International Journal of General Medicine

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Tetanus Cases in Mogadishu-Somalia: A Tragic Disease Despite the Existence of a Century-Old Safe and Efficient Tetanus Vaccine

Kazım Kıratlı[1], Ibrahim Mohamed Hirsi[2], Burak Çelik[3], Murat Aysin[4], Ahmed Mohamed Ali[1], Selim Turfan[5], Hakan Zeybek[6]

[1]Mogadishu Somalia Turkey Recep Tayyip Erdoğan Training and Research Hospital, Department of Infectious Diseases and Clinical Microbiology, Mogadishu, Somalia; [2]Mogadishu Somalia Turkey Recep Tayyip Erdoğan Training and Research Hospital, Department of Pediatrics, Mogadishu, Somalia; [3]Health Sciences University, Fatih Sultan Mehmet Training and Research Hospital, Department of Emergency Medicine, Istanbul, Turkey; [4]Balikesir University Faculty of Medicine, Department of Public Health, Balikesir, Turkey; [5]Giresun Training and Research Hospital, Department of Emergency Medicine, Giresun, Turkey; [6]Mogadishu Somalia Turkey Recep Tayyip Erdoğan Training and Research Hospital, Department of Orthopedics and Traumatology, Mogadishu, Somalia

Correspondence: Kazım Kıratlı, Mogadishu Somalia Turkey Recep Tayyip Erdoğan Training and Research Hospital, Department of Infectious Diseases and Clinical Microbiology, Mogadishu, Somalia, Tel +252 611 522 947, Email drkazimkiratli@gmail.com

Introduction: Despite the efforts and support of the World Health Organization and other international organizations to reduce the incidence of the disease, tetanus is still an acute condition with serious consequences, including death. The purpose of this study was to assess the tetanus patients we have been monitoring over the past two years in Somalia, a country with a protracted civil conflict, extreme poverty, and restricted access to hospital, social security, and public health facilities.

Methods: This study includes tetanus patients who were admitted to the Recep Tayyip Erdoğan Training and Research Hospital in Mogadishu, Somalia, Turkey between January 1, 2022, and November 1, 2023. Hospitalization, diagnosis, treatment, complications, death, and test results were all looked at in addition to the patients' sociodemographic details.

Results: The average age of the 196 patients was 10 years, with males making up 67.9% of the total (min-max: 7 days-71 years). Acute injury was the cause of 53.1% of tetanus cases, with the legs being the most frequently injured body area (28.8%). A mean duration of stay of 11 days was observed for 82.1% of the patients who were monitored in the hospital (min-max: 1–38 days). The total fatality rate was 14.3%, and 85.7% of patients had never had a tetanus vaccination. The group with severe tetanus had higher rates of intensive care admission ($p<0.001$), generalized/neonatal tetanus ($p<0.001$), high non-vaccination rate (p:0.011), antibiotic usage ($p<0.001$), and a positive blood culture ($p<0.001$). Almost all of the complications ($p<0.001$) and all of the deaths ($p<0.001$) were in the severe group.

Conclusion: In sub-Saharan Africa, immunization rates are regrettably still insufficient despite the tetanus vaccine's low cost and great effectiveness. Public education and encouragement on anti-vaccination must continue alongside the enhancement of vaccination programs. Otherwise, low- and middle-income countries will still be plagued by this illness, which has been overlooked in high-income nations.

Keywords: immunization, Somalia, Sub-Saharan Africa, tetanus, vaccination

Introduction

The neurotoxin generated by *Clostridium tetani (C. tetani)*, which is present in soil, dust, or animal feces, causes tetanus, an infection marked by generalized hypertonia that presents as excruciating jaw and neck muscle spasms.[1–3] Tetanospasmin and tetanolysin, secreted by *C. tetani*, cause agonist and antagonist muscles to contract, resulting in hypertonia, which manifests as the recognizable "tetanic spasm". Tetanospasmin specifically impacts the motor plate of the nerve and muscle, resulting in a clinical condition that includes rigidity, muscle spasms, and autonomic instability.[4] Tetanolysin complicates matters by causing tissue damage, while hypertonia can result in death from

Received: 28 March 2024
Accepted: 25 August 2024
Published: 3 September 2024

asphyxia, heart failure, or pulmonary problems.[5] The severity of symptoms varies depending on the distance of the infected focus from the central nervous system. Once the neurotoxin reaches the brainstem, usually within two weeks of symptom onset, it causes autonomic dysfunction. This dysfunction can lead to catastrophic rhythm abnormalities due to the loss of autonomous control, especially in individuals with fluctuating blood pressure and heart rate. Studies have revealed that 10% of infected patients die from their illness, and symptoms might linger for weeks or months. In developing countries, the mortality rate is estimated to rise from 20% to 45%, depending on access to early therapy and intensive care.[6] According to the Centers for Disease Control and Prevention (CDC), nearly 100% of tetanus patients die in nations without access to critical care.[7] Long-term mental problems and motor impairment are frequently seen in survivors.[4]

C. tetani, the gram-positive, spore-forming, obligatory anaerobic bacillus, is more commonly found in hot, humid areas with rich soil containing organic content.[8,9] Tetanus spores can endure for extended periods due to their hardiness.[10] Tetanus is frequently linked to trauma,[11] and although *C. tetani* can enter the human body by skin ruptures, tears, and punctures, it can also be spread by insect bites or syringe inoculation.[8,12] A wound, often small and unnoticed, like a tiny tear from metal or wood splinters or thorns, is the most frequent source of infection. Individuals most at-risk include those who have not received vaccinations, those who use intravenous drugs, and those with weakened immune systems are among the groups most at risk of infection among individuals who have this wound. Dog bites, open fractures, injections, and dental diseases are other known sources of infection.[8,9,12] The most evident fact is that vaccine deficiency is the primary cause of tetanus. Individuals who are not vaccinated, just partially immunized, or completely immunized but lack a sufficient booster dosage are often at risk of contracting tetanus.[10]

