* British Medical Journal, i, p. 547, 1875.
† Medical Record, iv, p. 386.
‡ Fox, *op. cit.*, p. 135.
§ Medical Times, London, 1878, i, p. 647.

nective tissue may be secondary in Bright's disease, they may account for the flushing, sweating, tinnitus, headache, faintness, palpitation, constipation, diarrhœa, vascular congestion of the intestines, diuresis, etc., to a great extent.

"Given a recognizable lesion of a sympathetic ganglion or nerve," says Fox, "certain phenomena are found following this as a sure consequence. It is Nature's own experiment to teach the physiology of the sympathetic. But, on the other hand, given these same phenomena without a coarse lesion of the sympathetic, is it not justifiable to say that they depend upon a morbid condition of these structures, even though such a condition cannot be recognized by the usual means of investigation? This is what frequently happens. The common distinction between organic and functional disease of the sympathetic is only an unscientific method of expressing this thought. A ganglion or a series of ganglia, apparently healthy, may be changed in some occult way by the sun's rays, by the circulation of blood altered from its normal condition, by what is called irritation carried to it from disease in a distant organ, or by emotion. It cannot be doubted that these influences change in some way the equipoise of the ganglion; for, as their result, are seen phenomena precisely corresponding to the effects of coarse experiments upon the sympathetic in animals and of easily recognized lesion upon these organs in man. *The starting-point of the irritation is seen, the channels by which the irritation is conveyed, the consequences of the irritative action beyond the ganglion; but the absolute condition of the ganglion itself, in so far as it differs from its state in health, is incapable of being, in all cases, demonstrated.*

"The irritation may arise from some portion of the same nervous system or from any part of the cerebro-spinal. It may be reflected only on its own fibres or upon cerebral or spinal nerves. The reflected effects may be sensory, motor, or vaso-motor, or all together; and yet the ganglionic centre of this reflex arc may seem, even microscopically, to be unchanged. It

is almost an axiom that irritations which induce sympathetic phenomena are generally reflex rather than direct."

The nerve-filaments that act upon the pupil arise from the spinal cord, and pass into the anterior roots of the two lower cervical and six upper dorsal nerves. There is slight contraction of the pupil on section of this nerve, and gradual dilatation on its irritation in the neck. Irritation of the neck sympathetic causes contraction of the vessels of the iris, and dilates the pupil by contraction of the radiating fibres of the iris. Such are the views of Donders.

Ogle, Gairdner, and others describe myosis caused by aneurismal pressure on the cervical sympathetic, and upon its being severed. Neck wounds have been followed by hyperæmia and contracted pupil upon the side of the wound, and pallor and mydriasis on the other side, with lessened secretion of sweat upon the side of the lesion and increase upon the other.

Wagner, quoted by Ogle,* regards the sympathetic as taking part in glaucoma formation through inflammatory pressure irritation. Schmidt-Rimpler considers that the existence of an influence exerted by the sympathetic on increase of intra-ocular pressure, and thus on the occurrence of the glaucomatous process, is not to be denied. In consultation with Dr. William F. Smith, the Chicago oculist, in a contemplated iridectomy to relieve a left glaucoma, we found slightly lessened sensation and reflexes upon the entire left side of the body, and these I incline to regard as indicating more of a sympathetic nervous system than cerebro-spinal impairment.

Isaac Ott† investigated the cilio-spinal centres: On division of the upper spinal cord the pupil dilated when the sciatic was stimulated by electricity. When the cord-centres were excited by another irritant—carbonic acid—through the blood, then the pupil was also dilated. When the first thoracic and superior cervical sympathetic ganglia were extirpated, and the sciatic

* Med. Chir. Trans., vol. xli.
† Journal of Nervous and Mental Disease, October, 1881.

irritated, the pupil still dilated. He concludes from numerous other experiments that fibres dilating the iris run in the trigeminus, and that the sympathetic ganglia also have an influence on the diameter of the pupil. When in a cat the right first thoracic ganglia is cut away from all spinal connection, the trunk of the sympathetic below it cut, and the opposite sympathetic divided in the neck, then the right pupil will be found to be larger than the left. If now a section be made above the first thoracic ganglia the pupils will be of the same diameter. Extirpation of the upper right cervical ganglion then lessens the right pupil. Atropia does not change the result.

These instances are mentioned to show *the varying consequences of multiple sympathetic lesions*, as it can be inferred that not only in ocular, but in all other sympathetic phenomena, the seat of the lesion, its nature and distribution, particularly as regards its multiplicity, modify the results. Just as myosis or mydriasis, unilateral or bilateral, may result from single or multiple sympathetic lesions, so may the other phenomena be crossed, unilateral, or compensated by the position, extent, and nature of the lesion.

Ott further showed that *a tonic influence exists in the sympathetic that caused injury not to be manifested, necessarily, immediately after the lesion.*

Of prime importance in the consideration of Erichsen's disease is the evident fact that *lesions of the spinal ganglia or rami communicantes, while paralyzing and congesting the vessels in the immediate vicinity of the lesion, induce distant sympathetic phenomena upon irritation of cerebro-spinal nerves elsewhere*, as pupillary dilatation from sciatic stimulation.

The sympathetic is often involved in injuries to the spine or brachial plexus. Myosis is met with sometimes as the result of lateral curvature of the spine. The rôle of the sympathetic is a very important one in epilepsy, some forms of hemiplegia, headaches, particularly hemicrania; in sun-stroke, in sleep and its disturbances, in paretic dementia and mania.

Eulenberg and Guttman found that the inferior cervical ganglion is most frequently affected in Basedow's disease. In this disorder the eyes are protruded; there is cardiac palpitation and enlargement of the thyroid gland, interpretable as a paralysis of the cervical sympathetic, the first effects of which will be vasomotor dilatation of the cardiac vessels, secondarily stimulating the cardiac ganglia to abnormal activity.

That many kinds of sleeplessness are due to changes in the brain blood-supply is a matter of common observation. Sleep is attended with decrease in the cerebral-artery sizes. The sleepiness following upon a good dinner, the diffusion of the circulation through massage or a hot bath before going to bed, causing sleepiness; the benefit of a narrow mustard-plaster slip down the length of the spine, and of catharsis, at times, all point to the derivation of blood from the brain as a necessary forerunner of sleep.

That the sympathetic may be involved in tabes dorsalis is seen in the altered pupils, the gastric, intestinal, and vesical crises; in the permanent pulse acceleration, eruptions, ecchymoses, and altered function of the sweat-glands. Duchenne, even, located the starting-point of tabes in a cervical sympathetic lesion. Fürstner and Zacker, of Heidelberg,* trace syringomyelia *to some morbid conditions of the sympathetic which induced the abnormal changes in the cord.* Kesteven † reports a case of *destruction of the rami communicantes of the seventh dorsal sympathetic ganglion* from hæmorrhage, causing loss of hepatic and renal tone, diminished bile secretion and scanty urine, constipation from imperfect peristalsis, vesical impairment, the morbid condition being conducted through the splanchnic to the solar plexus, upsetting the balance between the sympathetic or vaso-constrictor and cerebro-spinal inhibitory actions.

Crushing accidents to the upper dorsal region occasionally lead to priapism, which through nervi erigentes irritation may

* Archiv für Psych., B. xiv, H. 2.
† British Medical Journal, ii, p. 945, 1882.

cause a paralytic vaso-constriction. Hanging notoriously causes erection.

"Lesion of the lower dorsal region between the seventh and twelfth dorsal nerves may lead to any or all of the lesions that would follow *either irritation or paralysis of the splanchnic nerves*,—constipation, visceral imperfections, and congestions generally.

"In punctured or gunshot wounds of the spinal cord there is found on the side of the motor paralysis *a vasomotor paralysis also*, with temperature elevation, and *a hyperæsthesia for all modes of sensibility* (*owing in part to hyperæmia in limb and cord and nerve-roots.*)"

Very often the vasomotor paralysis passes away, the sympathetic ganglia taking on an independent action.

Fox's conclusions as to spinal-cord lesions influencing sympathetic action are:—

"1. That most, if not all, the cases in which changes of temperature, oculo-pupillary phenomena, alterations in the movements, the secretions, and the vascular tone in the abdominal cavity through the splanchnic nerve, can be best explained by lesion of the sympathetic centres in the cord itself primarily.

"2. That in all inflammatory spinal lesions it is very possible that the alterations of nutrition and the vasmotor congestion, the early stages of inflammation, *may be derived from the ganglia outside the cord.* The nutritive deficiencies necessarily associated with and dependent on vascular alterations may owe their origin to, or may base their starting-point in, the sympathetic centres of the cord, or, as in the case of descending lateral sclerosis, be the first effect of cutting off a strand or column of the cord from the higher regions of the brain. In either case the vasomotor nerves play a certain part in the causation of the inflammatory state."

Through the writings of all investigators it is plainly indicated that, while the sympathetic system may be independent

of the cerebro-spinal, the latter is never independent of the sympathetic system.

Vulpian * discusses the important subject of the vasomotors of the spinal cord. The vessels with which the cerebro-spinal axis is so freely supplied are, like others, accompanied by vaso-motor nerves, both constrictors and dilators. He relates certain experiments he made on the spinal cord, and with the following general results: Excitation, by means of the induced current, of a communicating branch, passing between a ganglion of the sympathetic and the root of a spinal nerve, *led to constriction of the vessels that are visible on the surface of the cord* in that part of its course which corresponded to the irritated nerve-fibres. If the excitation ceased the vessels recovered their normal size, and when resumed the constriction returned. The same results followed electrical irritation of an intercostal nerve between the point at which it receives a communicating branch from the sympathetic and that of its implantation in the spinal cord. Vulpian thinks that these facts, with Brown-Séquard's ligation experiment, prove that a vaso-constrictive reflex action provoked in the pia-mater vessels of the cord by excitation of the nerves of a visceral organ (kidneys, for example) may not only be manifested in the pia mater, but in the substance of the cord itself, and by reason of constriction of the vessels of the latter cause anæmia of this organ, thus abolishing its action and producing more or less paresis, or paralysis, essentially the reflex paralysis of Brown-Séquard. That the cord functions are impaired by its anæmia has been abundantly established by the experiments of Flourens, Panum, Pelz, and Vulpian himself, by immediate mechanical means, chiefly by artificial embolism. An excitation from a disordered viscus, or blocked blood-vessel, to the cord could be reflected out along vaso-constrictor nerves to the cord-vessels, depriving it of blood for varying periods of time, and, in this way, causing the reflex paralysis of Séquard. The possibility of prolonged spasm of the vessels has been denied

* Leçons sur l'Appareil Vasomoteur, Physiologie et Pathologie, Tome ii. Paris, 1875.

by Weir Mitchell, Jaccoud, and others. Jewell thought that ascending neuritis, so ably dwelt upon by Weir Mitchell in his "Injuries to Nerves," had not been properly considered in relation to reflex irritations. There is not a reasonable doubt but that inflammatory processes may attack the nerves, and extend from a region, which is itself the seat of inflammation, to the spinal cord—in some instances rapidly—and cause organic trouble in the cord at the point of implantation, and develop symptoms referable to parts of the cord not in immediate relation to the primitive seat of disease.

