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TETANUS

—AND—

Tetanoid Affections

WITH CASES.

BY B. ROEMER, M. D.,

ST. LOUIS.

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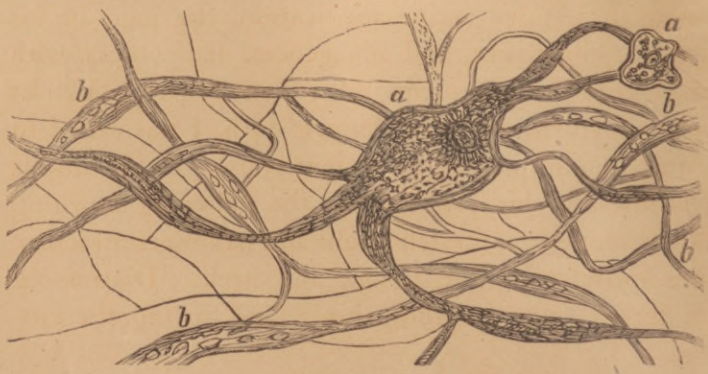

SEE PAGE 33.

Roemer, Bernard

ON TETANUS AND TETANOID AFFECTIONS, WITH CASES.

By B. Roemer, M. D., St. Louis, Mo.

The following cases are taken from my diary as they occurred in my practice during the years from 1862 to 1868. The remarks which I have added, form rather an expansion of short notes taken at the bedside of my patients, than an elaborate comment,—the result of after thought. References are freely given, and if the reader notices familiar faces in these pages, he should remember that experience and study are valuable only in comparison with the labor of others, who, as common property, are our guides and commentaries, and whose opinions should be subject to the maxim, "*creta an carbone notandum.*"

Case I.—Robert B. entered hospital with vuln. sclopet. of left arm: entrance of ball on ulnar side of wrist, ranging upwards near interosseous space, and passing through elbow joint, with exit at middle third of humerus. July 1, 1862. Omitting treatment of wound, I state that on August 25th, his bowels having been constipated to require active medication, the pain in his arm and epigastrium, and his general listlessness, with uneasiness at the præcordia induced me to pay him strict attention. In the night of August 25th, I was called to see him; he complained of violent cramps in his bowels and stiffness in his jaw, and on the following morning he lay immoveable, stretched out and having contraction of the muscles of the larynx and neck. Distressing pains darted over the whole body, and during the vio-

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lent paroxysm of the spasm, of from two to six minutes interval, the contents of the bladder were forcibly ejected. Perspiration, difficult and labored respiration, and increased pain at the lower sternum and from the ensiform cartilage towards the spinal column were added. At 5 P.M. his voice was sensibly altered, face sardonic and pulse accelerated. There was neither re- nor pro-curvation. The wound had become hot and dry. The intermissions between the exacerbation became shorter, and spasms were provoked by touch and muscular volition. His mind remained unimpaired, and the successful issue was in no small degree due to his prompt and anxious obedience to my directions. The temperature was for the first fourteen hours 105° F., and afterwards 100°. The treatment up to the evening of August 26th, consisted in the repeated exhibition of cathartics: castor oil, ol. tiglii, elaterium with calomel, aided by enemata of progressive strength. Meanwhile he was ordered,

℞ Ext. Cannab. Indic. gr. ss.
Quinine, grs. ij. M

every hour, increasing the extract after the third dose, to one and one and a half grains every hour. His bowels responded Aug. 27th, 12:30 A. M. Has taken twenty-three grains of ex. cannab. ind. On Aug. 27th, at 5 A. M., the treatment having been continued and the symptoms materially abated, I reduced the extract to its primary dose. The condition of his arm necessitating an operation, I amputated at 3 P. M. on the same day. Trismus remained for five days, with an "inexplicable" stiffness of the whole body. Cannabis ind. was reduced to one-fourth and one-eighth grain doses at longer intervals. Total amount taken 146½ grains.

The arm on dissection disclosed a spiculum of bone pressing on the median nerve, without, however, affecting its calibre or condition. The patient was about the ward on Sept. 6th, and the stump had healed on Sept. 18th. Tetanus followed the injury in 56 days, and amputation had no share in the recovery.

Case II.—Wm. B. A.; vuln. scl. Ball entered left inferior maxilla, midway between its angle and coronoid process, ranging horizontally forward along maxilla to the last right incisor, destroying bone and teeth in its course, and fracturing by concussion the inferior right maxilla at the second molar; exit on right half of lower lip, which was much torn. Ligaments implicated: left buccinator, pterygo-maxillary, left superior constrictor and right buccinator. After removal of all spicula of bone, I resected the angle of the left inferior maxilla; a fistulous opening forming on the right inferior maxilla, point of fracture, it was sufficiently enlarged to clear it of pieces of bone and two teeth, after which Barton's fracture bandage with fixed chin and maxillary band of leather was adjusted. In the second week symptoms of opisthotonos appeared under obstinate constipation and pain at the præcordia. The spasmodic contractions were intermitting and every ten or fifteen minutes. The treatment consisted of ex. cannab. ind. one-half to one and one-half grains, every one or two hours, combined with quinine and active cathartics. His bowels acted upon repeated enemeta in thirty-six hours. Made a perfect recovery, tetanus being relieved on the fourth day.

Case III.—F. C. A.; accidental vuln. sclop. of left wrist. Amputation below elbow necessary on first day. Trismus appeared on the third day after admission in

the hospital, and on the fourth day after injury. Tonic spasm marked in subacute form. *Treatment:*

℞ Ext. Cannab. ind. grs. 1 to 3
Quinine, grs. 2 M

every half to one hour. Made a good recovery in six days, after taking 63 grs. of the extract. Dissection of wrist disclosed no alteration in the nerves implicated.

Case IV.—W. H. D.; v. s. through right wrist. Had been furloughed from another hospital (Richmond, Va.), fainted on his way to the railroad depot, and was brought by citizens to my hospital. The primary injury was undoubtedly much aggravated by his fall. Tetanus in a subacute form set in on the eleventh day after reception of gunshot wound. Amputation became necessary five days after the appearance of tetanus. The treatment was the same as in the preceding case. Spasm disappeared on the fifth, and he fully recovered on the ninth day.

Case V.—T. P.; v. s. Ball entered radial side of left forearm, a little below elbow, traversing the joint. Tetanic spasm commenced on the fifteenth day; amputated arm above elbow on the second day after admission. The treatment consisted of opium in 1-2-3 grs. doses every one and two hours. Spasm with recurvation recurred at longer intervals, but with increased violence. Substituted ex. cannab. ind. gr. 1 to 3, with quinine grs. 2, every hour. Recovered in eleven days. Took thirty-five grs. opium and afterwards fifty-one grs. of the extract. Temperature, for two days 103.5°, then 101°, and 99.5° F.

Case VI.—Thos. B.; ball entered ulnar aspect of right arm, middle third, ranging towards and traversing elbow

joint, with exit one inch below external condyle, and fracturing external condyloid ridge. After removing many spicula of bone, it was found necessary to resect the partially detached portion of the fractured condyle. The patient improved rapidly, although amputation was daily held before him. An abcess of the triceps m. was freely opened. On June 9th (the gunshot wound was received May 12th—entered hospital May 20th), prolonged constipation supervened, and during the succeeding night trismus. Active cathartics and enemata were at once ordered, with a desired effect on June 11th, or 46 hours after trismus. Having divided *my* supply of Indian hemp some time previously with other surgeons, and having no confidence in the article at command, prescribed

℞ Quin. sulph, ℈ i.
Chloroform, gtt, L.
Mucil. acaciæ, f. ℥ ss.
M. S., a teaspoonful every two hours,

and applied chloroform to the arm and spine. Warm poultices were actively resumed. Tetanus in a subacute form developed itself on June 10th. 9 P. M., and a persistent anæsthesia by chloroform failing to control the spasm, I applied morphia in grain doses to the openings in the triceps m. The third dose, in the course of as many hours, had a decided effect. On June 14th he was much relieved; the before scanty discharge of pus became profuse. Trismus continued for one week, until June 20th. Morphia was continued in reduced doses, and tonics added with stimulants. The wound healed well, leaving the arm anchylosed at an angle of 110 degrees, but with full use of hand and fingers. Temperature, 101.5°, 103° and on June 13th, 99° F.

Case VII.—N. B.; Tetanus in consequence of a minute punctured wound in the heel from stepping upon a nail. Had his shoes on at the time, and the hole in the leather was scarcely perceptible. Two days after the accident he felt stiffness of the jaw and an unusual costiveness of the bowels, to which, however, he paid no attention. A botanic physician advised a liniment, etc., without indicating the nature of the case. Had the first tetanic spasm on the 5th day at 7 P. M. Living twenty-three miles from the patient's house, I saw him about seven o'clock next morning. Found the botanic practitioner engaged in preparing poultices of peach tree bark (he declared that with the leaves the case would be quite a simple one), and giving Mr. B. repeated hot plunge-baths. Acute tetanus fully developed. Temperature, 104.5°, and an hour afterwards, or half-hour before death, 106° F. A previous attempt to forcibly separate the clinched jaw resulted in the loss of two teeth, which were shown me. Spasm extremely violent (with hydrophobic spittle around teeth), and mixed with tonicity of muscle and convulsive tremor; shoulders raised upwards and slightly backwards at each paroxysm; muscles of larynx and pharynx violently and persistently contracted so as to produce a quick succession of gurgling sounds; the eye drawn backwards and injected; face red and a white foam around lips. The case being hopeless for medication per os I confined myself to endermic applications of morphia, cannabis indic., and inhalations of chloroform combined with enemata. The inhalation of chloroform seemed to call forth violent spasm of the glottis, and a labored or spasmodic inspiration. The tobacco enema and the $\frac{1}{20}$–$\frac{1}{15}$ drop of nicotine, showed no effect whatever. The patient died a little more than

an hour after I arrived, having been comatose for the last twenty minutes. Mode of death: apoplectic spasm. Autopsy refused.

Case VIII. J. B. H.; admitted to hospital February 14, 1864. Presented 3 cystic tumors upon left thigh, internal aspect, extending from lower edge of middle third of thigh to the groin near pubic portion of fascia lata and saphena opening; overspreading sartorius, pectinæus, abductor magnus and gracilis muscles; with a base of oval form; longest diameter (along axis of femur) 10 inches, shortest diameter at right angles with former 5.5 inches, and with a vertical radius of 5¾ inches. Had been operated upon twice within five years, but the tumor returning he was ordered to hospital for treatment. The great press of surgical business (just after a battle) compelled me to postpone the case in favor of more urgent ones, and I placed him upon the general list for future attention. On March 2d, at 8 A. M., and probably also during the night, he gave symptoms of trismus and in a few hours afterwards of tetanus, increasing rapidly in violence. Believing tetanus to be due to pressure upon a nerve, he was at once placed under the influence of chloroform, and the whole tumor excised, which amounted now to four cysts. Tetanic spasm set in while under anæsthesia, trismus only having been noticed before chloroform was exhibited. Temperature before operation 101°, immediately after removal to his bed 102.5° F. Respiration became greatly embarrassed, and I resorted once during the operation to artificial inspiration, finishing the enucleation of the tumor without anæsthesia. Tetanus assumed its full vigor after the

patient's removal to his ward, opisthotonos interchanging with tetanus erectus. In the treatment I had prescribed early in the morning ol. ricini in full doses with croton oil, followed by injections, and a volatile liniment was freely applied over the maxillary articulation, region of the mastoid process, nuchæ and spinal column, aided by the local use of morphia in 2 grain doses. Internally I ordered,

℞ Chloroformi, Ether. Sulphur. āā f. ʒ i
Tr. Opii. f. ℥ ss.
M. S. a teaspoonful with mucilage every hour.

At 10 A. M. (operated at 9 A. M.) deglutition became impossible, every attempt inducing an instant and violent spasm. Temperature 103°. The above mixture was repeatedly applied to the lips with a sponge and the following enema given:

℞ Sodæ Chlor. ℥ ss.
Tr. Opii. f. ʒ vj.
Chloroformi, gtt. xxx.
Mucilag. f. ℥ j. M.

Chloroform was also brought in contact with the spinal column upon raw cotton. Bowels acted at 12 M. Hemorrhage from a superficial artery of the wound required the removal of the dressing, and the bleeding vessel being secured by torsion, a solution of morphia was injected along the edges of the wound, while in apposition. The spasm, however, continued unabated. Temperature at 2 P. M. 104.5° F. Respiration became more and more irregular and stertorous, and the patient died at 6 P. M, under spasm of the glottis. Temperature at 5:30 P. M. was 106° F. The continuance of tetanus was about 10 hours. The whole of the tubercular mass weighed 4 pounds and 7 ounces.

Careful dissection gave no alteration of the nerves implicated or adjacent. The post mortem examination of the brain and spinal column was made 12 hours after death; body well nourished; rigor mortis fully developed; veins superficial to the brain distended; substance of the brain healthy; about one drachm of a serous fluid was collected from the lateral ventricles, of a specific gravity of 1007—cerebro spinal fluid; lining membranes of the ventricles normal, under the microscope showing no traces of inflammation; similar condition of choroid plexus, septa and fornix. The spinal cord was free from inflammatory evidences; the arachnoid close to the opening irregular and distended; blood-vessels healthy; pons varol. normal; slight vascularity of dura mater. The microscopic examination of the spinal cord was made especially in the cervical region, the condition there being more strongly marked. The instrument used was one of fine powers, giving 400 diameters. I feel obliged here to return my warm thanks to Assistant Surgeons Goodwin and Goldsmith for their continued and valuable assistance, also to Mr. J. M. Tomlinson, whose late return from his studies of the paintings in Italy enabled me to secure his services in copying the microscopic results, which I shall give on a future page.

Case IX.—I. N., a laborer, was visited by me on the night of Aug. 29th, 1868. Found him lying upon the floor, able to answer my questions, but, as he says, obliged to be quiet on account of "sudden pain over his body." On examination diagnosed trismus and opisthotonos. Had a fixed jaw for two or three days and remembered, on my directing his attention properly, that

he had received a slight injury to one of his feet about a week ago, of which, however, no trace remained. Bowels constipated for several days. Ordered a full dose of castor oil with two drops of croton oil at once, to be followed by enemata, if required, and the folowing local and internal remedies:

℞ Tr. Aconit. Rad. f. ℥ ss.
Glycerin., Chloroformi, āā. f. ʒ vi.
M. F. Lin. S.

Use freely over muscles of jaw and neck, and,

℞ Tr. Aconit. Rad. f. ʒ ij.
Quin. Sulph. ℈ iss
Syr. Limon, f. ℥ i M. S.

a teaspoonful every 3 hours. Six hours afterwards, two doses of the mixture being taken, and the liniment applied three times, I found the symptoms unchanged; spasm more prolonged and epigastric pain intense. Temperature 104.5° F. Gave two teaspoonsful of the liquid, to be repeated in one hour. No relief being obtained, I substituted the ex. cannab. ind. in ½ grain doses every hour, and injected hypodermically a solution of hemp (10 grs. to 2 drachms water), 10 minims as a dose. In six hours, 9 grains having been used internally, and 5 grains hypodermically, the patient slept 20 minutes, and woke up under a severe spasm. Continued the hemp in 2 gr. doses every hour, and repeated its hypodermic exhibition every two hours as indicated by the violence of the spasm. Twenty-four hours after the first exhibition of cannabis ind., the patient took 4 grains at a dose every hour for four hours, with two injections of one gr. each. Spasm of shorter duration; masseter muscles sensibly relaxed and the patient in better condition. Temperature 101°. The extract was now diminished to

2 and 1 grain doses, which he continued for five days. Took internally 174, and by the syringe 21 grains of the extract. Recovered fully in two weeks.

Although Wunderlich's observation on a high temperature in fatal cases of tetanus and at their termination is fully verified in the foregoing cases, yet it should be borne in mind, that many persons give a temperature during health much above or below the accepted average, and that, consequently, without anterior data no implicit reliance can be based upon the thermometer.

Tetanus was not of common occurrence in the Crimean war. Macleod saw there 6 cases in camp, and 7 in Scutari; he estimates the percentage to gunshot wounds below that given by Alcock, 1 in 79. Its fatality was universal; nor could a predisposing cause be detected in the locality of the wound. Prof. Busch of Bonn (in Verhandlung des Naturh. Vereins für Rheinland u. Westphalen, 1867, s. 15) gives the following reports on tetanus during the late wars:

From the fights in Paris (1848) among 1000 wounded,	no case.	
Stromeyer in the Schleswig-Holstein war (1849), -	1	"
Demme (Austrian army), Italian war (1859), - -	86	cases.
Demme (Italian army) Italian war (1859), - - -	140	"
Busch, Crimean war, among 12094 wounded. -	19	"
Busch American war* (1861–5) - - - -	363	"
Busch Bohemian war (1866) - - - -	21	"

In Guy's Hospital during 7 years tetanus occurred as follows:

After 856 case of contusions - - -	1	case.
" 1364 cases of operations - - -	1	"
" 456 cases of burns - - -	3	cases.
" 594 cases of wounds - - -	9	"
" 398 compound fractures - -	9	"

* See below.

Busch considers the percentage of recoveries greater in tropical climates, although there the liability to tetanus is greater. Thus is the negro race more predisposed than the white race; and Mr. Peat gives in his Essay on Tetanus in the East Indies (Poland in System of Surgery, vol. 1., p. 321), these estimates among castes: Hindoos 1.63, Mussulmans, 1.09, Parsees, 1.005, and Christians, 0.75 per cent.

In the Indian campaign unextracted balls seemed to favor the advent of tetanus, especially if underlying strong fasciæ. Mention is made of sudden changes in temperature, as after the battle of Ferozepore and Chillianwallah, and a like cause was adduced by Baron Larrey in the Egyptian and German campaigns (1809), 100 cases following the battle of Bautzen, and a still greater number after Dresden. Baudens reports that in Africa, during a north-east wind in December, 40 slightly wounded soldiers gave fifteen cases of tetanus, of which twelve died, and the recovery of the remainder was ascribed to their removal to a warm place. Yet, after the battle at Alma, although the opposite extremes in temperature prevailed, no such results were noticed; and Hennen, to reconcile these differences in meteorological causes, taught that cold air in motion predisposed to tetanus, and cited the battle of Muskau as an example, after which few of the French soldiers had tetanus, although the heat was great; whilst after Dresden, the weather being cold and wet, a great number died with it, even after primary operations. In both Indies heat predisposes the native and foreigner alike, and according to Dr. Kane the same obtains in the Arctic regions.

