

volve the hands and feet. The patient is relaxed in the absence of stimulation.

Arthritis of the temporomandibular joint is usually the result of a blow on the chin or of forcibly opening the jaws of a patient who is only partially anesthetized. It is associated with tenderness over the joint, local pain on movement of the jaw, and rigidity of the masseters; but rigidity of the neck is lacking. Pain is referred to the ear, and a point of tenderness can be detected by placing the finger in the auditory canal while the patient opens and closes the mouth.

Hysteria may simulate any disease; but careful examination, a sympathetic attitude, and the use of suggestion will usually produce symptoms foreign to the condition being considered. Thus, if sensory symptoms or paralysis are produced by suggestion, tetanus can be excluded.

Meningitis is accompanied by extreme headache, stupor or coma, rigidity of the neck, and increased pressure of the cerebrospinal fluid which contains an excess of protein and white blood cells. The spinal fluid in tetanus is normal.

Rabies resembles tetanus in the ease with which convulsions are produced, the clenching of the jaws, and the presence of laryngeal spasm; but it differs in the marked evidence of cerebral irritation. The patient is restless, agitated or maniacal, suffers from delirium, anger, or is delusional. There is hyperesthesia of the skin, and a tenacious, ropy mucus issues from the mouth.

Strychnine poisoning can duplicate all the symptoms of tetanus with one exception—between the clonic convulsive seizures there is complete muscular relaxation instead of tonic rigidity.

#### Prognosis:

Favorable indications are: late onset, limited muscular spasm, absence of laryngeal symptoms, infrequency of clonic spasms, ability to take food and drink, ability to sleep, and a normal temperature. According to Vener, the patient with tetanus who can be kept alive for nine days has at least a 90 per cent chance of recovery. Anders, in an earlier series of cases, gives the mortality rate for patients surviving beyond the tenth day as 30 per cent.

Acute tetanus developing within ten days of injury is accompanied by a mortality rate of over 75 per cent; if it develops more than fifteen days after injury, the rate falls rapidly, and in certain series of cases has been less than 10 per cent.

#### Prophylaxis:

The fundamental principles governing the pathogenesis of tetanus have been known for many decades. Despite this knowledge, methods of prevention prior to the World War were very inadequate. Too much reliance was placed on the protection afforded by antitoxin; insufficient attention was given to the fact that effective passive immunity rarely lasts longer than a week; wounds were often cauterized or flooded with antiseptics in futile attempts to destroy tetanus spores. Since the World War, however, there has been a distinct improvement in the

application of preventive measures. It is now recognized that primary care of the wound is the most important prophylactic measure, and that the administration of large amounts of antitoxin will not compensate for faulty surgical care.

#### Care of the Wound:

In the treatment of a wound in which the objective is the prevention of tetanus, one should aim toward the removal of dirt and foreign bodies. To prevent further contamination, the wound should be covered at once with several thick pads of sterile gauze. There should be no preliminary investigation; fingers, dressings, gauze, antiseptics and instruments should be kept out of the wound. After the surface has been protected from further contamination by the application of sterile gauze, a wide area of surrounding skin should be scrubbed with soap and water until the last vestige of dirt has been removed. Effective cleansing may require shaving of the hair and the use of grease solvents such as benzine or ether. After the surrounding area of skin has been thoroughly cleansed, the protective pads over the wound may be removed. Gross dirt and foreign bodies should be lifted, not wiped, from the surface of the wound and sent to the bacteriologic laboratory for cultural examination. If possible, the tissues affected should be excised en bloc. If this is not possible, the surface of the wound should be irrigated with sterile water. The deeper recesses of the wound should be protected from further contamination by placing the injured part on a vertical plane, if possible, and by avoiding the use of water under pressure, since irrigation may wash dirt into the deeper recesses, if the wound is kept in a horizontal position. Loose particles of dirt should be floated instead of forced away. Blood clots and adherent particles of dirt may then be removed by gentle friction with pledgets of cotton moistened with liquid soap, irrigating the area from time to time with sterile water. The surface of the wound may then be inspected. Dead, mutilated tissue should be removed and rough uneven edges should be trimmed back to normal tissue. The deeper portions of the wound may now be investigated and cleansed, enlarging the opening as necessary to permit removal of all dirt, foreign bodies and dead tissue. Under this treatment; properly performed, most tetanus spores will be removed from the wound and such as are missed will be unable to germinate in the presence of normal healthy tissue. Tetanus spores have many times the resistance of animal cells to antiseptic chemicals. It is therefore sheer nonsense to introduce ether, iodine, phenol, peroxide of hydrogen, or any other chemical substance into the wound. To do so may actually predispose to the development of tetanus by debilitating healthy tissues so laboriously exposed. If it is possible to do so, severed nerves and tendons should be sutured, and all "dead spaces" in the depths of the wound obliterated. No pockets in which serum may collect should be permitted to remain. If the size of the wound renders the coaptation of healthy tissues an impossible task, Carrel-Dakin tubes should be inserted, but gauze, simple wick, and rubber tube drains should be avoided. In the Carrel-Dakin treatment of infected