The insufficiency of the fright theory as a cause is seen prominently in the terrified individual escaping the alleged effects of terror when his bones are broken,—a most ridiculous assumption; furthermore, fright is a prolific exciting cause of the ordinary definite insanities, most prominently epileptic, choreic, and hysterical. I reported one case of delirium grave (or typhomania) from terror and distress.* Fright also causes heart failure, vomiting, and diarrhœa. As a rule, the effects of a scare are temporary; it can be easily understood that where a predisposition to insanity exists these effects may become permanent. The cerebral vasomotor system is involved in the effects of fright, and admitting, for the occasion, that hysteria may be induced by this means, "functionally" deranging the brain, epilepsy may also be of this functional nature, and be none the less permanent and destructive. Whether we regard the emotionalism as causing the flushings and other evidences of vasomotor derangements, or the flushings causing the emotionalism, both are cerebral conditions in which the vasomotors are concerned, and are absent in healthy conditions.

The heart palpitation is another emotional cause or product. In fact, the mind, and especially the proper exercise of memory, depends upon the integrity of the sympathetic nervous system, not only of the head, but of the rest of the body as well. To infer that merely because emotionalism exists it is the cause of

* Journal of Neurology and Psychiatry, 1883.

a co-existing general disease, in the absence of proof, is as irrational as to assume that the disease is the cause of the emotionalism without proof other than the mere association. In the Kelly case (see chapter on Traumatic Insanity) there was a lesion of the upper cervical sympathetic, with flushing upon that side of his face, great emotionalism, suspicious delusions, and anger. He is still in the Kankakee Asylum, but the flushings and emotionalism have ceased, while the general mentality is lowered. This is one of many instances of emotional disturbance from a derangement of the sympathetic, and the bodily cause of the mental condition was beyond dispute. *Per contra*, there are innumerable instances of mentality influencing bodily conditions. Faith-curers have coined thousands of dollars in not only ridding silly people of imaginary disorders, but occasionally emotionalizing the vasomotor system into improvement of small, but real, organic troubles; just as the simple visit to the dentist's office *may* cure a toothache. My wife has paroxysms of "hay fever," and the mere thought of stepping out of bed has brought on an attack of sneezing.

Oppenheim's rebound from "railway spine" to an exclusive "railway brain," and his conversion of the traumatic meningomyelitis of Erichsen into traumatic hysteria, is altogether too radical, and has no justification in fact. Where are there any cases of fright alone causing the symptoms of Erichsen's disease? Even when trauma is associated in such way as to leave the spine uninvolved the major symptoms of concussion are not present.

Irritations from spinal or visceral diseases may set up head troubles analogous, if not identical, with those caused by head injuries. The body is a unit, and centripetal influences often disturb centres as gravely as when those centres are directly damaged.

One of the remaining difficulties my Case XX experiences is that when he attempts to write for any length of time continuously he is compelled to stop by a sensation of heat in his

spine, that continues for a day or more, attended with a drawing feeling in his legs.

Years ago I held the belief that the unilateral head and body phenomena upon the side of the injury receipt could be best accounted for on the supposition of a *contre coup;* the brain being hurt by impact on its opposite side from the part of the skull that was struck, thus enabling the lesional effects to cross back to the side of the stroke. Oppenheim also advances this idea, but there are insurmountable objections to it. In the first place, there are usually no other evidences of cerebral concussion,—no consciousness loss, vomiting, etc., as a rule; and the head stroke is frequently either very slight or *has not occurred at all.*

Besides this, the hemiparesis is not cerebral, as it is not necessarily attended with sensory derangement on the same side as the motor disturbance; and the lessened, instead of increased, electrical irritability points to the spinal cord rather than to the brain.

One of the best proofs of the sympathetic derangement being the cause of many, if not most, of the symptoms is the fact of *the non-decussation of the sympathetic* (unlike the cerebral nerves, when involved), *causing head and body symptoms always upon the side of the lesion.* Nor need we stop here, for, as Oppenheim was the first to point out, neither motor nor sensory derangements in Erichsen's disease have anything to do with the distribution of definite strands of the cerebro-spinal nerves, but areas are always affected without regard to such distributions, and this is *precisely what we might expect to find in sympathetic lesions;* for the independent action of the vasomotor system affords its own areas, its own centres, and distributions. Cerebral nerves, he notes, are never singly involved; there is a disturbance of the harmonic action of different muscle-groups. Irregular vasomotor action would account for this, and also for the fact that the speech disturbances are not those of cerebral lesions; neither aphasia nor defective articulation, but

sui generis. Want of prompt nutrient reflex, through vasomotor innervation defects, would account for this hesitating, sometimes explosive speech. There may be pareses of one or more, or part of an extremity; but, as Oppenheim says, "the disease never affects muscles that are innervated by one nerve, and in this, and other respects, there are radical differences from organic disease of the brain, spinal cord, or peripheral nerves, and the peculiarities of muscle contractions differ from those of organic central cerebro-spinal lesion,"—more evidence of sympathetic impairment, for these contractions of areas without regard to definite muscles can be accounted for in no other way. The hemianæsthesia does not occur co-extensively with cerebral or spinal localization distribution, as in disease of the cord, or brain,—still another evidence.

With cutaneous and mucous anæsthesia there is inclusion of the special senses; the tinnitus, photophobia, and auditory hyperæsthesia are indicative of vascular engorgement somewhere in the optic and auditory apparatus, not necessarily discoverable in the fundus oculi or tympanic membranes; the defective sight and hearing can be explained as vasomotor contractile irritation, particularly when a sympathetic branch penetrates with the arteria centralis retinæ. The optic nutrient reflexes are therefore imperfect.

Similarly the occasional œdema, cyanosis, hyperidrosis, the pareses, and sensory difficulties, can be regarded as vasomotor. Undue peripheral or central arteriole contraction can produce anæsthesiæ; and doubtless vasomotor localized pareses can account best for the hyperæsthetic areas, and may point to the seat of the graver derangement. Oppenheim mentioned the absence of blood and pain in an operation on one case, reminding him of cadaveric section. Certainly vasomotor constriction accounts for both. In local applications of cocaine hydrochlorate this capillary contraction is observed, and is claimed by some to be the cause of the anæsthesia. Certainly it is safe to infer that where there is no blood there is no function.

Erichsen notes (page 53) that "in all cases where the anterior crural and obturator nerves were affected the whole of the lumbo-sacral plexus seemed to have participated in the paralytic condition." This would indicate sympathetic rather than cerebro-spinal trouble.

The discrepancies between the symptoms when standing and lying could be best accounted for on the assumption of those two positions producing vascular changes, evident as a diseased vasomotor system when erect and somewhat compensated for in the recumbent position. Just as in cerebral anæmia, symptoms abate when lying down and are vigorous when standing up.

The emaciation and trophic derangements generally are indisputably due to vasomotor impairment.

Hyperæmic nerve-roots or congested prevertebral ganglia would certainly produce irritability, and vasomotor cord and pial constriction could arise from sympathetic irritation in any way, whether lesional or "functional," *and evidences of such irritation be absent post-mortem, just as the arteries empty at death, and for the same reasons.*

The good effects of quietude, rest, darkness, solitude, point also to the lessened equilibrium disturbances of blood-supply. With a deranged sympathetic system, the blood, instead of flowing equably to the parts needing nutritive rehabilitation, goes "hither and yon," as apt to wrong as to right places; an arm movement may flush the head and back, talking may engorge the auditory apparatus, and an attempt to read congest the visual centres, producing muscæ, flickerings, etc.

Analyzing the symptomatology, we find that pain in the back exists when the meninges are inflamed or congested, or when there is irritation of the posterior nerve-roots, or when there is cord-compression; but no evidences of the existence of inflammatory, congestive, or irritative influences have been found post-mortem in the cord or its membranes.

The pain must then be due to some cause outside of the cord or membranes, acting reflexly on the sensory centres. The same

reasoning holds good in regard to all other sensory symptoms, and, by parity, to the motor also, until secondary changes in structure supervene.

There is no demonstrable patho-anatomical condition of the cord or its membranes to which a fair array of the symptoms of Erichsen's disease can be ascribed. "Spinal irritation" affords a few similar symptoms, but the pathology of that disease is *sub judice* and undemonstrable.

Spastic conditions of the cord-vessels, in my opinion, account best for spinal irritation symptoms.

That histological changes in the cord are not requisite to severe and even fatal diseases, wherein the cord functions are deranged or destroyed, is apparent in Landry's ascending paralysis and in many cases of poisoning. Circulatory derangements, either in the vessels or their contents, and irritative peripheral lesions, may impair or suspend the operations of the central nervous axis.

Just as the brain is always the seat of insanity, but not always the seat of its cause, *so may the spinal cord be the seat of Erichsen's disease, but not the seat of its cause.*

Hilton's ascription of the tinglings produced by a slight fall to extreme tension of the little sensory nerve-filaments delicately attached to the spinal marrow should have led him to seek the causes of graver symptoms, from severe blows or falls, in the same direction.

A lesion of the spinal sympathetic could produce direct and indirect nerve-root irritation, and a strain or tear of a ramus is likely to be accompanied by similar though lesser strains or tears of a spinal nerve-root, the latter being more stoutly enveloped than are the rami communicantes.

The intimate connections of the spinal and sympathetic nerve-roots cannot be disturbed without *some* results following, and the chain of ganglia in front of the vertebræ, with their delicate ramifications and comparatively feeble attachments to the spine, are more likely to suffer from jars, such as are described

as occurring in railway and some other accidents, than are any other nervous structures.

Hodges,* in an article entitled "So-called Concussion of the Spinal Cord," says: "Sprains of the ligaments of the vertebræ, rupture of the complicated aponeuroses and muscles of the back, are common and enduring lesions, too obvious in their symptoms to need detailed descriptions. They are, without exception, the most frequent cause of the phenomena assumed to be those following concussion of the spinal cord. They give rise to much local pain, a difficulty in rising from the seat, a stiffness, and contribute readily to any disposition on the patient's part to make much of his injury. The attitude, or the cautious and constrained movements of the body, may be made to suggest inferences which cannot be too guardedly accepted." Page, also, is quite inclined to disparage Erichsen's disease as very often a mere sprain, but we can well inquire if something else might not as easily or more readily have given way in an accident that "ruptures the complicated aponeuroses and muscles of the back." Every one knows that simple wrenches and sprains to the back may cause suffering, stiffness, etc., but the effects are usually temporary, and *simple* sprains have nothing in common with Erichsen's disease. Usually, amelioration is promptly obtained by affusions, anodynes, massage, or other means, and sleep is not disturbed nor the other bodily functions deranged, which is far from being the case in full-concussion cases. Then the pain is due to an irritative influence external to the spine carried into the spinal cord in any case of the kind whatsoever, whether muscles, bones, ligaments, or aponeuroses are ruptured or strained. Now, if more delicate structures are ruptured by a peculiarity of the accident—a jar or tremulous shaking such as characterizes true concussion vibrations of the spine—the "complicated aponeuroses and muscles" may escape and more serious consequences befall.

