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Trends and Hospitalization Outcomes of Tetanus Cases: A Multicenter Retrospective Study in Suzhou, 2013–2023

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Objective: To investigate the epidemiology, and hospitalization of tetanus in Suzhou, Jiangsu Province, China, focusing on the severity of the disease, treatment, outcomes and hospitalization costs, and to explore the risk factors for severe tetanus.

Methods: This retrospective, multicenter observational study analyzed tetanus patients admitted to various medical institutions between 2013 and 2023. Patients were classified into two groups as severe or non-severe, using the Ablett classification. Differences between the two groups were compared using the Chi-squared test, Fisher's exact test and Mann–Whitney U-test. Binary logistic regression analysis was used to evaluate potential risk factors for severe disease.

Results: A total of 63 patients with tetanus were included in this study. The median age of the patients was 57.0 (48.0–74.0) years, with a predominance of males (65.1%). There was an overall increasing trend in the rate of severe illness in tetanus patients from 2013–2023 ($P<0.001$). The proportion of patients admitted to the hospital was highest (39.7%) in summer (June–August) ($P=0.001$). The rate of severe tetanus was significantly higher in patients aged ≥65 years than in those aged 0–40 years and 41–64 years ($P=0.019$). The incubation period was 8.0(5.0–11.0) days for severe tetanus patients and 11.0 (8.0–18.0) days for non-severe patients ($P=0.005$). Compared to the non-severe group, the severe group shouldered a higher hospitalization cost, with total costs amounting to US $19062.8(4675.4–29,385.4) and US $4291.1(1356.6–19,635.4), respectively. Binary logistic regression analysis revealed that patients aged 65 years and above significantly increased the risk of developing severe disease (OR = 3.345, 95% CI: 1.039–10.770).

Conclusion: Tetanus occurs primarily in the summer in Suzhou City, Jiangsu Province, China. The incubation period is shorter in patients with severe tetanus. The elderly are the main affected population, with the risk of developing severe disease escalating with advancing age. Knowledge of tetanus immunoprophylaxis should be strengthened to further reduce morbidity and mortality.

Keywords: tetanus, severe, hospitalization, risk factors

Introduction

Non-Neonatal Tetanus is a disease caused by Clostridium tetani, occurring after 28 days of age. The bacterium enters the body through a break in the skin or mucous membrane, where it multiplies in anaerobic conditions and produces exotoxins. This leads to an acute and specific toxic condition characterized by persistent tonic contractions and paroxysmal spasms of the skeletal muscles throughout the body.[1]

According to statistics, approximately 70,000 people were infected with tetanus globally in 2019, and over 30,000 people died from the disease.[2] Tetanus remains common in developing countries, with a high mortality rate of up to 45.5% in African nations.[3] In developed countries, tetanus has a low incidence and favorable prognosis. However, due to

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inadequate primary or booster immunization among the elderly who account for the majority of reported tetanus cases,[4] the healthcare burden of tetanus in this demographic area remains significant.[5]

Although tetanus is a non-transmissible disease, it will not be eradicated even if the number of cases decreases to zero at some point in the future. This is because the causative agent of tetanus remains present in the soil, natural infection does not confer immunity, and any unvaccinated person is at risk of developing tetanus. However, tetanus can be completely prevented through proper wound management and vaccination.[6] Therefore, vaccination is essential to control tetanus.

With the popularization of vaccination and other measures, neonatal tetanus has been effectively controlled, but non-neonatal tetanus remains a serious public health problem. In 2016, about 13,500 cases of tetanus were reported globally, of which non-neonatal cases accounted for 85%, according to data jointly released by WHO and UNICEF.[7] Patients with severe tetanus infection can experience life-threatening symptoms such as laryngospasm, asphyxia, lung infection, and organ failure. Without medical intervention, the morbidity and mortality rate is nearly 100%, and even with aggressive comprehensive treatment, the rate remains 30%–50% globally.[1] This not only causes suffering to patients but also imposes a heavy economic burden on their families and society.[8] Therefore, studying the risk factors associated with severe illness in tetanus patients is of great significance.