Dr. F. Sorrel sums up from his special reports that in the late war there occurred in the Confederate armies

66 cases of tetanus, with 6 recoveries, out of 56,775 wounded—a mortality of 91 per cent., giving 1 case for every 860 wounded. This statement, however, is incorrect, since a number of cases are omitted. (In December, 1864, to which period the report is here quoted, Dr. Baer, an assistant to Dr. Sorrel, informed me, that the cases of tetanus under my charge were not included, because my report had not been received; and a similar fate befell, undoubtedly, that of others.) The Guy Hospital Reports by Poland, give from 1825 to 1858 exclusive 72 cases of tetanus, an average of .063 per cent. of all cases treated, of which terminated fatally 62 or 86.1 per cent. Of these 72 cases were 69 of traumatic and 3 of idiopathic origin. Peat and Morehead report from the Iepeeboy Hospital, at Bombay, 0.8 per cent. tetanus of all patients in charge with a mortality of 93.95 per cent.. and from the City Authorities (Dr. Leith), we have in six years 1716 deaths from tetanus, a mortality of 92.3 per cent. According to Busch (loc. cit.), Blanc saved 43; Demme, 7, and he himself, 33.33 per cent., whilst in the American war only 7.4 per cent. recovered. In London, out of 345,132 deaths in six years, 110 were from tetanus, the whole number treated being 117, a mortality of 94 per cent., and in England, for the same years, 759 died from this disease out of 811 cases, in a total of 2,431,602 deaths, a mortality of 93.53 per cent. Additional tabular results show (Am. Journ. Med. Sc. Oct., '58, page 477,) that tetanus is more common in the United States, even in the more northern latitudes, than in England. Of the 16 cases by Turner, 12 were of traumatic origin with 4 recoveries, 66.6 per cent. (perhaps inclusive of trismus and subacute tetanus), 2 cases were idiopathic, with 1 recovery, 50 per cent., and 2 cases were trismus

nascentium with 100 per cent. mortality, or an average of 68.74 per cent., much below the ratio of other Reporters, showing how uncertain statistics appear if derived from a limited number of cases. The discrepancy will be more distinct from the per centage of my cases now reported, 5 cases of a subacute and 2 of acute tetanus recovering, with 2 deaths, giving an average mortality of only 22 per cent.

Macleod's opinion on the absence of predisposing causes in certain gunshot wounds over others to tetanus, is verified by most observers. Watson reports a case of tetanus fatal in fifteen minutes after an injury of the thumb from the breaking of a china dish. T. Spencer Wells, after it had been recorded that in 300 cases of Ovariotomy only one resulted in tetanus, had in one month two cases to follow that operation. D. Gordon relates a successful case of uterine tetanus, witnessed by Prof. Simpson. The Bombay Reports state that no ratio exists between the violence of tetanus and the severity of the injury, and that 86.56 per cent. occurred after wounds of the extremities. John Hunter believes that all cases seen by him resulted from wounds of tendons, for "these parts heal less readily." Prof. Fonssagrives, of Montpellier, had two fatal cases, a child and an adult, following the hypodermic injection of quinine dissolved by the aid of sulphuric acid. A third case occurred in New Orleans, resulting fatally two months after a similar operation, the injection having been made in the deltoid muscle. Travers relates cases dependent on the ligation of the umbilical, spermatic cord and of the anterior crural nerve, and he considers tetanus after tying the umbilical cord common in hot climates—yet in the Dublin Lying-in Hospital,

the infants died, at one period, within two weeks at the rate of 17 p. c.,* and the *Berlin Monatschrift für Geburtskunde*, 1864-5, gives 95 fatal cases of trismus nasc. among 380 births in the practice of one midwife. In the belief of Travers a clean cut never results in tetanus. S. Cooper, per contra, gives an instance where it followed the amputation of the mamma, and the Earl of Darnley died with tetanus from the amputation of two of his toes. A slight wound of the ear, a cut from a whip below the eye without abrasion, the paring of a corn, a bite on the finger from a tame sparrow, the extraction of a tooth, the injection for hydrocele, cupping without scarification, and similar trivial causes have led to fatal tetanus, so that the enumeration of exciting causations seems to amount to a *gratis dictum.*

Sir James McGregor, (Med. Chir. Transact. vol. VII. and vol. VI. p. 453) fixes the latest term of tetanus supervening upon an injury on the 22d day. The *Bombay Hosp. Reports* sum up as follows:

10 days' interval in				148	out of	306	cases,	or	48.366	p. c.,
10-22	"	"	"	134	"	306	"	"	43.790	" "
+ 22	"	"	"	24	"	306	"	"	7.843	" "

and deaths occurred after 5 days in 62 cases; in Guy Hosp., the 3 fatal cases died—2 after the 28th and 1 after the 32d day. Poland (loc. cit. page 319), gives

130 cases up to the 10th day,				mortality	101	or	77.69 p. c.
126	"	"	"	" 22d "	"	65	" 51.50 " "
21	" beyond the 22d			"	"	8	" 38.09 " "

and in 327 fatal cases died—

*2944 infants died out of 17550 in this Hospital. (Dr. Jos. Clarke.)

in 2 days - - - - -	79
" 2 to 5 " - - - -	104
" 5 " 10 " - - - -	90
" 10 " 20 " - - - -	43
" + " 22 " - - - - -	11
Total, - - - -	327

Hence, the second and tenth days embrace 59.33 p. c. of the whole mortality—still the favorable prognosis in tetanus is not, as some authors insist, commensurate with a long incubation.* Sir Brodie (Med. Gaz. Clin. Lect. vol. II. 344) holds the 17th day as the latest period, and Blanc (Chelius' Surg. I. 415) saw a case one month after the injury. The case of Robt. Byrd now reported (No. I.) had 56 days intervening between the reception of the gunshot wound and acute tetanus. Watson gives the range of incubation from the 4th to the 14th day, and also B. Travers (in Further Inquiry Concerning Constitut. Irritation, tetanus p. 292) limits the accession of tetanus to a fortnight. Curling refers to a case recorded by Ward (Copland's Med. Dict. vol. III. p. 1114), in which tetanus supervened 10 weeks after a burn in the axilla.

The *symptoms* of tetanus are in general well marked, enough so at least in its typical form to allow a prompt and distinctive diagnosis. If we, however, compare the various subdivisions of this class of diseases, as evidenced by tonic spasms, we find as much difficulty here as in every other aspect of this affection. The majority of diseases can be traced from their symptoms to uniform and controlling causes, and *vica versa*, but in tet-

* Dr. O'Beirne saw in the Peninsula 200 cases, all of which proved fatal, and Hennen affirms, that he never witnessed a case of "acute symptomatic Tetanus" to recover. Of the same opinion are Dickson and Morgan.

anus we have no such deductions for its successful study. The following classification of transitory tetanus seems to me to be proper:

I. Tetanoid affections.

1. Spasmodic muscular action from systemic sympathy.
2. Tonic spasm, following and concomitant with other diseases of the nerve centres.

(Rigor, Trousseau's intermittent tetanus, tetanillus and rheumatic spasm are embraced under (1); the intermittent tetanus is perhaps a tetanic epilepsy, (*Vide Journal des Connaiss. Medic.* June 10, 1860.) The case of hysterical tetanus reported by Dr. Belcher in *Med. News and Libr.* 1866, p. 199, examplifies the affection under (2); in this instance tonic spasm blended with hysteria followed upon a slight punctured wound made by a pair of scissors.)

II. Trismus.

1. Simple trismus.
2. Trismus nascentium *seu* neonatorum.

(This last affection is usually regarded as a *tetanus* of infants, and my reason for classing it here is its *superficial* similarity to a pure tetanus. To me it seems much nearer allied to uræmic intoxication, and might be termed a uræmic eclampsia of infants.)*

III. Partial tetanus.

1. Opisthotonos.
2. Emprosthotonos.
3. Pleurothotonos.

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* The epidemic occurrence of trismus nascentium, as above alluded to, militates much against the assumption of its being a true tetanus, which cannot be said to recur under such conditions.

IV. Tetanus proper.
  1. Acute.
  2. Subacute tetanus.

V. Strychnia tetanus.

(Tetanus from strychnia, etc., is allied to II, III and IV only by symptoms. Its pathology does, however, warrant a deduction of treatment of one to the other.)

All of these different classes, with exception of the last, may be traumatic or idiopathic. Tetanoid affections are usually the result of idiopathic causes, and the idiopathy of *true* tetanus may justly be doubted, of which more hereafter.

The muscles generally first implicated are those of the jaw, throat and neck, constituting trismus. The beginning of tetanus, after an interval of variable length in which trismus seems firmly to establish itself, is marked by an acute pain at the sternum and ensiform cartilage. The muscles of the jaw give now in their distortion to the face a sciurous expression, as I have termed it, from the resemblance to the full pouches of a squirrel's neck. Pain near and dryness of the wound are an uncertain accession. The incipient general spasm extends from the diaphragm to the spine, most usually from above in a downward course, until slowly all the muscles of the trunk, face and extremities are implicated, the hands and fingers only remaining under more or less limited control of volition. The sphincter muscles finally are overpowered and from the combined result of an exhaustive action of the facial muscles and the beginning of a succumbing of the mental faculties the risus sardonicus is developed, which constitutes the acme of tetanus. We have three stages:

1. Premonitory or incubative symptoms of uncertain length of time and character.
2. Implication of the spinal cord.
   (a.) Spasm of distinct or isolated muscles. Trismus.
   (b.) Intermission in the progress of symptoms sometimes well marked.
   (c.) Spasm of general or unilateral muscles. Partial or general tetanus.

(This is evidently the most decisive step in true tetanus. If opiates, etc., can procure rest or a cessation of spasm, and if catharsis can be effectually brought about, we may assume a subacute form with more favorable prognosis.)

3. Sympathetic or continuous implication of pons varolii and brain with spinal polarity.

Clonic spasm indicates a participation of the brain and the prognosis is more doubtful. The risus sardonicus and the persistence of spasm of the glottis evidence the centralization of the nervous erethism. If the transit upon the brain has been sudden, we may expect also asthenic sequences. Pari passu with the progress of tetanus, a general hyperæsthesia is added, so that spasm follows through the senses of touch, etc. Medullary apoplexy, as in other convulsive affections, must be regarded as a subordinate accession in tetanus, and is manifested by the loss of consciousness, involuntary epileptiform motion and sudden death. In apoplexy of the spinal cord, the attack itself is sudden, usually preceded by prolonged pain in the cord and by congestion, and its first symptoms are paralysis. Like tetanus, it affects the sphincter muscles; is rapid in its course and unaccompanied by contraction of the limbs.

Reflex excitability is consequently destroyed, the respiratory act embarrassed, and we notice aphonia with impairment of speech. To this follows paralysis of sensation and sometimes the opposite, hyperæsthesia; one or both sides may be equally affected with an increased temperature in the paralyzed parts. In epilepsy, on the contrary, we have in the contraction of the cerebral blood-vessels from similar causes a loss of consciousness, the direct result of an increased volume of blood, which, by its downward pressure upon the spinal cord, produces a tonic contraction of the laryngeal and respiratory muscles; the latter being first acted upon, (evidencing the paroxysm by the usual premonitory exclamation), and shortly afterwards of the muscles of the body generally, causing the fall of the body. The acme comprehends an exhaustion of the nervous powers, and stupor, after which the slowly recurring respiration, sleep, etc., indicate a return to the cerebral equilibrium.

Asphyxia is the usual and legitimate mode of death in tetanus. The insufficiency of blood-oxygenation and the continued presence of venous blood in the nerve-centres, especially if the attack is violent and rapid in transition, lead at times to pressure upon the encephalon and to death from asthenia, or an arrest of the cardiac action through the medulla oblongata. Asthenia may also be supposed a casual mode of death from the great waste of tissue by metamorphosis after violent (*especially* after long continued) muscular action, and after increased and irregular excitability of the trophic nerves or their representatives. This deficiency in constructive material is not only steadily augmented, but the pabulum is at the same time withheld in the non-arterialization of the blood during thoracic and diaphragmatic spasm.

Sudden death in tetanus is the result either of spasm of the glottis or of structural changes in the nerve-centres during violent general spasm, and the post mortem appearances of a vascular or inflammatory character should always be carefully referred to the mode of death, not only because they may point alone to the last phenomena of life totally differing from tetanic causes, but they may be due to certain cadaveric changes: equalization of fluids by their reduction to a level or to their mutual points of resistance; influx of liquids through orifices before spasmodically closed, especially in tetanus, because of the non-coagulable character of the blood; and chemical changes precursory to decomposition. Moreover, it should be remembered that any prolonged and intense functional activity must and does lead to a corresponding structural abnormality, the result of a cause utterly incapable of explaining the causation of the functional aberration.* The complete muscular relaxation after death, and the subsequent rigor mortis furnish great objections to microscopic examinations. Every deviation in the course of the disease from true tetanus should be carefully noted, so that the observer may be prepared for corresponding necroscopic conditions, and in view of the most common morbid appearances of the brain and spinal cord the question is open, how many of the cases with congestion of the spinal cord showed at the same time the greatest degree of cerebral congestion, and what were the symptoms before death between them?

In cerebro-spinal meningitis we find uniformly opisthotonos either fully developed or indicated by slight

* Niemeyer gives an account of a *waxy* muscle, in a post mortem of tetanus, which owes its peculiarity to the spasmodic functional exaltation.

contractions and spasmodic twitches of the muscles of the back; tremor similar to consecutive electric shocks, and in some instances severe trismus are induced upon the slightest touch. The morbid appearances of the nerve-centres point to the true locality and pathology of this disease in revealing the blood vessels of the pia mater engorged, the membranes thickened, fluid in the ventricles, base of brain, and in the membranes of the spinal cord; we find lymph deposited over the pons varolii and along the medulla oblongata and spinal cord; fibrine along the fissures of the brain, etc., from which we are warranted to conclude that the tetanic affection was a secondary or progressive phenomenon of a disease, which under other phases, gives occasion to paralysis, coma, or convulsive contractions of muscles. We have effusions of serum beneath the cerebral membranes with opacity in typhus; yet tetanic spasm has never been recorded as being symptomatic of it. Tetanus in its milder form is sometimes observed during disordered catamenia as a hysteric tetanus; in such cases the lesions, or absence of lesions of the spinal cord, are in analogy with true tetanus. The same is true of some forms of chorea, in which the grotesque movements have gone beyond control and assume the type of tetanic spasm. The French school locate this affection in an excitability of the cerebellum, which fails to co-ordinate the muscular activity, but it is really, perhaps, an irritation of the excito-motor nerves. In it, also, we have no anatomical lesions. *Trousseau* speaks of a grave form of intermittent rheumatic contractions, in which the patient is seized suddenly with tetanic rigidity; the muscles of his neck, chest, and abdomen act convulsively and curve the trunk forward, and the

spasm can be produced by compression. He ranks this affection among the neuroses with epilepsy, hysteria and eclampsia, and regards it due to the brain and spinal cord, without lesions of either. *Pritchard* in his Treatise on Diseases of the Nervous System gives instances of a convulsive tremor without cerebral or spinal disturbance. One of the effects of uræmic poisoning is opisthotonos and general tetanic spasm, not only the result of purely experimental, but clinic production. Carbonate of ammonia, if injected into a vein, produces these results, and the exhalation of ammonia and its presence in the blood has been supposed the chief cause of uræmic intoxication. Tetanic spasm can also be obtained after ligating the renal arteries or excising the kidney; the spasm continuing as long as urea is retained in the circulation. Trismus nascentium is supposed by *Simpson* to be due to albuminuria; autopsies, however, have given no morbid changes beyond a doubtful collection of serum in the spinal canal containing urea, and a doubtful cerebral anæmia. It is possible that it is of traumatic origin, with idiopathic causes, as filth, damp, and hot or cold air, but the position of Simpson is more probable, as already mentioned. *Richardson*, perhaps from such facts as above enumerated, classes tetanus among the zymotic diseases, produced as a specific poison in the wound, and which he is capable, as he avers, of creating at will, by the introduction of carb. of ammonia into the system, losing sight of the grave question, why tetanus under such genetic circumstances, is of so comparatively rare occurrence, and why it is not decidedly epidemic and inoculable. But tetanus is a concomitant symptom, not only in uræmic diatheses, also structural

diseases of the kidney may lead to it. *Fincham* relates before the Western Med. and Surg. Society (*London Lancet*, Feb. 1861, p. 175), a case of renal abscess, in which the patient labored under the most violent spasm of the muscles of the neck, jaw, trunk, and extremities, *consciousness* and *rationality* remaining unimpaired; autopsy showing no structural changes in the nerve-centres, but numerous small abscesses in both kidneys. Add to this that we have tetanic spasm at times in delirium tremens, depending on inflammatory excitement or nervous erethism; in central hyperæsthesia, and in arterial hyperæmia; in anæmia of sudden occurence in diseases involving the brain, spinal cord, with (catalepsy), or without paresis (chorea), or the mesocephalon alone (hysteria), in the strictly local hypercinetic affections of the jaw (trismus), of the face, in strabismus as a symptom of intestinal or cerebral disease, in writers' cramp, in the administration of chloroform for anæsthetic purposes; following the mechanical pressure of the cerebro-spinal fluid in spina bifida, etc., and tetanus as an abstract pathological fact, appears surrounded by contradictory symptoms and negative vital phenomena. As in the case of N. B. (No. 7.) tetanus sometimes approximates hydrophobia* in its guttural spasm on attempting to drink, or in an adventitious horror of water and its rejection; in the flow of saliva, thirst, laborious respiration, with well-marked clonic spasm, hallucinations, delirium even to mania,

* Case 5 (Ogle's Collect. of Cases of Tetanus in St. George's Hosp., *Brit.* and *For. Med. Rev.* 1868, Oct., p. 485) is a combination of tetanus and hydrophobia. In the perusal of this case the reader will, however, discover tetanic and epileptic spasm so blended as to resemble hydrophobia. It exemplifies, also, the complication of spinal and cerebral symptoms.

etc. *Macleod* alludes to a thick spittle adhering to the teeth, leading one to look upon hydrophobia as a hybrid between tetanus and epilepsy. The interchange of rigor with tetanus has been noticed by most writers; if the former is a precursory anæmia of the cord depending on the toxæmia, the last might be considered an anæmia of the brain depending upon the spinal cord.

According to *Valentin* (*Physiol. des Menschen*, II. 2. p. 366) tonic and clonic spasm is induced by a direct injury to certain portions of the spinal cord. The same results from the loss of blood, as after ligation of the cerebral carotis. Its explanation lies in the diminution of repelling and equalizing pressure upon the cerebrospinal fluid, which is impelled forward to fill the vacuum. An evacuation of this fluid above the first cervical vertebra results in irregular movements like intoxication and circular motion, and according to *Magendie* (*Physiol. u. Klinische Untersuch. über die Hirn v. Rückenmarkflüssigkeit*, s. 43) and *Longet* (*Anatomie et Physiol. du syst. nerv. de l'homme et des anim. vertébr.*, and in his *Annal. médic. psychol.* VI, p. 160), symptoms of hydrophobia are developed with backward movements, which subside after healing the wound and reproduction of the fluid. Tetanic spasm from strychnia results from a paralysis of the blood vessels of the cord (congestion) and affects the system rapidly because the exciting agent has a certain and self-containing influence proportionate to the overdose taken. The greatest resemblance between tetanus proper and tetanic spasm from strychnia is in opisthotonos. Traumatic tetanus may be said to end where strychnia tetanus commences; the last invading the brain in its beginning (the hands and fingers also are

very early contracted), while the first reflects its energy in that direction only in an advanced stage. The risus sardonicus is the opening in strychnia poisoning and in tetanus it is ushered in as the finale.