Wallerian nerve-degeneration may be produced by tearing

* Boston Medical and Surgical Journal, April 21, 1881.

of nerve-roots, and trauma has given rise to such. Strains of these roots can as readily irritate as that terminal sensory strands may carry in impressions from bruised and torn muscles or other tissues.

The irritative, vascular disturbances a sympathetic lesion would institute are plain enough in congestions, plugged vessels, capillary stases, irregular blood-supply leading to, or not leading to, inflammation, *all of which* would be manifest in the immediate vicinity of the lesion and not necessarily elsewhere, as a careful reading of Vulpian will disclose. Nor need the vasomotor lesion be necessarily a disruptive one. A portion only of the ramus or ganglion may be deranged, bruised, or torn, and vasomotor dilatation would ensue thereabout, with attendant localized, irritative effects.

Whether one or more rami or ganglia are disturbed in the spinal region with attendant local hyperæmia in the nerve-root vicinity, a vasomotor derangement of the cord, brain, and viscera would follow, and the distant effects upon the sympathetic would be of an irritative character, precisely such as we find in Erichsen's disease, to which would be added the additional symptoms of that disorder due to cord, nerve-root, and meningeal irritation through their blood-supply being rendered irregular,—now congested, now absent; in one place anæmic and in another hyperæmic and vacillating. In extreme cases ischæmiæ, or infarctions with focal softenings or other degenerations could easily be imagined as induced.

Erb, Berlin, and others suggested ecchymoses in the cord to account for the symptoms, similar to those occurring in the sclerotic or retina when the eye was bruised. Transfer those small capillary extravasations to the ganglia bodies, the connective-tissue capsules, ligaments, and vertebral periosteum possible thereabout from a concussion, and the irritations are carried in to the cord and will become as manifest as though located directly therein.

Such extravasations may subsequently clear up as readily

as they do in the eyeball. But vessel-rupture, hæmorrhage great or little, is not necessary to the production of sensory troubles in that vicinity; irregular blood-supply from a deranged vasomotor region is fully sufficient. A turgescence, such as could readily occur from the blow or fall, whether the sympathetic strands or ganglia were damaged or not, would set up pain and general symptoms as readily as a swollen muscle can reflexly cause general disturbances.

If there shall be found anything in Erichsen's supposition that the left leg is more frequently affected than the right, an explanation may be discovered in the fact that the vena cava presses against, and to some extent cushions, the right lumbar ganglia; while on the left side the corresponding ganglia rest upon the vertebræ along the edge of the psoas muscle.

The question would properly arise, how it happened that, with a lesion, a disturbance, tear, strain, or anything else that could eventuate in such an accumulation of symptoms, the onset should be so late?

1. Such cases as Boyer's sudden-death instances, without cord-lesions, could have been due to cardiac nerve, cervico-dorsal-ramal ruptures, or such prevertebral damage as would (with the knowledge we now possess of the sympathetic) fully account for the heart engorgement and "failure of respiration." The condition of the visceral front of the spinal column was not noted in the autopsy records, and Page sets the example for such criticisms, in one case suggesting that an unobserved tear could have occurred in the lumbar nerves of a case of paraplegia with no cord-lesion to account for it.

2. In delayed manifestations the "latent tonic influence" of Ott may be appealed to. Sympathetic lesions do not, in many cases, produce immediate symptoms, and the explanation, I think, occurs in the partial independence of that system and the fact that the trouble induced by some of its lesions may be cumulative, in the manner pointed out by Vulpian: first, a local vascular congestion, which paved the way to

inflammation later. Either the slowly-growing prevertebral blood disturbance, functional or organic, congestive or occlusive, from deranged ganglia passed to the inflammatory stage, or the congestive stage persisted and increased; in either case *time would be required and the irritative phenomena would not be at once apparent.* Several weeks or months might intervene. In cases where a very long time existed between the accident and symptom appearance *I should look for positive degenerations* that had slowly, but surely, been induced. These could be carious, periosteal degradation, connective-tissue proliferations, arterial scleroses, etc.

3. A lesion may be vascular, osseous, ligamentous, etc., and by extension or secondary implication destroy, or partially destroy, the nerve-root, or ramal, or ganglionary vicinity, and only make itself apparent when months had elapsed. This would account for the unsuspected dislocations and fractures found post-mortem in Erichsen's disease, associated with consistent symptoms. Discriminate and indiscriminate degenerations are used by some pathologists to describe destructive processes limited to certain functional areas and such as are not so limited. Bramwell, than whom we have, in many respects, no clearer-headed neuro-pathologist, uses the distinctions elucidatively.

As this book will be read by lawyers and others not medically educated, it will be as well to explain that a parallel is afforded by an elevator-shaft fire. When it is confined it may be called discriminate; if it burn the building, or parts adjacent to the shaft, it is indiscriminate.

We can here advert to Knapp's case of a stab in the abdomen, with peritonitis, followed by Erichsen's disease. As to which lesion—that caused by the knife or the inflammation—induced the symptoms, we may leave to the future study of similar cases to determine. We certainly, in this description, coupled with some of Oppenheim's narrations, have a justification for my prevertebral-lesion theory.

There is a disposition on the part of the sympathetic nervous system to *readjust* itself to something like a normal condition after injury, just as the debased lung surcharges and develops by exercise the opposite lobe, and everything depends upon how suddenly or gradually, this vicariation may have been instituted. Foster's instances of re-instituted normal sympathetic action after section in dogs, and Fox's dictum of the compensatory tendency after lesions, with my Kelly case, in which the flushings and delusions disappeared with only the brain degradation due to their continuance remaining, teach that Nature may tend to an equilibrium in this respect, but the "damaged man" may accrue, simply because nothing can completely atone for a scar, however trivial.

Instances of "very severe symptoms at the first, with subsequent rapid recovery," are doubtless those where Hodges' "so-called spinal concussion" only existed. There might not have been ruptures of muscles or aponeuroses, but there could have been Hilton's nerve-root stretching, with sprain of the vertebræ and ligaments, and no lesion of the main tissues in front of the spinal column, or a rapid disappearance of congestion, or other causes of irritative trouble, just as an ankle-sprain may be transient.

Remissions are as liable to occur as in graver disorders, such as paretic dementia, and probably for the same reasons: a lessening of congestion in localities, under favoring influences, acting derivatively or in unknown ways.

Emotional disturbances may end a remission and precipitate the disease. We find a mental cause often operating very badly in heart disease, sometimes killing. The mental condition, especially the depression in Erichsen's disease, is due to irregular cerebral blood-supply. Congestion of the brain, especially venous or passive, notoriously induces melancholic, apprehensive feelings and hypochondria. The probabilities are that to a greater or less extent the cerebro-spinal centres may be directly implicated in a great number of cases, adding to the symptoms of Erichsen's disease or aggravating them. Spinal

or even cerebral lesions may accompany and often spring from the vasomotor troubles. Just as we seldom have pure, uncomplicated cases of myelitis without meningitis, or the latter without the former, so to obvious cord injuries those of the sympathetic may be added in all degrees of combination, precisely as pneumonia, pleurisy, and pericarditis are often associated.

We have no record of the prevertebral condition in post-mortem accounts of these cases. As a rule, the section is made dorsally with the cadaver face down and the peritoneal cavity undisturbed, and the spinal nerves are severed inside the canal. Hereafter, when the anterior parts are examined some sources of error should be guarded against, by remembering that hypostatic congestion of these parts always occurs after death, when the person lies supine, which is the almost invariable position in dying and while waiting sepulture. Then, again, some of the prevertebral ganglia are naturally of a reddish color, the superior cervical especially. Ante-mortem congestive and inflammatory conditions could thus be masked and undiscovered post-mortem. In visceral examinations it is very seldom that the prevertebral sympathetic is carefully examined. There is no record of any examination of this part in concussion cases, and I predict that where a lesion exists in Erichsen's disease this will be the place in which it will be found. In microscopical examinations the finest microtome has distorted tissues; artefacts have been often taken for lesions. A former pathologist of the Utica New York Asylum caused post-mortem lesions by using alcohol to harden the brains he examined, and claimed that all insanities resulted from the same brain changes. Brodie stated that we were not justified in denying lesions because we did not find them in brain concussion, and recently degeneration of cell-groups, ossifications, etc., have been found as the results of concussion of the brain,—conditions that had been overlooked by previous observers. What the initial lesions may have been we can only conjecture; certainly the brain-cells were damaged from the start.

Oppenheim and others have called attention to arterial scleroses appearing some years after institution of Erichsen's disease, and Knapp called my attention to a case of the kind reported in the June, 1889, *Neurologisches Centralblatt.* Precisely such a result could be expected to follow upon vasomotor derangements, for, when the arterial muscular contractility has been unexercised or unduly changed, degenerations are as likely to occur in arterial walls as in voluntary muscles when cut off from "trophic" influences.

CHAPTER XIV.

TREATMENT.

We may know to a reasonable certainty what will benefit a patient, and yet circumstances may place remedial measures beyond reach. Thousands of sufferers "die in the harness," for it is often a choice between starvation or work in spite of sickness. A moral bravery is induced by having a family to provide for, and while this fortitude may do much it often fails, and the patient becomes as helpless as though his legs were cut off.

Where it is possible the utmost quietude should be secured in Erichsen's disease, and it is safe to treat the initial stages as those of a severe strain, with hot fomentations, rest in bed, or sitting, as the patient feels the most comfortable. The seclusion, darkness, and quietness usually sought by the sufferer is an indication of their necessity, and disagreeable mental influences should be removed as much as possible. Excitement of all kinds and stimulants must be avoided.

In debilitating disorders such as this the bromides should be used as little as possible; as a rule, far better results can be obtained with ergot. The soothing effect of this drug in hyperæmic irritation of the spine is often very striking. I uniformly use Squibb's fluid extracts of ergot, hyoscyamus, conium maculatum, etc., for long experience has taught me the worthlessness or at least unreliability of other preparations in the market. A few drops of conium at rare intervals allays excitability, but its continued use is not to be thought of. Opium adds to the constipation, increases the cerebral congestion, and is unsatisfactory generally. The ergot fluid extract may be given in ten-minim up to drachm doses three or four times daily, to allay the back pain and irregular circulation. Cardiac rapidity may be controlled with digitalis, and assists the ergot in quieting the

patient. Better sleep is secured very often by these simple means. Sulfonal, dissolved in very hot liquids, gives occasional relief from the insomnia, but it is more useful in functional disorders. When pain or congestions keep the patient awake or cause restless sleep the ergot is better than sulfonal, though they may be used conjointly.