Tetanus remains 135 times more common in low-income countries than in wealthy ones, despite recent reductions in tetanus fatality rates linked to vigorous immunization programs, according to the World Health Organization (WHO). Maternal and neonatal tetanus poses a risk to 75 million mothers and infants globally, according to CDC data. The Global Burden of Disease research projected more than 73,000 cases of tetanus in 2019. A modeling study indicates that between January and December 2020, an estimated 30 million children failed to receive all three necessary doses of the tetanus-containing vaccine. Despite efforts, tetanus immunization is still not consistently and preventively delivered in several countries.[4] In the last twenty years, the implementation of supplementary immunization activities (SIAs) has allowed WHO to determine that tetanus has vanished as a public health issue in nearly fifty countries; however, data indicates that tetanus remains a public health concern in 12 countries.[13] Despite evidence that vaccination programs are being started in these 12 nations, Somalia does not appear to have been included in the programs for the Implementation of SIAs.[14]

The Global Peace Index indicates that Somalia remains one of the areas with high conflict risks, even with a post-terrorism order recently established in East Africa.[15] The inability to implement vaccination programs may be the main cause of public health issues exacerbated by the hazards of war, terrorism, and conflict. Despite the efforts and assistance of the WHO and other international organizations, tetanus remains an acute disease with major complications that can result in death. Our study sought to assess tetanus patients who applied to the emergency service in Somalia, a country with persistent civil war, extreme poverty, and limited access to public health, social security, and hospital services.

Materials and Methods

Study Design

This study is a retrospective review of the database of tetanus patients who were admitted between January 1, 2022, and November 1, 2023 to Mogadishu Somali Turkey Recep Tayyip Erdoğan Training and Research Hospital, which is under the mentorship of Turkey in Somalia. Permission from the Mogadishu Somalia Turkey Recep Tayyip Erdoğan Training and Research Hospital Scientific Research Ethics Committee (08.11.2023-MSTH/16085-881) and hospital administration was acquired prior to the study's commencement. Furthermore, the "Ethical Principles of the World Medical Association Declaration of Helsinki" were taken into consideration when conducting the research. Since the study was retrospective in nature, patient consent was not obtained.

Place of Study

The study was conducted at the Mogadishu Somali Turkey Recep Tayyip Erdoğan Training and Research Hospital, established by Turkey as part of humanitarian aid efforts in Mogadishu, the capital of Somalia. This hospital employs medical professionals from Somalia and Turkey, including doctors, nurses, and other healthcare workers. It serves all indigenous people in Somalia; most of whom reside in Mogadishu. As one of the largest and most comprehensive training hospitals in sub-Saharan Africa (SSA), it is a reference center for critical care, operating rooms, and various medical services. The hospital's infectious diseases clinic receives patients from the emergency room, nearby regional clinics, other local medical facilities, and other hospital departments, treating a large number of patients, particularly those with infectious illnesses.

Patient Selection

Study participants comprised all patients, regardless of age, who were diagnosed with tetanus and admitted to the hospital emergency room, clinic, or intensive care unit (ICU). Excluded from the study group were patients who were admitted to the infectious diseases clinic and transferred to another facility within 24 hours, patients who died there, patients who were brought to the emergency room in cardiopulmonary arrest, and patients whose clinical records could not be accessed.

Acquisition of Data

Using research forms, information about the hospitalized patients' demographics, potential sources of infection exposure, and requirement for ICU admission were noted. Demographic information and anamnesis details are initially entered into the files for every patient at the infection clinic. Information and prognostic data are documented on the patient follow-up forms subsequent to the examination and testing. The attending clinician creates the diagnostic data for the patients. In this context, in addition to vital follow-ups and prognoses for the patient, the data recorded in the case report forms are as follows: the site and region of the disease in terms of tetanus, the severity of tetanus, the duration of hospitalization, whether or not he stayed in the ICU, the duration of the stay in the ICU, if any, the time he received hospital treatment, service period, clinical classification, clinical symptoms, autonomic nerve dysfunction, tetanus vaccination history, whether there are tetanus complications, if so, which complications, mortality, treatment of the patient, duration of treatments, blood culture, iv antibiotic use, antibiotic name, antibiotic duration, comorbidity and routine blood hemogram and biochemical parameters.

Statistics

Statistical analyzes of the study were conducted using Statistical Package for Social Sciences version 25.0 software for Windows (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp., United States of America [USA]). The assumption of normality for quantitative variables was tested with Kolmogorov–Smirnov and Shapiro–Wilk tests. For univariate analyzes of the variables included in the study, Chi-Square, Fisher Exact test and Mann Whitney *U*-tests were used, depending on the variable type and whether the assumptions were met.

