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Modern Surgery - Chapter 12. Tetanus or Lockjaw

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XII. TETANUS, OR LOCKJAW.

TETANUS is a microbic disease invariably preceded by some injury and characterized by spasm of the voluntary muscles. The wound may have been severe, it may have been so slight as to have attracted no attention, it may have been inflicted upon the alimentary canal by a fish-bone or other foreign body, or may have been situated in the nose, urethra, vagina, or ear. It is possible that infection can occur through a mere abrasion of a mucous membrane. The so-called idiopathic tetanus is either not tetanus at all, or the term expresses the fact that we have not found the traces of an injury which did exist. Tetanus arises most frequently after punctured or lacerated wounds of the hands or feet, and before it appears a wound is apt to suppurate or slough; but in some instances the wound is found soundly healed. The toy pistol produces a peculiarly dangerous wound. The fact that the bacillus of tetanus is anaërobic explains the comparative frequency with which punctured and lacerated wounds are attacked, for in such wounds the bacilli are deeply lodged in recesses or cavities into which air does not penetrate or are covered with discharges which exclude air. Suppuration favors the growth of tetanus bacilli, because the pyogenic organisms consume oxygen. Occasionally, though fortunately very rarely, tetanus follows vaccination. It is essential that vaccine virus should be carefully selected and prepared. When care is taken, the operation is absolutely safe. When tetanus follows vaccination, it arises from infection of the wound either at the time of vaccination or, as is common, at a later period from scratching or some other fouling. Tetanus may appear within twenty-four hours after an accident, but it may not arise until many days or even several weeks have elapsed. Samuel D. Gross, in his "System of Surgery," speaks of one case occurring in a man five weeks after injury, and another in a girl four weeks after injury. It prevails more in certain localities than in others. Colored people are very susceptible, and the disease may exist endemically. Tetanus is due to the growth in a wound of a bacillus which was first described by Nicolaier and was first cultivated by Kitasato. It is the most widely distributed of all the pathogenic bacteria. It is very difficult to cultivate and cannot be cultivated at all unless air is absolutely excluded. Tetanus bacilli or their spores are found particularly in garden soil, in the dust of walls, walks, and cellars, in street dirt, and in the refuse of stables. There is much suggestive evidence that virulent tetanus bacilli come from the intestinal canal of animals; that organisms lose their virulence when long outside of the intestinal canal; and that the highest degree of virulence is obtained by organisms which have passed frequently through intestinal canals. The above view is known as the fecal theory and is strongly advocated by Somani.*

In tetanus the bacilli do not enter into the blood, but toxic products produced by them pass into the circulation, become fixed in the nerve-cells of the brain and cord, and produce the symptoms of the disease. Hence tetanus is an intoxication and not an infection, and a drop of blood of an animal with tetanus, if injected into another animal, will not produce the disease. Tetanus toxin poisons the nervous system as would strychnia or

* "Verhandl. d. 10. internat. med. Cong.," Berlin, 1890, Bd. v, Abth. 15, p. 152.

some other vegetable alkaloid. It is probably the most powerful of known poisons. It has been estimated that $\frac{1}{278}$ of a grain is sufficient to kill an adult weighing 165 pounds ("American Medicine," Nov. 30, 1901). The great power of the poison is shown by the report of Dr. Nicholas's case ("Comptes rendu de la Société de Biologie," 1893). Dr. Nicholas had been using a syringe to inject filtered cultures of the bacilli of tetanus and he accidentally pricked his finger with the needle. In four days tetanus began, and the Doctor barely escaped with his life in spite of the fact that the fluid was free of bacteria and the dose of toxin was extremely minute. The nature of the virulent poison which is produced at the seat of inoculation is uncertain: Some believe it to be alkaloidal, like the vegetable alkaloids; others maintain that it is an enzyme or ferment (Nocard, Courmont, and others).