Phenacetine does well in a few cases in quelling pain, but is not to be depended upon. Antipyrin and antifebrin occasionally affect the heart badly, and are of questionable use in Erichsen's disease.

I have secured excellent sedative effects by the use of moderate galvanic currents down the spine, the stabile descending or ascending, in cases of organic spinal-cord disease, particularly tabes; the lancinating pains are often allayed by using five to ten milliampères of current strength, and sometimes the whole course of the disorder may be thus changed for the better. It does not seem to be so effective in concussion cases, and in their acute stages electricity should not be used. Knapp observed some gain under galvanism at times.

Anything that distributes the circulation will benefit, such as warm baths, massage, and derivatives. Catharsis, when rendered necessary through bowel atonicity, gives much relief and indicates the congestive nature of the ailment.

Pleasant surroundings, through preventing inequalities of circulation, are very beneficial.

Dr. Sven A. Lundgren contributes the following, at my request. His scientific massage treatment has helped patients I have intrusted to him very greatly, evidenced in often compelling sleep and relieving pain:—

"Massage is a useful derivative treatment in localized hyperæmic states when judiciously used. Mere rubbing does not suffice. The masseur should understand the anatomical and pathological conditions, and be instructed in the manifold methods of the movement cure, or at least act under the direction of one who is skilled in such matters.

"The back, at first, should not be touched, but, by deeply kneading the extremities and gradually approaching the trunk with the deep pressures, spinal blood-stasis can be relieved.

"In later stages, where there is a general anæmic condition or irregular vascular action, soft, regular massage along the spine brings a new blood-supply to the weakened parts and breaks up old congestive tendencies. In addition, a soothing effect is thereby obtained on the skin and peripheral nerves, secondarily allaying the central spinal irritability.

Remoter parts of the body are healthily influenced, tone is given to the stomach, heart, lungs, and viscera generally, and the sympathetic system is evidently directly reached by massage. Obstructive actions are dispelled, a freer flow of the gastric, intestinal, and other secretions may be induced, when necessary, and the appropriate movements are resorted to. Easier evacuation and assimilation naturally follow.

"The pulse may be reduced from ten to twenty heart-beats per minute, respiration regulated, and old chronic constipations may be broken up. Where there is a tendency to sluggish circulation, as in the enforced quiet of Erichsen's disease, a healthier tone of the muscles may be produced by arm and leg massage, such as the patient could not secure from painful, active, voluntary movements."

Body and limb massage after cerebral concussion I can especially recommend as opposing the inflammatory conditions the brain is likely to suffer from, later, when not properly treated.

Hydrotherapy has, as in traumatic brain troubles, proven very useful. Sea or lake voyages have helped chronic cases. At Baden-Baden, Paris, and Geneva are water-cure establishments, more or less skillfully managed. Some exist in this country, but in the main they are quackish; most, not all, of them undertake to cure everything, in blessed ignorance of the fundamentals of medicine. My Case XX was greatly helped by the use of the "Regendouche" at Dr. Glatz' place, in Champel, near Geneva, Switzerland.

CHAPTER XV.

MEDICO-LEGAL CONSIDERATIONS.

When Herbert Spencer treated some living issue he always went beyond its immediate or superficial aspects, and sought out the remoter causes of phenomena that are operative everywhere and in everything. Medicine and law fraternize, and too often clash, and as law and civilization advance, it is, in many instances, because adjustment is being made to established medical facts. Witches are no longer burned, and madmen are recognized as sick instead of satanic. But both law and medicine have many decades to travel before they will co-operate as they should in the interests of justice.

An apparently remote, but really direct, cause of so many pseudo-experts being able to maintain themselves for years in communities is the general state of medical education.

The president of Cornell University, Professor Adams, in a recent publication, inveighed against the superficiality of medical education in this country, due to the miserable equipment of American schools from want of endowment, their dependence upon students' fees for maintenance, and the fact that a ten-year-old child could pass the preliminary examination for admission.

Huxley told a large assembly that there were few present who could tell the significance of an act each performed every moment of his life—respiration. It is not fashionable for people to know as much about their own bodies as of the geography of Siberia, which can concern them but remotely, while even a superficial knowledge of physiology may be worth life itself; for diseases are largely within the power of man to control, and no man with physiological knowledge but can look back with assurance that he has escaped sickness, and, in all likelihood,

death itself, through what he knew to prevent them. "But we cannot all be doctors," is urged; no, but through traditional methods of instruction memories are loaded with valueless matters, such as the details of contemptible royal intrigues, overdoses of classical verbiage, rather than where to find your own pulse. Ignorance of the bodily workings is so profound among the multitude that it falls an easy prey to the pretender to such knowledge, who assumes the apparel, owlishness, equipage, and externals generally that are associated in the vulgar mind with wisdom. The mysticism looked for is a survival of the fetichism which in olden days left the healing art to priests, and an ultra expression of this association of medicine with supernaturalism is seen in pilgrimages to the Grotto of Lourdes and the mummeries of "metaphysicians." In proportion to this ignorance charlatanism will thrive and honest medicine be discouraged.

A scientific medical course presupposes a literary education, for technical terms cannot be otherwise understood. Chemistry is the veritable front door to medical as to other sciences, yet it may safely be asserted that not one in a thousand graduates from the average American school has a rudimentary knowledge of this branch. Indeed, the "faculty" snub the chemical professor and his department, and plainly announce their hostility to instruction in this most fundamental science.

The first consideration is to get a diploma, by hook or by crook; to be able to write some kind of a prescription is next, and to know enough to perform some simple, but flashy, operation concludes the student's yearnings, for he knows that through these superficial things he is judged by patrons. The ability to successfully care for some complicated disease weighs but little, for such distracting study will take too much time and thought from the business aspects of a "successful practice." The study of human nature and how to profit by it pecuniarily is too engrossing to permit time to be wasted in learning medicine.

Other studies, such as anatomy, pathology, etc., are hastily

skimmed to enable answers to a few questions, and the great bulk of instruction absolutely needed to intelligently treat the commonest ailment is scarcely alluded to, and, as to collateral sciences, of which every doctor should know something, such as comparative anatomy, electricity, optics, they are unheard-of topics.

The last official report of the Illinois State Board of Health states that there were in the United States and Canada 227 medical schools, of which 92 became extinct. Only half of these were recognized by the board as legitimate,—that is, there were over a hundred bogus medical schools in the country; 92, only, exacted some kind of an education for admission; 45 required theses before graduation; 30 demanded three years' attendance; the others less time,—down to four months. So, about only ten in a hundred could be considered reputable, and it is apparent that we have a superabundance of diploma-mills turning out 5000 graduates yearly "to practice," as Professor Adams says, "their ignorance upon the community."

Codes of ethics, which gentlemen never need, prohibit respectable medical men from soliciting clientage. Business ability, while rigidly obeying the letter of the code, violates its spirit in every way, and one of the most effectual methods of building a practice is to form a clique, at a cost of $15 for incorporation, and start a school by each "professor" contributing his share to building expense. If he can do this it does not matter how ignorant he may be. Then these enterprising coteries practically instruct their crowds of pupils to bring cases to the faculty rather than undertake their treatment themselves. Fully two-thirds who begin do not go through school, but they become broadcast advertisers of the "professor," who is also open to consultation fees from the other third. Of 13,219 American students in 1883 only 4408 graduated.

Of course, here and there may be found able teachers, bright scholars, and creditable careers as schools and schooled, by way of exception, but the *status* of instruction is disgracefully

low in America, and statisticians such as Secretary Rauch, of the State Board, declaims against it in vain.

European institutions are incomparably superior because older, and whatever may be truthfully affirmed against monarchy, in other respects, it encourages scientific medicine. Professorships in such places are evidences of merit, ability, learning, as the rule; while in our medical chairs we find a preponderance of scrambling medical politicians, mediocrity, and downright ignorance, the usual medical lecture consisting of boasts, solecisms, religious platitudes, and medical slang.

Atop of all this, it will sound queer to claim that from this bad state of things will grow up conditions that will give America the very best of a medical future, and yet it is even so, for here there is no hot-house fostering of science by potentates; everything must work itself out in the ratio of intelligent growth among the people, who, as they can understand and appreciate desirable things, will build them up. The evolution of medicine in this country is working itself out naturally, and every gain will be permanent because based upon the lifted mental plane of the whole people, and not dependent upon the knowledge of the few.

It would obviously be a great mistake for a lawyer to select an expert from among "college professors" on the presumption that the mere holding of a chair was evidence of knowledge. There is something in the title that lends dignity, and this, it is thought, counts with a jury; but its influence is counteracted if some student coaches the opposition and eviscerates the professor, which is so often the case that attorneys should inquire as to whether the professor really knows anything about the subjects he pretends to teach. If there is a charlatanism of savants what can be expected of pseudo-savants?

Then, again, under our "peculiar institutions," the physicians who hold positions in *public* institutions, such as county or city hospitals, state or county insane-asylums, are only by the purest accident either reputable or skilled; for, of course, there

are notable exceptions. These places are secured by intrigue and purchase from the saloon-keepers, gamblers, and burglars who constitute our political masters; hence, when physicians are alienists or neurologists by the grace of politicians it cannot but be surprising if they know or care much about medical matters, and, as a rule, these professors and political appointees are the very ones the lawyers can depend upon to adopt their views and swear through thick and thin, regardless of the realities of a case. Scientific examination of the patient is wholly unnecessary with them; all they want to know is what the lawyer wishes them to say. No one, unless experienced in such matters, can realize to what an enormous extent the most bare-faced perjury is indulged in by respectable-appearing, venerable practitioners who are members of churches and "stand high socially."

Erichsen speaks of "honest differences of opinion;" such may exist between honest men, but when both sides, as is often the case, do not know what truth is, have become so accustomed to telling lies that they habitually think lies, where can be the "honest difference"? As a rule, among regular physicians in consultations where no money-issue is at stake, a fair agreement can be reached, but the divergences of opinion in many medico-legal cases are too great to admit of but one conclusion, and that is that some one is lying. Astute lawyers will do well to obtain transcripts of the testimony of physicians in previous cases, and they will discover either the consistency or inconsistency of the statements such witnesses have practiced at different times.

Often a skilled surgeon will go any lengths to serve his railroad. A comic instance of this servility occurred where a ruptured man was informed by the surgeon that there was nothing the matter with him, and six months after, as a casual patient and without being recognized, he obtained a prescription for a truss from the same surgeon. Several months later a re-examination enabled the doctor to reaffirm his first opinion, to which he swore on the stand, but was discomfited by the presentation to him of his own prescription.

Cross-examination with the assistance of a "coach" will do more to bring out the truth than anything else. There is an "orificialist," as he calls himself, in this city, whose income is said to be $25,000 per year. He treats gout, rheumatism, insanity—everything, apparently—by rectal surgery, and flocks of patients fill his rooms. He enjoys the reputation among the people of being skilled in the treatment of insanity and nervous diseases, and charged $3000 for practicing dilatation of the rectum upon a hysterical female; a case of lateral spinal sclerosis he treated by cutting the sphincter and snipping off the fringes of the rectum. I regret greatly that this eminent man has not the time to appear some day on the witness-stand. Yet, in country places, such characters help to rob railroads or defeat honest damage-suits simply because the attorneys do not know what constitutes medical knowledge.