Results

Retrospective scanning, recording, and analysis were done on the 196 cases of tetanus that were diagnosed and monitored between research period. The ages of the patients ranged from 7 days to 71 years, with an average of 10 years old. The patient population consisted of 63 (32.1%) females and 133 (67.9%) males. Of the patients, 144 (73.5%) reported being unemployed. Acute injury accounted for 53.1% of cases of tetanus, followed by medical interventions (11.2%) and traditional treatments (9.7%). The most common body parts into which the agent penetrated were the arms (26.9%), face (21.7%), and legs (28.8%). 161 people (82.1%) were hospitalized for tetanus diagnosis and treatment, and their average length of stay was 11 days (minimum-maximum: 1–38 days). 61 patients (31.1%) were followed in ICU and their average stay in ICU was 12 days (min-max: 1–32 days). Clinic durations ranged from 1 to 34 days, with an average of 9 days.

The symptoms, complications, and supportive care administered are listed in Table 1.

According to the severity of the illness, we separated the cases into four groups: 38 mild cases (19.4%), 65 moderate cases (33.2%), 47 severe cases (24.0%), and 46 very severe cases (23.5%). Upon doing a clinical classification of the patients, we identified 130 cases of generalized tetanus (70.4%), 43 cases of localized tetanus (21.9%), 14 cases of newborn tetanus (7.1%), and 1 case of cephalic tetanus (0.5%).

Table 1 Symptoms of the Cases, Developing Complications and Supportive Treatments Administered

Individuals (n:196)					
Symptoms*	**n (%)**	***Complications****	**n (%)**	***Supportive Treatment****	**n (%)**
Trismus (lockjaw)	196 (100)	Infection (Aspiration pneumonia/ Urinary tract infection)	65 (33.2)	Diazepam	157 (80.1)
Neck/muscle stiffness	182 (92.9)	Ischemic hypoxic cerebropathy	56 (28.6)	Baclofen	134 (68.4)
Fever	155 (79.1)	Sepsis	42 (21.4)	Midazolam	59 (30.1)
Dysphagia	132 (67.3)	Organ dysfunction	25 (12.8)	Phenytoin	51 (26.0)
Opisthotonus	108 (55.1)	Airway obstruction	16 (8.2)	Magnesium sulfate	43 (21.9)
Seizure/Confusion	99 (50.5)	Hepatic dysfunction	6 (3.1)	Neuromuscular blockade	23 (11.7)
Sialorrhea	93 (47.4)	Myocardial injury/atrial fibrillation	1 (0.5)	Phenobarbital	10 (5.1)
Nausea and vomiting	73 (37.2)	Pulmonary embolism	1 (0.5)	Atropine/adrenalin	8 (4.1)
Dysarthria	69 (35.2)	Acute respiratory distress syndrome	1 (0.5)		
Dyspnea	60 (30.6)				
Autonomic nervous dysfunction	48 (24.5)				

Notes: * There are patients who have more than one symptom, develop complications, and receive supportive treatment.

The types and rates of antibiotics given to patients during their course of therapy and follow-up are displayed in Table 2.

Questioning the patients about their immunization history revealed that 168 (85.7%) had never received a tetanus vaccination, 6 (3.1%) had received a partial vaccination, and 3 (1.5%) had received a full vaccination. Regarding 19 people (9.7%), there was ambiguity about their vaccination history. In all, 84 individuals (42.9%) had tetanus-related complications. Using the disease severity as a guide, we divided the cases into two categories: mild-moderate and severe-very severe. At least two body locations were injured in 16 patients (8.2%). In terms of clinical tetanus, 15 of these individuals (93.8%) belong into the severe category ($p<0.001$). According to our analysis, road accidents accounted for 50.0% (n:8) of the causes of multiple extremities injuries. The leg was the most often observed anatomical location (81.3%, n:13) in individuals with multiple extremity injuries. Table 3 presents a comparison of blood culture characteristics, job, gender, entry site, entry site counts and etiology based on the severity of the disease.

Table 2 Antibiotic Treatments Administered to Cases

Individuals (n:196)					
***Antibiotics** **	**n (%)**	***Antibiotics***	**n (%)**	***Antibiotics***	**n (%)**
Metronidazole	154 (78.6)	Meropenem	32 (16.3)	Ampicillin	9 (4.6)
Ceftriaxone	62 (31.6)	Piperacillin / tazobactam	27 (13.8)	Acyclovir	6 (3.1)
Penicillin G	60 (30.6)	Cefotaxime	23 (11.7)	Azithromycin	3 (1.5)
Vancomycin	43 (21.9)	Clindamycin	16 (8.2)	Teicoplanin	1 (0.5)
Clarithromycin	40 (20.4)	Ampicillin / sulbactam	10 (5.0)		

Notes: * There are patients who are administered more than one type of antibiotic.

Table 3 Characteristics of Gender, Job, Etiology, Site of Entry, Site of Entry Counts and Blood Culture According to Severity of the Disease

Individuals (n:196)			
Severity of Tetanus n (%)			
	Mild-Moderate Group (n=103)	**Severe Group (n=93)**	**p value**
Gender			
Male	70 (68.0)	63 (67.7)	0.974
Female	33 (32.0)	30 (32.3)	
Job			
Farmer	4 (3.9)	4 (4.3)	0.249
Mechanics	6 (5.8)	6 (6.5)	
Construction worker	2 (1.9)	0	
Others	11 (10.7)	19 (20.4)	
Unemployed	80 (77.7)	64 (68.8)	
Etiology			
Acute injury	69 (67.0)	35 (37.6)	<0.001
Unclean delivery	1 (1.0)	13 (14.0)	
Medical interventions	15 (14.6)	7 (7.5)	
Animal bites	2 (1.9)	3 (3.2)	
Electrical injuries	0	2 (2.2)	
Traffic accident	1 (1.0)	13 (14.0)	
Traditional medicine	12 (11.7)	7 (7.5)	
Gunshot	0	3 (3.2)	
Unknown	3 (2.9)	10 (10.8)	
Site of entry			
Leg	27 (26.2)	34 (31.2)	0.027
Arm	37 (35.9)	20 (18.3)	
Face	22 (21.4)	24 (22.0)	
Trunk	14 (13.6)	21 (19.3)	
Unknown	3 (2.9)	10 (9.2)	
Site of entry count			
One	102 (99)	78 (83.9)	<0.001
Two and more	1 (1)	15 (16.1)	

(*Continued*)

Table 3 (Continued).