The instructive experiments of *Dr. S. W. Mitchell* are entitled to be mentioned here, as they have, in my opinion, an important bearing upon this subject. Similar results were obtained by *Dr. B. W. Richardson*, of London. The first phenomena noticed by *Dr. M.* were in consequence of his research on the cerebro-spinal fluid and its agency in producing convulsions under pressure.* Injecting half an ounce of water (66° F.) into the spinal canal of a rabbit, convulsions ensued and shortly afterwards death. By this injection the blood was displaced in the spinal vessels and caused bleeding from the exposed veins of the cord and head. A larger amount of water under 100° F. was borne in the second experiment, and spasms followed instantly upon the introduction of water at 32° F. Every variety of convulsive action was thus effected. Subsequent experiments proved that the local and external application of extreme cold upon the spine brought about similar results. The agent usually employed was rhigolene. As the reader is familiar with the nature of these experiments, I will confine myself to a cursory notice of the results: (loc. cit. p. 108) "it results from these experiments that at or about the fourteenth vertebra from above downward we cease to notice backward spasm and stupor, and see only signs of weakness or of tetanic rigidity in the legs." A jet of rhigolene thrown upon the spine of a frog (p. 110) "occasions spasmodic

* Amer. Journ. Med. Sciences, 1867, January, p. 103.

movements of the legs, and at intervals violent tetanic contractions." The pigeon, under the application of cold to the spine "may be handled or laid on its back and side, while at any moment a loud sound or a sudden motion will break the spell and it will abruptly run backward several feet" (p. 111). The following symptoms of partial tetanus (emprosthotonos and opisthotonos) should be marked: (loc. cit. p. 112) "in the spasm from chilled spine or cerebellum the head is carried at ease during the interval between the fits, but at the moment of attack the bill strikes the floor quickly, first on one and then on the other side, the head being drawn violently forward. Even in the most terrible of the summersaults caused by cold, the head was drawn forward, and the backward turn was produced by the action of the muscles of the legs and wings, rather than by those of the back, neck and spine." It is of some importance to ask, what influence the point of gravitation may have upon the spasmodic position of a pigeon, and what the results would have been in man? *Dr. Mitchell's* view is undoubtedly correct, that the tendency of a pigeon during spasm from anæmia is toward violent backward motion (op. cit. 1868, January, p. 31), and I would only add, that the phenomena resemble opisthotonos rather than epilepsy. He adds (op. cit. 1869, April, p. 334), "very little, then, of the convulsive acts is due to the direct effect of cold, much more to the intense and overpowering congestion which in turn wears off. The added proof lies in the fact, that local irritants which congest more slowly occasion in the spine the same phenomena after the lapse of a longer interval." Intense cold to freezing, and the injection of water produced, consequently, similar effects, that is, any displac-

ing agency upon the spinal fluid gives tonic spasm.

Direct injury to the cerebellum and spinal cord conditions similar results. *Fodéra*, *Magendie*, *Flourens*, *Purkinje* and *Krauss* have observed tonic spasm and opisthotonic movements in mammals and birds after the loss of the cerebellum. *Mitchell* also has verified these experiments. *Hertwig*, *Lafargue*, *Volkmann* and *Nicolucci*, on the contrary, have denied them. This discrepancy in so direct and conclusive experiments originates, perhaps, in the peculiarity of certain animals. *Ecker*, *Burdach*, *Magendie*, a. o., declare the ebbing and flowing of the cerebro-spinal fluid, while *Haller* and *Flourens* deny it, owing to their selecting animals for experiments which in reality do not possess this quality (domest. rabbits). *Flourens* saw a backward movement five, and *Bouillard* only four times in eighteen experiments.

In this connection we will now consider some of the post mortem appearances of tetanus.

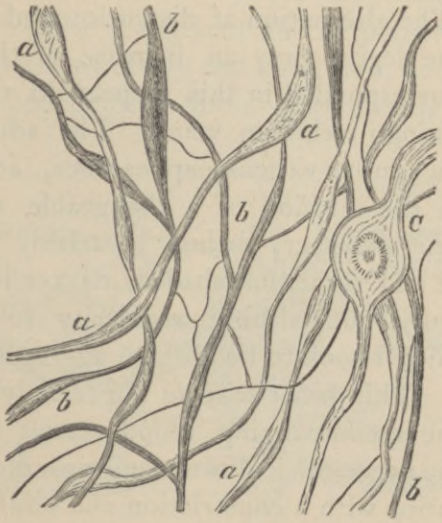
From the *Guy Hospital* we have the anatomical dissection of 34 cases, in 20 of which the brain was examined and found in a normal and healthy condition in 11, or 55 p. c.; in the remaining 9 cases it was congested, pinkish, with ulcerations upon the under surface of the anterior lobes and decomposed. The spinal cord was examined in 19 cases; in a few it was redder that usual, congested and softened, but in the greater number nothing abnormal was discovered. The condition of the nerves at the wound was noticed in 14 cases, of which 5 showed them to be inflamed. In addition to these data the heart was violently contracted in 1 case (laryngotomy having been performed to relieve suffocation; death took place on the second day), in 7 cases the lungs were congested; pneumonic appearances were discovered in

3 and apoplectic in 4 cases. In one instance the larynx was closed by folds of the epiglottis being caught in the rima glottis. *R. Froriep* (*Neue Notizzen*, 1837, Jan., No. 1) has observed in 7 cases a direct injury of a nerve from pressure or wound, with a peculiar inflammation, knotty swelling and redness. *Erichsen* (in his Practical Clinical Remarks on Tetanus, *London Lancet*, 1859, vol. I, p. 355) is of opinion that "in traumatic tetanus a certain condition of the nervous system is always to be met with, namely, an unhealthy state of the nerve-branch or twig running from the wound, ... congested, inflamed, infiltrated, its neurolemma thickened, softened and discolored, often for a considerable distance from the wound." *Friedrich* (Dissert. de Tetano traumat., Nov. 1837, in Casper's *Wochenschrift*) has collected a number of cases with inflammation of the adjacent nerves. *I. F. South* saw two cases (the preparations of which are in St. Thomas' Museum), in one of which thin plates of bone, and in the other similar plates of cartilage existed on the arachnoid coat of the spinal marrow; but, he adds, that in many other cases examined by him no such appearances were observed, nor any other characteristic of disease. *Demme* and *Flechner* describe the presence of a new formation of connective tissue in the cord, and the added investigation of *Rokitansky* sums up as follows: that the product of proliferation is a viscous matter; filled with nuclei; not capable of progressive formation; usually found in the white medullary substance; is microscopic; uniformly discovered in the medulla oblong., crura cerebri, inferior peduncles (corpora restiformia) and over the spinal cord; and the result, in his opinion, of persistent congestion. *Rouse*, Surg. Registrar to St. George's Hosp., traced in

a fatal case of tetanus the radial nerve into the wound, which had divided in three branches above the injury, two of which were cut across without morbid appearance. The brain and spinal cord were healthy. The same condition is reported by *Peck*, of the same hospital, in regard to the ulnar nerve. *My first case* now reported (Robt. B.) gave on dissecting the elbow joint, a mechanical pressure upon the median nerve without further lesions, and my eighth (J. B. H.) nothing abnormal in the nerves of or surrounding the tumor. Case No. 3 (F. C. A.) was similar to No. 8.

Fergusson, of King's College Hospital, found slight vascularity of the cauda equina and all other portions of the cerebro-spinal axis natural. *Curling*, London Hospital, saw only a small quantity of fluid in the lateral ventricles, and *Rodgers*, Infirm. of the Strand Union in England, reports in an idiopathic case the superficial veins around the spine gorged with blood, the dura mater congested, a small quantity of bloody serosity upon the pia mater opposite the fourth cervical vertebra, the pia mater much injected as far as the cauda equina, the cord vascular especially in the cervical region, and the membranes of the brain and the brain itself congested. *L. Clarke* gives in six cases disintegration and softening of portions of the cord in its grey substance, in some parts almost soluble. *W. H. Dickinson* (*Med. Chir. Transact.* vol. II. p. 265), gives a minute description of the microscopic appearances of the spinal cord, of which I transcribe the following: The blood-vessels distended with blood, dilated to many times their calibre; crammed with blood-corpuscles so as to look like solid cylinders; in some places blood-corpuscles were extruded; oftener only the fluid por-

tions of the blood traversed the wall, appearing translucent, in contact with and surrounding the vessels, lying in the grey matter of the nervous substance, in the white, in the fissures and occasionally outside the cord; a certain amount of the nervous element disintegrated, as if the exudation had a solvent action upon the tissue; the central and anterior parts of the grey matter most extensively affected on the side opposite to that of the injury; the irritative cause of tetanus on reaching any column or segment of the cord appeared to diffuse itself throughout its whole length undiminished in intensity; cervical region no more affected than the lumbar, etc. The accompanying diagram shows the micro-



CASE No. VIII.—*J. B. Hartley.*—Longitud. section of posterior spinal cord; cervical region. ($\frac{400}{1}$.) *a*—nerve tubes; *b*—capillaries; *c*—nerve corpuscle and tubes.

scopic view of the spinal cord in the *case of Hartley* (No. VIII) above given; the portions subjected to the test were examined in their natural condition, and others, immediately adjacent, after being hardened with chromic acid; the blood-vessels presented uniformly an engorged condition, stagnation with coalescence of corpuscles and a predominance of the white bodies. The internal dynamis of the blood current must have been sufficiently powerful to enlarge the coats of the vessels at their weaker or less supported diameters, and to produce now and then a corresponding constriction. At these pouches or dilatations, the fluid portion of the blood was distinct from clusters of red and white corpuscles, which adhered together and to the walls of the vessels. The alternation of distention and constriction was in some degree only an increase of their relative size, and corresponded in this respect to the anatomy of the meningo-rachidian veins. The adjacent nerve tubes had a similar varicose appearance, at times flattened, and the interior of a changeable reflection of light—their periphery being invariably translucent, pearl-white and somewhat shaded, darker lines running longitudinally but without regularity to the neurilemma, which I took to be funiculi aggregating into the fasciculus. This gave rise to an imperfectly transmitted light. The accompanying blood-vessels adopted the shape of the nerve-fasciculus to their own diameters, giving a dilatation with a constriction and *vice versa.* The transparency of the neurilemma had a broader field, and its transmitted light was more distinct at a dilatation, but scarcely perceptible near the pouch of a blood-vessel. Minute hair-like fibres were visible in two localities, seem-

ingly afloat and without terminus except in their origin, which lay in the centre of the tube.

The autopsy of a case by *Dr. Bodine* (Transactions of Pathologic. Society of Philadelphia, *American Medical Journal*, 1866, July, p. 130.) gave these results: the membranes of the brain without particularly abnormal appearances, though there was considerable pearliness of the arachnoid; the substance of the brain much softened with a punctuated redness; ventricles normal; some congestion at the base of the brain; spinal meninges somewhat congested; the cord throughout its whole extent softened, and in the cervical portions almost diffluent (p. 132). I transcribe the second question suggested by the author: "Were the tetanoid symptoms, which were so prominent on the patient's admission, the indications of his real condition, and were the pathological appearances found after death, owing to

CASE VIII. *J. B. Hartley.*—Long. section of anterior spinal cord; cervical region. Specimen hardened with chromic acid. *a*—pigmentary nerve corpuscle; nuclei and ramifications; tubular cylinders, and capillaries traversing them. *b*—Blood vessels filled with white bodies. Hair-like fibres are seen traversing the field, usually attached to a nerve tube.

the continuance and persistence of tetanus, or was his real disease from the beginning an inflammatory affection of the cerebro-spinal substance and membranes, and was tetanus a mere epiphenomenon?" A somewhat analogous case (to which I shall refer hereafter) is that of *W. W. Keen*, (softening of the spinal cord, rigid and persistent contractions of flexors of lower extremities, *Amer. Jour. Med. Sc.*, 1869, July, p. 128), and gives these cerebro-spinal lesions: "Dura mater not adhering; redness over entire pia mater, especially on outer and upper anterior half of left hemisphere; base of brain red without difference of consistence; puncta vasculosa abnormally marked, especially in posterior portion of each lobe; in lateral ventricles half a drachm of cerebro-spinal fluid; vessels from fornix forming the puncta vascul., large, numerous and distended; corpus striat. and thalam. opt. on both sides slightly vascular; dura mater of *spinal cord* vascular, adhering to the arachnoid from 1st to 6th dorsal nerve, left side, and to 8th dorsal on the right side; entire cord vascular and softened; transverse sections almost diffluent; least so at the lumbar enlargement; below 5th cervical the outlines of grey matter indistinct from diffluency; *microscopically*, all the arteries of brain and cord with fatty degeneration; large number of compound granular corpuscles in the softened mass; no fibrous developments; nerve tubes of the softened parts narrower than usual, often deprived of their myeline, especially on the left side of the cord, but anterior and posterior portion alike; nerve roots wasted, and their arterial walls fatty; cylinder axes throughout normal." The progress in this case was the reverse from that reported by Dr. Bodine.

In the case reported by Dr. Keen contraction and spasm interchanged with paralysis; an arterial hyperæmia of the spine with hyperæsthesia following a cerebral paresis. The peculiarity of a progressive paralysis of all inhibitory action leading to a permanent and post-mortem contraction of certain muscles (loc. cit., p. 130), and during life intermitting with spasmodic twitching of muscles and pain, alternate rigidity and flexibility, and convulsions under a semi-coma, places this case in juxtaposition with locomotor ataxia. The spanæmia consequent to an altered supply of blood induced a diminished trophism of the brain, and secondarily of the muscles involved. The investigations of *Kussmaul* show that spasmodic contractions and paralysis follow. The account of Dr. Bodine's case illustrates the transition of tetanus to other affections with dissimilar morbid appearances, but similar initiatory phenomena and causes. Both conditions, of a mere excitation of the spinal and inflammation of the cerebral centre, may therefore exist together, one a superinduced condition upon the other, either by direct continuity or toxæmically transplanted. It might be, however, assumed *a priori*, that tetanus from injuries of the head should result only from slight contusions, in other words, the effect of the primary injury must not be sufficient to excite a predominant inflammation from structural changes within the encephalon.

The definition and opinions of writers on the *pathology* of tetanus are multiplied by the theoretic or practical deductions from each class of cases. *Watson*, the Xenophon of medical literature, regards tetanus as an irritation of the spinal cord or of its efferent nerves; he considers the brain not involved and assumes a certain

predisposition of the body for the most part necessary to render it susceptible of the disease under the operation of an exciting irritation. He adds that it is a spasmodic disease, characterized by neither an increase in muscular exertion as in mania, nor by its diminution as in paralysis, but by a perversion of muscular force. *Copeland* suggested the ganglia and sympathetic nerves to be the seat and pathological cause of tetanus (*Lond. Med. Reposit.*, May, 1822), and *Swan*, following these views, stated that the ganglia after tetanus were preternaturally injected, which statement is supported by *Andral*, *Dupuy*, a. o.; *Meyer* and *Vetter* speak of ossific deposits (as reported by *South*, loc. supra. cit.) irritating ganglionic nerves as productive of this disease. The *French School* hold it an inflammatory affection of the spinal nerves. The inflammatory appearances insisted upon by *Larrey*, *Magendie*, *Récamier*, *Ollivier*, a. o., are negatived by the absence of tetanus in true inflammation of the spinal cord and its contingencies. Certain similarities between tetanus and hydrophobia have been made prominent by *Bilgner*, who calls it "*Hundskrampf*," or dog-spasm (*Chelius' Syst. Surg.*, I, p. 414), and *I. L. Bardsley* recommends a treatment like that in hydrophobia (*Cyclopæd. of Pract. Med.*, 1833), from his opinion of the pathology of tetanus. *Froriep* and *Pelletier* (*Neue Not.*, 1837, Jan., No. 1), consider a local nervous inflammation as the cause, and that the general irritability arises secondarily from it in the course of the nerve trunk. *Curling* (*op. cit.*) regards it a simple functional disturbance, the seat of which is the tractus motorius of the spinal marrow (tract. intermedio-lateralis of the grey substance). *Lawrence* (Lectures in *L. Lancet*, 1829, vol. 1) leaves the pathol-

ogy undecided, as no clearness exists in what the derangement of the spinal cord consists, and because examinations have not shown that any derangement of that part is characteristic of tetanus. *Wilk. King* of Guy's Hosp. usually opened his post-mortem examinations in tetanus with these words: "We will now proceed to give you a demonstration of a case of healthy anatomy, for there will be no *visible* morbid appearances, etc." [Italics my own.] *Richardson* (*Med. Journ.*, 1861, April, p. 523) classes tetanus among the zymotic diseases, produced as a specific poison in the wound, which opinion is advocated by *Roser*, *Wells*, *Thomson*, and *Betoli*, thus approximating tetanus to hydrophobia. *Simpson* also regards a peculiar blood-poison generated in the wound or elsewhere the cause of tetanus. *C. H. Jones* (*Clin. Observ. on Funct. Nerv. Disord.*, p. 123), calls it a functional excitement of the spinal cord, and gives *Heiberg's* opinion that it is an affection of the blood localizing itself in the muscles.

While the direct application of post-mortem appearances in tetanus has negatived a clear pathology, yet the character of a primary disease, to which tetanus may be a sequence, is often indicated. We recognize in tetanus and tetanoid spasm a *progressive* and a *retrograding* manifestation. Progressive in so far as certain diseases, characterized by a distinct and established morbid anatomy, result at times, often as a pathognomonic symptom in well marked tetanic spasm, and retrograding, because in certain cases of tetanus, perhaps impure types, we find phenomena more or less verging towards inflammatory causes, located in the spine and its superior nerve centre. The *middle* ground is held by pure tetanus. Phenomena in the morbid

anatomy of progressive tetanic affections are no more indicative of the *causes*, than the evidences of hyperæmia and inflammation in retrograding tonic spasm establish the *effects* of tetanus. That there exists a certain interchange of similar symptoms based upon a dissimilar pathological condition and *vice versa*, is perhaps not difficult to show; but in how far such diseases may be deductions of one from another, their idiosyncracies and virulence gradually developing a *system* or chain of affections, is an obscure theorism and improbable of demonstration. *Brown-Séquard* has maintained that irritations emanating from a centripetal nerve may result in very different morbid conditions—insanity, hallucinations, illusions, vertigo, extasis, hysteria, chorea, catalepsy, epilepsy, hydrophobia and tetanus; but the connection of one with, and the deduction of one from another is not established. *C. H. Jones* (*op. cit.*, *Vindemiatio*, p. 344) remarks (12) in this connection, that, "a series of gradations may be traced from tonic spasm through clonic tremors and choreic agitation to actual paralysis." My present reference to cases of a spasmodic and paralytic character is made with the view of drawing attention to such a transitory concatenation, and I propose to deduct from them the following conclusions:

1. Impressions upon the peripheral nerves of unusual character, amounting to irritation or excitation, are capable of producing a train of symptoms which differ as much between themselves as in their history of existence in diseases of dissimilar origin.

