

6084 Cases of Non-neonatal Tetanus from China: A Literature Analysis

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Abstract

Objective: To describe the clinical characteristics and the situations of the treatment and outcome of tetanus and find out the focus of tetanus prevention and treatment to reduce morbidity and mortality in China, this paper retrospectively studied the literature and analyzed the clinical characteristics and the situations of treatment and outcome of tetanus in China.

Methods: Four databases, including the Chinese Bio-Medical Literature Database, Chinese National Knowledge Infrastructure, Chinese Scientific Journal Database, and Wan-fang Data, were searched from 1 January/2000 to 30/October/2022. Descriptive statistics calculated frequencies and percentages.

Results: The total 151 articles, including 6084 tetanus patients, met the inclusion criteria. 5925 patients were recorded gender in detail, of which 66.67% (3950/5925) were male, and 33.33% (1975/ 5925) were female. The average age of the detailed records was 4773 cases, with an overall average age of 46.69; the minimum and maximum mean ages are 25.00 and 65.22 years old, respectively. The number of patients' residence places recorded was 580; those from rural areas had the highest percentage, 88.62% (514 / 580). The causes of injury recorded were 1592 cases in total; injuries caused by metals, wood, and wooden spikes, such as rusty nails and iron pieces, accounted for the highest percentage of 54.52% (868/1592). The patients recorded outcome amounted to 4305 cases, of whom 402 died, and the mortality was 9.34%. The leading causes of death included treatment terminated by family members, asphyxia due to persistent spasms, respiratory failure, and autonomic dysfunction, in which family automatic abandonment and asphyxia accounted for the highest percentage, both 24.00% (54/225).

Conclusion: the overall success rate of tetanus treatment in China has dramatically improved, but the prevention and control situation of non-neonatal tetanus is still strenuous; the focus of it should be put on the prevention of adult tetanus and standardizing the use of sedative and spasmolytic drugs. Popularize tetanus prevention and treatment knowledge to the people, and strengthen the training in grass-roots hospitals, the combined application of Chinese and western medicine may be a new direction with the value of exploring reducing the dosage of sedative and spasmolytic drugs.

1. Introduction

Tetanus, with muscle spasms as the primary manifestation, is an acute specific infectious disease caused by tetanus bacillus invading the nervous system by exposure to wounds; although it is rare in developed countries, still common in many low-income and middle-income countries¹. The average morbidity of tetanus in the whole population in Africa was relatively high, ranging from 0.3010/100 000 to 0.5490/100 000, the average annual morbidity of tetanus in the United States was 0.01/100 000 from 2001 to 2008, and Australia had an incidence of 0.35 per million by 2002²⁻⁴. The incidence of neonatal and childhood tetanus has been significantly reduced in China since it began implementing the childhood immunization program in 1978, but adult tetanus occurs now and then and there is an absence of accurate studies on the incidence of tetanus in the general population in China. It is reported that tetanus mortality rates are as high as 16% to 52.6%; the mortality rate can reach 65%-70% in areas where intensive care is lacking⁵⁻⁷. Tetanus is still a serious public health problem, which is responsible for around 60,000 deaths annually around the globe, with a reported 213,000–293,000 deaths worldwide, and seriously threatens people's lives and health⁸⁻¹⁰. The disease is fatal but preventable through vaccination, tetanus antitoxin (TT), or tetanus immunoglobulin (TIG) after trauma¹¹. There is a lack of epidemiological data on non-neonatal tetanus in China, but in some reports, some hospitals admitted more than 30 tetanus patients in a year, Guangdong medical college 72 cases in two years¹², Leizhou People's Hospital 60 cases in one year¹³, Luoding People's Hospital 90 cases in two and a half years¹⁴, so the current situation of non-adult tetanus prevention and control in China may be not optimistic, therefore, this study analyzed the literature on non-neonatal

tetanus published from 2000 to 2020 in China to describe the clinical characteristics and the situations of the treatment and outcome of tetanus and find out the focus of tetanus prevention and treatment to reduce morbidity and mortality in China.