Individuals (n:196)			
Severity of Tetanus n (%)			
	Mild-Moderate Group (n=103)	**Severe Group (n=93)**	**p value**
Blood Culture			
Positive	13 (12.6)	66 (71.0)	<0.001
Negative	13 (12.6)	15 (16.1)	
Unknown	77 (74.8)	12 (12.9)	

Of the patients that were monitored for tetanus, 28 (14.3%) passed away. 168 patients (85.7%) underwent "Tetanus vaccine (T.vaccine) + Human Tetanus Immunoglobulin (HTIG) + Antibiotics + Supportive" treatment. Table 4 enumerates hospitalization, ICU stay, clinical categorization, autonomic nerve dysfunction, history of vaccinations, complications, mortality, and therapies in accordance with disease severity.

In 79 (40.3%) of the patients, the blood culture was positive. A total of 180 cases (91.8%) received intravenous antibiotics. In total, 14.3% of the patients had diabetes mellitus in 11 patients (5.6%), hypertension in 9 patients (4.6%),

Table 4 Characteristics of Hospitalization, ICU Stay, Clinical Classification, Autonomic Nervous Dysfunction, Vaccination History, Complication, Mortality and Treatment According to Severity of the Disease

Individuals (n:196)			
Severity of Tetanus n (%)			
	Mild-Moderate Group (n=103)	**Severe Group (n=93)**	**p value***
Hospitalization			
Yes	68 (66.0)	93 (100.0)	<0.001
No	35 (34.0)	0	
ICU Stay			
Yes	2 (1.9)	59 (63.4)	<0.001
No	101 (97.1)	34 (36.6)	
Clinical classification			
Generalized	58 (56.3)	80 (86.0)	<0.001
Localized	43 (41.7)	0	
Cephalic	1 (1.0)	0	
Neonatal	1 (1.0)	13 (14.0)	
Autonomic nervous dysfunction			
Yes	0	48 (51.6)	<0.001
No	103 (100.0)	45 (48.4)	

(*Continued*)

Table 4 (Continued).

Individuals (n:196)			
Severity of Tetanus n (%)			
	Mild-Moderate Group (n=103)	**Severe Group (n=93)**	**p value***
Vaccination History			
Unvaccinated	82 (79.6)	86 (92.5)	0.011
Partially vaccinated	6 (5.8)	0	
Totally vaccinated	3 (2.9)	0	
Unknown	12 (11.7)	7 (7.5)	
Complication			
Yes	8 (7.8)	76 (81.7)	<0.001
No	95 (92.2)	17 (18.3)	
Mortality			
Yes	0	28 (30.1)	<0.001
No	103 (100.0)	65 (69.9)	
Treatment			
T.vaccine+HTIG	12 (11.7)	0	<0.001
T.vaccine+HTIG+Antibiotics	15 (14.6)	0	
T.vaccine+HTIG+Supportive	1 (1.0)	0	
T.vaccine+HTIG+Antibiotics+Supportive	75 (72.8)	93 (100.0)	

Note: *Pearson's chi-square test and Fisher Exact test.

chronic renal failure in 2 patients (1.0%), chronic cardiac disease in 4 patients (2.0%), neurological disorders in 7 patients (3.6%), and other chronic comorbid illnesses in 4 patients (2.0%).

Table 5 presents the length of hospital stay, length of treatment, and features of laboratory results categorized by disease severity.

Table 5 Characteristics of Hospitalization Duration, Treatment Duration and Laboratory Findings According to Severity of the Disease

Individuals (n:196)			
Severity of Tetanus (Median - Min - Max)			
	Mild-Moderate Group (n=103)	**Severe Group (n=93)**	**p value***
Age (years)	8.5 (0.1–71.0)	12.0 (0.1–68.0)	0.364
Duration of Hospitalization (days)	6.5 (2.0–32.0)	15.0 (1.0–38.0)	<0.001
Duration of ICU (days)	4.0 (2.0–6.0)	12.0 (1.0–32.0)	0.033
Duration of Service Stay (days)	7.0 (2.0–32.0)	11.0 (1.0–34.0)	<0.001

(*Continued*)

Table 5 (Continued).