China has classified neonatal tetanus as a legal infectious disease, and surveillance data show that China reached the WHO neonatal tetanus elimination goal in 2012.[9] However, China still lacks an epidemiologic surveillance and reporting system for non-neonatal tetanus, and the incidence of the disease is unknown.[10,11] Therefore, this study aimed to review the epidemiology and hospitalization situations (severity of the disease, treatment, outcomes and hospitalization costs) of non-neonatal tetanus patients in Suzhou, Jiangsu Province, China, from 2013 to 2023. The study analyzed the symptoms, treatment, and prognosis of patients with severe and non-severe tetanus, explored the risk factors for severe tetanus, and provided evidence-based insights for improving future tetanus management strategies.

Materials and Methods

Data Source

The medical information of the study subjects was sourced from the Suzhou Health and Family Planning Statistics Information Center and the discharge records of the hospitals the patients attended. Medical information was reviewed and evaluated in detail by two researchers. Information was extracted and compared separately using a uniform form and was finally arbitrated by a third researcher.

Diagnostic Criteria

The inclusion criteria included patients over 28 days of age and with a discharge diagnosis of tetanus during the period of the study. Exclusion criteria included patients with incomplete medical records or those whose diagnosis of tetanus could not be confirmed. Based on the Diagnostic and Medical Criteria for Non-Neonatal Tetanus published by Dr. Wang CL, Chief Physician of the People's Hospital of Peking University,[1] the diagnostic and grading criteria of tetanus were classified into grades I–IV according to the Ablett grading method, with grade III and above considered severe tetanus. Grade I (mild): mild to moderate clenching of teeth, no dyspnea, no convulsions, no or mild dysphagia. Grade II (medium): moderate clenching, mild to moderate episodes of muscle spasms, moderate dysphagia, moderate dyspnea with a respiratory rate of 30–40 breaths/minute. Grade III (severe): severe clenching, severe persistent episodes of muscle spasms, a respiratory rate of >40 breaths/minute, severe dyspnea, severe dysphagia, tachycardia (heart rate >120 beats/minute). Grade IV (extra severe): Grade III with severe autonomic dysfunction.

Research Methods

Patients' medical record information was collected and analyzed, including gender, age, occupation, site of injury, incubation period, post-injury disposition, main clinical symptoms, treatment history, disease severity, hospitalization time, hospitalization cost, and disease outcome. The study subjects were divided into severe and non-severe groups based on whether the grading was ≥grade III. All clinical data were obtained from medical records.

Statistical Analyzes

All statistical data were analyzed using R version 4.1.1. Categorical variables were expressed as n (%) and compared using the Chi-squared test or Fisher's exact test. Continuous variables showing normal distribution were expressed as mean ± standard deviation (SD), and those showing non-normal distribution were expressed as median with interquartile range (IQR) and compared using the Mann–Whitney *U*-test. Binary logistic regression analysis was used to assess the risk factors associated with severe illness. A *P*-value < 0.05 was considered statistically significant.

Ethical Considerations

The study complies with the Declaration of Helsinki. Ethical approval to conduct the study was granted by the ethics committee of Suzhou Center for Disease Control and Prevention (NO.2024-MG-03). This is a retrospective study based on the Suzhou Health and Family Planning Statistics Information Center and the hospital information system. Patient consent was waived by Suzhou Center for Disease Control and Prevention because no contact with patients was conducted and patient anonymity was assured.

Results

Demographic Data of Tetanus Cases

Tetanus Hospitalization in Different Years and Seasons

From January 2013 to December 2023, a total of 63 non-neonatal patients were hospitalized for tetanus in Suzhou City. Of these, 31 (49.2%) were severe cases, and 32 (50.8%) were non-severe cases. The incidence of tetanus and the rate of severe cases showed an overall increasing trend from 2013 to 2023 ($P < 0.001$). See Figure 1. The rate of severe cases among tetanus hospitalized patients is higher after 2020 than before 2020 ($X^2=15.276$, $P < 0.001$). See Table 1. The highest proportion of patients admitted to the hospital was in summer (June-August) at 39.7%, while the lowest was in winter (December-February) at 9.5%, with a statistically significant difference ($P = 0.001$). See Table 2.