Judge Bartlett's views concerning duties of experts (see page 70) are not based upon a sufficient grasp of the situation. I claim that *it is the physician's duty to coach the attorney, in and out of court, whether he testify or not.* It is the privilege and right of the expert to suggest queries that will lead out the truth, and, where they exist, to expose the ignorance, knavery, or both, of the medical witness of the other side. If a physician take sides with a lawyer and both honestly believe in their case,—that the plaintiff is shamming or that his trouble is genuine,—what is there to deter the conscientious doctor from espousing what he believes in? *Esprit de corps* is unavoidable, but it will never lead the properly-organized physician into conspiracy against the right. I believe that physicians, more than any other class of persons, are imbued with a high sense of honor, and, if they are really worthy of the name of physicians, there will be more good deeds and refraining from wrong to their credit than to that of any profession whatsoever to the end of the world.

I have known the most arrant trickster-experts to dignifiedly sit apart from their attorneys in court, pretending to hold

no intercourse with them, so as to impose the appearance of being unbiased upon the jury, and during court adjournment these experts were closeted with the attorneys. Now, let me ask, which is the better course,—to coach openly, in and out of the court-room, or to pretend not to do the first and surreptitiously do the latter?

But this coaching, if properly done, will never permit the taking advantage of mere timidity on the part of a witness, "browbeating," or helping in any of the multitude of tricks too many of the legal profession indulge in. In a long experience I have noted that the higher the court the less is the trickery by attorneys, and that the best lawyers disdain to resort to the methods of the police-court shyster.

After such an arraigning of both legal and medical gentlemen, I am glad to be able to say that frequently I have met judges, attorneys, medical experts, plaintiffs, and defendants, regardless of the side that employed me, who impressed me as upright in every respect, unwilling to take unfair advantage, to misrepresent, pervert, or to allow anything but the most honorable intercourse or proceedings; and when, in such instances, a good judge has presided over all (and I am glad to say that I believe in the integrity of the Judiciary more than in that of all others concerned), I have concluded a case with a feeling of hopefulness for the future of our race and of gratitude that there are high-minded, straightforward men *everywhere*.

When an expert has to listen to testimony and realize that matters are falling into a hopeless muddle through want of information on the part of court, jury, attorneys, or witnesses, or overbalancing astuteness of counsel, the temptation to set things right by a suggestion is irresistible, and need not be resisted if the expert feels that injustice can be prevented by his interference. Then it is beyond endurance for one who has devotedly mastered his subject to listen to the prevarications and falsifications of an ignorant or designing person.

It is seldom that the hypothetical case can be a fair pres-

entation of facts, enabling categorical answers. In fact, there is no better method of getting at half-truths than through simple "yes-and-no" answers. The hypothetical questions may be likened to the letters that physicians receive from distant patients, detailing their troubles and the causes that led to them so imperfectly that no doctor upon such narrations *alone* can prescribe. The physician must remember that in considering this form of interrogation he must base his judgment wholly upon its statements, and not allow himself to be influenced in his decision by outside matters. If he cannot give an opinion upon the case thus summed up he should say so, and, as a rule, it is best to declare the unfairness of hypothetical questions in general. Sometimes they are so constructed that they had best be answered by sections or not at all.

The attorney should insert the results of his expert's personal examination of the patient.

Answers based upon hearing all the evidence in a case can be more intelligently given, for there are multitudes of important matters the physician can observe and interpret which cannot be adequately summed up.

I have spoken of the injustice of excluding the narration of subjective symptoms and what the patient said at the time of the examination. The physician can give his opinion of the condition of the patient at the time of the examination, and why not, therefore, the details upon which that opinion is constructed?

Besides the exuviating process, mentioned in a previous chapter, as resorted to by lawyers sometimes, the physician must be on the alert for a tricky combining of two of his previous answers to elicit a contradictory third answer on his cross-examination. In all cases questions should be fully understood before an answer is given. The probability of the plaintiff having been drilled to simulate, his medical knowledge, and whether he has been influenced by suggestions should be considered, as well as his intelligence and opportunities for learning.

Often the question is asked if the manifestations of a spinal

lesion are not invariably below the seat of the hurt, as, for example, when the upper part of the body exhibits mostly the effects of a blow to the hips. The simile of a watermelon bursting at the part opposite to that struck, or the fact that lock-jaw has been caused by a kick in the rump, may be cited as homely, but convincing and justifiable, offsets to the ruse.

In Utopia, doubtless the "conjoint-report" system will be adopted by physicians, but when there is such inequality of knowledge between medical witnesses such a report would be farcical in the extreme. Then it often happens that neither side wants the truth to appear; each simply wants to win the case.

Physicians of the other side should always be admitted to the examination by courtesy, and in reward for this the acknowledgment should be made by the opposing counsel that it was through courtesy that this was permitted.

I do not understand what justification the court may have in appointing his own experts, and I fail to see the equity of compelling the corporation to pay for the services of court experts. I have noticed that usually and naturally, as a result, the leaning was toward the real employer. If the judge can so appoint, it would be fairer to divide the expense between contending sides.

The *Medical Standard* recently stated that, under the legal principle that no man is compelled to criminate himself, the privilege of examining patients under anæsthesia without their consent had repeatedly been refused by American courts; but another periodical (the *Northwestern Lancet*) qualifies this position, stating that "anæsthetics have sometimes been administered for the sole purpose of determining whether certain symptoms were genuine or not, and, in the hysterical, diagnosis is often much aided by this plan. In medico-legal cases, where there is reason to doubt the reality of the disability claimed, the matter could often be settled by putting the claimant of injury under an anæsthetic. This has sometimes been done, but in a

recent case in France where it was proposed the injured person refused to submit to anæsthetization, and, when the matter was argued before the court, his attorney took the ground that the procedure was objectionable because it involved a certain degree of risk to life which his client was in no way called on to undergo for the mere purposes of an examination which would be of no benefit to himself. The attorney further argued that the only situation in which the court would be justified in ordering anæsthesia for diagnostic purposes would be in a criminal case where it was done for the benefit of the accused. The court fully sustained this decision."

It would not be necessary to remind physicians that cruelty in examinations is not to be tolerated were it not that I have seen the full concentration from lenses being allowed to pain the retinæ of photophobic patients, and that, too, when there is no use of an ophthalmoscopic examination in Erichsen's disease; admittedly, the retina may be normal.

The matter of taking contingent fees partakes too much of the speculative, but is a consideration of conscience and business, though unwise from the latter stand-point, for in the vast majority of cases the expert will find himself swindled. A cash basis for services is the most dignified and least troublesome plan to adopt in the end.

Lawyers often have an idea that the more physicians they can obtain to testify upon their side the more the jury is apt to be impressed. Physicians and the court should oppose this cumulative-testimony nonsense by endeavoring to limit the number of medical witnesses by equal numbers for both sides. The quality rather than quantity of medical testimony should afford the grounds for argument.

It is noticeable that coroners' juries frequently exonerate railroad companies in the face of flagrant neglect and culpability, but this tendency of residents along the line of a road to discharge a feeling of indebtedness is fully counterbalanced by the very general prejudice petit jurors have against corporations.

In conclusion, I can say that corporations and individuals are very much alike, for is not the former composed of the latter? An aggregation of scoundrels and narrow-minded men will bribe juries, suborn perjurers, and spend a hundred thousand dollars or more per annum to fight claimants, just or unjust, rather than make settlements by which the company would make a great net gain in the end. It is very likely that the secret-service accounts of such a corporation would reveal matters of interest to stockholders, for when confiding patriots trust a "triangle," or stockholders a "detective system," they are not supposed to know for what the money is used, or to care how much may be the amount. On the other hand, I know of railroads with broad-minded, shrewd, business men at their heads, who swiftly settle all claims, and their balance-sheets show immensely less expense *per capita* of claimants than where the corporation had chronic litigation symptoms.

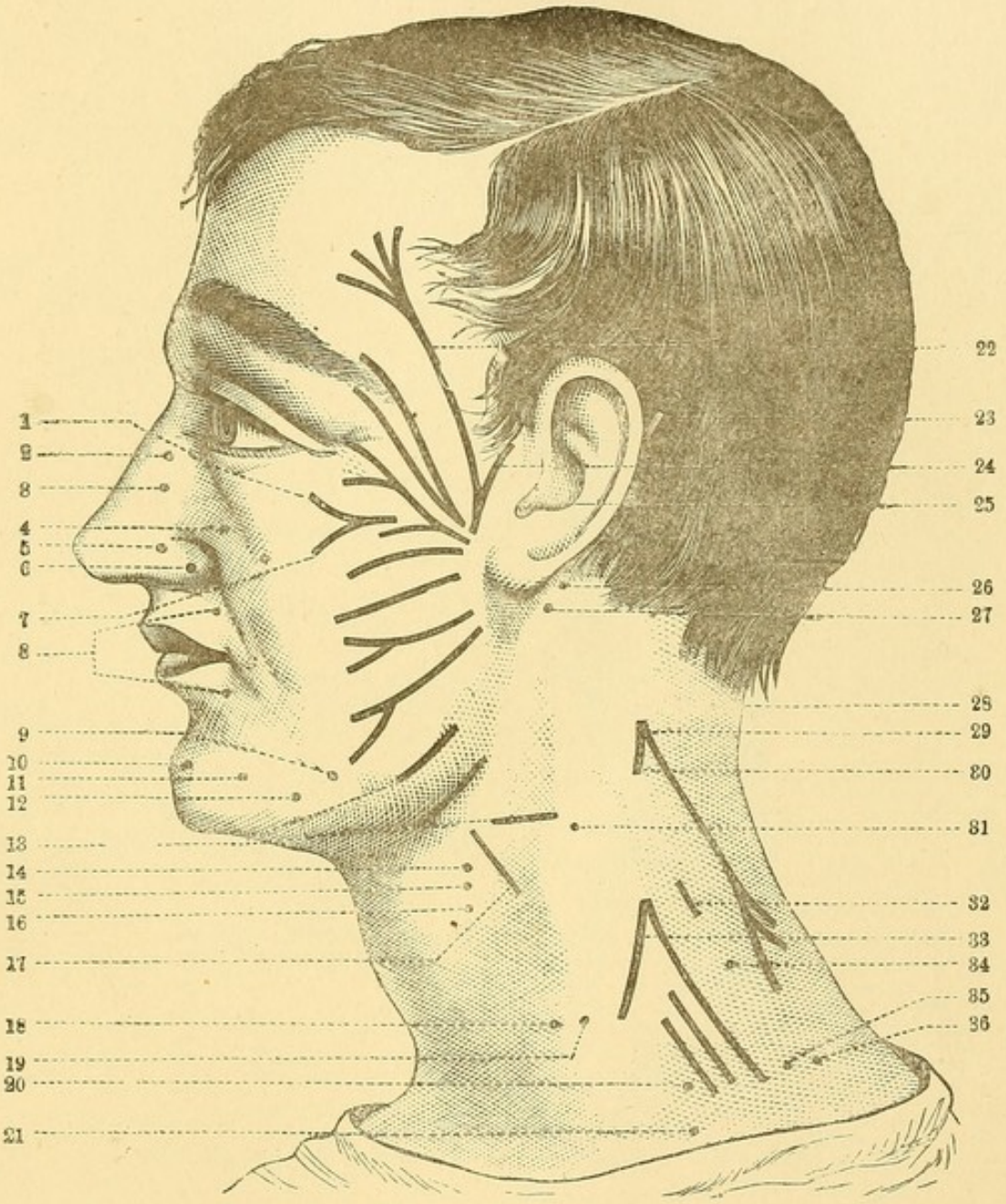
GLOSSARY.