In illustration of this fact, I transcribe case 114 of my diary:

"J. Dean, wounded in battle of Seven Pines, ampu-

tation of left little finger. Resulted in nervous irritation, clonic spasmodic contractions and asthenic fever. This case was admitted to hospital during the most intense heat of the summer (1862), and the atmospheric condition contributed much to the advent of febrile symptoms. After amputation the patient was removed to the only vacancy in the hospital, a garret-room in a four-story building with metallic roof, and in a few days the alteration in his countenance, a shaking palsy, furred and dry tongue, wiry and quick pulse, hollow eyes, paleness, constipation, headache, etc., indicated the amount of nervous sympathy. A hectic fever supervened shortly afterwards. The treatment consisted in his removal to a cooler room, free admission of fresh air, tonics, opiates at night, cathartics when necessary, fomentations to the stump and whole arm, etc., and in a few days I had the gratification to see him convalescent." The incubation here verged towards tonic spasm.

I give also case 215 (S. H. B.): "a gunshot wound in right lumbar region, compression by a large cicatrix, resulting in complete dysecoia. Was returned to hospital for treatment because of pain in his back, neck and over the scalp, and suspected of simulating. I found on examination the large cicatrix firmly impacted around the lumbar vertebræ. He complained of sibilant noises in his ears, like in hysteria. Local treatment did not relieve; the disease had a rapid course of development, it failed to oscillate, and the impaired vision pointing to a general nervous affection, corroborated by vertigo, deafness and sinister movements of the body, I based the symptoms upon the previous injury. The remarks of J. L. Gaultier (de Physiolog.

et Patholog. Irritabilitatis, p. 21) are applicable here: "Where the irritation is slight relatively to the amount of organic nervous power, or where the susceptibility is not increased, the limitation of it (*the irritation*) to its original seat may be long continued,—but where it is more considerable, organic nervous power being low, and the susceptibility, either local or general, consequently high it will extend itself or manifest its effects more or less prominently in remote situations."

2. The occurrence of one case of true tetanus under absence of inflammatory necroptic appearances invalidates their presence as causation in all cases. Multiplied microscopic examinations alone can decide on the presence or absence of inflammatory lesions in their *ultimate* existence, and having in view the want of morbid appearances in the most acute cases of tetanus and their unexpected general development in less pronounced instances, it is evident—

(a) That *microscopical* inflammatory appearances, to the naked eye devoid of all abnormality, are sufficient to account for the violence of tetanus, and that

(b) The *visible* lesions may be only a gradual expansion of those microscopic; either a morphological condition the result of structural exaltation and due to the peculiar organization of the patient, or the added effect of complications and extension.

3. Arterial hyperæmia is not the cause of tetanus, nor is venous congestion a direct or primary agent in its production.

4. Certain relations of the cerebro-spinal fluid with the central canal of the spinal cord, the arachnoid spaces and their prolongations are capable of determi-

ning the normal, exalted or depressed nerve-power; a venous stasis of the spinal cord, and a hyperæmia of the encephalon corresponding with an increased relative volume of the fluid and consequent pressure, and a congestion of the vessels of the cord with an anæmic brain agreeing with its quantitative, local reduction, giving as results spasm, coma, paralysis, etc.

Virchow and *Kölliker* deny that there exists a communication between the sub-arachnoid spaces and the ventricles of the brain, and between these and the sub-arachnoid spaces of the spinal cord, but the anatomical preparations and experiments of *Luschka* have established this fact. There is an ebbing and flowing of the cerebro-spinal fluid from the brain to the cord and *vice versa.* (*Med. Times and Gaz.* 1858, Jan. 16). The larger capillaries of the spinal cord are incased in three tunics, the space between them and the vessels being occupied by a clear and colorless fluid. (Robin in *Brown-Séquard's Journ. de la Phys.* 1856, Oct.) The sheath and its fluid can be traced to the smallest vessels, and both accompany them in all their anastomoses and bifurcations. The proportion in their diameters is in favor of the perivascular canal, which is thus subject to certain changes of calibre, forming under pressure now and then a dilatation or contraction, as the force of distension or its structural character may determine. These minute canals are so intimately connected that their injection is accomplished without difficulty, and are seen to pursue in the nerve-substance a course from without inwards and in the reverse direction. As the cerebro-spinal fluid of the great sub-arachnoid spaces is based and cushioned upon the venous blood of the cord, and supports the nerve-substance of the cerebro-

spinal axis, so fulfills the fluid of the minute perivascular spaces a similar office in protecting the molecular nerve-substance against undue pressure, obviating friction between nerve-filaments and fasciculi, and aiding in the re-establishment of an adequate equipoise between the transmission of blood and the hygrometric status of the cerebro-spinal fluid. Compression, approximation and irritation from friction result from undue blood supply, and relaxation, irregular constriction and elongation from want of support; in other words, an *increase* of pressure from the fluid in the spaces gives an encroachment upon the elementary nerve and approximation and friction between the component parts of a nerve-bundle; and a *diminution* of the support leads to relaxation and elongation of the nerve-tube with undulatory approximation of its walls and to friction of one nerve-filament or fibre with another lying in proximity. A tendency to locally augment the normal volume of the cerebro-spinal fluid, either from traumatic or idiopathic causes, has the direct effect of producing a stasis in the arterial blood-vessels surrounding or accompanying it in its ramifications, and a contraction of the veins in order to balance the blood supply and the augmented pressure from the fluid. A continuance of this mutual power to displace leads not only to the fuller development of the abnormality itself, but implicates also sooner or later the entire cord. The microscopic views of the spinal cord support this statement.

In order that the motor nerves should attain their utmost excitation to muscular action, the inhibitory function should be diminished to its greatest extent. The former should receive an increased, and the latter

a decidedly reduced volume of arterial blood stimulus. I would refer here cursorily to the demonstration of a third class of nerves by *Eulenburg* and *Landois* (*Schmidt's Jahrbücher*, 1866) called the inhibiting (*Zurückhaltenden*) nerves, spoken of by Setschenow before Drs. E. and L. undertook their experiments, and the function of which is to regulate the degree of movement while under irritation, subject to exaltation, depression and paralysis. *Malkiewitz* has pointed out that in certain spasmodic effects of poisons these nerves are in a state of paralysis. The same was taught by *Pflüger*. *Lister* locates this action of inhibition in all afferent nerves according to the degree of stimulus applied, and in the absence of direct proof for the existence of Eulenburg's *Zurückhaltenden Nerven* this is sufficiently explanative. Certain peculiarities in the therapeutic action of poisons may be due to the contraction necessary for a diminished volume of blood. A dose of strychnine which kills an animal in full digestion does not act upon one during abstinence in the same length of time. Absorption alone cannot explain this, for it is more active in the favorable case. .Cold acts in like manner, it requiring a larger dose of strychnine to kill a frog in winter than in summer. Remedies in general do not act upon the sick as promptly and energetically as on the well. A contraction of the arteries carries with it, if due to cardiac inaction or toxæmia, a congestion of the veins and capillaries depending on them, but this phenomenon may be so reversed as to base an arterial anæmia by contraction upon a venous hyper- or toxæmia. The minute arteries have the capacity, owing to their structure and design, to contract upon the introduction of any abnormal or non-arterial sub-

stance if brought directly in contact, or, and especially if the foreign substance comes through the veins, in antagonism with them. This contractile power assimilates them to the valvular structure of the veins and serves to hold the capillary circulation intact. The intimate connection between the circulation in the spinal cord and the fasciculous canals (theca of the vertebral substance and perivascular fluid) renders any disturbance in either of easy transmission to the whole nerve-substance by means of mechanical forces, (pressure, friction and dilatation), and without assuming the character of such structural changes as we meet in inflammation. Since functional activity implies a certain turgescence of the structure, its exaltation may depend upon a more than usual degree of that turgescence and a greater distribution of its impressions, or it may so involve the whole of an organ, which in health is charaterized by two or more distinct and parallel functions, as to interchange and coalesce them to an abortive discharge of one or both of them, sensation, motion, trophism and inhibition. The length of time necessary to exhaust this vascular capacity is the tolerance of the organ, and the amount of vascularity determines with this tolerance the degree of subsequent inaction or rest required for a perfect and healthy renewal of the normal functional activity. Vascularity and equipoise of contraction between the fluids of the spinal cord are synonymous with action and rest, and the undue amount or unusual persistence of this vascularity leads to morbid phenomena. All organs of the body, for whose functional existence it is required to alternate the ultimate conditions of contraction and dilatation at regular intervals, have the

structural peculiarity of adapting the surrounding tissues and formations to each turgescence, and the same holds true in reference to the brain and spinal cord. The peculiar structure of the arteries and veins, they holding themselves in a compensating antagonism, rests and bases itself upon the underlying cerebro-spinal fluid in all its divisions and this parallelism is true of the spinal cord independent of the brain. The cerebro-spinal opening is the dividing line beyond which in either direction a distinct nerve centre has its peculiar function, subject to mutual disturbances only from more than ordinary causes. In the event of the brain or spinal cord being under excitation, the cerebro-spinal fluid is displaced as far and as long as the induced vascularity demands, and the subsidence of the excitation or the replacement of the fluid to its former level insures a state of rest,—if the former is called *disease*, the latter condition must exist in *health*. The dynamis of a normal volume of displaced fluid invading the most minute spaces of the nerve-substance in the cord, exalting the functional activity of motion and sensibility, and this without inhibition because of the coalition of the nerve filaments and fasciculi, has for its product spasm ; and its morbid increase (spina bifida, hydrocephalus, certain forms of mental derangements, etc.,) results in coma, syncope and irregular movements. Inflammatory appearances in the cerebro-spinal axis accord with a diminished volume of fluid, and in the reverse condition we may suppose that an anæmia is in preponderance. Both conditions are possible from sanguine excitation or from undue absorption of the serosity. The uniform and gradually augmented encroachment of the fluids in

the cord and its minute canals upon the spinal nerves without continuity upon the brain gives rise to a continued spasm, the locality and intensity of which is governed by the totality of the parts implicated. Surrounding the nerve roots and fasciculi as they pass each other in close proximity, this fluid serves to isolate and maintain them safe from mutual pressure, and their contact under an irritative compression from a relatively increased volume of fluid facilitates not only the transmission of nerve stimulus to an exalted action, but, hinders the separate current of the nerve power, motor sensitive.* The inhibition applicable to one nerve is

* If the volume of the cerebro-spinal fluid, as some anatomists insist, is much lessened immediately after death, the development of the rigor mortis, certain peculiar contractions of dead bodies after cholera and yellow fever, and the instantaneous rigor on battle-fields from sudden and violent death, may be due to its displacement upon the spinal cord, effecting in the motor nerve-fibre the same results after death, which during life are produced in the cord itself. The progress of a dead body from relaxation to the rigor, and its subsequent return to mobility, have these important analogies: the rigidity passes from the free muscular tissues of the head to those of the neck, trunk, and extremities, in the order named; and A. G. Sommers found but one exception to this rule in two hundred dead bodies; the inferior maxilla is firmly drawn against its superior, no matter in what position death found it; and the arms and legs are contracted upon themselves; the rigor discontinues as it commenced. Tonic spam in trismus passes to the rigidity of death without intervening relaxation. The thermometric condition of the surrounding air exerts little or no influence over the advent of rigor mortis, often before the cadaveric warmth has equalized itself with the temperaature, the rigidity has set in. After removal of the brain and spinal marrow, the rigor nevertheless begins. *Mende* asserts that in the fœtus and the stillborn infant this rigidity is not developed. The same obtains in death from hemorrhage; *instantaneous* death, however, from hemorrhage, gives an extreme rigidity, in which the last position of the body in life is retained, like after instantaneous death from brain wounds. (*Dr. Fodere* of Strasburg). Morgagni has observed a similar rigor in death from asphyxia. The likeness of this rigor to tetanus, has been noticed by *Carpenter*, and the objection of its prolonged continuation, and the succession of flexibility and true rigor mortis was anticipated by him. That these phenomena are not due to the coagulation of the blood, as *Treviranus' Orfila* and *Beclard* believed, has been demonstrated (*Sommer, Muller's Handbuch d. Physiol.* II., p. 43), nor is it indisputable that the cause of rigidity is

communicated to others lying in contact with it, and

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seated in the muscles, as *Nysten* and *Rudolphi* think. The mere fact that the limbs remain rigid after division of the fasciæ and lateral ligaments of the joints, and become relaxed on division of the muscles, does not establish the cause in the muscular fibre. The divided muscle itself remains under the rigor mortis in its superior portion; beyond the division a complete flexibility exists. Of this I have satisfied myself often. Moreover a rigidity under such conditions, must be equivalent to a surviving contractibility of the muscular fibre, such as we notice during life, against which the facts militate that rigid muscles are insensible to irritation, and especially that in the preceding complete relaxation of all the muscles, no such latent contractibility can be supposed to exist. It would be impossible, satisfactorily to explain upon such grounds, why in some instances the fœtus has been known to be expelled after death of the mother, and why the finger, introduced into the pharynx of a decapitated animal, is tightly held. *Richardson's* conclusions (presented before the St. Andrew's Med. Graduates' Assoc. in London), that "the cause of rigor mortis is the coagulation of the muscular fluid—muscle fibrine—under heat as excitant," and that "rigor of the muscle and coagulation of blood are truly the last evidences of the phenomena, which in their totality we call life," are modified by the fact, that very often the rigidity is well manifest, while the blood is still fluid (p. e. after death by drowning, and prussic acid), and that textures as rich in blood vessels as the red muscle, fail in rigidity. A second objection lies in the fact that a paralyzed muscle (Busch) will tear, for instance, under a weight of sixty grm., when the same muscle, under rigor mortis, supports twelve times that weight, unimpaired. Can it be possible that the relative volume of "muscle fibrine" is changed after death, or that it is not commensurate to its muscular power? The peculiar muscular contractions of dead bodies after cholera and yellow fever, have been noticed by *Brandt* and *Brown Sequard.* (*Am. Journ. Med. Sc.*, 1856, Oct., p. 446). The muscular movements are observed only in those of strongly developed muscular force after short duration of the disease, and previous absence of decided cramp or spasm. The more rapid the attack of cholera, especially in cases of robust constitution, the smaller is the attempt of repair, and the greater the centric morbid action. Death results from the toxic abundance of an altered, and yet diminished, volume of blood by inaction of the peripheric blood vessels. The condition is a capillary hyperæmia (toxæmia), by which the supply of blood stimulus to the brain is cut off. Brown-Sequard substitutes his carbonic-acid theory. The blood being rapidly deprived of its watery portions, and without its necessary oxygen, we recognize in the absence of spasm or cramp an arterial anæmia of the spinal cord, with a stasis in the cerebral sinuses and veins. The contractions after yellow fever are noticed in the congestive type, with short paroxysm and limited pervigilium but normal incubative stage. The only metaptosis intervenes between incipient apoplexy or convulsions, and stupor. The blood under autopsy is dark, non-inflammatory, and of thick consistency. Capillary congestion, evidenced during life by petichiæ and ecchymoses, is such that extravasation is

the causes which effect the increase of muscular exertion lead also to the perversion of muscular force, so that a primary and purely reflex phenomenon assumes in time a functional importance, with structural abnormalities commensurate with the continuance, power and systemic effect of the spasm produced.

5. Tetanic spasm has its origin in the disturbed equilibrium between the several fluids of the spinal cord,

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extensive from natural orifices, and the black vomit is but a collective emesis of exosmosed and vitiated blood. The same conditions appear, consequently, here as in cholera, and the cadaveric spasm is allied to the tonic contraction of living muscles from a diminished support to the cerebro-spinal fluid. (*Vide Valentin's Phys. d. Menschen*, II., 2, p. 366). As an adjunct to the pressure thus produced upon the nerve ramification an additional influence in the production of these contractions and of rigor mortis, is given in the shortening of muscles when cooling; but a certain degree of heat induces the reverse, a shortening upon the addition of warmth, and the peculiar position assumed by dead bodies after yellow fever and cholera may be in part the result of an increased chemico-molecular action, by which latent heat is evolved from the prior exhaustion of the primary agent, blood. The peripheric and centric nerves respond to the electric shock or current, long after death, and their activity must be supposed to be gradually diminished. *Matteucci* (in his *Fenomeni fisico-chem.* p. 118–119), and *Du Bois Raymond* (*Poggendorff's Annalen*, book LVIII, 1843, s 5 a. s.) have thought to prove this to be a muscular irritability, because muscles and single muscular fibres deprived of their nerves even to the microscopic test still possess this power to contract. This proposition involves the question of absolute dissection, and if the microscopic preparations of *Dr. Beale* are examined (*L. Lancet*, 1866, July 21), and the report of *Rouget*, supported by Krause, Waldeyer, Engelmann, Letzerich, Kühne, Conheim, Vulpian, a. o., on the ultimate termination of nerve fibres, it will become evident that the contractions of muscles or their fibres as noticed by M. and R., were due not only to nerve filaments suffered to remain, but that the contractile force was equivalent to their number and preservation. As the report of Dr. Rouget has an important bearing, I give an extract: "This nervous expansion is traversed in every direction by minute canals, establishing a connection between the numerous nuclei of the plate and communicating, probably, on the one hand with the space intermediate between the sarcolemma and the contractile fibrillæ, and on the other hand with the interstice between the matrix of the nerve-tube and the medullary layer, an arrangement which is doubtless related to the special action of certain poisonous substances upon the terminal extremity of the motor nerves of animal life."

and in its modifications and irregularities we trace the phenomena of spasm in its transitory forms. Tetanus in its progression, the true type of this disease, originates in the spinal cord and is complicated with brain symptoms only in the continuance of the exciting cause upon that organ. Retrograding tetanus, on the contrary, is a symptom of hyperæmia of the brain, which in time involves the spinal cord. The portion of the spinal cord first affected in trismus lies near to the atlas and axis. Descending to the lower cervical, dorsal and lumbar regions the spasm becomes general, symmetrical or lateral. Hyperæsthesia has reference to the medulla oblongata, and in true tetanus, an increased sensibility is consequently very early manifest. The opposite implies a congestion or softening of these parts; loss of consciousness, dilatation of the pupils, spasm of the respiratory muscles, glottis and diaphram with deficient oxygenation of blood connect the base of brain. The lower the regions of the spinal cord involved the more general, and the higher or more restricted to the atlas, the more limited are the symptoms.