Basic Characteristics of Tetanus Patients

The median age of the 63 non-neonatal tetanus patients hospitalized was 57.0 (48.0–74.0) years. Eight (12.7%) were aged 0–40 years, of whom two (25.0%) were severe; 31 (49.2%) were aged 41–64 years, of whom 12 (38.7%) were severe; and 24 (38.1%) were aged ≥65 years, of whom 17 (70.8%) were severe. There was a significant difference in the rate of severe cases among the three age groups ($P = 0.019$). Twenty-eight patients were from urban areas of Suzhou, 30 from county-level cities within Suzhou, and five from other areas. There were 41 (65.1%) male patients and 22 (34.9%)

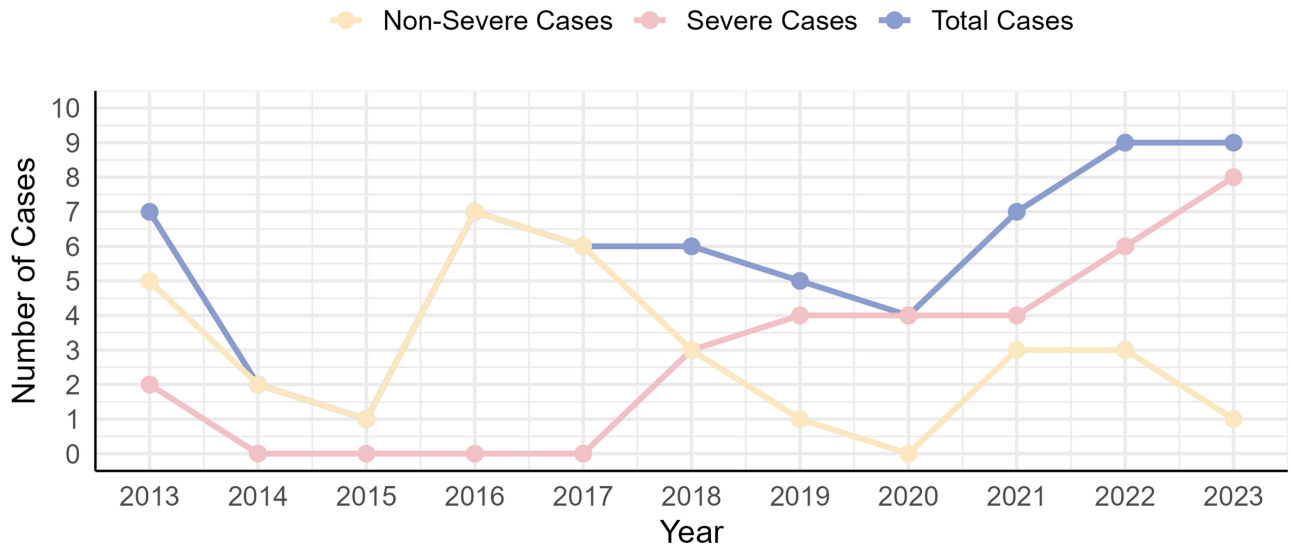

Figure 1 Number of tetanus cases in Suzhou, 2013–2023.

Table 1 Number of Tetanus Cases Before and After the Covid-19 Pandemic in Suzhou City [n(%)]

Year of admission	Total, n=63 [n(%)]	Severe group, n=31 [n(%)]	Non-severe group, n=32 [n(%)]	χ^2	*P*-value
2013–2019	34(54.0)	9(26.5)	25(73.5)	15.276	<0.001
2020–2023	29(46.0)	22(75.9)	7(24.1)		

Table 2 Number of Tetanus Cases in Different Seasons [n(%)]

Season of admission	Total, n=63 [n(%)]	χ^2	*P*-value	Severe Group, n=31 [n(%)]	Non-severe Group, n=32 [n(%)]	χ^2	*P*-value
Spring (3–5m)	14(22.2)	15.979	0.001	5(35.7)	9(64.3)	-	0.638*
Summer (6–8m)	25(39.7)			13(52.0)	12(48.0)		
Autumn (9–11m)	18(28.6)			9(50.0)	9(50.0)		
Winter (12–2m)	6(9.5)			4(66.7)	2(33.3)		

Note: * Used Fisher's exact probability method.

female patients. Labor workers and farmers accounted for 20.6% of the patients, while 69.9% were unemployed or retired. None of the patients had ever received a tetanus vaccination, including both primary immunization and booster doses. Prior to admission, only 2(3.2%) had been treated with passive immunization. See Table 3.