A FEW WORDS that are frequently used in books on nervous diseases are explained below for the benefit of attorneys and other non-medical readers. No attempt at full definitions is made, and ordinary anatomical and general medical expressions are omitted. Dunglison's Medical Dictionary, or some other work of the kind, should be consulted for fuller information.

AFFERENT, ... Toward a centre, as the brain or cord.
AMBLYOPIA, ... Defective vision.
AMNESIA, ... Memory loss or impairment.
ANÆSTHESIA, ... Defective sense of touch.
ANALGESIA, ... Loss of pain appreciation.
ANOREXIA, ... Aversion to food.
APHASIA, ... Speech defect from brain disease.
APHONIA, ... A speech difficulty.
ASTHENOPIA, ... Vision easily fatigued.
ATAXIA, ... Irregularity of movements.
ATROPHY, ... A wasting.
AURA, ... Phenomenon preceding epilepsy.
DELUSION, ... A faulty idea.
DIPLOPIA, ... Double vision.
EFFERENT, ... From a centre.
FULGURANT, ... Lightning-like.
HALLUCINATION, ... A baseless perception.
HEBEPHRENIA, ... Insanity of puberty.
HEMIANÆSTHESIA, ... Sensation impairment in one-half of the body and extremities.
HEMIPARESIS, ... Half-sided paresis.
HEMIPLEGIA, ... Half-sided paralysis.
HYPERÆSTHESIA, ... Extreme sensitiveness.
HYPERALGESIA, ... Excessive pain-sense.
HYPERIDROSIS, ... Excessive perspiration.
HYPERTROPHY, ... Overgrowth.

Illusion,	Distorted perception.
Katatonia,	A peculiar form of insanity, with melancholia, catalepsy, and mania alternately.
Monoplegia,	Paralysis of a single part.
Monospasm,	Spasm of a single part.
Myelonal,	Relating to the spinal cord.
Neuritis,	Nerve inflammation.
Neurosis,	Defective nervous condition.
Neurotic,	Having a neurosis.
Paranoia,	Insanity characterized by logical perversion.
Paraparesis,	Paresis of upper or lower half of body.
Paræsthesia,	Aberrant sensations.
Paraplegia,	Paralysis of upper or lower half of body.
Paresis (in Neurology),	Incomplete paralysis.
Paresis (as Insanity),	A synonym for Paretic Dementia contracted from Progressive Paresis.
Paretic (in works on Insanity),	A contraction of Paretic Dementia.
Paretic (in Neurology),	A condition of lessened motility.
Paretic Dementia,	Insanity, with grand delusions and sometimes convulsions and fury.
Peripheral,	External.
Photophobia,	Extreme sensitiveness to light.
Psychosis,	Insanity.
Tabes Dorsalis,	Synonym for Locomotor Ataxia.
Tinnitus Aurium,	Auditory hallucinations or illusions.

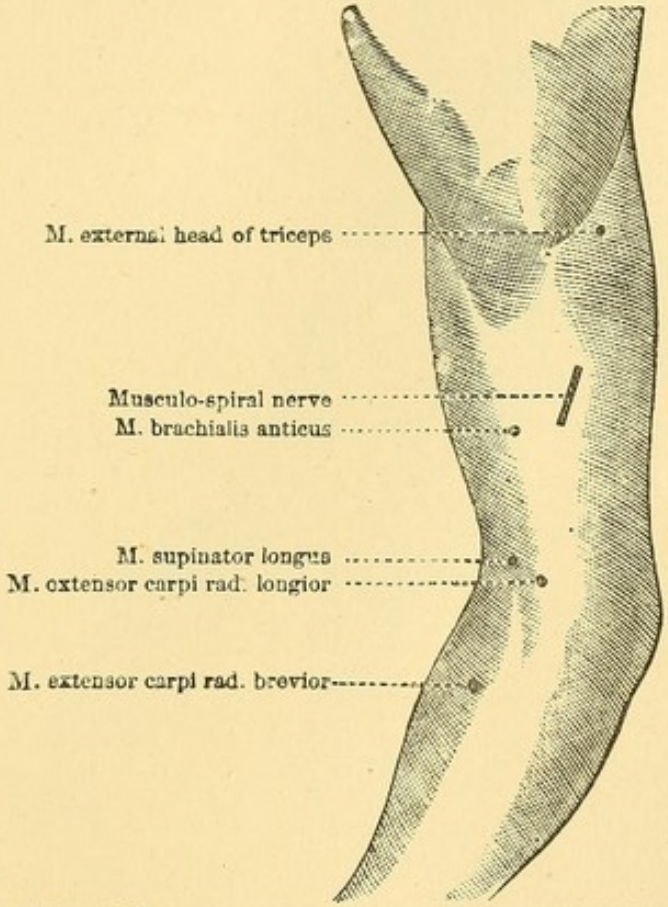
PLATE IV



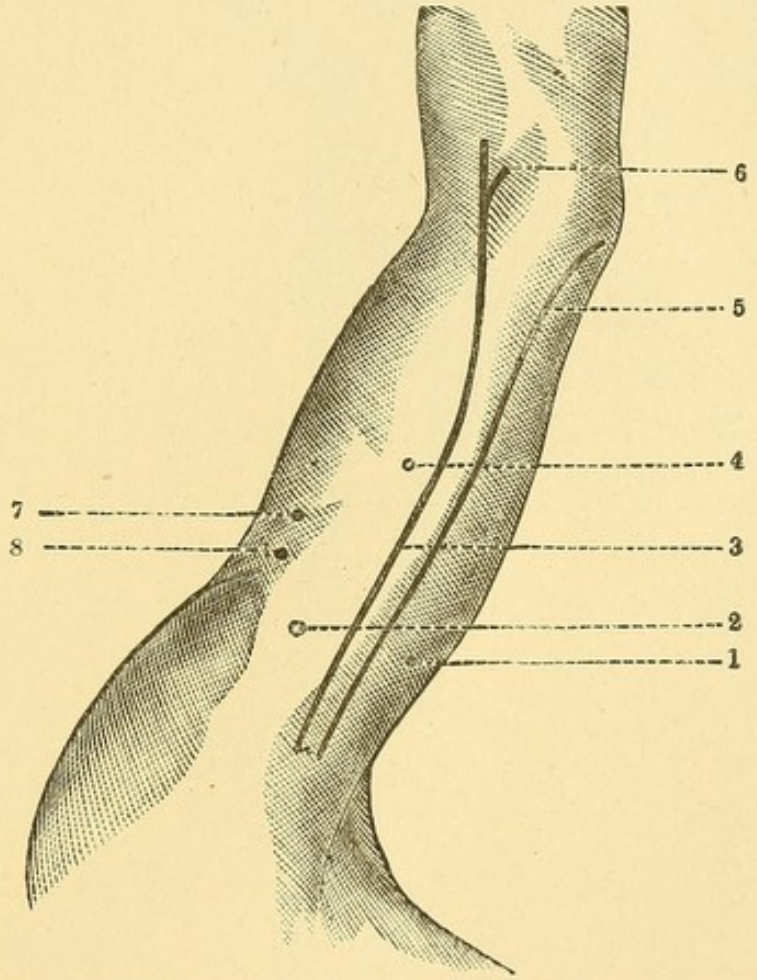
A Diagram of the Motor Points of the Face.

1, m. orbicularis palpebrarum; 2, m. pyramidalis nasi; 3, m. lev. lab. sup. et nasi; 4, m. lev. lab. sup. propr.; 5, 6, m. dilator naris; 7, m. zygomatic major; 8, m. orbicularis oris; 9, n. branch for levator menti; 10, m. levator menti; 11, m. quadratus menti; 12, m. triangularis menti; 13, nerves, subcutaneous, of neck; 14, m. sterno-hyoid; 15, m. omo-hyoid; 16, m. sterno-thyroid; 17, n. branch for platysma; 18, m. sterno-hyoid; 19, m. omo-hyoid; 20, 21, nerves to pectoral muscles; 22, m. occipito-frontalis (ant. belly); 23, m. occipito-frontalis (post. belly); 24, m. retrahens and attollens aurem; 25, nerve—facial; 26, m. stylo-hyoid; 27, m. digastric; 28, m. splenius capitis; 29, nerve—external branch of spinal accessory; 30, m. sterno-mastoid; 31, m. sterno-mastoid; 32, m. levator anguli scapulæ; 33, nerve—phrenic; 34, nerve—posterior thoracic; 35, m. serratus magnus; 36, nerves of the axillary space. In this text m. = muscle; n. = nerve.

PLATE V

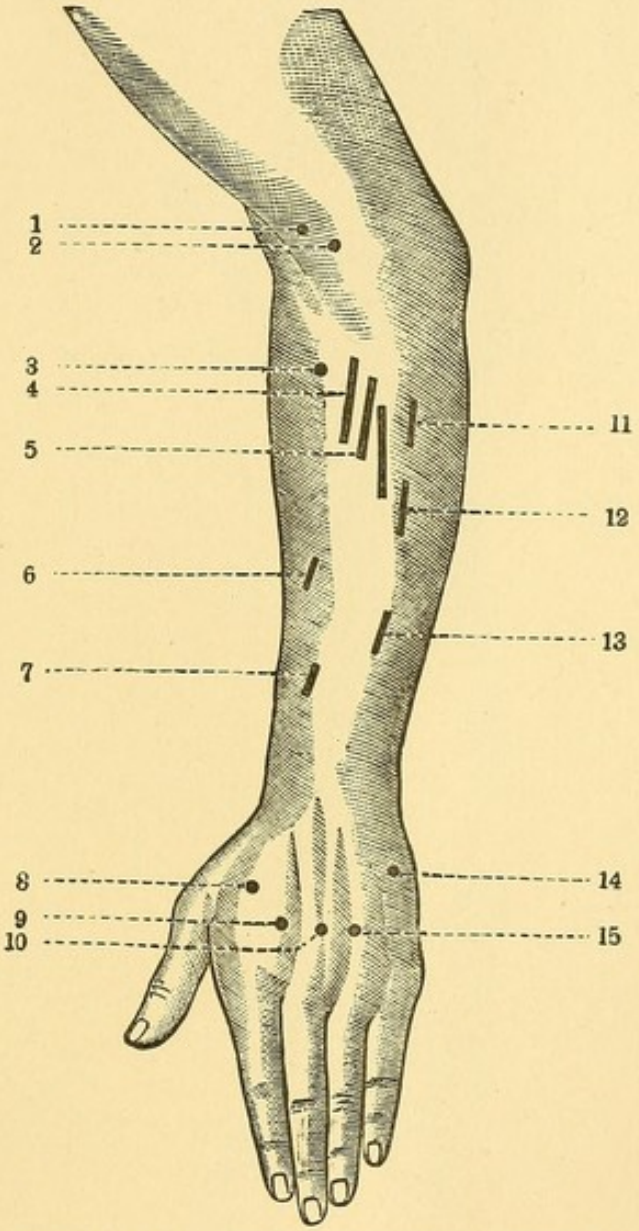


THE MOTOR POINTS ON THE OUTER ASPECT OF THE ARM.