6. Post-mortem appearances may be classified as follows:

I. PROGRESSIVE TETANUS.		II. RETROGRADING TETANUS.	
1. *Pure type.*	2. *Complicated.*	1. *Sympathetic.*	2. *Direct.*
No visible lesions after death. Microscopic displacements and preponderance of cerebro-spinal fluid. Sometimes these appearances are fully developed and become evident to the naked eye. These lesions are confined to the spinal cord and nerve tubes.	Lesions of the spinal cord and brain from causes distinct from tetanus, and might have existed without tetanic spasm.	Lesions of the brain but not of the spinal cord. Tetanus is the result of a secondary displacing pressure, and displacement itself of the cerebral fluid.	Lesions of the brain and spinal cord. General inflammatory condition from injuries of spine, etc.
True tetanus. Hysterical tetanus.	Tetanus with secondary brain symptoms. Cerebro-spinal meningitis.	Tetanus in hydrocephalus; delirium tremens.	Certain mental derangements; cases of Drs. Rodgers and Bodine.

Further microscopic examinations will perhaps reveal also *local* changes of the nerve-ramifications and anastomoses in traumatic tetanus. These, probably, are not the direct effect of the injury, but the result of the centric disturbance which pervades a particular nerve-trunk to the wound from a spinal point opposite to the injury.

7. The proximate cause of this spinal disturbance may be traumatic and idiopathic. The former embraces an excitability in the nerves by which the circulation of blood is determined, and the latter demands in addition, a predisposition for a disturbance in the cerebro-spinal fluid from centric and not peripheric (traumatic) causes. The predisposition may be determined by cold, moisture, lowered vital powers, etc., but it should not be overlooked, that a wound leading at once to systemic irritation, fever, etc., gives seldom cases of tetanus, while wounds characterized by slight local irritation and

a reflex or derived implication of the nerves give the largest number. A purely idiopathic tetanus is therefore within the category of traumatic causes, which in their minuteness may altogether escape the memory of the patient and the diagnosis of the surgeon. A given number of gun-shot or other wounds may produce a certain percentage of tetanus, just as the same number exposed to the inclemencies of temperature, etc., furnishes a certain percentage of pneumonia, pleurisy, bronchitis, diarrhœa, etc., and this ratio will be found to correspond to the predisposition of each case for one or the other. *Hunter* very justly remarks, that in tetanus "there must be a predisposition to the disease; thus madness is produced from the slightest cause when the mind is predisposed; so it is in agues and fevers, the constitution being particularly predisposed at the time to such diseases."* He errs, however, when he maintains "that those most susceptible to the disease are of sickly and weak frames and of suspicious minds, and not of strong and robust ones." The trophic and ganglionic nerves are usually involved in withholding the

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* To illustrate the general application of these views, I give Case No. 125 of my diary:

Parker, Wm. T., entered hospital under sequelæ of vuln. sclopet. (fracture of os frontis without compression of brain), received two months previous. His present condition, (August 1863, wounded June,) is one of dementia in its first stage; wound healed; seems continually in profound meditation; loss of memory; despondent; fears the steps of any one behind him, and even in the profoundest listlessness, turns quickly round if any one nears him; violent gesticulations, involuntary and during sleep; sometimes periodically spasmodic; liver torpid; urine scanty and abounding in hippuric acid; tongue dry and parched; pulse hard, not full, 90 per m., and intermitting. In the treatment I exhibited antimony, digitalis, and mercurials to ptyalism, cold water, etc. His father applied for his discharge, which was readily obtained, and from him I learned that insanity was inherited from the mother. I transcribe the following question, made by me at the time in my report: "Is the seat of this disease a *direct* se-

organic stimulus to the secretions from the liver, pancreas and the glands of Peyer, Lieberkühn, etc., and the spasm of the intestinal muscular coat contributes much to the early production and to the persistence of constipation, one of the most important levers for tetanus, and competent of sustaining the exalted polarity of the nerve-cells in the muscular fibres of the intestines. The expression of tetanus is an *intravascular auxesis* of the spinal cord; not an increase of the absolute volume of the spinal, subarachnoid and intravascular fluid, but a centralization of and a reciprocal displacing pressure from a normal quantity, with microscopic but without, to the naked eye, visible lesions in true tetanus and with morbid appearances of inflammation, partial disorganization and other structural changes in symptomatic and consecutive tetanic spasm.

In the *treatment* of tetanus two propositions should be considered as having a vital bearing upon the successful exhibition of a remedy, and as explaining in some degree the contradictory results obtained by dif-

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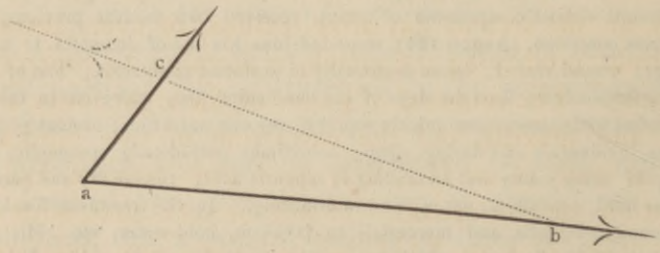
quence of the injury, or had the reflex action upon the hepatic system induced and, together with the injury, located a predisposition for insanity? In other words, does the following diagram verify the pathogeny in this case?"



a—seat of injury. *b*—hepatic complication. *bc*—reflex action of morbid condition from *b* towards nerve centre. *ac*—idiosyncratic or hereditary tendency of latent morbidity. *c*—result.

ferent practitioners: 1. The mode of treating this disease should be directed either to the *resistance* of the system to the morbid action or to its tolerance; and 2. The remedy should not be looked upon as fully tested and curative, unless it has been so administered as to impress upon the system its own toxic effects. As an example I quote quinine, which, in acute rheumatism scarcely ever lowers the pulse nor lessens the other symptoms without its physiological effect derived from its therapeutic virtue—deafness. I propose now to give a cursory synopsis of the treatment as reported from the most reliable sources.

I. Amputation, division of nerves, local applications, etc.

Tolland (*Pacif. Med. and Surg. J.*, 1869, Jan.), reports two cases of traumatic tetanus successfully treated by division of the injured nerves, combined with internal treatment of secondary importance. The removal of a large cystic tumor, reported by me (Case VIII), had no direct effect upon the spasm; in Case V amputation was performed thirteen, and in Case III two days before tetanus set in; in Case IV I amputated five days after the appearance of tetanic spasm, and in the very acute case (Case I.) amputation became necessary on the second day after tetanus, in every instance without modifying the attack or seeming to control its advent. The removal of pieces of the right lower alveola and maxilla, and the extraction of two implicated molar teeth (Case II.), four days after tetanus, had no relation to the spasm. It will be seen that, with the exception of Case VIII, no operation was undertaken with the view of influencing the tetanic spasm. In India, amputation was uniformly unsuccessful unless per-

formed early and before centric irritation had developed itself; and in Guy's Hospital, amputation, division of the injured or implicated nerve, local applications, baths, and the free opening of the wound, exerted no control over the spasm. Gherardi amputated for tetanus three times unsuccessfully. Dr. Th. Mack (St. Catharine in Canada) likewise amputated in a compound dislocation of the elbow, resulting fatally a few hours afterwards. A division of the median nerve by Dr. Fayrer of Calcutta, combined with the internal treatment of chloroform, cannabis indica, camphor and opium by smoking gave a successful issue. The internal treatment, however, preceded the division of the nerve seven days, and the section seems to have had the greatest share in this recovery from a sub-acute tetanus. Dr. Middleton (Blockley Hosp. Phil.) reports a recovery after division of the ulnar nerve; it does not appear that any internal treatment was added. Section of nerves gave no curative results in the practice of Baron Larrey. In connection with this mode of treatment, I add that the Jamaica Med. Journals recommend long and deep incisions along each side of the spinal column until free bleeding is established, followed by cauterization of the wound with caustic potash. The treatment of Trousseau includes blood-letting and cupping along the spinal column, and Mursina was successful with the actual cautery.

II. Mixed Treatment.

The following table will give a brief account of cases treated with a variety of remedies; it is, of course, impossible to assign a curative agency to any one of them, nor can this plan of treatment be recommended as possessing the indications required.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
J. F. Thompson,	Sub-acute.	Warm fomentations, with laudanum and camphor; Tr. opii. and spts. ether., c. àà gtt. xl; laudanum gtt. 25 every half hour; chloroform anæsthesia for six and one-half hours; opium and whisky.	Died.
W. Allingham, (St. Thomas Hosp.)	"	Calomel and colocynth; castor oil; enema of turpentine and castor oil; Battley's Sedat. sol. gtt., 40; chloroform gtt. x, every two hours; mercurial oint. and opium to back and neck; incision of wound ✗; Tr. opii. gtt x. every hour; ptyalism; blister to spine; sol. morph. mur. f ʒ ss, ether, chlor. gtt. xv at night and repeated; brandy, wine, and tr. ferri. chlor.	Recov'd.
E. E. Millholland, (Balt. Infirm.)	Acute.	Ex. cannab. ind., gr. 1 to 2 every two and 1 h.; morphia internally and hypodermically; chloroform inhalation; injection of sol. of corroval in arm; two drops repeated three times.	Died.
Wm. Farrage, (L. R. C. P. E.)	"	Calomel grs. viii, ex. hyosciam, grs. xii in four pills, two every four hours; enema with ammonia; stimulat. linim. to spine; turpent. to abdomen, and hot fomentations: sol. morph. mur., Tr. hyosc., àà f ʒ ij., sp. ether. sulph. c. f ʒ iss, mist. camphor f ℥ iv. M., one-fourth part every two hours; enemata; ex. cannab. ind. grs. vi, ex. hyosc., assafœt. àà ʒ ss. M. 12 pills, one every hour; Tr. cannab. ind. gtt., 30 every two hours; counter-irritation to spine with Croton oil, turpent.; morphia alone and with hyosciam.	Died.
Dr. Papin, (reported by H. Z. Gill.)	Trismus nascent.	Purgatives: nourishment; blistering of spine by chloroform repeatedly; chloroform inhalations; not to complete and persistent anæsthesia.	Recov'd.
Dr. Büttner, (reported by H. Z. Gill.)	Acute.	Ung. morph., morph. one-eighth gr. quin. s. 3 grs., twice daily; magnes. sulph. as required; also from commencement Tr. gelsem. s. gtt. 20 every hour; quin. s. 5 grs. every three hours; podophyl. one fourth as cathartic; other simple remedies.	Died.
S. Job, (Newark Hosp.)	Sub-acute. (chronic.)	Enema of turpentine; opium, gr. i, with one ounce of Tr. colchic. f ʒ ij, ammonia carb. ʒ i, ether. chlor. f ʒ ij, aquæ f ℥ i. M. every two hours ?); laudan. ʒ i at night, and repeated; sponge bath with dilute vinegar; belladonna plaster to spine. This case partially relieved in two, and fully in three months.	Recov'd.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
W. H. Wickham, (King's College Hosp.)	Acute.	Cathartics; aconite in frequent and increasing doses; ex. woorara injected sub-cutaneously; brandy and quinine every four hours; cold to spine.	Died.
H. L. Burton,	Sub-acute.	Chloroform; calomel, jalap, tart. emet.; morphia full dose; castor oil, turpent., enema; hot water to abdomen; calomel, morphia; blister over whole spine; morphia one-third gr., calomel, tart. emet. every three hours.	Recov'd.
Dr. Ademollo,	Sub-acute. (chronic.)	Large doses of opium, morphine, belladonna, hyosciamus.; assafœt., camphor.	Died.
H. Steele,	Acute.	Cathartics, belladonna, and potass. brom. in full doses; ice bags to spine; inhalation of chloroform; atropia; cannabis ind.; morphia at night. The resume of remedies given by the author, includes the hypodermic injection of ex. calabar bean one-third, and 1 gr. internally, which is not apparent from the context.	Recov'd.

In an interchange of remedies it is generally impossible to attribute a passing or final amelioration of symptoms to any one; hence, cases are here given under a mixed treatment, which, in the opinion of some, may belong elsewhere.

III. Supporting and Stimulant Treatment.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
Dr. Williams, (England.)	Sub-acute. (chronic.)	110 bottles of port wine in forty-two days.	Recov'd.
Mr. Bott, (England.)	Sub acute.	2 gallons brandy in eight days.	Recov'd.
G. Rouse, (S. Reg. St. George's Hosp.)	Acute.	Brandy and turpent. injection; one-half ounce brandy every ten minutes.	Died.
G. Derby,	Trismus	Wine, nourishment, and *small* doses of morphia.	Recov'd.
Prof. Barnes, (St. Louis.)	Sub-abute.	Free purgation, with salts and senna; Madeira wine *ad lib.*	
Reps. Guy's Hosp.	Not stat'd.	Of the 72 cases 10 recovered, of which, in three instances, the treatment with wine, musk, and tonics, seems to predominate.	

Rush advocated wine and stimulants, generally combined with mercurials.

IV. Stimulant and Quinine Treatment.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
Hayn. Walton,	Trismus	Quin. grs. x, three times daily, with 6 ℥ Port wine or 4 ℥ brandy.	Recov'd.
Dr. Gunkle,	Sub-acute.	Morph. one-third to one-half gr. every two hours, alternated with 2 grs. of quin. in 2 ℥ whisky.	Recov'd.
P. D. Delagarde, (St. Barthol. H. Vol. II. '66.)	Sub-acute. (Chronic.)	Quinine; stimulants and supportive treatment; in 17 days.	Recov'd.
Reps. Guy's Hosp.	Not stat'd.	The 10 cases of recovery already referred to, owe their issue (Polland) to those medicines which support the system. At all events, 7 cases received quinine, and 3 wine, musk, and tonics.	

V. Ice and Applications of Cold.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
Dr. Carpenter, (N. Y. Journ. of Med. Jan. 1860)	Not stat'd.	Claims 16 successful cases out of 17 treated by the application of ice along the spine.	
W. V. B. Bogan, (Armory Square Hosp.)	"	Used ice over the spinal column and the local use of morph. to the wound.	Recov'd.

Hippocrates recommended the treatment by ice, and it has been adopted since by a number of practitioners. *Celsus*, however, considers the cold bath injurious, and *South* (Chelius' Syst. Surg., I., 420), says: "One mode of proceeding must be deprecated, viz., that of plunging the patient into a cold bath, which I once witnessed during my apprenticeship; the result was, that the patient was immediately lifted out—dead." As a revulsive, derivative, and anæsthetic, the local application to the spine of ether spray, especially rhigolene, may promise good results from the treatment of M. Mazade

(*Lyon Medic.*, 1869, July 4), and from the experimental results of S. W. Mitchel.

V. Hot Applications and Warm Baths.

Dr. Hassal, Royal Free Hosp., had a case of acute tetanus, which was treated with repeated hot bath and chloroform, Hoffman Anod., etc., in very small doses The case proved fatal. The Guy's Hosp. Reports speak of baths as valueless.

VI. Electricity.

Dr. Althaus recommends electricity as a curative agent in tetanus, but gives no cases. (*Vide* W. Watson, Philos. Trans., London, 1863, and the case of S. Perry, *N. York Med. Reposit.*, vol. IV., p. 77). Dr. H. Griffin reports a traumatic tetanus, in which Dr. W. T. Owen gave ex. calab. bean ½ gr. every half hour, until 4 grs. were taken without effect; ordered chloral hydr., 20 grs. every four hours, and flaxseed poultice with opium; Dr. G. continued the chloral grs. xv., + morph. mur. gr. ¼ every four hours; also chloroform inhalations; Prof. Holland, in consultation, applied the continuous galvanic current with marked success. Patient recovered (*Vide Amer. Pract.*, 1872, Feb., p. 93). Mendel also reports a successful case with galvanism, and J. W. Holland specifies the application of certain currents from 16 cups as follows: directly through masseter m. no advantage; + electrode upon infra-orbital nerves, and — elect. over masseters and temporals relieved the pain; the exciting of antagonistic muscles (Mendel's proceeding) gave no benefit; — *elect. behind sterno-mast. and the + over ensiform cartilage* gave immediate relief to the diaphragmatic pain and spasm, relax-

ing the sterno-mastoid m., and *still more benefit* was obtained from the + pole behind angle of jaw, and the — elect. retained. The spasm of the rectus and intern. obliquus muscles relaxed under this constant current in ten minutes.

VII. Cetonides aureæ.

M. Guerin Meneville noticed before the French Academy of Science the experiments of Motschouski, a Russian Entomologist, upon this insect as producing, reduced to a powder, a profound sleep lasting sometimes thirty-six hours, and which has the reputation of relieving the spasm in hydrophobia. M. has been successful in most cases and I insert this notice of the cetonides in order to renew the attention to this subject.*

VIII. Ammonia.

Dr. Charbonnier (*L. Lancet*, 1867, July 6) had a successful case after failing in seven other instances with a different treatment, from the administration of six drops of Liq. ammoniæ every half hour.

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* The proper name of this insect is *cetonia aurea* or *aurata* (Linn.), and belongs to the family of *Scarabæidæ*, and to the sub-family of *Cetoniini*. Their metasternum is porrected, the epimera very large and the elytra sinuated at the side. Prof. C. V. Riley, entomologist for the State of Missouri, has kindly furnished me for experimental purposes, the following specimina, obtained by him in this country (the aurea being European): Euryomia (Cetonia) melancholica; (Lac.), E. inda; (Linn.), and E. fulgida (Fabr.), and it is probable that all Cetonides partake of similar therapeutic properties as the C. aurea. Future results with these insects will be given, and the profession should investigate their claims to a place in the *Materia Medica*. As the name of *Cetonides aureæ* given by M. is entomologically incorrect, and as nearly all the cetoniæ have a bright, or golden color, it appears to me possible that M. did really not mean the cetonia aurea alone, but all cetonides which possess the characteristics *auratæ*.

IX. Hydrocyanic Acid.

H. Ward (Gloucester) exhibited it successfully in one case every half hour and, after relief had been obtained, every four hours. Dr. T. C. Curling, gave small doses in three cases with fatal results.

X. Oil of Turpentine.

E. Phillips records a fatal case. J. Wilmshurst claims for the fumes of the oil of turpentine anæsthetic properties, allaying spasm and pain without impairing the heart's action. The South Sea Islanders, who are said to be especially subject to tetanus, produce for its relief an artificial irritation of the urethra and the beneficial effects of turpentine may reside in its action upon the urinary organs to induce in full or over-doses strangury and hæmaturia. It is probable that on similar grounds extensive blistering with empl. canthar. has given satisfactory results. Wm. Leigh (St. George's Hosp.) reports a recovery from the internal use of turpentine and conium suppositories. Mott gave in a successful case a teaspoonful of turpentine every fifteen minutes, and one hundred and twenty-three teaspoonsful in all.