Table 3 Patient Characteristics at Admission [n(%)]

Variables	Total, n=63 [n(%)]	Severe Group, n=31 [n(%)]	Non-severe Group, n=32 [n(%)]	χ^2	*P*-value
Area					
Suzhou urban areas	28(44.4)	13(46.4)	15(53.6)	-	0.307*
Suzhou county-level cities	30(47.6)	17(56.7)	13(43.3)		
Other areas	5(8.0)	1(20.0)	4(80.0)		
Sex					
Male	41(65.1)	18(43.9)	23(56.1)	1.321	0.250
Female	22(34.9)	13(59.1)	9(40.9)		
Age					
0–40	8(12.7)	2(25.0)	6(75.0)	-	0.019*
41–64	31(49.2)	12(38.7)	19(61.3)		
≥65	24(38.1)	17(70.8)	7(29.2)		
Occupation					
Farmers	6(9.5)	3(50.0)	3(50.0)	-	0.574*
Labor workers	7(11.1)	5(71.4)	2(28.6)		
The unemployed	44(69.9)	21(47.7)	23(52.3)		
Other professions	6(9.5)	2(33.3)	4(66.7)		
Vaccination history					
Yes	0(0)	0(0)	0(0)	-	-
No	63(100)	31(49.2)	32(50.8)		
History of post-injury passive immunization					
Yes	2(3.2)	0(0)	2(100)	-	0.492*
No	61(96.8)	31(50.8)	29(49.2)		

Note: * Used Fisher's exact probability method.

Injuries, Treatment, and Prognosis of Cases

Site of Injury

A total of 25 patients (39.7%) had injuries in the lower limbs, 19 patients (30.2%) had injuries in the upper limbs and head, six patients (9.5%) had injuries in the trunk, and 13 patients (20.6%) had unknown injury sites. There was no significant difference between the severe and non-severe groups in terms of site of injury ($P = 0.102$). See Table 4.

Hospitalization and Treatment of Cases

The median hospitalization duration for tetanus patients was 24.0(6.0–35.0) days, with a median interval of 15.0 (12.0–15.0) days between injury and initial visit. The median incubation period was 10.0(7.0–14.0) days, comprising 8.0(5.0–11.0) days for severe cases and 11.0(8.0–18.0) days for non-severe cases ($P = 0.005$). Sixteen patients received post-injury care before hospital admission.

Among the 63 patients, 11 (17.5%) received Tetanus Antitoxin (TAT) treatment alone, 16 (25.4%) received Human Tetanus Immune Globulin (HTIG) treatment alone, 24 (38.1%) received both TAT and HTIG, and 12 (19.0%) received neither TAT nor HTIG. There was a significant difference in passive immunization treatment between severe and non-severe groups ($P = 0.028$). Twenty-six patients required mechanical ventilation, with 18 severe cases (69.2%) and only eight non-severe cases (30.8%), showing a significant difference ($P = 0.013$). Pulmonary infection developed in 32 patients (50.8%). Of the 63 patients, 54 were successfully treated and discharged. Five patients were discharged without complete recovery: some were transferred to other medical institutions for further treatment, while others were discharged at the request of their families, who chose to discontinue treatment. Additionally, four patients succumbed during hospitalization. Refer to Table 4.

Table 4 Symptoms and Treatment of the Patients with Tetanus [n(%)]

