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Emergency treatment for a tetanus patient and literature review

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Abstract

Tetanus is an acute zoonotic disease caused by the invasion of tetanus bacteria into wounds, where they proliferate and secrete toxins. This condition is characterized by persistent skeletal muscle spasms and heightened excitability of nerve reflexes, manifesting as clenched jaws and both tonic and clonic spasms. The primary muscle groups affected are the masseter, dorsal, abdominal, and limb muscles[1]. Key measures for treating tetanus include thorough wound management, as well as controlling muscle spasms and lung infections[2]. This article presents a case of tetanus, initially diagnosed in the internal medicine department. After excluding conditions related to stroke, the patient was transferred to the surgical department for debridement and anti-infection treatment. Ultimately, the patient's condition stabilized and showed improvement. We aim to deepen clinical physicians' understanding of tetanus by sharing the diagnostic and therapeutic insights from this case.

Keywords Tetanus; Muscle Spasms; Wound Management; Clostridium tetani; Immunization

1 Case Documentation

A 66-year-old male patient, weighing 52 kg, sought medical attention for unclear speech and restricted mouth opening that had persisted for 17 hours. The patient's family reported that 17 hours ago, they discovered the patient's speech was unclear, his mouth was restricted, and he was unable to extend his tongue, with symptoms progressively worsening. He also experienced discomfort during swallowing. There were no conscious disorders, hemiplegia, hemiblindness, or blurred vision. The patient did not report any discomfort such as fever, chills, chest tightness, chest pain, or cough. Initial consultation by a physician included cranial CT and MRI to rule out stroke. Upon further questioning regarding his medical history, it was revealed that the patient was accidentally injured by a wooden stick 12 days ago and did not receive proper treatment. Given the possibility of tetanus infection, he was transferred to the surgical department for continued diagnosis and treatment.

1.1 Physical Examination

- Body temperature: 36.5 °C
- Pulse: 110 beats/min
- Respiration: 20 breaths/min
- Blood pressure: 162/100 mmHg

The patient was conscious with a wry smile on his face and tightly clenched jaws (Figure 1). Bilateral pupils were equal in size and round, measuring approximately 2.5 mm in diameter, and showed a sensitive response to light. There was no congestion in the conjunctiva and no cyanosis on the lips. Thoracic symmetry was noted, with coarse breath sounds in both lungs. No dry or wet rales were detected. The heart rhythm was regular, and no murmurs were identified in the heart valves. The abdomen was soft without tenderness or rebound pain. The limb muscle strength and tension were normal. The bilateral Babinski sign was negative, while neck resistance was positive. Visible swelling was evident at the distal end of the fourth finger on the left hand (Figure 2). Upon squeezing, purulent exudate was visible seeping from the nail bed.

1.2 Laboratory Results

- White blood cell count (WBC): 11.13 × 10^9/L
- Neutrophil percentage: 69%
- Red blood cell count (RBC): 6.01 × 10^{12}/L
- Platelet count (PLT): 315.00 × 10^9/L
- Hypersensitive C-reactive protein: 4.07 mg/L

1.3 Liver and Kidney Function

- K+: 4.20 mmol/L

Figure 1. With clenched teeth and a bitter smile

Figure 2. Swelling of finger

Figure 3. Suppuration of nail bed

Figure 4. After debridement

- Na+: 137.68 mmol/L
- Creatinine (Cr): 99.17 μ mol/L
- Albumin (Alb): 45.57 g/L
- Alanine aminotransferase (ALT): 17.19 U/L

The emergency department reported the patient as critically ill. During treatment, the patient sweated profusely. After administering an intramuscular injection of 5000 IU tetanus immunoglobulin, the patient's condition improved. Partial debridement of the fingers was performed (Figures 3 and 4), along with local tetanus antitoxin injection therapy. Due to a positive penicillin skin test, cefuroxime and metronidazole were administered for anti-infection treatment. Fluid replacement, ECG monitoring, and oxygen therapy were provided for symptomatic treatment. Considering the patient had obvious muscle spasms, he was transferred to the ward for further treatment.

2 Discussion

2.1 Overview of Tetanus

Tetanus is triggered by a neurotoxin produced by the *Clostridium tetani* bacterium, which enters the body through the skin or mucous membranes. The primary clinical symptom is muscle spasms. As the disease progresses, even mild stimuli can trigger generalized tonic seizures, resulting in numerous complications and potentially fatal outcomes [1].

2.2 Global Impact

According to the 2016 Global Burden of Disease Study, the number of disability-adjusted life years (DALYs) for all ages due to tetanus globally in 2016 was 2.36 million, a decline of 90.5% compared to 1990 [3]. The World Health Organization (WHO) asserts that the neonatal mortality rate from tetanus in 2010 was reduced by 93% compared to 1980 [4]. However, for developing countries, tetanus is a pressing issue that demands serious attention. Although the incidence rate of tetanus in China is not clear, it occurs sporadically. The prevention of post-traumatic tetanus still faces issues such as the inappropriate use of tetanus toxoid and antitoxin, insufficient attention to active immunization, and non-standardized treatment of tetanus. In light of this case, the primary cause is the patient's inadequate awareness and insufficient emphasis on tetanus, coupled with a delay in seeking medical attention after the injury, ultimately resulting in wound infection and the development of tetanus.