XI. Strychnine.

Dr. J. W. Fell treated seven cases successfully with strychnine, in doses of $\frac{1}{10}$ to $\frac{1}{16}$ gr. in proportion with the specific twitching which he induced. He used, however, rather a mixed treatment of opium, mercury, and wine internally with the spinal application of antimony. Dr. E. Vanderpool reports nine cases of tetanus, eight traumatic and one idiopathic, treated with strychnine of which all recovered. Another case died, as he thinks

from the injudicious suspension of the remedy. The doses used were $\frac{1}{16}$ to $\frac{1}{12}$ gr. every two hours, until involuntary twitching of the muscles took place and the massseters relaxed, then the same dose was continued every six hours. Prof. Haughton (Proceedings of the Royal Irish Acad. 1856, November, and 1858, June) and Dr. O'Reilly (St. Louis, Mo.) have successfully acted upon strychnia tetanus with its antidotal, nicotine; and nicotine, as we shall see hereafter, is especially engaging the medical profession on account of its opposite action in true tetanus. The proposition is consequently nicotine *vs.* strychnia tetanus and tetanus proper, and strychnia *vs.* true tetanus; leaving the third logical conclusion *a similia similibus:* strychnia *vs.* strychnia tetanus. From the argument of Brown-Séquard it follows that strychnine increases the amount of blood in the spinal cord by paralyzing the blood-vessels, and in cases of tetanus (characterized by congestion) it should increase that condition. Ergot excites the muscular coats of the bloodvessels to action, and should therefore be an opponent to strychnia tetanus and applicable in all cases of tetanus in which the exhibition of strychnia is forbidden. Atropia also is allied to ergot in this respect, which (ergot) is a standard remedy in tetanic spasm from cerebro-spinal meningitis.

XII. Nicotine.

Morgan (*Am. Jour. Med. Sc.*, July, 1869, p. 255) gives a recovery with this treatment: ice-bags fully and persistently tried, mercury, camphor and opium substituted, then nicotine $\frac{1}{28}$ drop, liq. morph. five drops and wine every three hours, in two days increased the

dose to $\frac{1}{18}$ drop every four hours, fifteen minutes after each dose slept about ten minutes, nausea ; nicotine $\frac{1}{15}$ drop. Babington (Londonderry) gave nicotine in doses of $\frac{1}{8}$ drop, but frightful depression compelled him to desist, and Tufnell has two successful, and one fatal case with nicotine as recommended by Haughton (*Amer. Journ. M. Sc.*, Jan., 1860, p. 280) exhibiting in one case fifty-six drops in six days. Simon (Eng.) considers tobacco the best antitetanic remedy. My case No. VII. is not a fair exponent of the power of nicotine in controlling tetanic spasm, the tobacco enema and the $\frac{1}{20}$ drop of nicotine internally, preceding death only a few minutes.

XIII. Liquor Potassæ.

Dr. J. Reid (*L. Lancet*, 1861, March, p. 230) gives a recovery from subacute tetanus under this treatment: mercury with anodynes and antispasmodics in the beginning, on the 8th day, liq. potassæ with syrup of poppies and camphor water. He says, (p. 221) " to obtain a less easily excited condition of the system, also a diminution in the tonicity of the muscular fibre, and a decrease in that portion of the blood through whose agency is supplied irritability or vital activity to the nervous and muscular structures would be to gain a certain control over an exciting cause and a relaxation in the leading features of the disease." This he believed to effect by liquor potassæ.

XIV. Tartar emetic.

Dr. Conway (Neuschatel in Switzerland) had a recovery in a subacute tetanus. Continued it until excessive pain in the mouth and severe alvine evacuations

were produced. (*Vide Md. and Va. Med. Journ.*, 1861, March, p. 261.) Dr. Powers details the particulars of a case in which the full effects of strychnia upon the muscular system were relieved by small doses of tartar emetic. (*Vide Med. News and Libr.*, 1857, Feb., p. 25.) Dr. E. Vanderpool records a fatal case of traumatic tetanus treated with the same in combination with anodynes, stimulants and counter-irritants, and a successful issue under venesection to relaxation, tartar emetic ⅛ gr. every two hours regularly increased in forty hours to four grs. at a dose without producing nausea.

XV. Bromide of Potassium.

Authority	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
H. F. Andrews.	Sub-acute.	Potass. brom. grs. 30 every two hours; slept and relieved; the bromide every three hours 20 grs.; no paroxysm after one day's treatment; bowels acted spontaneously.	Recov'd.
Dr. Brown.	"	Pot. brom. grs. 10 every two hours, with increase of dose at night; continued four days without effect.	Not stat'd
Mr. Brown. (England.)	" (chronic.)	Pot. brom. grs. 20 every two hours and reduced to three doses in twenty-four hours; yielded after seven weeks' treatment; not severe.	Recov'd.
H. K. Steele.	Acute.	The bromide preceded and followed other remedies.	Died.
G. Derby.	Sub-acute.	Pot. brom. grs. 40 every hour, treatment continued for twenty-one days; took nearly twelve ounces of the salt.	Recov'd.
Dr. Bakewell. (Trinidad.)	Acute.	Potass. brom. grs. 30 repeated only once in a few hours.	"
Mr. Hancock. (Charing Cross Hosp.)		Potass. brom. grs. 30 every four hours with 20 minims of Tr. A. belladonna.	Died.

Bromide of Potassium exerts a decided influence over epileptiform spasm, at least while its exhibition is continued. It seems applicable as an adjunct to the treatment of tetanus on account of certain physiological and

therapeutical properties: it diminishes the excitability of the senso-motory nerves, of the spinal cord and encephalon, producing sleep, and while the heart is paralyzed under its full action it resists longest and is the last affected. Dr. Brown gives its effects as follows: "it mitigates the convulsive movements and spasmodic twitchings which are the result of a rapid conversion of sensory impressions into motor impulses, ... it acts as an anodyne, under certain circumstances relieving hyperæsthetical sensations and promotes sleep." (*Am. Jour. M. Sc.*, 1866, Oct., p. 525.)

XVI. Quinine.

In Guy's Hosp. twenty-five cases were treated with quinine, seven recovered, and eighteen died. (Compare cases under IV., especially Walton's successful exhibition of quinine with port and brandy.) Dr. H. Z. Gill gives a fatal case treated with twenty drops of tr. gelsem. semp., every hour; symptoms at first improved; quinia grains five every three hours was followed, etc. (*Vide supra* III.) J. M. Malone reports a recovery with quinine, and a case of a mixed treatment by D. E. Bishop received large doses of quinine with morphia and stimulants with satisfactory result.

Tonics in general have been at times productive of recoveries in tetanus. Drs. Elliotson and Hamerton gave carbonate of iron, the sulphate of zinc has been recommended and arsenic as an alterative tonic gave a successful issue in the hands of Wm. J. Holcombe. (Cases of an arsenic treatment are recorded in the *Am. Journ. Med. Sc.*, Vol., III, Old Ser., p. 133-376.) Quinine, however, seems especially of service when tetanus supervenes in broken-down or impaired constitutions,

in soldiers after fatigue, improper nourishment and exposure to malaria. The benefits from quinine are in a great measure due to its anti-zymotic properties: zymosis, not as a cause of tetanus, may be one of the many additional agents not only predisposing to nervous excitation, but especially hastening the rapid issue of tetanus. Dr. Binz observes in regard to this subject (*Experimentelle Untersuch. über das Wesen der Chininwirkung*, 1868) that "quinine prevents fermentation, its power of destroying the animalcular life is superior to that of creosote, morphia, and strychnine, the permanganate of potash alone is of greater power." It prevents the development of penicillium glaucum (mould as found upon organic bodies) and exerts a like antiseptic influence upon the lowest organism. The analogy between fermentation and the symptoms of zymosis explains the benefits of quinine in large doses. In my cases I have usually combined quinine with other remedies, the patients being soldiers out of camp. Should internal medication become impossible from the violence of the muscular spasm of the jaws and neck, then quinine-enemata should be substituted.

XVII. Sulphuric Ether.

W. V. B. Bogan had one recovery and one death from injections of this remedy. The case of E. W. Theobald had twelve successive inhalations, the lacerated hand having been amputated, and from the fifth day also large doses of opium being used; recovered. Dr. Tibaldi (Italy) records a successful case which he bled ten times, eight times in five days as much as twenty ounces of blood at once, applied one hundred leaches to painful parts, and loins rubbed

repeatedly with sulph. ether of which one ounce over back and neck allayed the spasm.

XVIII. Chloroform.

Dr. Poland in the Guy's Hosp. Reports gives the opinion, that in most of the cases in which chloroform was exhibited the disease was aggravated. Dr. G. H. B. Macleod abandoned chloroform in favor of opium, in one case the chloroform "was persevered in with the result of losing the patient." Dr. J. F. Thompson after trying other remedies kept up the influence of chl. for six and a half hours with fatal result; the force of the spasm and its frequency were diminished but prostration increased. T. Sp. Wells treated a case unsuccessfully with opium and ether, then woorara and lastly with chloroform, the influence of which was fully sustained for forty-eight hours. Also the case of Curling reported by Busch died, in which, after chloric ether and laudanum, chloroform to complete anæsthesia was persisted in. W. C. Van Bibber exhibited it exclusively in a fatal case, and Jas. L. Ord had a recovery from trismus with tr. opii., chloroformi àà f ℥ iv. M. a teaspoonfull every hour and applications of same with flannel to hand and arm. J. Ford Hassall lost his case under a treatment with hot baths and enemata, chloroform gtt. v and Hoffmann Anod. gtt. xx every four hours and chloroform anæsthesia for eight hours. H. Steele's fatal case had chloroform inhalations which affected the respiration dangerously. In my Case VI the internal and anæsthetic exhibition of it failed to control the spasm, in Case VII the inhalations gave violent spasm of the glottis and a labored and spasmodic inspiration, and in Case VIII, the operation being

commenced under chloroform with symptoms of Trismus only, tetanus was developed while under anæsthesia, nor did the subsequent local and internal use of it have any ameliorating effects. The fatal case of M. Labbé had opium and afterwards chloroform; several members of the Association of Physicians (France) concurred in the opinion of danger from giving chloroform in tetanus. Fayrer's case was successful after division of the median nerve, chloroform having been given for seven days, also cannabis ind., camphor and opium. H. Z. Gill (St. Louis) reports a fatal case in care of Prof. Gregory treated with the hypodermic injection of morphia, croton oil and enemata, full chloroform anæsthesia, cannabis indica (one trial, patient could not swallow) and atropine hypodermically. Also two additional deaths (cases of Prof. Gregory and Dr. Frazer) under cannabis ind. and chloroform, and a fatal trismus nascentium (case of Dr. Papin) under chloroform,—this last case however was irregularly managed in Dr. P.'s absence. Dr. Hinkle gives a successful instance of traumatic tetanus in the management of which chloroform, cannabis indica, etc., were employed, but it is probable that it was a hysteric tetanus. M. Aran adverts (in *Bullet. Général de Thérapie*, 1860, March) to spasmodic cramp, tetanie or intermittent tetanus, in which the local use of chloroform is recommended. These spasms are exceedingly liable to relapse, yet each application gave immediate relief. Wm. Corson reports a successful case in which the symptoms were modified and in the end entirely arrested by the repeated inhalation of chloroform. H. Z. Gill recommends anæsthesia with chloroform alternated in intervals of rest with opium.

Anæsthesia is a product of the brain; the vapor of the agent employed impressing its virtues directly upon the nerve-centre. Its exhibition in tetanus may thus court the progressive cerebral symptoms from the spinal cord by which its failure as a curative remedy would be explained. The two nerve-centres being co-ordinated in their controlling influence over the organism it follows, that the cessation of anæsthesia is the beginning of renewed tetanic spasm. The existence of one is the succumbing but not the annihilation of the other. The more vital and sensitive influence of the encephalon forcibly brought under anæsthesia overpowers the spasm, but its own existence forbids a total destruction of the opponent. M. Chassaignac notices the cyanotic condition of the blood after chloroform, and that its inhalation is in a certain degree always accompanied by partial asphyxia. This should be duly considered and have its full weight in the therapeutic exhibition of chloroform for the relief of a disease, which is characterized by a death from asphyxia. In partial proof of my views heretofore expressed, chloroform, exhibited under certain conditions, may be a direct cause for the continuance of the tetanic spasm, and it would follow that in complicated tetanus, where the tendency points to such an existing cause, its use is absolutely contraindicated. In the primary cerebral disease with true hyperæmia and arachnoid inflammation, and in the prototype of nervous exhaustion and brain atrophy, delirium tremens, the inhalation of chloroform is attended with different results: in the last often beneficial and curative, and in the first almost uniformly injurious and destructive. The cases of delirium tremens treated by Chamberlain show that the inhalation of chloroform to

full anæsthesia gives "opisthotonos, laryngismus, general spasm, stertor, etc. In delirum tremens of sthenic inflammatory character, the action of chloroform is almost parallel with the morbid tendency, while in that of a nervous erethism it may prove and has proved its opponent. In tetanus, the supervention of anæsthesia monopolizes the encephalon, through which as the superior nerve-centre, the spinal cord is placed *hors de combat*, and that without any agency of its own,—the disease is only masked. With the freedom of the brain from the overpowering anæsthetic, the spinal cord manifests its independent action, and this the more rapidly, because the encephalon has by anæsthesia lost in a certain measure its inhibitory power and its resisting capacity to the progress of the disease. The want of *immediate* consequences in a majority of cases, the faculty of allaying pain and spasm, and the occurrence of sleep now and then have combined to place chloroform in the false position of a permanent and positive remedy in tetanus, while the best results ever to be expected from it lie in its usefulness in mild cases to prevent the derivative effects of the disease upon the system at large, in reducing the exhaustion of the nervous and muscular force, and in thus rendering the equalizing and restorative endeavors of nature and the necessary therapeutic action of other remedies possible.

XIX. Chloral Hydrate.

A. G. Lawrence had a successful case of subacute tetanus following myelitis with this remedy in half drachm doses every three hours, three doses relieving the spasm. Widerhofer had a recovery in trismus neonatorum, giving one to two grains at the onset of each

convulsion, and reports five other successful cases out of ten or twelve (?) treated in like manner; he administers it in two to four grains' doses by the rectum if the infant cannot take it by the mouth. Dr. Dufour (*Gaz. des Hôpit.* No. 65, 1870) gives two speedily fatal cases in which the chloral had no time to act, and a third, a chronic tetanus, which recovered, the chloral being given in 30 grs. doses; 100 grs. were taken daily for 6 days and 240 grs. on the seventh were required to induce sleep. Morphia was found useless. A. Ballantine's case of acute traumatic tetanus received 60 grains of chloral, which produced sleep in five minutes; ʒ½ drachms were used in 24 hours, and the treatment continued for 20 days with success. H. Leach lost a case of idiop. tetanus with chloral ʒ i every ʒ hours and chloroform anæsthesia. H. Griffin's case has been noticed already under electricity, and the recovery from acute tetanus under the treatment of Mr. Branfoot followed the exhibition of 30 grs. of chloral every 4 hours, after 4 days increased to 60 grs., with 15 grs. every 2 hours afterward, which again were increased to 25 grs. as the spasm yielded or became worse. His patient had also opium gr. i every three hours in the onset of the disease and wine *ad lib.*

Anhydrous chloral was discovered by Liebig more than 35 years ago; this in contact with water gives the chloral hydrate. With caustic soda it is decomposed, chloroform and formate of soda being the chief results. This decomposition explains the physiological effects of chloral in the system. Although Demarquay denies this decomposition and action upon the nerves from the resulting chloroform, yet the subsequent researches of Richardson (*vide* also the experiments of MM. Per-

sonne and Roussin in *L'Union Med.*, 1869, Nov. 30 and Dec. 2.) who obtained by distillation chloroform from the blood after the exhibition of chloral, prove the correctness of Liebriech's position. Chloral hydrate replaces opium in many respects, and is admissable in cases where opium is contra-indicated. Its action as a hypnotic and sedative is reliable and does not lead to torpidity of the bowels, etc., on the contrary, it seems to stimulate them to action. The sleep induced by it, especially if resulting from repeated and moderate doses, is often so profound and accompanied by so thorough a relaxation, that great care should be exercised in its exhibition—the accumulative effects of repeated doses, in other words, must be guarded against. One case in my practice, after three doses of 15 grains each, and 3 hours apart (in spasm of the intestines with great pain) resulted in a persistent stupor verging to collapse, and only after 10 hours did the patient slowly recover from the effects of an accumulated dose. Hence chloral should be given in adequate doses without hasty or expectant repetition. Its physiological action is directed first upon the ganglionic cells of the brain, then upon the spinal cord, and lastly upon the ganglions of the heart, and chloral hydrate seems especially indicated in true tetanus, one circumstantial reason being its capacity, so desirable in the treatment of violent cases, to lower the temperature of the body from 6 to 8 degrees. Liebreich thinks chloral the antagonist of strychnia, their physiological effects neutralizing each other. It may be of further interest to the treatment of tetanus, to combine opium or morphia with it, because the full and prompt effects of both are obtained with smaller doses, and in cases of pre-existing feeble heart's action,

care should be exercised in the use of chloral in full doses, but opium and chloral (or the bromide of potassium, opium and chloral) might be advantageously combined.

XX. Conium.

The report of St. George's Hosp. for 1867 gives one fatal case, subacute tetanus, treated with suppositories of ex. conii grs. v every four hours and a recovery, also subacute, from spts. turpentine ʒ ss (and repeated) and suppositories of the extract three times daily. Fergusson (King's College Hosp.) reports a fatal case of trismus under ex. conii grs. iii every two hours, gradually increased to six and seven grains, and Radcliffe stated before the Royal Med. and Chir. Soc. 1859, No. 22, that several cases of tetanic spasm had given way to conium administered by the stomach; he believes it of very certain action and a better agent than woorara. Harley, however, claims to have proven by experiment that the extract of conium is a very uncertain preparation. Conium diminishes the irritability of the cord, has no purely cerebral effect and does not interfere with the sensory functions. Its peculiarity is that it has a greater action during rest than motion. Its full effect is sleep and it replaces opium in the corpora striata, smaller nervous centres and in the whole motor heart. Gradually increased doses until the full energy of the remedy is obtained (in a reliable preparation) would, therefore, fulfill certain indications in the treatment of tetanus.

XXI. Belladonna. Atropia.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
Dr Dupuy, (Gaz. Méd. Lyons)	Sub-acute.	Ex. and t. belladonna in double doses without effect; sol. sulph. atrop. 25 drops injected in sub-cutaneous tissues of lumbar region; in ¼ hour symptoms of poisoning, which were relieved; second injection with same results.	Recov'd.
J. Job.	"	Mixed treatment, one of the last remedies was a plaster of belladonna to spine.	"
W. Leigh, (St. George's Hosp.)	"	Hypodermic injections of atropia 1-40 gr. morphia 1-4 gr., and atropia 1-30 gr. morphia 1-3 gr.	"
Same.	"	Same treatment.	Died.
C. R. Greenleaf.	Acute.	Belladonna was used as a prominent remedy.	"
A. M. Brown.	"	Same.	"
Jas. Moore.	Sub-acute.	Morphine; ex. belladonna gr. 3, every 4 hours, and enemata of turpentine.	Recov'd.
Same.	"	Indian hemp; opium; belladonna, etc.	"
Ademollo.	"	Mixed treatment with belladonna.	Died.
H. K. Steele.	"	Same with belladonna and atropia.	Recov'd.
Mr. Hancock.	"	Tr. belladonna gtt. 20, with bromide of potassium.	Died.