Symptoms.—**Acute tetanus** begins within ten days of an accident. The usual period of incubation is from three to five days. In most cases the first symptom is stiffness of the jaw on opening the mouth. In some cases the first symptom is stiffness of the neck, and the patient believes he has "caught cold." In any case the neck soon becomes stiff, and finally both the neck and jaw are as rigid almost as iron. The fixation of the jaw is called *trismus*. The muscles of deglutition become rigid on attempts at swallowing. The muscles of the back, legs, and abdomen are thrown into tonic spasm, but the arms rarely suffer. If the infected injury is on the hand or foot, that extremity usually is found to be rigid. Spasm of the face muscles causes the *risus sardonius*, or sardonic smile (contraction particularly of the *musculus sardonius* of Santorini). The contraction of the muscles of the back is often so powerful as to bend the patient into a curve like a bow and allow him to rest only on his occiput and heels. This condition is known as *opisthotonos*. If he is bent forward, so that the face is drawn to the legs, it is called *emprostotonos*. If his body is curved sideways, it is designated *pleurostotonos*. An upright position is *orthotonos*. The spasm may be so violent as to cause muscular rupture.

The characteristic condition in tetanus is one of widely diffused tonic spasm, aggravated frequently by clonic spasms arising from peripheral irritations. These irritations may be draughts, sounds, lights, shaking of the bed, attempts at swallowing, contact of the bed-clothing, the presence of urine in the bladder or of feces in the rectum, or various visceral actions. The clonic spasms begin early in the case and become more frequent and more violent as the disease progresses. The muscles become more rigid and the attitude produced by the tonic contraction of the muscles is temporarily exaggerated. The forcible contraction of the jaw may loosen or break teeth. The spasms of the diaphragm, of the glottis, and of the muscles of respiration may produce death and always produce great dyspnea. The man laboring under a tetanic convulsion presents a dreadful picture; he is bent into some unnatural attitude, the face is cyanotic and covered with drops of sweat, the lips are covered with froth which is often bloody, the eyes bulge and are suffused, and the countenance expresses deadly terror and suffering. The agonizing "girdle pain" so often met with is due to spasm of the diaphragm. Each clonic spasm causes a hideous scream by the constriction of the chest forcing air through a contracted glottis. During the progress of the disease constipation is persistent, and retention of urine is the rule (because of sphincter spasm).

The mind is entirely clear until near the end—one of the worst elements of the disease. Swallowing in many cases is impossible. Talking is very difficult and it is impossible to project the tongue. The muscles throughout the body feel very sore. The temperature may be normal, but it is usually a little elevated, and always rises just before death. Hyperpyrexia sometimes occurs (108°–110° F.), and the temperature may even ascend for a time after death. Insomnia is obstinate. In 80–90 per cent. of cases of acute tetanus death occurs in the course of two or three days. If a patient lives a week, his chance of recovery is good. Death may be due to exhaustion or to carbonic-acid narcosis from spasm of the glottis or fixation of the respiratory muscles.

Chronic tetanus comes on late after a wound (from ten days to several weeks). The symptoms are not so severe as in acute tetanus. The muscular spasm is widespread, but it may not be persistent, intervals of relaxation permitting sleep and the taking of food. Chronic tetanus may last some weeks, and in about 40 per cent. of the cases the disease can be cured. *Trismus neonatorum* or *trismus nascentium*, the lockjaw of the newborn, is due to infection of the stump of the umbilical cord, and is practically invariably fatal. *Hydrophobic tetanus*, *head tetanus*, or *cephalic tetanus*, is a condition in which the spasms are confined chiefly to the face, pharynx, and neck, although the abdominal muscles are usually also rigid. It follows head-injuries, and gives a better prognosis than does general tetanus.