Individuals (n:196)			
Severity of Tetanus (Median - Min - Max)			
	Mild-Moderate Group (n=103)	Severe Group (n=93)	p value*
Duration of treatment (days)	7.0 (2.0–16.0)	10.0 (1.0–35.0)	<0.001
Duration of antibiotic treatment (days)	10.0 (3.0–32.0)	14.0 (1.0–34.0)	<0.001
Glucose (mg/dL)	93.0 (40.0–330.0)	98.0 (41.0–323.0)	0.015
Urea (mg/dL)	24.0 (4.0–105.0)	31.0 (6.0–508.0)	0.001
Creatinine (mg/dL)	0.5 (0.1–1.6)	0.6 (0.1–6.3)	0.001
Aspartate aminotransferase (AST) (U/L)	58.0 (3.0–790.0)	67.0 (19.0–1721.0)	0.042
Alanine aminotransferase (ALT) (U/L)	28.0 (6.0–455.0)	33.0 (7.0–864.0)	0.014
Total Bilirubin (mg/dL)	0.4 (0.1–2.3)	0.5 (0.1–11.8)	0.005
C-reactive protein (CRP) (mg/L)	8.0 (0–272.0)	29.0 (0–381.0)	<0.001
White blood cell (WBC) (10∧9/L)	9.0 (2.8–22.3)	12.0 (3.5–36.3)	<0.001
Hematocrit (HCT) (%)	36.0 (22.5–50.5)	36.2 (13.7–56.5)	0.607
Hemoglobin (HGB) (g/dL)	11.8 (5.7–18.3)	12.0 (3.2–18.5)	0.304
Platelet (PLT) (10∧9/L)	389.0 (8.0–1,262.0)	419.0 (11.0–1,133.0)	0.449

Note: *Mann Whitney U test.

Discussion

Tetanus remains a major public health concern, causing fatalities in low- and middle-income countries (LMIC) despite the availability of an inexpensive, safe, and highly effective vaccine against the tetanus disease.[16] Thus, raising the level of vaccination against tetanus in adults who have experienced trauma or whose vaccination history is unclear is essential to reducing the number of tetanus cases.[5,17] For lifelong protection against tetanus, the CDC recommends receiving a booster shot every ten years.[18] It is well acknowledged that a booster dosage may be necessary due to waning immunity, as evidenced by the fact that most of the 35–70 tetanus cases recorded annually in the USA occur among the elderly population.[19]

In Mogadishu, the capital of Somalia, where bombings and terrorism are persistent problems, our hospital admits a significant number of trauma patients, a major risk factor for tetanus. Unfortunately, low vaccination rates are caused by several factors, including living in rural regions, poverty, lack of knowledge, cultural and religious beliefs promoting anti-vaccine sentiments, and general ignorance. WHO data indicate that terrorism forced almost 2.6 million people to relocate within Somalia, a nation with a high proportion of poverty. Increased migration has made access to even very basic health care, including vaccinations, more challenging.[20] The main reasons for the high incidence of tetanus in underdeveloped nations are inadequate wound care and immunization programs.[21]

We categorized the cases into two groups (Group 1: mild-moderate cases, Group 2: severe-very severe cases) based on the severity of the condition. There was no statistically significant difference between the groups regarding age, gender, and profession ($p>0.05$). However, severe rates of both neonatal and generalized tetanus were higher in the severe group (<0.001). Out of the patients in our study, 147 (75.1%) had a history of trauma or injury that could have caused tetanus (medical intervention, dirty delivery, and unknown groups were excluded). A statistically significant difference was found between the groups regarding the tetanus entry site. Patients with a history of dirty delivery, road

accidents, electric shock, or gunshot were considerably more likely to be in the severe tetanus category (p: <0.001), while medical interventions and acute injuries were more common in mild cases. Differences were also noted regarding the point of entry. Arm injuries were more common in the mild group, while unidentified tetanus entry sites were mostly in the severe group (p:0.027). Fifteen of the sixteen patients with injuries to at least two body parts belonged to the severe tetanus category (93.8%, p<0.001). The most common anatomical location for multiple extremity injuries in 13 individuals (81.3%) was the leg, and traffic accidents accounted for 50% of the cases. In addition, The male-to-female ratio was 2.11 and ages ranging from 7 days to 71 years.

According to a Far Eastern research, 26% of tetanus cases had no identified source.[22] Some previous studies have shown that uncertainty in the entrance site is important.[5,23] A lengthy incubation period may potentially impact the detection of the entrance site, as may a weakness in the history or physical examination of patients in whom a definite entry site is not found. Additionally, the wound might be chronic (lasting a long time) or minor enough to be ignored. In 6.1% of the study participants, the entrance point was not identifiable.

Neonatal tetanus, linked to unhygienic deliveries, is prevalent in developing nations due to unsanitary living conditions, inadequate prenatal care, and low vaccination rates among pregnant women.[2] Noteworthy, 14 cases of newborn tetanus in our study were associated with rural women treated conventionally in non-hospital settings with a history of contaminated births.

Male gender has been linked to an increased risk of tetanus-related illness and death due to occupational exposure and the lower rates of immunization among males. Routine immunization of pregnant women may explain the high frequency in men.[11,24,25] In line with previous research, we also found a higher case rate (67.9%) in males.

Tetanus symptoms appear days or weeks after a wound, with an incubation period of one to three weeks. Symptoms include excruciating muscular spasms, trismus, dysphagia, opisthotonus, and abnormalities of the autonomic nervous system (hypo/hypertension, brady/tachycardia, or other arrhythmias). A complete recovery might take months, and muscle spasms could last up to four weeks.[26] In Tanzania, Melkert et al's[27] study reported that 95.7% of the patients had trismus, 89.3% had neck stiffness, 73% had general body muscular spasms, and 38.9% had dysphagia. In the Fan et al's[28] study, dysphagia was shown to be the symptom for which patients sought medical attention the most frequently, despite trismus being the initial symptom in virtually all of the patients. The study findings indicated that trismus (100.0%), neck/muscle stiffness (92.9%), fever (79.1%), and dysphagia (67.3%) were the most frequently occurring symptoms.