Trousseau ranks belladonna as the most constantly efficacious pain-calming remedy. Botkin and Michéa hold that it destroys the excitability of the motor nerves especially, next of the sensory nerves and of the cerebral hemispheres afterwards. Perhaps the views of Simon (Lectures on Pathology, p. 219) should be regarded; he recommends an extended external application of a solution of atropia or belladonna. The peripheral nerve-surface is so paralyzed by it as to render reflex movements impossible. Its exhibition should be governed by these rules: in cases where the pneumogastric nerve evidences a paralyzed heart's action, *small* doses may be combined with the anti-tetanic drug; it acts thus as a cardiac stimulant; large doses under such a condition would only hasten the fatal issue. (Harley believes atropia to be physiologically

the antagonist of the calabar bean and opium.) Ergotine for a similar reason may be combined in the treatment of tetanus with the anti-tetanic relied upon, it stimulating the action of the heart, so that for instance after the exhibition of a cardiac poison, upas antiar, corroval, vao in full doses, etc., the danger to the benefits, derived or expected, resulting from incipient or premonitory paralysis of the heart's muscles, may be obviated by the addition of belladonna, atropia, or ergot. From a case reported by Wilks in *Med. Times* and *Gaz.*, 1864, Jan. 16, digitalis may be included as a tonic for the heart's action. Acting through the pneumogastric nerve as local poisons their secondary effects upon the excito-motor functions of the cord, which they increase, are restricted or negatived in the small doses required and by the continuance of the more powerful primary anti-tetanic agent.

XXII. Aconitum.

Flower of Middlesex Hosp. reports a subacute case which recovered under Fleming's tr. of aconite gtt. iii to v every three hours, and morphia and aconitine hypodermically. My case No. IX gave under the continued use of aconite in full doses, both internally and locally, no improvement. Wm. A. Wickham gave in a fatal case aconite in frequent and increasing doses. De Morgan of Middlesex Hosp. reports a successful issue from excising the cicatrix, and administering strychnine $\frac{1}{10}$ and afterwards $\frac{1}{20}$ gr. every two hours, which he changed to tr. aconit. rad. gtt. v to viii every two hours, with beef tea, brandy and turpentine enemata. The successful case of chronic tetanus by Sedgwick took tr. aconit. gtt. v to

vii and x every four hours, he laid the wound open, removed a piece of woolen cloth, gave brandy six to ten ounces per diem, changed to chlorodyne gtt. xx every four hours with tr. sumbul. gtt. xx (because of flatulence) but reinstated the aconite. Prof. Wunderlich gives two successful instances which were treated with tr. aconit. gtt. xv to lx per diem; (his tincture is less than one fourth of the strength of that according to U. S. P.) one case recovered in twelve and the other in thirteen days.

The internal use of aconite is attended with the same depression and paralysis of the cardiac action as after corroval, vao, a. o., and the remarks under atropia apply also here. As an external application combined with the internal use of other remedies it deserves further trial in subduing hyperæsthesia and pain.

XXIII. Opium. Morphia.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
Macleod, (Crimean war.)	Acute.	Croton oil gtt. i, acet. morph. grs. 2 to 1 every hour with camphor. Opium as much as 15 grs.	Died.
Same.	"	Chloroform. Seeing the "utter futility of chloroform,".....he determined "to abandon it and trust to opium."	"
H. Turner.	Sub acute.	Relied on opium as the "sheet-anchor"	Recov'd.
Same.	"	" " " "	"
Same.	"	" " " "	"
Same.	"	" " " "	"
W. Allingham.	"	Chloroform with relief, etc.; finally opium freely, and stimulants.	"
S. Jones, (St. Thomas Hosp.)	Acute.	Calomel and colocynth; blister to spine; Battley's sedat. sol. f ʒss.	Died.
T. Peck, (St. George's Hosp.)	Sub-acute.	Calomel grs. 3 every 4 hours, with morph. acet. gr. 1; hypodermic injection of morphia gr. ¾, and repeated in four hours.	"
E. E. Millholland.	Acute.	In a mixed treatment, morphia was used internally and hypodermically.	"
Wm. Farrage.	"	Hydrochlor. of morphia with other remedies in combination and succession.	"

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
M. Stanley, (St. Barthol. Hosp.)	Acute.	Aperients, anodynes and opiates.	Died.
S. Job, (Newark Hosp.)	"	Opium treatment, fatal in 24 hours.	"
Same.	"	" " " 48 "	"
Same.	"	" " " 48 "	"
Same.	Sub-acute.	Opium treatment; (trismus only seems to have been developed)	Recov'd.
Jno. Rodgers.	Acute.	Opium grs. 5, camphor grs. 12, in 4 pills, one every 2 hours.	Died.
E. W. Theobald.	"	Inhalation of ether; after 5th day large doses of opium.	Recov'd.
Prof. Frick.	"	Opium and camphor; average daily quantity for 9 days: 80 grs. of opium and 160 grs. of camphor; total, 700 grs. of opium and 1400 of camphor.	"
S. T. Knight.	Trismus nascent.	By a mistake 8 teaspoonsful of a liniment containing 10 drops of laudanum to the teaspoon were given in 24 hours.	"
H. L. Burton,	Sub-acute. (Chronic.)	Calomel and morphia gr. ⅓, and repeated.	"
J. C. Nott.	Trismus.	Morphia gr. ½, hypodermically twice daily.	"
T. S. Wells.	Acute.	Opium and ether; woorara and chloroform.	Died.
J. L. Ord.	Trismus.	Tr. opii, chloroform, *ãã* ℥ iv; a teaspoonful every hour.	Recov'd.
J. F. Thompson.	Acute.	Opiates, etc.; tr. opii gtt. 25, every h.	Died.
W. V. B. Bogan.	Sub-acute.	Local application of ice; morphia.	Recov'd.
E. Hodges.	" (chronic.)	Morphia in powder locally, and in sol. with tr. hyosciam., calomel, tartar emetic, wine, etc.	"
Case V.	Sub-acute.	Opium grs. 3, every 2 to 3 hours; ex. cannab. indic. gr. 1 every hour.	"
Case VI.	"	Chloroform ineffectual; morphia gr. 1 injected in triceps m., repeated 3 times in 2 hours.	"
Case VII.	Acute.	Morphia endermically with other remedies.	Died.
Case VIII.	"	Morphia grs. 2 endermically; chloroform, opiates and morphia.	"
C. R. Greeleaf.	"	Calabar bean with morphia; 54 grains opium in 4½ hours.	Recov'd.
Jas. Moore.	Sub-acute.	Indian hemp; opium grs. 2 every h.; wine, and turpentine enemata.	"
Same.	"	Morphia alone; and ex. belladonna grs. 3; every 4 hours.	"
Same.	Trismus.	Indian hemp, actively; opium, belladonna, etc.	"
Same.	Idiopath.	Indian hemp and opium.	"
Gunkle.	Sub-acute.	Morphia gr. ⅓ to ½ every 2 hours; quinine and whisky.	"
M. Labbé.	Acute.	Opium and chloroform.	Died.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
Dr. Ademollo.	Sub-acute.	Large doses of opium, morphia, belladonna, etc.	Recov'd.
H. K. Steele.	Acute.	Morphine in a mixed treatment.	Died.
G. Derby.	Trismus.	Small doses of morphia, etc.	Recov'd.
H. K. Toland.	Sub-acute.	Morphia gr. 1 over wound every 6 h., tr. cannabis indic. gtt. 20 every 2 hours; after 2 weeks the morph. locally at longer intervals.	"
Northern Hosp. (Liverpool.)	Acute.	Morphine subcutaneously.	Died.
Tyndale and Bryson.	"	Hypodermic injections of morphia, and occasional application of chloroform to spine.	"
H. Z. Gill.	"	Morphia hypodermically; chloroform, etc.	"
Same.	"	Same treatment, with addition of tr. cannabis indic.	"
Morgan.	Sub-acute.	Camphor and opium without benefit; nicotine.	Recov'd.
St. George's Hosp.	"	Atropine 1-40 to 1-30, with morphia 1-4 to 1 3 gr. subcutaneously.	"
Same.	"	Same treatment.	"
Prof. Busch.	Acute.	Curare; morphia.	"
Same.	"	Morphia gr. ¼ hypodermically, every two hours.	"

The reports from the French hospitals in the Crimean war speak favorably of the effects of opium. This statement, however, must be considerably modified, because of their intermixture of trismus and subacute with acute tetanus. Baron Larrey also recommended opium and camphor, and Romberg relies on opium and surgical adjuncts.

The undoubted physiological actions of opium are that of an anodyne, hypnotic and soporific; its *modus operandi*, however, is but little understood. Entitled still to the foremost rank among anti-tetanic remedies, I will only advert to two cases illustrative of its action: the case of acute traumatic tetanus reported by Dr. Van Bibber, is a type of this disease; the judicious but unflinching increase of the remedy without regard to the quantity given, but with reference to the effects

obtained and to the tolerance of the system remaining should mark the exhibition of all therapeutic agents in so rapid and fatal a disease as tetanus. The disproportion between the effects of the remedy and the tolerance of the body under a continuance of spasm is the guide for a quantitative treatment and the difference between the quantity given and its absolute effects on the one hand and its relative effects on the other, form the measure of the amount of nervous excitation to be remedied. The second case to which I wish to allude is that reported by Drs. Tyndale and Bryson, * (compare also a parallel case in *Am. Journ. Med. Sc.*, 1866, July, p. 130) of which, however, I have only these *data:* "a man aged 35 years was admitted with tetanus, which prevented his speaking and swallowing; had much pain in the neck and jaws with risus sardonicus fully developed. The attack followed a blow on the head ten days previously. Treatment: hypodermic injections of morphia with chloroform to spine. Result: death in five or six days." The majority of chronic brain affections met with in the daily practice are due to local injury of more or less grave import, a fall or a blow upon the head, a sudden shake, etc., not necessarily resulting in fracture, laceration or extravasation, but rather accompanied with a molecular disturbance of the brain-mass in and upon itself. A peculiar sensation, swimming before the eye, a pricking of pins in the extremities, etc., constitute usually the whole account given by the patient of his then condition. In grave consequences, such as tetanus in the above case, the disturbance is evidently transplanted or extended upon the spinal cord

(* *Cinn. Lancet and Obs.*, 1869, Sep., p. 556.)

perhaps owing to certain systemic peculiarities, and the product of morbidity from that source is really the disease itself For should it be presumed that tetanus in this instance could not have been of a retrogressive character, the primary and preceding degree of inflammatory action would allow of no doubt. On the contrary, however, the symptoms of tetanus in this case must be looked upon as depending on a cerebral anæmia or arterial contraction. To produce the required narcotic effect of opium during the nervous excitement of such character would demand the full toxic dose. The agent called for seems to have been belladonna and active local irritants. The state of the cerebral mass, instead of being preceded by signs of active inflammation, is sometimes, and usually after injuries like the above, (blows and slight injuries,) accompanied by a peculiar morbid action, neither inflammatory as understood by arterial hyperæmia, nor by atrophy from waste of substance and deficient blood-supply. The appearances have been termed a sub-acute inflammation, and its transient effects upon the parts primarily involved being characterized by few autoptic lesions, and altogether overbalanced by the superinduced spinal symptoms, have led to a disregard of its importance in the disease treated. (Compare the cases of Drs. Bodine and Keen above given.) Battley's solution of opium given by S. Jones (St. Thomas' Hosp.) is devoid of all reliance as an opiate; it being in addition a nostrum, its employment becomes highly improper in any case, most especially in a disease like tetanus.

The hypodermic injection of morphine is liable to failure, as indeed, are all other remedies similarly exhibited. Wells failed in two instances, in the first the

spasm remaining unaffected, and in the second, in which the spasm was never violent and ceased altogether during sleep, a soporific effect of only two hours was the result. It must, however, be taken in consideration that nearly all therapeutic agents (Herman) especially curare and the poisons of serpents, act inadequately if introduced into the stomach or under the skin. No proportion, consequently, can be said to exist between an internal and endermic dose of a remedy. The following facts in regard to a hypodermic treatment I would here make prominent:

1. Remedies without avail internally, act decidedly if so injected.

2. Hypnotics act at once, if the quantity used be sufficient and the exitation to be overcome is moderate.

3. They act after a lapse of time if the second indication is increased; local pain, however, ceases generally much sooner.

4. They fail to act with small quantities used and much cerebral excitement, pain and spasm to be overcome.

5. Hypodermic injections are especially useful in tetanus from the difficulties interfering with deglutition.

6. The vehicle used in the injection should be as non-irritative as possible: water, glycerine, dry powder, acetic acid diluted, alcohol, etc., are solvents preferred in the order named.

7. Serious consequences sometimes arise from subcutaneous injections, but the usual and most common local effects are disproportionately counterbalanced by the benefits derived.

According to Ch. Hunter, late House-surgeon to St. George's Hospital, chloroform may be safely injected

with prompt hypnotic and anodyne effects. Like chloral, it produces narcotism, lasting many hours, not succeeded as after its anæsthesia by inhalation, by any stage of excitement. A further confirmation of such results would entitle chloroform anew to trials as an anti-tetanic. I will add that hypodermic injections sometimes fail to act on repetition, as in neuralgic pains which are not often as promptly relieved by a second as they were from the first injection. This circumstance has led me to consider a certain nerve locality in a paralyzed state, at least, in so far as the absorption of further injections is concerned, which is impaired or suspended. In my sixth case the three consecutive injections were made not only with an increased quantity but upon parts remote from each other.

The internal use of opium is advantageously combined with large doses of camphor, as in the case of Van Bibber. Professor Rochester has reported two successful cases of strychnia poisoning in which he relied upon camphor, and asks the question, "might it not possibly be successfully used in cases of traumatic and idiopathic tetanus?"

XXIV. Cannabis indica.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
Case I.	Acute.	Cannab. ind. gr. 1 every 1 to 1½ hour with quinine, grs. 2. Took in 36 h. 146½ grs. of the extract.	Recov'd.
Case II.	Sub-acute.	Ex. cannab. ind. ½ to 1½ grs. every one to two hours with quinine.	"
Case III.	"	Same treatment.	"
Case IV.	"	Same treatment.	"
Case V.	"	Opium 3 grs. every two or three hour; ex. cannab. ind. gr. 1 with quinine grs. 2, every hour.	"
Case VII.	Acute.	Morphia endermic., cannab. ind., chloroform and nicotine.	Died.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
Case IX.	"	Tr. aconit. r. gtt 15, quin. grs. 2½ every three, and double quantity every one hour; frictions with aconite lin.; cannab. ind. 1½ to 4 grs. internally, and 1 gr. hypodermic.; took 185 grs. of the ext.	Recov'd.
E. F. Millholland.	"	In the beginning only ex. cannab. ind. gr. 1 every two to one hour.	Died.
W. Farrage.	"	After other remedies, cannab. ind. grs. 6, ex. hyosciam., assafœt *àà* ʒss in 12 pills, 1 every h., tr. cannab. ind. gtt 30 every two hour, etc.	"
Same.	Sub-acute.	Tr. cannab. ind. gtt 10 to 20 every h.; calomel; counter irritants.	Recov'd.
Jno. Rogers.	" (idiop.)	Opium grs. 5, camphor grs. 12 in 4 pills, one every two h.; ex. cannab. ind. grs. 4, camphor grs. 12 in 4 pills, 1 every ¼ h.; wine, croton oil; enemata.	Died.
Ch. O'Donovan.	Acute.	Cannab. ind. throughout, took 1437 grs. of ex. in 22 days.	Recov'd.
Hague.	Sub-acute.	Tr. cannab. ind. ʒss every h.; croton oil and enemata.	"
E. W. Skues.	" (Chronic.)	Ex. cannab. ind. gr. ¼ to 2 every hours; wine; took daily 4 to 18 grs. (patient 9 years old.)	"
C. R. Greenleaf.	Sub-acute.	For 2 days ex. cannab. ind. gr. ½ to 1 without benefit; other treatment.	"
Jas. Moore.	" (Chronic.)	For 3 days tr. cannab. ind. gr. 1 to 3; lost its influence.—(Why?)—result not given.	
Same.	Trismus.	Narcotics with indian hemp.	Recov'd.
Same.	Idiop.	Opium and indian hemp.	"
H. K. Steele.		Mixed treatment with indian hemp.	Died.
H. H. Toland.	Sub-acute. (chronic.)	Morph. gr. 1 to wound; tr. cannab. ind. gtt 20 every 2 h. for 2 weeks; duration 4 weeks.	Recov'd.
Fayrer.	" (chronic.)	Chlorof., cannab. ind., camphor and opium, duration 7 weeks.	"
Theo. Mack.		Indian hemp; amputation.	Died.
H. Z. Gill.	Acute.	Morphine, chloroform, tr. cannab. ind., for 6 h. narcotized by chloroform, whisky and indian hemp.	"
Same.	"	Chloroform, cannab. ind.; died on second day.	"
S. G. Chuckerbutty.		13 cases; cannab. ind. fairly tried in 8 cases of which one died. Tr. cannab. ind. gtt. 30 to 40 every 2 to 3 hours.	6 Died 7 Re'd.
W. B. O'Shaughnessy.		Introduced cannab. ind., was successful in doses of 2 to 3 grs. every 2 h. until its intoxicating effects were produced; gave as much as 1 dr. of the tr. every ½ h.; had a wonderful success.	
Poland. (Guy's Hosp.)		Had no success with cannab ind.	
F. Hinkle.	Hysteric. tetanus.	Mixed treatment, ex. cannab. ind. most prominent remedy.	Recov'd.
I. Ashhurst.	Complic. tetanus.	Ex. cannab. ind. ¼ gr. 4 times daily; mixed treatment.	Died.

Cannabis indica (the Gunjah of India and the Haschisch of Hindostan and Persia) owes its medicinal properties to the resinous secretion contained in it. The great diversity in its reliability is due to the many and really spurious kinds usually sold, among which the Italian cannabis ranks foremost as the easiest of access. The resin and extract obtained from India possess the therapeutic virtues claimed. In its purity its action is directed first to the motor nerves, whence it is transmitted to the sensorium and nerves of sensation as a hypnotic. Its secondary effect is a paralysis of the voluntary muscles. As a hypnotic it is regarded by Fronmüller to have no dependent excitement of the vascular system, nor does it produce a stoppage of the secretions. He denies a consecutive paralysis. In order to convey a practical appreciation of its reliability of action I quote the following: (Fronmüller in *Am. Jour. M. Sc.* 1861, April, p. 554)—"Out of the 1000 cases (*experimented upon*) it was found that the narcotic property of the hemp was completely developed in 530, partially in 215 and little or not all in 255. With the extract the best effects were produced—

145	times	with a	dose of	12 grains.	17	times	with a	dose of	2 grains.
64	"	"	8	"	15	"	"	14	"
63	"	"	10	"	14	"	"	20	"
35	"	"	16	"	13	"	"	6	"
22	"	"	3	"	12	"	"	5	"

He concludes that of all known medicines which cause stupefaction, Indian hemp produces a narcotism most completely supplying the want of natural sleep without great excitement of the vascular system, etc. . . . . that it may be given in all acute inflammatory diseases, that it may be alternated with opium, where it (opium) has failed, and that the lowest dose of

the alcoholic extract to produce sleep is 8 grains, given in pill-form of one grain each." Of course, these 8 pills are to be given successively. Cannabis indica may be regarded as a cerebral sedative, indicated especially in that form of tetanus which is complicated with cerebral excitement and is useful therefore in delirium tremens, as I have found in two instances.