2. Materials And Methods

2.1. Materials and Methods

Four databases, including the Chinese Bio-Medical Literature Database, Chinese National Knowledge Infrastructure, Chinese Scientific Journal Database, and Wan-fang Data, were searched from 1 January/2000 to 30/October/2022, "tetanus" was the search term used. Two researchers independently screened the literature according to the inclusion and exclusion criteria, and a senior tetanus expert made the discriminations in case of disagreement. Data were extracted using Excel 2019 and mainly included clinical data such as paper title, publication unit, publication time, case source period and province, number of cases, case sex and age, incubation period, occupation, resident place, the severity of tetanus, causes of injury, the status of tetanus immunization 24 h after injury, the situation of wound management 24 h after injury, treatment and outcome. The literature of which cases came from the same period in the same hospital and the same case repeatedly reported in different journals was chosen from only one article. Due to patients in critical condition, their treatment terminated by family members was considered death.

2.2. Inclusion and Exclusion Criteria

Inclusion criteria: (1) the subject was non-neonatal tetanus; (2) general data, such as the number of cases, gender, and age, were basically complete in the reports. Exclusion criteria: (1) reviews and case reports; (2) the sources of patients are not clear; (3) cases before 2000 year; (4) neonatal tetanus.

2.3. Statistical Methods

Data were collated, organized, and summarized using Excel 2019. Quantitative data were expressed as mean and qualitative data were expressed as frequency. The composition ratio, mortality rate, and tracheotomy (T) rate were calculated for each group of cases.

3. Results

3.1. Description of Included Literature

According to the inclusion and exclusion criteria, the total number of 151 papers, in which the number of tetanus patients added up to 6084, were included from 128 hospitals in 25 provinces, autonomous regions, and municipalities, covering clinical and nursing studies. The first three proportions of tetanus cases were in Hebei Province (10.47%) (637/6084), Guangdong Province (10.21%) (621/6084) and Shandong Province (9.34%) (568/6084). Among 128 hospitals, the amounts of tertiary hospitals, secondary hospitals, infectious disease hospitals, and other hospitals were 93, 16, 12, and 7, respectively. Among the 151 articles, the clinical and nursing studies accounted for 56.29% (85/151) and 43.71% (66/151), respectively, and the literature with the theme of severe tetanus accounted for 47.02% (71/151). The distribution of tetanus patients is shown in Figure 1.

3.2. Description of Included tetanus cases

(1) Among 6094 tetanus patients, 5925 patients were recorded gender total, 3950 were male and 1975 were female, accounting for 66.67% (3950/5925) and 33.33% (1975/ 5925), respectively. (2) The total number of cases with records of age span was 5204; their age ranged from 1 to 100 years; the number of average ages recorded was 4773 cases, with

an overall average age of 46.69 years old; the minimum and maximum average ages were 25.00 and 65.22 years old, respectively. (3) The number of patients' residence places recorded was 580; patients from rural areas had the highest percentage, 88.62% (514 / 580). Occupations recorded was 645 cases, and farmer was the most common occupations, accounting for 83.56% (539/645). (4) The total incubation period recorded in detail was 24 cases; 1 and 120d were the shortest and the most extended incubation period, respectively. In summary, the average incubation period recorded was 1511 cases, and the total incubation period was 11.04 d on average. (5) The causes of injury recorded were 1592 cases; injuries caused by metals, wood, and wooden spikes, such as rusty nails and iron pieces, accounted for the highest percentage of 54.52% (868/1592), followed by sharp objects, such as glass and knives, accounting for 9.05% (144/1592). (6) The total number of cases recorded severity grading was 4034, of which the amount of I & II and III & IV were 1217 and 2817 cases, respectively. As shown in Table 1.

Table 1 General information about the cases			
Description of Included tetanus cases		Number of cases	Composition ratio
		N	(%)
Gender N=5925	Male	3950	66.67
	Female	1975	33.33
Place of residence N=580	Rural	514	88.62
	Cities and towns	66	11.38
Career N=645	Farmer	539	83.56
	Worker	20	3.10
	Unemployed	31	4.81
	Other	55	8.53
Average age N=4783	≤30	40	0.84
	31~40	753	15.74
	41~50	2031	42.46
	51~60	1797	37.57
	≥61	162	3.39
Average incubation	≤7d	412	27.27
Period N=1511	8~14d	850	56.25
	≥15d	249	16.48
Immunizations N=1200		26	2.17
	Passive immunity		
	Active immunity	14	1.17%
	No Immunizations	1160	96.66%
Severity grading N=4034	I&I	1217	30.17%
	III&V	2817	69.83%
III, IV N=2817	Critical care group	2028	71.99%
	Normal group	789	28.01%
Normal study group N=2006	I&II	1217	60.67%
	III&V	789	39.33%
<p>Note: Normal study group was the set of cases from the literature that studied both I&II and III&V</p> <p>The normal group was the set of III&V cases from the normal study group</p> <p>The critical care group was the set of cases from the literature that studied only III&</p>			