Holistic treatments in tetanus patients include wound dressing/debridement, isolation in a quiet/dark room, passive immunization (anti-toxin immunoglobulin), antibiotics (metronidazole, penicillin), medications to control muscle spasms (magnesium, baclofen), adequate fluid/nutritional supplements, and airway/respiratory support.[5,29,30] Tetanus toxin is neutralized by an antitoxin, a therapeutic intervention that needs to be given early and in the right dosages. High death rates are linked to low or incorrect dosages. Human-derived antitoxin, due to its longer half-life and lower side effect profile, should be used extensively.[31] Numerous studies have also highlighted the efficacy of penicillin and metronidazole, which are advised as initial antibiotic regimens.[29,30]

Key treatment objectives also include reducing convulsions, muscle spasms, and autonomic nervous system symptoms. Benzodiazepines are the most recommended drugs for these outcomes. As an option for managing abnormalities of the autonomic nervous system, clonidine, opioid analgesics, and epidural blocking medications have been found helpful.[32] According to recent statistics, tracheotomy is a better respiratory support option than endotracheal intubation as it can reduce the incidence of tracheal stenosis during long-term follow-up.[33]

Treating tetanus requires nutritional assistance, but the present evidence on the ideal calorie intake for critically sick individuals is still inadequate. The higher metabolic rate brought on by sympathetic activity, convulsions, malnourishment from trismus, the inability to open their mouth fully, and dysphagia can all be considered reasons why patients require extra energy.[34]

A study conducted in Korea between 2011 and 2019 on tetanus cases found an average patient age of 67 with women constituting 57.1% of cases. All patients had generalized tetanus; 85.7% of patients had trismus as the most common symptom; the average length of hospitalization was 39 days; 65.3% of the patients were monitored with mechanical ventilation; 20 patients (40.8%) had aspiration pneumonia; 5 patients (10.2%) passed away; and 35 patients (71.4%) were discharged with no further complications.[23]

In our study, metronidazole was the most often chosen antibiotic (78.6%). The severe group took antibiotics for a longer period of time (mean: 14 days, p<0.001). Diazepam (80.1%) and baclofen (68.4%) were the most often chosen medicines as supportive treatment (in terms of convulsions, muscle spasms, and autonomic nervous system symptoms). In the severe group, all patients were treated with "T. vaccine + HTIG + Antibiotics + Supportive" treatment (p<0.001). The majority of patients who had complications belonged to the severe category (p<0.001), as did all patients who experienced autonomic nerve dysfunction (p<0.001). Aspiration pneumonia/urinary system infection accounted for 33.2% of all associated complications.

The research findings indicate that the patients in the severe group had considerably longer hospital stays (mean: 15 days, p<0.001) and ICU stays (mean: 12 days, p<0.001) compared to the mild group. The severe group also had a higher blood culture positive rate (p<0.001). There were differences between the two groups when analyzed in terms of laboratory parameters, with the exception of hemoglobin, hematocrit, and platelet values. These differences included total bilirubin (p:0.005), CRP (p<0.001), WBC (p<0.001), glucose (p:0.015), urea (p:0.001), creatinine (p:0.001), AST (p:0.042), and ALT (p: 0.014). These differences are expected due to more complications, antibiotic use, and extended hospital and ICU stays in the severe group.

The mortality rate of a severe case of tetanus left untreated is nearly 100%. With appropriate treatment, this rate decreases significantly. In 2015, there were 56,743 tetanus-related deaths globally, with a fatality rate of less than 5% in affluent nations. South Asia and SSA accounted for 79% of these fatalities.[1,2,5] A recent study of several SSA nations reported that the mortality rates in Nigeria, Uganda, Tanzania, and Cameroon were 64%, 47%, 43.1%, and 48.5%, respectively.[35] Based on data, the countries with the highest number of instances of newborn tetanus fatalities per 100,000 people include Kenya, South Sudan, Somalia, and Afghanistan.[2] Critical care services are often unavailable in LMIC, where severe respiratory failure is the primary cause of death in tetanus patients.[36] Of the patients who had a follow-up tetanus diagnosis, 14.3% died; all of them were in the severe category (p<0.001). This rate is highly successful compared to SSA standards and is comparable to death rates in two developed nations like USA (13.2%) and Italy (16.5%).[37,38]

Regular childhood vaccinations improve children's health and development and boost the nation's economy by lowering mortality rates. The 2030 Immunization Agenda and Global Vaccine Action Plan, endorsed by the World Health Assembly in 2020, focus on universal vaccination.[39,40] Importantly, tetanus immunity cannot develop naturally; therefore, children should develop sufficient immunity against tetanus and maintain high antibody levels throughout life with booster shots every ten years.[41] Disruptions to regular immunization schedules brought on by the COVID-19 pandemic may revive some illnesses in the future.[42] In underdeveloped nations, the tetanus vaccine presents challenges due to a lack of healthcare workers, financial constraints, and transportation issues affecting rural areas.[43]

Nine individuals (8.7%) who were fully or partially vaccinated belonged to the mild-moderate category and in contrast, a larger percentage of unvaccinated individuals or those whose status was unknown made up the severe group (p = 0.011).

Limitations

The primary drawback of our study is the lack of data in SSA nations, where tetanus fatalities are highest. Studies conducted in these nations will clarify the existing ambiguity around vaccination, illness incidence, and mortality.