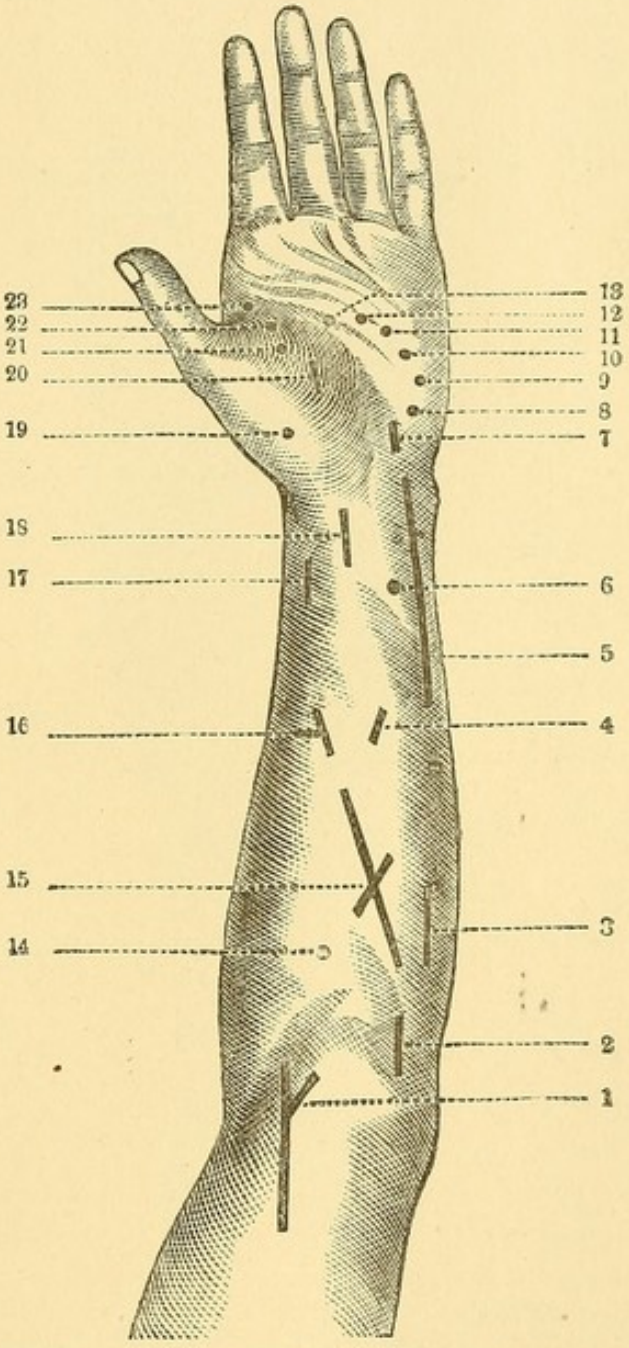
THE MOTOR POINTS ON THE INNER SIDE OF THE ARM.

1, m. internal head of triceps; 2, musculo-cutaneous nerve; 3, median nerve; 4, m. coraco-brachialis; 5, ulnar nerve; 6, branch of median nerve for pronator radii teres; 7, musculo-cutaneous nerve; 8, m. biceps flexor cubiti.



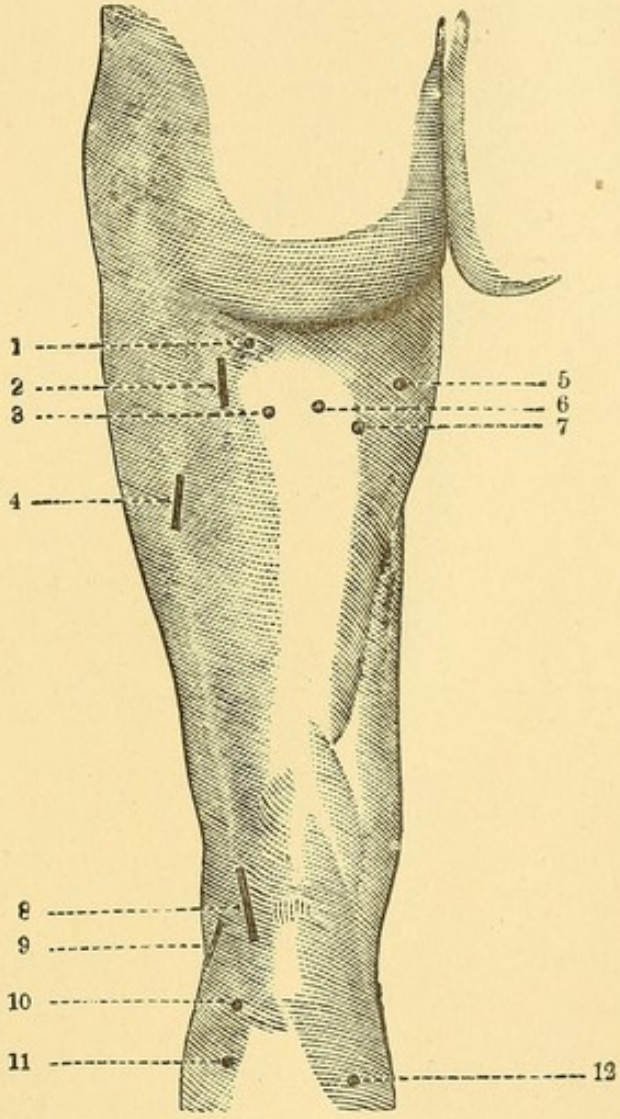
THE MOTOR POINTS ON THE EXTENSOR (POSTERIOR) ASPECT OF THE FOREARM.

1, m. supinator longus; 2, m. extensor carpi rad. longior; 3, m. extensor carpi rad. brevior; 4, 5, m. extensor communis digitorum; 6, m. extensor ossis. met. pol.; 7, m. extensor primi. internod. pol.; 8, m. first dorsal interosseous; 9, m. second dorsal interosseous; 10, m. third dorsal interosseous; 11, m. extensor carpi ulnaris; 12, m. extensor min. digiti; 13, m. extensor secund. internod. pol.; 14, m. abduct. min. digiti; 15, m. fourth dorsal interosseous.



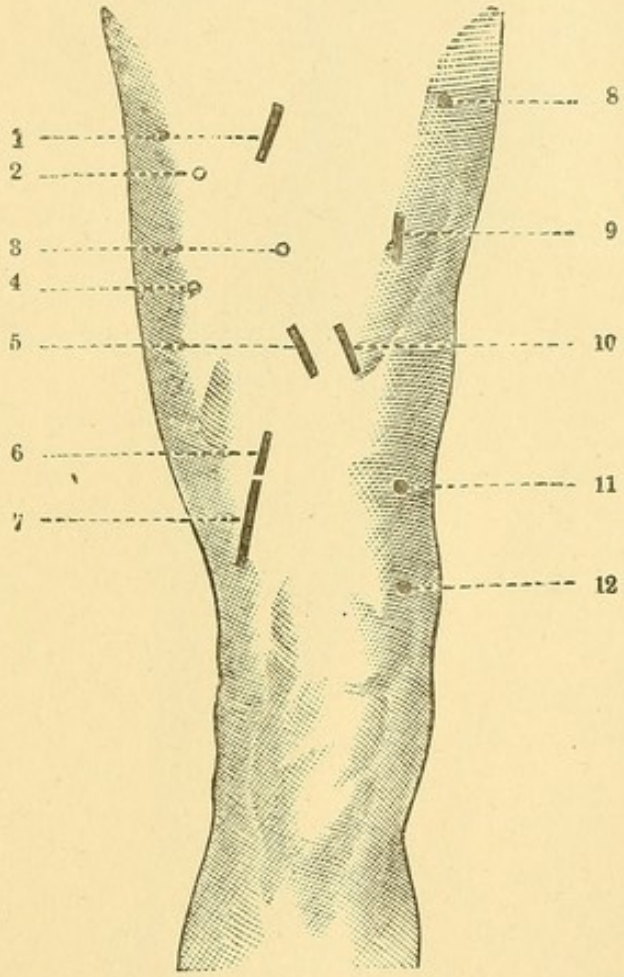
THE MOTOR POINTS ON THE FLEXOR (ANTERIOR) ASPECT OF THE FOREARM.

1, median nerve and branch to m. pronator radii teres; 2, m. palmaris longus; 3, m. flexor carpi ulnaris; 4, m. flexor sublim. digit.; 5, ulnar nerve; 6, m. flex. sublim. dig.; 7, volar branch of the ulnar nerve; 8, m. palmaris brevis; 9, m. abductor min. digit.; 10, m. flexor min. digit.; 11, m. opponens min. digit.; 12, 13, m. lumbricales; 14, m. flexor carpi radialis; 15, m. flexor profund. digitorum; 16, m. flexor sublim. digitorum; 17, m. flex. longus pollicis; 18, median nerve; 19, m. opponens pollicis; 20, m. abductor pollicis; 21, m. flexor brevis pollicis; 22, m. adductor pollicis; 23, m. first lumbricalis.