The results of Fronmüller, the opinion of Chuckerbutty, a. o.,(that a want of success with cannabis indica is owing to small and inefficient doses and to the inferior article used, or to its combination with other drugs, so that neither could be expected to exert its full influence) and a few isolated cases of judicious treatment place Indian hemp among the best of all known antitetanic remedies. The plan of treatment pursued by Mr. Skues, and especially the case of Dr. O'Donovan, though a heroic medication, are analagous to the opium medication of Prof. Frick, and of Dr. Knight, who exhibited unintentionally an overdose of laudanum to an infant with perfect success. The rule in tetanus is death from want of therapeutic action, and few patients are killed with medication—a homœopathic course of treatment is especially in tetanus innocent of shortening life by commission, but the error in omission is palpable and thereby augmented. As high an authority as Watson endorses the treatment of an Edinburgh physician, who gave to his own wife, while suffering under a tetanic affection, over 40,000 drops of laudanum, which is more than four ounces a day, and in all more than two imperial quarts. In my cases, now reported, after determining the remedy to be used, and finding it well borne, I prescribed the dose and the time of its administration with the effects produced; and I do not hesi-

tate to pronounce such a course as the only one at all promising. A combination of two or more remedial agents is only warranted after a reasonable quantity has been ineffectually given, and then I would prefer either a change in the mode of exhibiting it, from the internal to the endermic use, and *vice versa*, or a complete suspension for a time, until an equivalent has taken its place with a like failure, or has rendered the system susceptible to a renewed action of a moderately increased dose.

XXV. Calabar Bean. (*Physostigma.*)

Th. R. Fraser reports nine recoveries and two deaths, and recommends the extract in pill-form, or 32 grains solved in one ounce of diluted alcohol. He commences treatment by subcutaneous injection to be repeated until a decided effect is obtained; then by the mouth in a dose three times as large. In severe cases he persists with the hypodermic use, for an adult ⅓ gr. being sufficient, repeated in two hours, when the effects of the first injection have generally passed off. As vehicle he uses water.

E. Watson gives the following cases and authorities:

	Recoveries.	Deaths.
Alexander,	2	0
Campbell,	1	0
Bourneville,	0	1
Ashdown,	1	0
Bouchat	0	1
Macarthur,	1	0
Boslin and Curron,	1	0
His own cases,	4	6

To illustrate his treatment, I give a synopsis of two successful cases:

1. A. W., age 11, acute tetanus; calomel and jalap.;

cannab. ind.; Squire's gelatine paper (1 square) containing ex. calabar bean; in 1½ hours 2 squares; in 4 hours 3, and in 3 hours 2 more squares; 2 squares every hour during night; ex. calab. bean grs. 12 and vinum alb. 1 ounce, 5 drops = ⅛ gr. every half hour: after two grains were taken only momentary twitches; narcotism; continued calabar bean as needed.

2. John, age 13, sub-acute form; tr. calab. bean gtt. 5 every 2 hours, with benefit always for ½ hour; sleeps; gtt. 4 every hour; pupils contract; gtt. 5 every 2 hours and two doses at night; then every 3 hours, again increased to gtt. 6 every 2 hours and during night; lastly gtt. 6, 3 times daily.

A. Boutflower gives a recovery from traumatic tetanus under morphia ½ gr. subcutaneously; calabar bean 1 gr. internally, and ½ to 1⅛ grs. hypodermically; finger amputated; received in 9 days 40⅞ grs. by the skin, and 49½ grs. by the mouth. *C. C. Sherard* gave in a fatal trismus neonat. ex. physostigm. $\frac{1}{12}$ gr. repeated every hour, continued remedy every 30 minutes, and after 3 doses every 20 minutes, then ⅛ gr. every 20 and 10 minutes; remedy had no effect whatever; gave 4 grs. of the extract. *B. Duffy's* successful emprosthotonos received ⅛ gr. of ex. calab. bean endermically every 3 hours for one day; nausea; injection every 2 hours, again nausea, etc., and spasm yielding on the 6th day. *Wm. Haining* had a successful traumatic tetanus with the internal use of calabar bean 1 to 3 grs., and subcutaneously ½ gr. gradually increased to 6 grs.; 41 grs. were injected in one day producing the full physiological effects of the remedy; total amount taken, over 10 drachms and over 140 punctures. *Alexander*, from whose notes the eight cases by Watson are compiled,

remarks that one of the fatal cases included was not treated at all, as he only doubtfully swallowed one dose and died. *Andrews* exhibited in a recovery from a sub-acute tetanus, after quinine 8 grs. every hour and anodynes, the tr. calab. bean gtt. 10 every 4 hours, alternately with 10 grs. quinine; after 24 hours gave gtt. 15 every 2 hours, and gtt. 40.; finally in teaspoon doses with quinine 8 grs. every 4 hours. *F. Mason's* fatal case of acute tetanus was treated with the ordeal bean until its physiologic effects were produced, also a like instance treated by *Ridout*, received $\frac{1}{6}$ to $\frac{2}{3}$ gr. every hour for 13 days without success. *J. T. Newman* gives a recovery from acute tetanus with ex. ealab. bean $\frac{1}{3}$ gr. hypodermically. *Ch. R. Greenleaf* had success with this remedy by the mouth and hypodermically for 22 days; *a failure* with the $\frac{1}{8}$ gr. every hour; *a second recovery* with the $\frac{1}{6}$ to $\frac{1}{3}$ gr. every half hour, and $\frac{1}{3}$ to 1 gr. every 3 hours hypodermically, using from the 12th day this drug in the form of suppositories; his fourth case *died* under ex. calab. bean $\frac{1}{2}$ gr. every 2 hours, it manifesting its physiologic effects clearly; and his *fifth case* recovered, giving calab. bean and morphine to an equivalent of 54 grs. opium in $4\frac{1}{2}$ hours. *Anderson* reports the fatal case of Dr Jno. Davis with $\frac{1}{16}$ to $\frac{1}{4}$ gr. for 6 days internally, and $\frac{3}{8}$ to $\frac{1}{2}$ gr. for another six days hypodermically. *A. M. Brown* gives a fatal issue with ex. calab. bean $\frac{1}{4}$ gr. every hour, increasing every third dose to $\frac{1}{2}$ gr. than $\frac{1}{2}$ gr. every hour, and hypodermically every 15 minutes until $2\frac{1}{2}$ grs. were used; etc. *Brown* relates the treatment of a sub-acute case then in treatment, in which he gave the ex. calab. bean internally, and $1\frac{1}{3}$ gr. (maximum) hypodermically for 10 days, also the tr. in an equivalent of $2\frac{1}{2}$ grs. of the extract every 2 hours. *H. K. Steele* in his fatal case

regards the calab. bean as of the least value. *Holthouse* gives one recovery and one death from doses of 3 grs. every 2 hours, and once 4½ grs. *P. H. Watson* had 2 fatal cases, in each of which the calabar bean produced its full effects.

The calabar bean. ordeal nut, or esere of calabar, has been fully tested in its physiological effects. If the opinion of Dr. Fraser is received, then ⅓ grain subcutaneously must be an equivalent of 3 × ⅓, or one grain internally. This dose effects the system generally up to two hours, when the exhibition should be repeated—in tetanus, however, a quicker succession or a larger dose is to be recommended. The first case of E. Watson proves how far the tolerance of the body may be guided in a uniform medication of gradually increasing doses, but a treatment of ⅙ to ⅓ grain internally and ⅓ gr. hypodermically, and of $\frac{1}{16}$ to ¼ gr. internally, and ⅜ to ½ gr. hypodermically, as given in a case reported, does not accord either with itself or with the object to be gained.

The primary action of the calabar bean consists in a direct and powerful diminution of the reflex action of the central nervous system, (Fraser in *Am. J. M. Sc.*, 1868, April p. 502,) and may be detailed as follows: 1. Contraction of the pupils. 2. Paralysis of the motor nerves without affecting the muscular irritability and the intellect. (In other words its action is upon the spinal cord.) 3. It destroys life by paralyzing the respiratory muscles, and is a respiratory poison. (*vide* case I of E. Watson.) 4. It may weaken, but does not stop the heart's action, and is not a cardiac poison. (Hence not as antagonistic to atropia as Dr. Harley affirms.) Calabar bean excites the lachrymal and sali-

vary secretions and is *collectively* allied to conium and woorara.

XXVI. Curare.

Authority.	*Form of Tetanus.*	*Remedies and their doses exhibited in the order named.*	*Result.*
W. H. Wickham.	Acute.	Aconite in frequent and increasing doses; subcutan. inject. of ex. woorara and repeated; brandy and quinine; cold to spine.	Died.
Lloyd.	"	Woorara hypoderm. every 15 to 20 m. 1-20 to 1 gr.; used 6 grs.	"
T. S. Wells.	Sub-acute. (chronic.)	Woorara hypo. and epiderm.; 6 grs. in 6 days.	Recov'd.
Same.	Acute.	Assafœt. injections per an.; woorara inoculated in both arms.	Died.
Same.	Sub-acute.	Opium and ether; woorara; cloroform anæsth.	"
E. T. Milholland.		Corroval subcutan. after other rem'dies	"
Busch.		Subcut. inj. of 1-50 to 1-30 gr. of pure curare every 2 hours, in one case the recovery was ascribed morphia.	6 Re'd. 5 Died
Isambert.		Treatment with curare.	Died.
Same.		Same.	Recov'd.

T. Spencer Wells refers also to two chronic cases on the Continent (Europe) successfully treated by Vella, Maneo and Chassaignac and one additional in England, successfully treated with curare. *Demme* (Austrian army) had 8 recoveries and 14 deaths, but gives neither type of disease, dose, nor mode of exhibition. The cases of Prof. Busch may have been sub-acute. Continental reporters, especially the French, do not discriminate as carefully as they should, and my remark upon Busch's cases is based upon his statement, that in very acute cases curare is unworthy of confidence, and that then he gives generally the preference to other remedies, or to curarine. Profs. Vella and C. Bernard have tested the antagonistic powers of woorara and strychnine, and upon their affirmative report, M. Thiercelin applied the former in the counteraction of artificially produced convulsions and with marked success.

Woorara, curare or urari is represented by two distinct varieties (Harley speaks of five specimens of different strength because made by different tribes): corroval and vao or bao. The *former* is the most powerful of the curare kind ; acts first upon the heart through the blood and produces paralysis of its muscles ; then upon the voluntary and reflex movements depending upon the heart and upon the sensory and motor functions, destroying muscular irritability and paralyzing especially and primarily the sympathetic nerve. In this respect it has a similar effect with upas antiar, as we shall hereafter see, which, however, is its inferior in toxic activity, and both are liable to fatal results when exhibited under symptoms of cardiac inaction. The *second* and milder variety vao induces experimentally paralysis of the extremities, loss of reflex action and of respiration, and may be said to give: 1, Increase of the heart's action; 2, Paralysis of its muscles in rapid, and paralysis of the voluntary muscles in slow poisoning, and 3. Paralysis of respiration and circulation, affecting the sensory nerves first and the motor afterwards.

The action of urari is rapid (according to Prof. Kölliker) when injected into the blood or a wound, and slower through the mucous membranes. He, (Kölliker) believes its action to be first upon the peripheric nerves, then upon the brain, and lastly upon the spinal cord, which retains its reflex activity for some time. If it is agreed that the paralysis of involuntary muscles proceeds from the pneumogastric nerve (heart) to the sympathetic (iris), thence to the capillary vessels and splanchnic nerve (peristaltic motion), we are forced then to look upon *woorara as little calculated to take its place among anti-tetanic remedies*, especially also if we compare

the microscopic investigations of Jacubowich, (who after poisoning with curare discovered ruptured nerve-cells and broken cylinders,) with the post-mortem appearances of the spinal cord after tetanus above detailed. Some writers differ from these views (*vide British Med. Jour.* 1867, June 22, article "Action of Curare") in exempting the cardiac fibres of the pneumogastric and splanchnic nerves from all inhibitory action. To recapitulate, the uncertainty in the action of woorara on account of impurity and variety, its action upon the brain and heart with variable and indefinite violence, and the great difference of opinion from experimental sources (Harley, believing the motory nerves first and the sensory not at all or very late paralyzed, and Hammond and Mitchell teaching that, (*a*) corroval abolishes both the sensory and motor functions, and (*b*) that vao paralyzes the sensory nerves first, and the motor nerves afterwards)—combine to render woorara an unsafe remedy, but one deserving of further attention. It is contra-indicated in all cases manifesting a metastatic tendency upon the lungs and air passages, since it suspends the respiratory act and thus conditions or hastens death by asphyxia. C. Bernard has observed that a nerve tissue is characterized by physical, chemical, and physiological properties, and that the action of woorara and all its kindred poisons is directed upon the physiological. Tetanus is due to the physical combined perhaps with the chemical property of the nerve tissue and a remedy, in counterbalancing one with the other, is said to be curative, when by it a certain degree of positive or negative physiological disturbance is brought in antagonism with an equal degree of a physical or chemical character. In many

instances, consequently, the therapeutic virtue of an agent acts either in an obscure and undefined manner, or by a mere numerical strength, by which a certain amount of excitability or irritability is set aside by the greater exponent of a similar cause, which has a tendency to impress itself upon the nerve-center *from a different direction.* Thus, for instance, strychnine may act in its exhibition for the cure of tetanus. The curative value of a remedy, which the experience of most practitioners will admit, is too often restricted in practical application, it being pronounced by one almost a specific, and by another next to worthless. Much of this must be ascribed to a faulty reflection of the physician at the bedside, who remembers the experiments of the physiologist and forgets that the tolerance of a disease for its therapeutic agents is pathologically different from one purely experimental.

It seems to me proper to add here a short notice of a poison, which in many respects is closely allied to the one now considered. *Upas*, an arrow poison among the inhabitants of East India, is supposed to be obtained from arbor toxicaria (Rumph) called by the natives Ipo. Leschenault speaks of a milder poison, *upas antiar*, and of an *upas tiente*, derived from antiaris tox. and strychnos tiente, the former without convulsions until just before death, and the latter with strong tetanic spasm. Upas antiar produces also vomiting, languor and irregularity of and reduction in the heart's action, death being the result of paralysis of the muscles of the heart. Respiration, however, and the cerebral functions remain undisturbed. It is similar in its action with corroval, destroys the properties of the muscular fibre, and arrests the contractions of the heart. The

toxic effects are, 1, paralysis of the muscles of the heart, 2, of the voluntary muscles, and 3, of the nerves. The upas tiente produces tetanic convulsions, rigidity of muscles and general exhaustion, its action being expended over the brain. The active principle, according to Pelletier, is strychnia combined perhaps with igasuric acid, while the antiar contains the antiarin, a bitter and in alcohol and water soluble alkaloid. Its action is, 1, upon the spinal cord and brain, paralyzing the voluntary muscles, and 2, upon the muscles of the heart. The usual intermixture, however, of these two poisons has transferred the action of one upon the other, and their antagonism is only established in their purity. The upas tiente resembles, consequently, not only strychnine, but also certain inorganic salts of cyanic acid, for instance the sulphocyanide of potassium, leaving the muscular tissue intact, but resulting in tetanic contractions and paralysis through the brain. Upas antiar and tiente claim an equal attention with corroval, vao and strychnia in the treatment of tetanus.

Before concluding these observations, I would repeat the injunction, that the course of this disease should be taken in consideration as not only modifying the choice, but also the exhibition of the remedy. A routine of treatment is not applicable to tetanus. In progressive tetanus a greater care in the selection of the anti-tetanic remedy should follow a more doubtful and complicated diagnosis, and the employment of the ophthalmoscope may be highly useful in locating cerebral lesions. Its careful and repeated use (and even in tetanus it can be used if proper precautions are observed) is capable of indicating an organic disease of the encephalon, and

acute meningeal affections of the spinal cord and brain from the morbid changes of the optic nerve and retina, neuritis and neuro-retinitis. In tetanus both eyes are generally alike implicated, and a papillar and retinal hemorrhage evidence serious disturbances in the cerebral blood circulation from cerebro-spinal lesions.

My resumé on the treatment of tetanus is as follows:

1. Division of a nerve can be of benefit only if practiced very early; amputation is similarly practicable, but generally of little avail, because decided symptoms have already been developed.

2. Local applications and general attention to the wound are of the utmost importance to prevent complications, and to insure local quietude and avoid derived irritation. Fresh air is for a like reason instrumental in the successful management of tetanus.

3. General and unconditional quiet and rest around the patient are enjoined; all noises, even to speaking in an elevated tone, are to be interdicted, remembering that sudden death has often followed after exciting impressions.

4. Supporting nourishment in concentrated form, and stimulants should supply the exhaustion in a disease, which is not characterized by disorganization of any vital organ.

5. In cases where the patient is plethoric, the pulse full but not frequent, and where there exists a disposition to, or symptoms of, isochronic inflammatory action, venesection, leeching and cupping are indicated in the outset, and shall be promptly but carefully practiced. The subsequent action of the therapcutic agent is thereby rendered more certain.

6. Purgatives of prompt action are necessary in all instances, and should be repeated and interchanged until a desired effect is obtained, aided by enemata if demanded.

7. The selection of the anti-tetanic should be made according to the most promising statistics on tetanus, and with these references:—

(a). As corroval and its kindred remedies act upon the heart by paralyzing its muscular action, the cardiac condition should be carefully diagnosticated, its normal status by commemorative evidence and symptoms, —the tendency of the spasm, flushed face, etc., with the general phenomena of functional or organic disease—and the effect of the remedy, especially in cases in which no morbid action of the heart was found, but in which medication tends towards interfering with the cardiac action, should be considered.

(b). When the remedy in a quick but cautious exhibition sustains itself by the systemic tolerance, then the same should be continued in adequate doses until its full therapeutic virtues are elicited.

(c). The remedy should be given in a form easiest taken up in the system, to insure its action as soon as possible, to avoid accumulative effects, and with due regard to the difficulties of deglutition.

(d). It should be continued in its full effects upon the system until the abnormal condition of the spinal cord and nerves has been exhausted or annihilated.

8. As standard remedies, opium, cannabis indica and the calabar bean are entitled to the greatest confidence (in their purity of preparation), and their mode of exhibition is exemplified in the cases reported by

Calvert

Frick, Knight, Greenleaf and V, VI, and VIII, reported by me (opium), O'Donovan, Chuckerbutty, O'Shaughnessy and my cases, I, III, IV and IX (cannabis indica), and Fraser, Watson, Boutflower and Haining (calabar bean).

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