Diagnosis.—Tetanus may be confounded with strychnin-poisoning, with hysteria, with tetany, or with hydrophobia. Wood's table makes the diagnosis clear between tetanus, strychnin-poisoning, and hysteria.*

TETANUS.	HYSTERICAL TETANUS.	STRYCHNIN-POISONING.
<p>Muscular symptoms usually commence with pain and stiffness in the back of the neck, sometimes with slight muscular twitching; comes on gradually. Jaw one of the earliest parts affected; rigidly and persistently set.</p> <p>Persistent muscular rigidity very generally, with a greater or less degree of permanent opisthotonos, emprosthotonos, pleurosthotonos, or orthotonos.</p>	<p>Commences with blindness and weakness.</p> <p>Muscular symptoms commence with rigidity of the neck, which creeps over the body, affecting the extremities last. Jaws rigidly set before a convulsion, and remain so between the paroxysms.</p> <p>Persistent opisthotonos and intense rigidity between the convulsions and after the convulsions have ceased, the opisthotonos and intense rigidity lasting for hours.</p>	<p>Begins with exhilaration and restlessness, the special senses being usually much sharpened. Dimness of vision may in some cases be manifested later, after the development of other symptoms, but even then it is rare.</p> <p>Muscular symptoms develop very rapidly, commencing in the extremities, or the convulsion when the dose is large seizes the whole body simultaneously. Jaw the last part of the body to be affected; its muscles relax first, and even when, during a severe convulsion, it is set, it drops as soon as the latter ceases.</p> <p>Muscular relaxation (rarely a slight rigidity) between the convulsions, the patient being exhausted and sweating. If recovery occurs, the convulsions gradually cease, leaving merely muscular soreness, and sometimes stiffness like that felt after violent exercise.</p>

* "Nervous Diseases," by Prof. H. C. Wood.

TETANUS.	HYSTERICAL TETANUS.	STRYCHNIN-POISONING.
Consciousness preserved until near death, as in strychnin-poisoning.	Consciousness lost as the second convulsion comes on, and lost with every other convulsion, the disturbance of consciousness and motility being simultaneous.	Consciousness always preserved during convulsions, except when the latter become so intense that death is imminent from suffocation, in which case sometimes the patient becomes insensible from asphyxia, which comes on during the latter part of a convulsion and is almost a certain precursor of death.
Draughts, loud noises, etc., produce convulsions, as in strychnin-poisoning; may complain bitterly of pain.	Crying spells alternating with convulsions.	The "slightest breath of air" produces convulsion. Patient may scream with pain or may express great apprehension, but "crying spells" would appear to be impossible.
Eyes open and rigidly fixed during the convulsion.	Eyes closed.	Eyes stretched wide open.
	Partial spasm in the leg, producing in Wood's cases crossing of the feet and inversion of the toes. If all the muscles were involved, eversion would occur, as the muscles of eversion are the stronger.	Legs stiffly extended with feet everted, as the spasms affect all the muscles of the leg.

Tetany is distinguished from tetanus by the milder nature of the spasms, by the greater limitation of the rigidity, by the fact that spasms begin in the hands or feet, not in the jaw and neck, and in most cases by periods of distinct intermittence.

In hydrophobia tonic spasm does not exist, and if clonic spasms occur they are secondary to suffocative attacks.

Treatment.—Far better even than to treat tetanus well is to prevent it. Careful antisepsis will banish it as a sequence of surgical operations as thoroughly as it has banished septicemia. Every wound must be disinfected with the most scrupulous care. Every punctured wound is to be incised to its depth and thoroughly cleaned and drained. Puerperal tetanus is prevented by antiseptic midwifery, and tetanus neonatorum is obviated by the antiseptic treatment of the stump of the cord. In order to obviate all danger of the development of tetanus during vaccinia, perform the little operation with cleanliness and care properly for the wound and for the pustule. The skin should be cleansed with soap and water, rubbed with alcohol, and washed with boiled water. It should be gently scraped with a knife (which has been boiled) until serum exudes. The virus, taken from a hermetically sealed tube, is applied to the raw surface, and allowed to remain exposed to the air until dry. A piece of sterile gauze is laid over the part and is held in place by a bandage. This dressing is changed once or twice a day as may be necessary, and is used until granulation begins, at which time the use of any simple ointment is admissible. Do not apply a shield. The evil of shields is pointed out by Robert N. Willson ("American Medicine," Dec. 7, 1901).