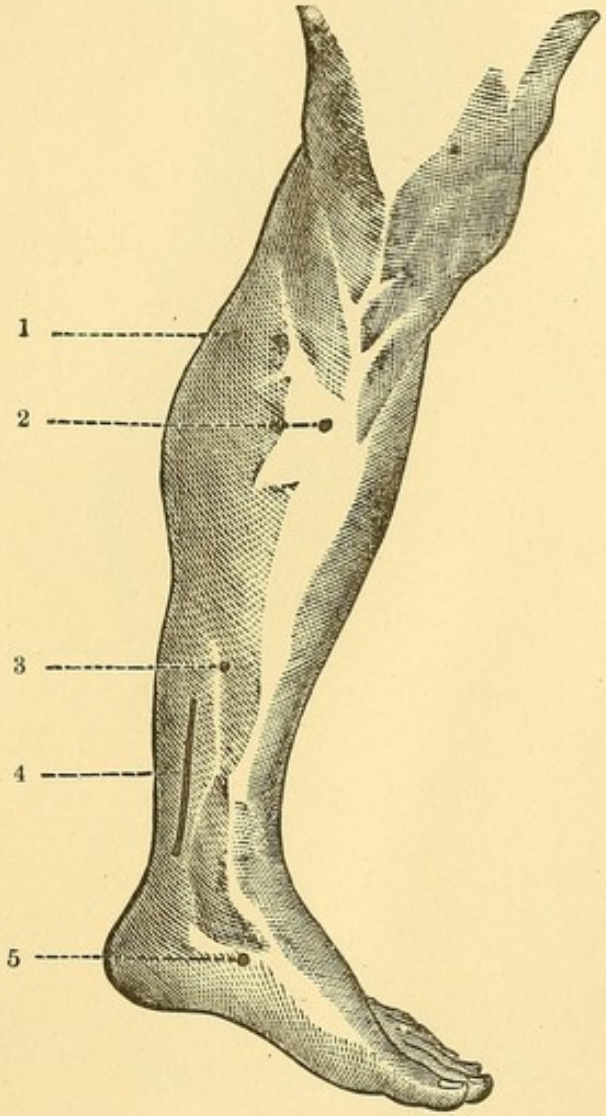
THE MOTOR POINTS ON THE POSTERIOR ASPECT OF THE THIGH.

1, branch of the inferior gluteal nerve to the gluteus maximus muscle; 2, sciatic nerve; 3, long head of biceps muscle; 4, short head of biceps muscle; 5, adductor magnus muscle; 6, semi-tendinosus muscle; 7, semi-membranosus muscle; 8, tibial nerve; 9, peroneal nerve; 10, external head of gastrocnemius muscle; 11, soleus muscle; 12, internal head of gastrocnemius muscle.



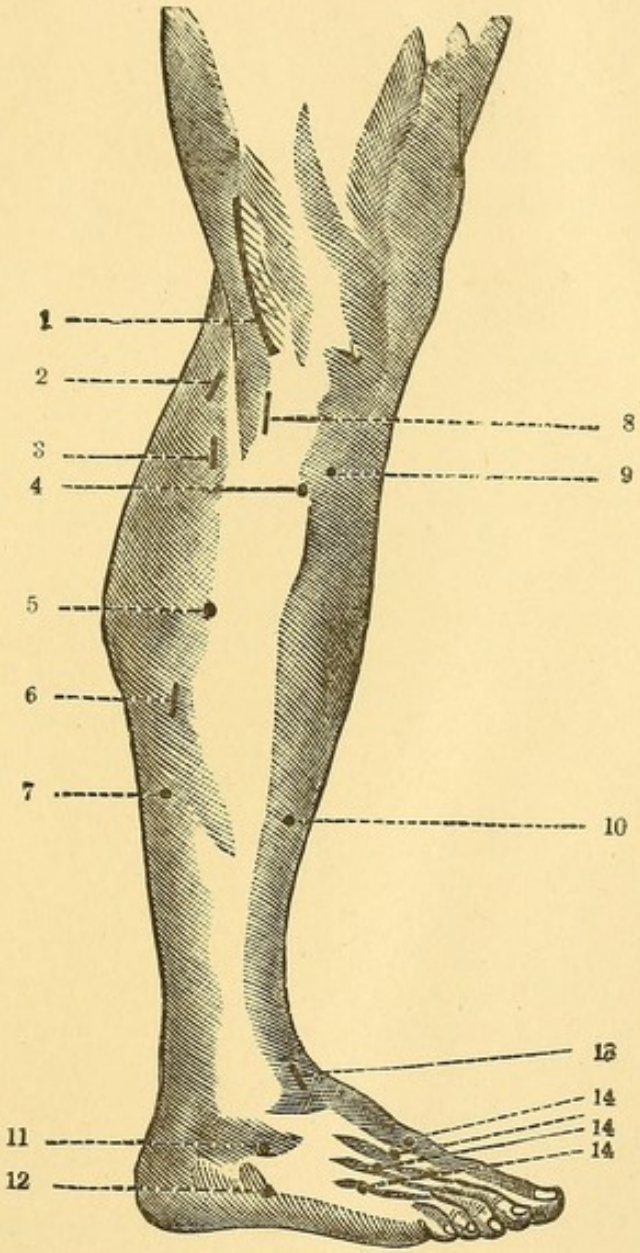
THE MOTOR POINTS ON THE ANTERIOR ASPECT OF THE THIGH.

1, crural nerve; 2, obturator nerve; 3, sartorius muscle; 4, adductor longus muscle; 5, branch of the anterior crural nerve for the quadriceps extensor muscle; 6, the quadriceps muscle; 7, branch of anterior crural nerve to the vastus internus muscle; 8, tensor vaginæ femoris muscle (supplied by the superior gluteal nerve); 9, external cutaneous branch of anterior crural nerve: 10, rectus femoris muscle; 11, 12, vastus externus muscle.



THE MOTOR POINTS ON THE INNER ASPECT OF THE LEG.

1, internal head of gastrocnemius muscle; 2, soleus muscle; 3, flexor communis digitorum muscle; 4, posterior tibial nerve; 5, abductor pollicis muscle.



THE MOTOR POINTS ON THE OUTER ASPECT OF THE LEG.

1, peroneal nerve; 2, external head of gastrocnemius muscle; 3, soleus muscle; 4, extensor communis digitorum muscle; 5, peroneus brevis muscle; 6, soleus muscle; 7, flexor longus pollicis; 8, peroneus longus muscle; 9, tibialis anticus muscle; 10, extensor longus pollicis muscle; 11, extensor brevis digitorum muscle; 12, abductor minimi digiti muscle; 13, deep branch of the peroneal nerve to the extensor brevis digitorum muscle; 14, 14, 14, dorsal interossei muscles.

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JOHN V. SHOEMAKER, A.M., M.D.

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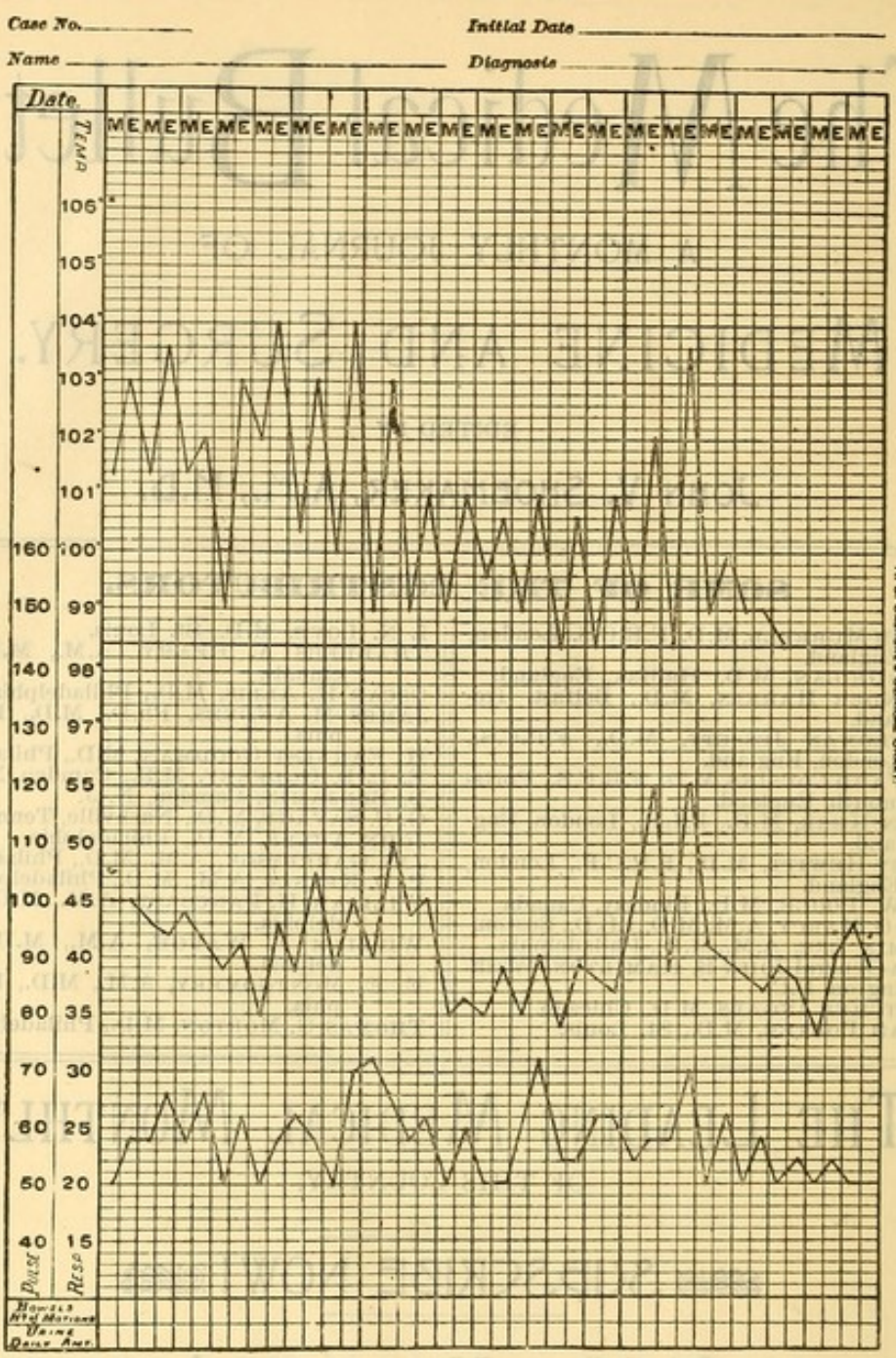

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DISEASES

OF THE

Heart and Circulation

IN INFANCY AND ADOLESCENCE.

WITH AN APPENDIX ENTITLED "CLINICAL STUDIES ON THE PULSE IN CHILDHOOD."

—BY—

JOHN M. KEATING, M.D.,

Obstetrician to the Philadelphia Hospital, and Lecturer on Diseases of Women and Children; Surgeon to the Maternity Hospital; Physician to St. Joseph's Hospital; Fellow of the College of Physicians of Philadelphia, etc.,

—AND—

WILLIAM A. EDWARDS, M.D.,

Instructor in Clinical Medicine and Physician to the Medical Dispensary in the University of Pennsylvania; Physician to St. Joseph's Hospital; Fellow of the College of Physicians; formerly Assistant Pathologist to the Philadelphia Hospital, etc.

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* Aconiti.	{ Aconite. † Tartaric Acid, 60 † P.	5½ oz. to 24 gr.	100	1 to 3 drops.

* 60 Fineness of Powder as per U. S. P.
† P. Macerate 24 hours. Percolate, adding Menstruum to complete (1) pint tincture.

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