3.2. Circumstances of injury

3.2.1. Causes of injury

A total of 3513 cases recorded the circumstances of injury, of which causes of injury were unknown in 162 cases, and that of 60 patients were atypical trauma, accounting for 4.61% (162/3513) and 0.85% (60/3513), respectively. The causes of injury recorded were 1592 cases in total; injuries caused by metals, wood, and wooden spikes, such as rusty nails and iron pieces, accounted for the highest percentage of 54.52% (868/1592), followed by sharp objects, such as glass and knives, accounting for 9.05% (144/1592). Others included firecracker explosion, fall, animal injury, freezing, burning, and scalding. As shown in Table 2

Table 2 Causes of Injury		
Causes of Injury	Number of Cases N	Composition Ratio (%)
Injury caused by Metal and wood	868	54.52
Injuries caused by Sharp objects	144	9.05
Explosive injury	80	5.03
Fall injury	82	5.15
Animal injury	75	4.71
Freezing, burning, and Scalding	37	2.32
Otogenic injury	11	0.69
Injury-derived oral Cavity	27	1.70
Iatrogenic injury	20	1.25
Bruise	92	5.78
Crush injury	34	2.14
Intravenous drug Taking	33	2.07
Others	89	5.59
Total	1592	100

3.2.2. Injury sites and Wound management 24h after injury

The total number of injury sites were recorded was 1258 cases, the lower extremities was the highest percentage, accounting for 54.35% (699/1258), followed by the upper extremities that are 36.47% (469/1286). The head and neck, and trunk accounted for a smaller portion. As shown in Figure 2.

The overall amounts of wound management 24 h after injury recorded was 775 cases, 87.74% (680/775) of patients did not deal with their wounds 24 h after injury, a small number of patients deal with their wounds by themselves, and a minimal number of patients sought formal wound treatment in the hospital. As shown in Figure 3.

3.3. Approach to toxin neutralization

The overall number of papers detailing the approach to toxin neutralization was 54, covering 49 hospitals of different levels and 2036 cases. The methods of toxin neutralization included using TAT alone, TAT after desensitization after a

positive TAT skin test, TIG after a positive TAT skin test, TIG alone, and a combination of TIG with TAT. Using TAT alone had the highest proportion, accounting for 57.12%, followed by TIG after a positive TAT skin test (15.32%). As shown in Table 3.

Therapy		Literature (N)	Type of Hospital				Cases (N)	Composition Ratio (%)
			Tertiary Hospital (N)	Secondary Hospitals (N)	Specialized Hospitals (N)	Community Hospitals (N)		
TAT	TAT alone	31	22	1	5	1	1163	57.12
	TAT after desensitization	3	1	1	0	0	62	3.05
	TIG after Positive Test	5	3	1	1	0	312	15.32
TIG alone		9	8	0	0	0	270	13.26
TIG+TAT		6	5	0	0	0	229	11.25
Total		54	39	3	5	1	2036	100

3.4. Therapies of sedation and spasmolysis

The overall number of cases detailing therapies of sedation and spasmolysis was 2488; the therapies used more frequently were diazepam, hibernation mixture, and midazolam alone, accounting for 14.83% (369/2488), 13.38% (333/2488) and 7.03% (175/2488), respectively. Dual therapies included a combination of diazepam with phenobarbital, diazepam with hibernation mixture, and a combination of propofol with magnesium sulfate, accounting for 13.87% (345/2488), 11.17% (278/2488), and 5.14% (128/2488), respectively. Besides, triple and quadruple therapies were not also in the minority. As shown in Table 4.