Variables	Total, n=63 [n(%)]	Severe Group, n=31 [n(%)]	Non-severe Group, n=32 [n(%)]	χ^2/Z	*P*-value
Admission to hospital					
Post-injury care	16(25.4)	7(43.8)	9(56.2)	0.255	0.613
Interval between injury and initial visit [Median (IQR), d]	15.0(12.0–15.0)	15.0(12.0–15.0)	15.0(10.0–20.0)	−0.328	0.743
Incubation period [Median (IQR), d]	10.0(7.0–14.0)	8.0(5.0–11.0)	11.0(8.0–18.0)	−2.808	0.005
Injury sites					
Cryptogenic	13(20.6)	7(53.8)	6(46.2)	-	0.102*
Upper limbs and head	19(30.2)	11(57.9)	8(42.1)		
Lower limbs	25(39.7)	8(32.0)	17(68.0)		
Trunk	6(9.5)	5(83.3)	1(16.7)		
Emergency treatment after hospitalization					
TAT	11(17.5)	1(9.1)	10(91.9)	9.100	0.028
HTIG	16(25.4)	9(56.3)	7(43.7)		
TAT and HTIG	24(38.1)	15(62.5)	9(37.5)		
Neither TAT nor HTIG	12(19.0)	6(50.0)	6(50.0)		
Complications during hospitalization					
Pulmonary infection	32(50.8)	19(59.4)	13(40.6)	2.690	0.133
Special treatment during hospitalization					
Mechanical ventilation	26(41.3)	18(69.2)	8(30.8)	6.227	0.013
ICU	2(3.2)	2(100)	0(0)	-	0.493*
Discharge from hospital					
Hospitalization duration [Median (IQR), d]	24.0(6.0–35.0)	30.0(7.0–49.0)	16.0(4.25–34.5)	−1.561	0.118
Recover	54(85.7)	26(48.1)	28(51.9)	-	0.873*
Not complete recover	5(8.0)	3(60.0)	2(40.0)		
Death	4(6.3)	2(50.0)	2(50.0)		

Note: * Used Fisher's exact probability method.

Table 5 Medical Costs for the Inpatients with Tetanus (US $)

Variables	Hospitalization Costs (US $)*	Severe Group (US $)*	Non-Severe group (US $)*	Ratio	*Z*	*P*-value
Medical costs for hospitalization, median [IQR]						
Total costs	11684.1(1838.1–26,941.7)	19,062.8(4675.4–29,385.4)	4291.1(1356.6–19,635.4)	4.44	−2.310	0.021
Costs for comprehensive medical services	1384.8(447.2–5396.5)	3943.9(1176.9–6439.8)	796.4(286.7–3471.7)	4.95	−2.268	0.023
Costs for diagnosis	1485.7(484.1–3715.4)	2647.5(794.8–4197.1)	767.1(365.4–2184.0)	3.45	−2.681	0.007
Cost for treatment	67.6(0–139.5)	116.1(0–143.5)	17.7(0–134.6)	6.56	−1.160	0.246
Costs for medication	4464.4(778.1–13,872.5)	9551.6(1873.7–18,384.7)	2254.0(494.0–11,315.1)	4.24	−2.076	0.038
Costs for consumable	227.8(4.5–1033.0)	714.3(29.4–1341.5)	65.6(0.2–547.4)	10.9	−2.647	0.008
Costs for others	0(0–9.7)	0(0–0.7)	4.2(0–14.0)	0	−2.688	0.007

Note: *Costs are based on the average exchange rate for each year.

Basic Characteristics of Dead Patients

The median age of the four deceased patients was 57.5 (54.0–72.0) years, with three of them being male (75.0%). The duration of hospitalization was 4.0(2.0–6.0) days. The median incubation period was 7.0(7.0–8.5) days, and the median time interval between injury and medical consultation was 8.5 (7.0–14.0) days. Among these patients, two were classified as severe cases, while two were non-severe cases. Only one received wound treatment after injury; the remaining three did not receive any treatment.

Direct Medical Costs for Patients

Table 5 illustrates the direct medical costs of tetanus patients. The median total cost paid by tetanus patients was US $11684.1(1838.1–26,941.7). Among these expenses, the largest portion was allocated to medications (Western medicine costs, Chinese medicine costs), totaling US $4464.4(778.1–13,872.5). This was followed by diagnostic costs, including pathology tests, laboratory tests, imaging studies (such as X-rays or CT scans), and other clinical diagnostic assessments necessary for evaluating patient condition and managing potential complications, amounting to US $1485.7 (484.1–-3715.4). Comprehensive medical services costs (general medical services, general therapeutic manipulation, nursing care) accounted for US $1384.8(447.2–5396.5), while consumables amounted to US $227.8(4.5–1033.0), and treatment (non-surgical treatment, surgical treatment) reached US $67.6(0–139.5).