When tetanus exists, always look for a wound, and if one is found, open

it; if there are sloughs, cut them away, wash the wound with peroxid of hydrogen and then with a hot solution of corrosive sublimate (1 : 500). dry the wound with gauze, paint the surfaces of the wound with bromin, and secure drainage by packing with iodoform gauze. Dennis disinfects the wound with a solution of trichlorid of iodine (0.5 per cent.).

Surgeons of a former day were accustomed to amputate for tetanus if the wound was upon an extremity. When we reflect that the poison-producers are in the wound and not in the circulation, it seems a reasonable treatment. As a matter of fact, it never does any good, because, when the symptoms begin, the toxin has already entered into the nerve-cells and become fixed. Kitasato has shown that if a mouse is inoculated with tetanus near the root of the tail, excision of the tail and cauterization of the stump will not prevent tetanus unless it is performed within one hour of the inoculation; and Nocard inoculated sheep near the root of the tail with tetanus spores, and although the moment symptoms appeared he amputated well above the point of inoculation, the animals died of the disease. We must regard amputation as a useless method of treatment. It is maintained by several surgeons that in certain wounds, like those inflicted by the toy pistol and those contaminated with earth or with fecal matter, antitetanus serum should be injected as a preventative. Obviously, this cannot be done for every wound, and it is doubtful if the procedure is really useful. - Reynier injected antitoxin into a patient on whom he was about to operate because there was a case of tetanus in the wards and yet this man developed tetanus ("Gaz. des Hôpitaux," July 16, 1901). Nevertheless it is sure that animals can be rendered immune to tetanus, and the prophylactic power of antitoxin is warmly advocated by many eminent men. (See F. L. Taylor, in "N. Y. Med. Journal," July 20, 1901.)

Keep the sufferer from tetanus in a darkened, well-ventilated, and quiet apartment, so as to exclude as far as possible peripheral irritation. Watch for the occurrence of retention of urine, and use the catheter if necessary. Secure movements of the bowels by administering salines, castor oil, croton oil, or enemas. Give plenty of concentrated liquid food, and stimulate freely with alcohol. If swallowing causes convulsions, give an inhalation of nitrite of amyl before an attempt is made to swallow. If this treatment does not make swallowing possible, partially anesthetize the patient and feed him by means of a pharyngeal tube passed through the nose. Large doses of the bromid of potassium, or of this drug with chloral, give the best results, as far as drug treatment is capable of giving results. If bromid is used, give about ʒj every four to six hours. Other drugs that have been used with some success are gelsemium, morphin, curare, injections and fomentations of tobacco, physostigmin, anesthetics, cocain, and cannabis indica. An ice-bag to the spine somewhat relieves the girdle pain. Hot baths have been advised. It is said that venesection followed by the intravenous infusion of saline fluid does good. This procedure is followed by a free flow of urine and by lessening of the number of the paroxysms. It may be repeated several times during a few days (E. J. McOscar, in "American Medicine," Sept. 14, 1901; A. V. Moschowitz, in "Med. News," Oct. 13, 1900). Baccelli's method of treatment is the administration of carbolic acid hypodermatically.