wounds, freshly prepared sodium hypochlorite solutions of from 0.45 to not more than 0.50 per cent strength are carried to the deepest pockets through rubber tubes with numerous lateral openings. Irrigation may be continuous or intermittent. If Dakin's solution is used continuously in full strength, the skin will require protection by vaseline. Dakin's solution dissolves sloughing tissue, but is more irritating than the more stable and practically nontoxic chloramine-T used in a 1 or 2 per cent strength. Chloramine-T is soluble in water, but dichloramine-T is soluble only in oils. Neither chloramine nor dichloramine exerts the strong solvent action of Dakin's solution on necrotic tissue; but being less irritating to the skin they are often preferred. Although Dakin's solution is irritating to the skin and destructive to the peritoneum, it does not interfere with wound-healing, being practically harmless to subcutaneous tissues. The great advantage of these compounds over ordinary antiseptics resides in their solvent action on exudates and necrotic tissue. Azochloramide is also frequently used as a substitute for Dakin's solution. When none of these preparations is available, hydrogen peroxide may be used.

The wound is finally covered with a layer of coarse-mesh paraffin gauze and several thicknesses of ordinary sterile surgical gauze. The coarse-mesh paraffin gauze prevents adhesion of dry surgical gauze to the wound surface. During the lengthy primary care of the wound a general anesthetic is required. Local anesthesia should be avoided in the treatment of wounds in which tetanus is feared.

Subsequent care of the wound involves frequent changes of dressings and inspection for evidence of further necrosis.

Not all wounds require such meticulous attention. Deep puncture wounds, wounds associated with contusion and crushing of soft tissue, and compound fractures are particularly dangerous. Simple incised wounds made with a sharp cutting instrument are least dangerous. The presence in the wound of any sort of foreign body greatly augments the hazard of tetanus. The danger is further increased when the injury is sustained during warm weather. According to statistical studies by Wainwright, certain occupations are almost exempt. Industrial injuries account for only about 20 per cent of the incidence of tetanus, the larger number following street accidents, farm injuries, and stab and gunshot wounds. Children, farmers, hostlers, soldiers, automobile mechanics, and others particularly subject to injury and contact with street dirt or garden soil furnish most of the cases. Children under 15 years of age constitute about 30 per cent of the population, but 50 per cent of the deaths from tetanus are in this group. For these reasons, active immunization of these groups is now advocated.

#### *Active Immunization with Tetanus Toxoid:*

Active immunization with tetanus toxoid is now obligatory in the French army. In certain children's institutions combined active immunization for

diphtheria and tetanus is a routine procedure. Immunity is established by the administration of two or three doses of toxoid given at intervals of two months. Immunity is established slowly, but a person previously immunized responds to a subsequent dose of toxoid with a rapid increase of antitoxin to a high level. Thus, increases of from 6 to 200 times the previous level have been observed, so that the majority of cases show from 1 to 2 units of antitoxin per cubic centimeter of plasma. This is a greater concentration than can be maintained for a week by passive immunization with a prophylactic dose of antitoxin. A patient who has been immunized, and who subsequently sustains an ordinary injury, may safely be given another dose of toxoid instead of a prophylactic dose of antitoxin. Unfortunately there is as yet no effective skin test indicating the degree of immunity. For this reason, immediate passive immunization by the administration of 1,500-3,000 units of tetanus antitoxin or combined tetanus and gas gangrene antitoxin is advised when the nature of the injury or the degree of contamination inordinately increases the risk of tetanus. A dose of toxoid may also be given at the same time, in order to induce a more durable immunity, and to render subsequent doses of antitoxin unnecessary. Active immunization of pregnant women in areas where puerperal and infantile tetanus occurs, has been suggested. The subject of active immunization has recently been studied by Boyd and by Gold. In the French army wounded soldiers, in whom development of tetanus is feared, are given a prophylactic injection of serum and 1.5 cc. of modified toxin, followed in 20 days by 2 cc. and 30 days later by a third dose.

#### *Passive Immunization:*

The indiscriminate use of tetanus antitoxin may be dangerous if it causes neglect of other important prophylactic measures. Tetanus antitoxin does not give complete protection under any and all circumstances. Protection is relative and of short duration. Whether to give or not to give antitoxin is a question of estimating the risk of tetanus as compared with the risk of an allergic reaction or of sensitizing the patient. It is well known that tetanus may follow the most trivial injuries, but in most instances it will be found that the wound was neglected or improperly treated. In any event, such occurrences make a profound impression because of their extreme rarity. There are millions of minor injuries, but only 1,200 cases of tetanus annually in the United States.

Wainwright reports that only 14 per cent of industrial surgeons use tetanus antitoxin routinely as a prophylactic. He believes its use is necessary only in wounds soiled with dirt from street, barnyard or stable. Many industrial insurance companies will not authorize the administration of tetanus antitoxin as a routine measure, regarding the cost as prohibitive compared to the risk entailed.

If indicated at all, tetanus antitoxin should be given immediately in adequate dosage and repeated every 7 days until danger is past. For protection of persons not previously actively immunized, whose injuries are ordinary, the administration of 1,500 units is suggested. At the same time 1.5 cc. of toxoid