In the severe group, total costs were 4.44 times higher than in the non-severe group ($P = 0.021$), comprehensive medical services costs were 4.95 times higher than in the non-severe group ($P = 0.023$), diagnostic costs were 3.45 times higher than in the non-severe group ($P = 0.007$), medication costs were 4.24 times higher than in the non-severe group ($P = 0.038$), and consumable costs were 10.9 times higher than in the non-severe group ($P = 0.008$). There were no significant differences between the severe and non-severe groups in terms of treatment costs.

Risk Factor Analysis for Severe Cases

All significant variables identified in the univariate analysis were included in the binary logistic regression analysis for age ≥65 years and having a chronic disease. The multifactorial results revealed that age ≥65 years was a significant risk factor for tetanus. Tetanus patients aged ≥65 years had 3.345 times the risk of developing severe illness compared to patients aged <65 years (95% CI: 1.039–10.770, $P = 0.043$). Refer to Table 6 for details.

Discussion

Although the prevalence of tetanus has declined with the tetanus vaccination, approximately 30,000 people worldwide still succumb to tetanus each year.[2,12,13] Our study reviewed the incidence of tetanus in Suzhou City, China, over the last decade (2013–2023), encompassing a total of 63 tetanus patients admitted to various medical institutions. This investigation revealed that tetanus patients were predominantly male (65.1%), consistent with the findings of Cai MT et al.[14] The underlying reasons considered include the higher engagement of men in outdoor physical labor, leading to more opportunities for injuries, coupled with their tendency to overlook details and hygiene, often treating wounds casually post-injury, thereby increasing the likelihood of tetanus infection compared

Table 6 Multiple Logistic Regression Analysis of Risk Factors Associated with Severe Cases in Tetanus Patients

Variables	Univariate logistic regression analysis		Multivariate logistic regression analysis	
	χ^2	*P*-value	Odds Ratio (95% Confidence Interval)	*P*-value
Age				
<65	7.255	0.007	1.00	0.043
≥65			3.345(1.039–10.770)	
Sex				
Male	1.321	0.250	-	-
Female				
Occupation				
Farmers	2.036	0.574	-	-
Labor workers				
The unemployed				
Other professions				
Season				
Spring	1.835	0.638	-	-
Summer				
Autumn				
Winter				
Injury sites				
Cryptogenic	6.255	0.102	-	-
Upper limbs and head				
Lower limbs				
Trunk				
Presence of complications				
No	2.690	0.101	-	-
Yes				
Chronic disease				
No	4.636	0.031	1.00	0.220
Yes			2.046(0.652–6.415)	
Interval between injury and initial visit				
<15 days	0.176	0.674	-	-
≥15 days				

to women. Among these patients, 20.6% were farmers and labor workers. Similarly, many previous studies observed a high proportion of farmers among tetanus patients.[15–17] The factor possibly correlated with the nature of their work, working environment, and inadequate awareness of health management. Consequently, there is a pressing need to enhance awareness of workplace hygiene among this set of people, along with the necessity to ensure proper wound sterilization.

Our study found that the highest percentage of tetanus admissions (39.7%) occurred during the summer, consistent with the findings of Mikio Nakajima et al.[18] Seasonality of tetanus was also observed in the study by F. Marc LaForce, M.D et al[19] who reported that 64% of tetanus cases were documented between May and October. In our study, the proportion of tetanus admissions from May to October was 69.8%, indicating a comparable outcome. The seasonal prevalence of tetanus may be attributed to increased outdoor activities and reduced clothing coverage during summer months, leading to a higher susceptibility to bumps and scratches. Furthermore, since most patients were elderly individuals with limited health management awareness, the hot weather during summer likely contributes to wound infection and inflammation.