2.3 Pathogen Characteristics

The pathogen responsible for tetanus is *Clostridium tetani*, a member of the *Clostridium* genus, a Gram-positive, obligate anaerobe. Its spores are widely distributed within the soil and other environments. Although the incidence rate of tetanus is not high now, tetanus will pose a potential threat to public health when natural disasters occur. After the 2010 earthquake in Haiti, the incidence rate of tetanus was higher than usual, and the fatality rate of tetanus after serious natural disasters was between 19% and 31% [5]. *Clostridium tetani* can enter the human body through damaged skin, often due to wounds contaminated by objects such as soil, feces, sputum, punctures from nails or needles, burns, crush injuries, and injuries from fireworks and firecrackers, among others, with necrotic tissue inside the wound. There are also some less common routes of infection, such as epidermal wounds, surgical procedures, insect bites, tooth infections, open fractures, chronic wounds, and intravenous drug abuse. In a study of 2422 tetanus patients, 21.9% showed no obvious invasive wounds, implying that *Clostridium tetani* may enter the body via minor abrasions [6]. Similarly, according to the medical history, the patient in this case also did not have any obvious open wounds.

2.4 Incubation Period and Clinical Categories

The incubation period for tetanus ranges from 3 to 21 days, typically around 10 days. However, varying with the wound's characteristics, size, and location, the period can extend from 1 day to several months. It has also been observed when removing foreign objects, such as shrapnel, that have been in the body for many years [7]. Tetanus is clinically categorized into three types: systemic tetanus (88%), local tetanus (12%), and head tetanus (1%) [8]. In this case, the patient exhibited a 10-day incubation period and displayed typical clinical symptoms at the time of consultation, fitting the systemic type. The shorter the incubation period, the less favorable the prognosis [9]. The bacterial cells themselves and exotoxins do not exhibit significant tissue toxicity at the local site, and there might not be any evident signs of inflammation or infection. Some wounds may even appear healed. In this case, the patient showed no open wounds upon presentation, yet local tissue swelling was noted.

2.5 Immunity and Prevention

Tetanus spores are widely present in the natural environment, and humans generally have no natural immunity to tetanus. Therefore, artificial immunity is needed to make the body develop immunity to tetanus toxin. There are two methods: active immunity and passive immunity. Tetanus is a preventable disease because the growth of *Clostridium tetani* requires an anaerobic environment. Early and thorough debridement and improved circulation after trauma are key factors in preventing tetanus. Active immunity, also known as automatic immunity, involves injecting tetanus toxoids into the human body, causing the body to produce antibodies against tetanus toxin, thereby gaining immunity. Research has shown that three doses of tetanus basic immunity in infants and young children, combined with one dose of booster immunity in the second year, will provide 3-5 years of protection. Children can receive another dose of booster immunity in the early stages, and the protective effect can last until adolescence. If adolescents continue to receive one dose of booster immunity, it can provide long-term protection into adulthood, including for women of reproductive age [10]. The tetanus vaccine is safe for use, with a low incidence of adverse reactions.

2.6 Passive Immunity

Passive immunity refers to the body's passive reception of tetanus toxin antibodies, which can confer immunity rapidly but for a limited duration. The commonly used passive immune drugs currently include refined tetanus antitoxin (TAT) injection, human tetanus immunoglobulin (HTIG), and equine tetanus immunoglobulin. TAT is a liquid antitoxin globulin preparation derived from TT-immunized horse plasma, refined through gastric enzyme digestion. It encompasses IgG from horse serum and necessitates a skin test prior to use, as it frequently induces allergic reactions. The prevalence of these reactions ranges from 5% to 30%, with an approximate fatality rate of 1 in 10,000 [11]. A literature analysis revealed that among 2636 patients experiencing adverse reactions to TAT, 10 fatalities occurred [12]. HTIG uses tetanus vaccine to immunize blood

donors, collects plasma containing high-titer tetanus antibodies for purification, or uses gene recombination technology to prepare, with a low allergic reaction rate, high titer, long in vivo half-life (3-4 weeks), convenient use, and no need for skin testing [11, 13]. The market time of tetanus immunoglobulin is relatively short. The addition of column chromatography purification process reduces the content of IgG and other macromolecular proteins, increases the relative content of the active ingredient antibody fragment F(ab')2, and reduces allergy rates. It has been clinically used in some hospitals [14-16]. More clinical research is needed as a substitute for HTIG when it cannot be obtained, but skin tests are still required before use, using subcutaneous or intramuscular injections of 1500-3000U. The method for tetanus prophylaxis following trauma is determined by the type of injury and the individual's vaccination history. We need to pay attention to distinguishing between susceptible and non-susceptible tetanus wounds, identifying high-risk wounds, and inquiring about the victim's active immunization history.

2.7 Treatment Principles

The main principles of tetanus treatment include sedation, analgesia, muscle relaxation to control spasms, and correction of autonomic dysfunction to avoid exhaustion. Thorough debridement and anti-*Clostridium tetani* treatment; neutralizing toxins in the circulatory system; symptomatic and supportive treatment [17-19]. At present, the immunization coverage rate for children with tetanus is relatively high, but the immunity to tetanus decreases in adulthood. We call for attention to strengthening immunization for special populations, such as military personnel, police, construction workers, horticultural workers, farmers, field workers, and explorers, to enhance the adult immune barrier against tetanus. By reviewing case studies, summarizing the essentials of tetanus prevention and treatment, and incorporating the latest research, we aim to offer guidance for clinical diagnosis and treatment.

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