Yandell says, in summing up Cowling's report on tetanus: * "Recoveries

* American Practitioner, Sept., 1870.

from traumatic tetanus have been usually in cases in which the disease occurs subsequent to nine days after the injury. When the symptoms last fourteen days, recovery is the rule, apparently independent of treatment. The true test of a remedy is its influence on the history of the disease. Does it cure cases in which the disease has set in previous to the ninth day? Does it fail in cases whose duration exceeds fourteen days? No agent tried by these tests has yet established its claims as a true remedy for tetanus."*

It is now claimed by some observers that we have a remedy which fulfils the requirements of Yandell in the tetanus antitoxin serum. Behring's serum is said to be six times as strong as Tizzoni's, but it is difficult or impossible to estimate the exact power of either. Serum is usually prepared as follows: A horse is injected repeatedly with the toxins obtained from cultures of tetanus bacilli, the strength of the injections being gradually increased. Eventually the animal becomes immune to tetanus. Some days after the final injection a cannula is placed in the jugular vein of the immunized animal, blood is drawn into a sterile vessel and is permitted to coagulate during twenty-four hours, and at the end of this period the serum is separated from the clot, is evaporated to dryness in a vacuum over sulphuric acid, and the powder is placed in hermetically sealed glass tubes. In order to use the serum, dissolve the powder in sterile water, in the proportion of 1 gm. to 10 c.c. The fluid serum sold in the shops bears this proportion to the powder. The serum can be given subcutaneously or intravenously, or can be injected into the brain or under the cerebral dura or the spinal arachnoid. If used subcutaneously, from 20 to 30 c.c. of the fluid serum should be injected into the abdominal wall, and this dose should be given every six or eight hours until there is improvement. Then from 5 to 10 c.c. should be given every six or eight hours. As the symptoms abate the dose is lessened and the intervals between the doses are increased. In a violent case of tetanus the first dose should consist of 40-50 c.c., and this can be repeated in four or five hours. In a case of tetanus which recovered, reported by Mixter, enormous doses were given. This patient received in the aggregate 3400 c.c. of serum, or 285 c.c. a day.† Roux and Borrel maintain that the toxins of tetanus pass from the blood into nervous tissue and are fixed in the nerve-cells. As the antitoxin when given hypodermatically or intravenously remains in the blood, it can only antidote the poison in the blood and not that in the nerve-cells. These observers advise that the antitoxin be placed where the toxins are active—that is, that it be thrown into the cerebrum. The skull is trephined or opened with a small drill, a blunt needle is passed to the depth of one and a half inches into the frontal lobe, and the serum is slowly injected. Abbe follows Kocher; uses a local anesthetic and bores a very small hole through the skull midway between the outer angle of the orbit and the middle of a line running across the head from one external auditory meatus to the other. The serum should be concentrated. One gram of dry antitoxin is dissolved in 5 c.c. of water, and this amount is the proper dose. The opposite frontal lobe should also be injected either at once or the next day. Even when serum has been injected into the cerebrum it should also be given subcutaneously. Abbe employed intracerebral injection in 5 severe cases and 3 of them recov-

* Quoted by Hammond, in his "Diseases of the Nervous System."

† Boston Med. and Surg. Jour., Oct. 6, 1898.

ered. He is a strong believer in the method ("Annals of Surgery," March, 1900). Moschcowitz has collected 38 cases so treated and claims that one-half of them recovered. Cerebral abscess followed in 1 case ("Med. News," Oct. 13, 1900). Tuffier has reported a successful case in which he injected 10 c.c. of serum into each frontal lobe ("Gaz. heb. de Med. et Chir.," July 4, 1901).

The value of the tetanus antitoxin is doubtful. It seems to distinctly benefit chronic tetanus, but to have only a trivial effect on the acute disease. Nancrede estimates that antitoxin treatment has lessened the mortality of acute tetanus about 5 per cent. Other writers give much better figures. In 290 cases so treated, collected by Moschcowitz, 117 died. The intracerebral injection is still an experiment, but appears to be more successful than other methods. Kitasato has shown that injections of iodoform render animals immune, and Sonnani has maintained that this drug in a wound prevents the disease. If antitoxin is not obtainable, give hypodermatic injections of iodoform, 3 to 5 grs. *t. i. d.*