Table 4 Therapies of sedation and spasmolysis		
Therapies	Case N	Composition Ratio (%)
Diazepam	369	14.83
Hibernation mixture	333	13.38
Midazolam	175	7.03
Diazepam combined with phenobarbital	345	13.87
Diazepam combined with hibernation combination	278	11.17
Propofol combined with magnesium sulfate	128	5.14
Propofol combined with midazolam	103	4.14
Midazolam in combination with vecuronium bromide	73	2.93
Midazolam in combination with diazepam	56	2.25
Midazolam in combination with remifentanil	58	2.33
Triple therapy	269	10.81
Quadruple therapy	129	5.18
Others	172	6.91
Total	2488	100

3.5. Outcome and tracheotomy

A total of 4305 cases with detailed records of patient outcomes were named the “**contrast group**”,

which had 402 deaths and a mortality rate of 9.34% (402/4305), with a tracheotomy rate of 47.91% 1317/2749. The total number of 2749 cases in the control group with detailed records of tracheotomy was named the “**contrast tracheotomy group**” which had 222 deaths and a mortality rate of 8.08% (222/2749), with a tracheotomy rate of 47.91% (1317/2749). The leading causes of death included treatment terminated by family members, asphyxia due to persistent spasms, respiratory failure, and autonomic dysfunction, treatment terminated by family members and asphyxia accounted for the highest percentage, both 24.00% (54/225), followed by respiratory failure 21.78% (49/225). As shown in Figure 4.

A total of 3519 cases detailed records of tracheotomy; the tracheotomy rate was 58.42% (2056/3519). The overall number of patients in the “**normal study group**” (table1 for definition) with records of patient prognosis was 1977, including 224 deaths, the mortality was 11.33% (224/1977), the number of tracheotomies was 387, and tracheotomy rate was 19.58%(387/1977); The total number of 1376 patients in the “normal study group” with records of patient outcomes and tracheotomy was named “**normal study group with tracheotomy**” which had 120 cases of death, and a mortality 8.72%(120/1376), with 387 cases of tracheotomy and a tracheotomy rate of 28.13% (387/1376).

A total of 1269 cases in the “Critical care group” (table1 for definition) recorded outcomes, including 110 deaths, the mortality was 8.67% (110/1269), of which the tracheotomy rate was 60.52%; 931 cases in the “**Critical care group**” with

records of outcomes and tracheotomy of patients was named “**Critical tracheotomy group,**” including 75 cases of death, the mortality was 8.06%(75/931), the tracheotomy rate was 82.49(768/931)%. The comparison is shown in table 5.

Table 5 Outcome and tracheotomy					
Group	cases N	Case of T N	Rate of T (%)	Death N	Mortality %
Contrast group	4305	1317	30.60	402	9.34
Contrast tracheotomy group	2749	1317	47.91	222	8.08
Normal study group	1977	387	19.58	224	11.33
Normal study group with T	1376	387	28.13	120	8.72
Critical care group	1269	768	60.52	110	8.67
Critical tracheotomy group	931	768	82.49	75	8.06

4. Discussion

4.1. Case analysis

In this study, the total number of non-neonatal tetanus cases in the past 20 years is 6084, plus there are 9 out of 34 provincial administrative regions in China in which the number of tetanus was unclear, besides the cases are limited to 1~5 hospitals in these provinces, so the actual patients may be more. Although in 2012, China was validated as having eliminated maternal and neonatal tetanus¹⁵, the control situation of non-neonatal tetanus in China is dire in this study, and more attention should be paid to reducing the morbidity of it. According to the survey, the percentage of males (66.67%) was greater than females (33.33%), similar to the studies of S Anuradha, Sam Olum, and Surabhi GS¹⁶⁻¹⁸, but it is less than the study of Ananda¹⁹. The higher prevalence in males may be related to the fact that males are often engaged in heavy and outdoor work, such as agricultural or technical work, which has a higher likelihood of injury. While the lower incidence in females may be associated with the factor that females are usually engaged in light physical labor and had immunizations during pregnancy²⁰. Patient occupation is a significant risk factor for tetanus. The proportion of farmers was as high as 83.56 %, and the proportion of people living in rural areas was as high as 88.62% in the study, which is greater than other research; Zhee Fan reported 47.0%¹⁰, Dr. K.V.L. Sudha Rani reported 28.65%²¹, but is similar to AHM FERROZ reported 72.5%²². The results showed that the leading group of people suffering from tetanus are low-income people, especially farmers and workers from rural areas; the reasons probably are that they are more likely to be exposed to the causal organism, short of necessary labor protection in agricultural production and work site activities, sufficient awareness of tetanus, and formal treatment of wounds after injury, which increase the risk of tetanus infection^{23,24}. In this study, most tetanus cases were among young and middle-aged people; the overall average age was 46.69 years, average age greater than 40 years accounted for 83.42%, the mean age of the 40~60 years population accounted for the highest percentage (80.03%). Compared to developed countries, the patients from China are younger; S. Tosun reported that most tetanus cases were during the advanced ages²⁵, 62% were patients aged 65 years in a report Australia³, and around 80% of the patients were 60 years of age in Japan²⁶. However, the mean age of the patients is similar in Africa, the mean age was 33.0 years in a report in Nigeria²⁷, and Amanuel Amare reported the mean age was 33.8 years in Ethiopia²⁸. The leading reasons are that the level of tetanus antibodies and protection rate of people over 40 years are shallow in China²⁹⁻³¹, and young people lack effective immunization programs and appropriate treatment of injuries in developing country²¹.