Conclusion

We examined 196 patients who were followed up in our hospital in a period of approximately 2 years and unfortunately we lost 28 of these patients. During this period, we do not have information about how many tetanus patients could not apply to the hospital or applied to other hospitals in Somalia, one of the SSA countries. Vaccination against tetanus in LMIC, especially among children, is crucial due to the vaccine's affordability and high efficacy. Immunization programs should be continually refined and improved. Local health experts must persistently educate, inform, and encourage the public about the importance of vaccination, combating anti-vaccination sentiments that pose a significant threat comparable to the lack of access to vaccines. Without these efforts, diseases like tetanus-which are nearly eradicated in wealthy nations-will continue to be a severe issue in developing nations.

The tetanus toxin is particularly lethal, causing severe muscle spasms, autonomic dysfunction, and potentially fatal complications. Ensuring widespread vaccination is vital to prevent the catastrophic impacts of tetanus toxin. It is a matter of civilization and equity that we do not allow individuals in the 21st century to die from tetanus when we have had a safe and effective tetanus vaccine for 100 years.

To the best of our knowledge, this is the largest case series conducted in Somalia, and it will provide valuable insights and guidance for future research. This study, which included patients of all ages, aimed to generate data that will aid in developing new strategies and providing recommendations the severity and mortality associated with tetanus.

Acknowledgments

This study has been presented as poster presentation in the 12th Turkey EKMUD Scientific Congress, Susesi Hotel, Belek-Antalya, Turkey, 18-22 May 2024.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Rhinesmith E, Fu L. Tetanus disease, treatment, management. *Pediatr Rev*. 2018;39(8):430–432. doi:10.1542/pir.2017-0238
2. Kyu HH, Mumford JE, Stanaway JD, et al. Mortality from tetanus between 1990 and 2015: findings from the global burden of disease study 2015. *BMC Public Health*. 2017;17(1):179. doi:10.1186/s12889-017-4111-4
3. Mertens T. Vaccination in Germany - Recommendations of STIKO. *Dtsch Med Wochenschr*. 2019;144(4):239–243. doi:10.1055/a-0479-3890
4. Bae C, Bourget DT. *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; 2023. PMID: 29083804.
5. Yen LM, Thwaites CL. Tetanus. *Lancet*. 2019;393(10181):1657–1668. doi:10.1016/S0140-6736(18)33131-3
6. Rushdy AA, White JM, Ramsay ME, Crowcroft NS. Tetanus in England and Wales, 1984–2000. *Epidemiol Infect*. 2003;130(1):71–77. doi:10.1017/S0950268802007884
7. Global Tetanus Vaccination, Centers for Disease Control and Prevention. 2024. Available from: https://www.cdc.gov/globalhealth/immunization/diseases/tetanus/data/fast-facts.htm. Accessed26, August, 2024.
8. Fava JP, Stewart B, Dudzinski KM, Baker M, Volino L. Emerging topics in vaccine therapeutics for adolescents and adults: an update for immunizing pharmacists. *J Pharm Pract*. 2020;33(2):192–205. doi:10.1177/0897190018802937
9. Berkowitz AL. Tetanus, Botulism, and Diphtheria. *Continuum*. 2018;24(5):1459–1488. doi:10.1212/CON.0000000000000651
10. Pascual FB, McGinley EL, Zanardi LR, Cortese MM, Murphy TV. Tetanus surveillance--United States, 1998--2000. *MMWR Surveill Summ*. 2003;52(3):1–8.
11. Roper MH, Vandelaer JH, Gasse FL. Maternal and neonatal tetanus. *Lancet*. 2007;370(9603):1947–1959. doi:10.1016/S0140-6736(07)61261-6
12. Dong M, Masuyer G, Stenmark P. Botulinum and tetanus neurotoxins. *Annu Rev Biochem*. 2019;88(1):811–837. doi:10.1146/annurev-biochem-013118-111654
13. Maternal and Neonatal Tetanus Elimination, World Health Organization. 2024. Available from: https://www.who.int/initiatives/maternal-and-neonatal-tetanus-elimination-mnte/progress-towards-global-mnt-elimination. Accessed26, August, 2024.
14. Maternal and Neonatal Tetanus Elimination, World Health Organization. 2024. Available from: https://www.who.int/initiatives/maternal-and-neonatal-tetanus-elimination-mnte/programmatic-update. Accessed26, August, 2024.
15. Global peace index. (2021) measuring peace in a complex world. Available from: https://www.visionofhumanity.org/wp-content/uploads/2023/06/GPI-2023-Web.pdf. Accessed26, August, 2024.
16. Qaderi S, Qaderi F, Tarki FE, et al. Generalized, non-neonatial tetanus is a highly fatal disease in Afghanistan: a case series study. *Int J Infect Dis*. 2021;103:568–572. doi:10.1016/j.ijid.2020.12.019
17. China Trauma Rescue and Treatment Association; Peking University Trauma Medicine Center. Chinese expert consensus on tetanus immunization. *Zhonghua Wai Ke Za Zhi*. 2018;56(3):161–167. doi:10.3760/cma.j.issn.0529-5815.2018.03.001
18. Tetanus Vaccination, Centers for Disease Control and Prevention. 2024. Available from: https://www.cdc.gov/vaccines/vpd/tetanus/index.html. Accessed April 16, 2019.
19. Sahan S, Demirbilek Y, Sonmez C, Temel F, Sencan I. Epidemiological study of tetanus seropositivity levels in different age groups in Ankara Province, Turkey, 2017. *Jpn J Infect Dis*. 2019;72(1):14–18. doi:10.7883/yoken.JJID.2018.222
20. World Health Organization. 2020. Sept 15, Available from: https://www.who.int/news-room/feature-stories/detail/somalia-building-A-stronger-primary-health-care-system.
21. Arogundade FA, Bello IS, Kuteyi EA, Akinsola A. Patterns of presentation and mortality in tetanus: a 10-year retrospective review. *Niger Postgrad Med J*. 2004;11(1):58–63. doi:10.4103/1117-1936.174763
22. Center IDS. Infectious agents surveillance report 23. *IASR*. 2002;23:1–2.
23. Bae S, Go M, Kim Y, et al. Clinical outcomes and healthcare costs of inpatients with tetanus in Korea, 2011–2019. *BMC Infect Dis*. 2021;21(1):247. doi:10.1186/s12879-021-05935-w
24. Marulappa VG, Manjunath R, Mahesh Babu N, Maligegowda L. A ten year retrospective study on adult tetanus at the epidemic disease (ED) hospital, Mysore in southern India: a review of 512 cases. *J Clin Diagn Res*. 2012;6(8):1377–1380. doi:10.7860/JCDR/2012/4137.2363
25. Andersen A, Bjerregaard-Andersen M, Rodrigues A, Umbasse P, Fisker AB. Sex-differential effects of diphtheria-tetanus-pertussis vaccine for the outcome of paediatric admissions? A hospital based observational study from Guinea-Bissau. *Vaccine*. 2017;35(50):7018–7025. doi:10.1016/j.vaccine.2017.10.047