Among the 63 tetanus patients, our study revealed that the majority (79.4%) experienced definite acute trauma preceding the onset of tetanus. Specifically, 19 (30.2%) patients sustained upper limb and head injuries, 25 (39.7%) had lower limb injuries, and six (9.5%) suffered trunk injuries. Head trauma, in particular, can expedite the invasion of the central nervous system by Clostridium tetani, potentially exacerbating tetanus severity.[20] However, our study found no direct correlation between the site of trauma and disease severity, which could be attributed to the limited occurrence of head trauma cases (only one). In this study, 13 (20.6%) patients were found to have no visible wounds of which 7 (53.8%) were critically ill. Some studies have found that as many as 30% of tetanus patients have no visible trauma.[21,22] These findings illustrate that there are no safe wounds for tetanus. Thorough wound debridement following trauma plays a crucial role in mitigating tetanus severity. Some studies suggest that early and comprehensive wound debridement in tetanus patients can significantly reduce the case fatality rate.[23] Among the four fatal cases, only one patient underwent post-injury care, while the remaining three received no treatment or medical intervention, resulting in two of them progressing to severe tetanus. Hence, it is imperative to enhance public awareness regarding tetanus and its importance in preventive care.

The median incubation period of tetanus patients in this study was 10.0 (7.0–14.0) days, with a median time interval between injury and initial visit of 15.0 (12.0–15.0) days, indicating that most tetanus patients did not seek immediate medical attention following disease onset. Specifically, severe patients had a median incubation period of 8.0 (5.0–11.0) days, whereas non-severe patients had a median of 11.0 (8.0–18.0) days. Among the four fatal cases, the median incubation period was 7.0 (7.0–8.5) days. Notably, the observed incubation periods were shorter than the median incubation period in both severe and fatal cases. Literatures suggest that shorter incubation periods and onset times are associated with poorer prognoses, indicating a more severe disease course.[24,25] Therefore, individuals experiencing symptoms suggestive of tetanus, such as clenched teeth and muscle tension post-injury, should promptly seek medical attention to avoid treatment delays.

The incidence of concurrent pulmonary infection in tetanus is notable, with Wang et al reporting an incidence of 84.54%.[26] In our study, 32 (50.8%) out of 63 tetanus patients developed pulmonary infections, a figure comparable to that reported by Xiao K et al (58.7%).[27] This underscores the significance of preventive measures and control strategies for pulmonary infections in tetanus patients. Huang YH et al observed pulmonary infections in 12 tetanus cases, among which five developed severe pneumonia and one progressed to multiple organ failure.[23] Lung infection is closely linked to airway management and sedation status. Early tracheostomy in severe cases enhances airway management, reduces the duration of mechanical ventilation, and rationalizes the use of sedative muscle relaxants, thereby effectively mitigating the risk of lung infection.[1]

The cost of treating tetanus patients with severe illnesses can amount to tens of thousands of dollars, imposing a significant medical and financial burden on both the patients' families and the community.[28] In this study, we found that total costs, comprehensive medical services costs, diagnostic costs, medication costs and consumable costs were all significantly higher in the severe group compared to the non-severe group. Our study revealed that the medical cost of treating tetanus (US $11684.1) surpassed that reported in Guangxi Province, China (US $2937)[11] and Vietnam (US $521).[29] A Korean study indicated that the cost per tetanus hospitalized patient was three times the annual health expenditure per capita in Korea.[30] According to the China Statistical Yearbook 2023, the total health expenditure per capita in China was US $836.0. Comparatively, the cost of tetanus hospitalization per capita in our study was US $11684.1, representing a staggering 13.98 times the total health expenditure per capita and significantly surpassing the findings of the Korean study. This underscores the severe personal financial burden posed by tetanus. Additionally, the tetanus severe rate in Suzhou City from 2013–2023 exhibited a general upward trend, with a case fatality rate of 6.3%, higher than studies conducted in Fujian Province, China (5.23%),[26] and Guangzhou City, China (0%), but lower than Guangxi Province, China (11.2%).[31] These findings further highlight the seriousness of tetanus and the heavy personal financial burden.

Currently, advancing age is a global risk factor for tetanus, with adults aged 50 and over experiencing twice the incidence of tetanus compared to their younger counterparts.[32] Several studies indicate a correlation between tetanus severity and age. A study in the United States found that tetanus patients aged over 65 years had a higher risk of developing severe disease.[33] Within this study, 38.1% of patients were aged 65 or above, with approximately 70% of

them classified as severe cases. The incidence of severe tetanus among patients aged 65 or older (70.8%) was significantly higher compared to those aged 0–40 years (25.0%) and 41–64 years (38.7%). This indicates that without adequate protection, the elderly are at higher risk of injury. The age group of 65 years and older was identified as a significant risk factor for severe tetanus in multifactorial analysis (OR = 3.345, 95% CI: 1.039–10.770). In addition, the incidence of severe tetanus cases was higher after the onset of the COVID-19 pandemic compared to the pre-pandemic period, which we attribute to a potential decline in population immunity. Therefore, the elderly should be considered a high-risk group and prioritized for primary immunization when appropriate. Multifactorial analysis did not yield significance for the chronic disease factor; however, the odds ratio (OR) already indicated that tetanus patients with chronic diseases were approximately twice as likely to develop severe illness compared to those without chronic diseases. Chronic diseases were also identified as a risk factor for tetanus immunodeficiency by Serkan Oncü[34] and Mehmet Aksoy,[35] among others. The presence of chronic diseases increases tetanus-related mortality. Since the chronic disease history of the patients in this study was self-reported, there may be bias. Subsequently, we will expand the sample size to continue in-depth exploration.

The most effective preventive measure for tetanus is tetanus vaccination.[31] The latest World Health Organization (WHO) Tetanus Position Paper (2017) recommends the use of Tetanus toxoid-containing vaccine (TTCV) for active immunization, supplemented by passive immunization agents for temporary additional protection for those without a history of TTCV vaccination.[36] However, in this study, all tetanus hospitalized patients were not vaccinated against tetanus. Therefore, the publicity of tetanus vaccine should be increased to enhance people's awareness of vaccination and to improve their antibody levels. Immunoprophylaxis for post-traumatic tetanus at all levels of healthcare in Suzhou commonly uses only TAT or HTIG, which is inconsistent with the optimal immunization strategy proposed by the WHO. Overuse of TAT and HTIG was shown to be common in China by Gao and Liu et al[10,37] Possible reasons for this are physicians' lack of understanding of the pathogenesis of tetanus and the misinterpretation of TAT and HTIG as the gold standard for tetanus prophylaxis. According to Chinese Guidelines for post-traumatic use of tetanus vaccines and passive immune preparations, tetanus patients should begin a full course of TTCV immunization on the same day as receiving HTIG or TAT if they have not completed a full course of TTCV immunization or if their immunization history is unknown.[38] If the patient has previously completed a full course of TTCV immunization, a dose of TTCV should be boosted at this time. If TTCV is not available on the day of treatment with HTIG or TAT, it should be administered four weeks later.[38] Therefore, there is a need to train doctors on the latest tetanus guidelines and to update their knowledge and competence in tetanus immunization.

There are some limitations in the present study. Firstly, the retrospective design may introduce several forms of bias: information bias could arise from incomplete medical records, and selection bias may occur due to the exclusion of patients who did not seek hospital treatment or were misdiagnosed. Secondly, Suzhou is a developed city on the eastern coast of China, where urbanization is progressing rapidly. This is one of the important reasons for the small sample size of this study. Finally, our study is limited to Suzhou City, which may restrict the generalizability of our findings. We expect to expand our research scope in the future to address these limitations. Despite these limitations, a comprehensive review of the available data was conducted, and given the lack of similar studies in China, our findings provide valuable reference points for other regions.

Conclusion

Tetanus in Suzhou City occur primarily in the summer months. Risk factors for severe tetanus are related to age; the older the age, the higher the risk of severe disease. The cost of hospitalization for severe patients is significantly higher than the cost of hospitalization for non-severe patients. Therefore, it is crucial to strengthen public awareness and education about tetanus, particularly the importance of timely vaccination. This can be achieved through targeted educational campaigns in schools to educate students, in workplaces such as construction sites where workers are at higher risk of injury, and in community health programs aimed at older adults and their caregivers. Additionally, the Guidelines for the Use of Tetanus Vaccine and Passive Immunization Agents for Non-Newborn Infants should be more widely disseminated, and healthcare professionals should receive further training to improve their knowledge of tetanus diagnosis and treatment. These efforts can help reduce both morbidity and mortality from tetanus.

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Disclosure

The authors report no conflicts of interest in this work.

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