26. Deniz M, Erat T. Generalized tetanus: a pediatric case report and literature review. *Rev Inst Med Trop Sao Paulo*. 2023;65:e40. doi:10.1590/s1678-9946202365040
27. Melkert D, Kahema L, Melkert P. Reduction of mortality due to tetanus by immunisation and proper wound management of the patients in sengerema designated district hospital, Tanzania. *Trop Doct*. 2014;44(3):163–165. doi:10.1177/0049475514521804
28. Fan Z, Zhao Y, Wang S, Zhang F, Zhuang C. Clinical features and outcomes of tetanus: a retrospective study. *Infect Drug Resist*. 2019;12:1289–1293. doi:10.2147/IDR.S204650
29. Cook TM, Protheroe RT, Handel JM. Tetanus: a review of the literature. *Br J Anaesth*. 2001;87(3):477–487. doi:10.1093/bja/87.3.477
30. Akseer N, Rizvi A, Bhatti Z, et al. Association of exposure to civil conflict with maternal resilience and maternal and child health and health system performance in Afghanistan. *JAMA Network Open*. 2019;2(11):e1914819. doi:10.1001/jamanetworkopen.2019.14819
31. Patel JC, Mehta BC. Tetanus: study of 8,697 cases. *Indian J Med Sci*. 1999;53(9):393–401.
32. Rodrigo C, Fernando D, Rajapakse S. Pharmacological management of tetanus: an evidence-based review. *Crit Care*. 2014;18(2):217. doi:10.1186/cc13797
33. Mahieu R, Reydel T, Maamar A, et al. Admission of tetanus patients to the ICU: a retrospective multicentre study. *Ann Intensive Care*. 2017;7(1):112. doi:10.1186/s13613-017-0333-y
34. Preiser JC, van Zanten AR, Berger MM, et al. Metabolic and nutritional support of critically ill patients: consensus and controversies. *Crit Care*. 2015;19(1):35. doi:10.1186/s13054-015-0737-8
35. Sangwe clovis N, Palle JN, Linwa EMM, Ndung Ako F, Tabe Benem-Orock V, Chichom Mefire A. Factors associated with mortality in patients with tetanus in Cameroon. *Sci Prog*. 2023;106(1):368504221148933. doi:10.1177/00368504221148933
36. Afshar M, Raju M, Ansell D, Bleck TP. Narrative review: tetanus-A health threat after natural disasters in developing countries. *Ann Intern Med*. 2011;154(5):329–335. doi:10.7326/0003-4819-154-5-201103010-00007
37. Centers for Disease Control and Prevention (CDC). Tetanus surveillance United States, 2001–2008. *MMWR Morb Mortal Wkly Rep*. 2011;60(12):365–369.
38. Filia A, Bella A, von Hunolstein C, et al. Tetanus in Italy 2001–2010: a continuing threat in older adults. *Vaccine*. 2014;32(6):639–644. doi:10.1016/j.vaccine.2013.12.012
39. Immunization agenda. 2030: a global strategy to leave no one behind. Geneva: world Health Organization; 2020. https://www.who.int/teams/immunization-vaccines-and-biologicals/strategies/ia2030. Available from. Accessed 2021 Jun 8.
40. World Health Organization. Global Vaccine Action Plan. Geneva. 2021. Available from: https://www.who.int/teams/immunization-vaccines-and-biologicals/strategies/global-vaccine-action-plan. Accessed 2021 Jun 21.
41. Akane Y, Tsugawa T, Hori T, et al. Tetanus in a partially immunized child. *J Infect Chemother*. 2018;24(12):980–982. doi:10.1016/j.jiac.2018.05.002
42. Harris RC, Chen Y, Côte P, et al. Impact of COVID-19 on routine immunisation in South-East Asia and Western Pacific: disruptions and solutions. *Lancet Reg Health West Pac*. 2021;10:100140. doi:10.1016/j.lanwpc.2021.100140
43. Pathirana J, Nkambule J, Black S. Determinants of maternal immunization in developing countries. *Vaccine*. 2015;33(26):2971–2977. doi:10.1016/j.vaccine.2015.04.070