4.2. Analysis of circumstances of the injury

In this study, the causes of injury were mainly some common factors in life, such as stabs by nail and wood, cuts by knife and glass, firecracker explosions, and animal bites, etc³²⁻³⁶, injury by metal and wood accounted for the highest percentage (54.52%). The others included road traffic accidents, burns, fissures of the foot, fall injury, intravenous drug taking, and post-surgical wounds^{33,37,38}. The injury causes resembled other research, for example, these reports from Southern India³⁹, Northwestern Tanzania²³, Ethiopia²⁸, and Turkey²⁵. There were also cases of atypical injuries such as abrasions⁴⁰, sole abrasions⁴¹, stomatitis³⁴, otitis media⁴², and paronychia⁴³, so it can be known that there is a possibility of tetanus as long as an open wound in the skin or mucous membrane, coupled with the presence of pollution, hypoxia and moisture environment. In the study, 90.82% of Tetanus attacks were due to infection of the extremities, especially the lower extremity (54.35%), which is much higher than reported in Nigeria (lower limbs (39.24%) and the upper limbs 18.99%))⁴⁴, similar to a report that the injuries were on the lower limbs patients(48.75%), the injuries were described on the upper limbs (36.25%)⁴⁵, differs from a report from India that upper limb wounds were the most common(51.6%). Followed by wounds on the lower limb (38.3%)¹⁶. 87.74% of patients in this study did not deal with their wounds 24h after injury, and 9.30% of patients treated their wounds by their native methods, for instance, using a Band-aid to stanch after alcohol briefly⁴⁶, self-binding with Chinese herbal medicine^{24,33}, which can lead to incomplete disinfection and even create a polluted and oxygen-deprived environment, furthermore, 96.66% of patients did not inject TAT or TIG^{47,48}, resulting in significantly increase in the risk of infection. It is similar to some research in Bangladesh⁴⁵ and India^{16,21}. It is evident that injury site, wound management 24h after injury, and causes of Injury are significantly associated with patients' occupations and place of residence. Factors of injury are common in agricultural work and industrial labor daily, so the affected population is mainly farmers, workers, and people in rural areas. The principal causes are insufficient knowledge of tetanus, poor hygiene attitudes and conditions, and little hospitalization consciousness. Besides, they suffered minor injuries, so they didn't take it seriously or did not. Therefore, it is unlikely that many people will go to the hospital and be injected with tetanus immunoglobulin or tetanus antitoxin. It is one of the leading causes of why non-neonatal tetanus frequently occurs in developing countries, including China.

4.3. Analysis of toxin neutralization

Although some studies have shown that TAT has a high probability of allergy (5%~30%), and the chance of allergy after desensitization remains 14.1%⁴⁹, some countries have banned TAT as a passive immunization agent against tetanus⁵⁰, and the incidence of TIG allergy is only 0.2%⁵¹, which has the advantages of safety, easy clinical operation, low incidence of allergic reactions, strong neutralizing effect of toxins, and longer protective and preventive effect than TAT⁵². However, in this study, most hospitals, including tertiary hospitals, preferred tetanus antitoxin to strengthen passive immunity⁵³⁻⁵⁵, and some hospitals continued to use TAT after desensitization after positive skin tests⁵⁵⁻⁵⁷, due to the disadvantages of TIG, such as high price, few sources, complex preparation, and insufficient supply.

4.4. Analysis of Therapies of sedation and spasmolysis

Tetanus spasm is the most potent toxin, causing muscle tonicity, spasm, and autonomic instability⁵⁸. In severe cases, continuous spasms of respiratory muscles lead to asphyxia and respiratory arrest^{59,60}, so controlling muscle spasms and sedation is one of the keys to treatment. However, excessive sedation and muscle relaxation may prolong the duration of tracheal intubation and mechanical ventilation and increase the risk of ventilator-associated pneumonia, tracheal stenosis, complicated deconditioning, and acute respiratory distress syndrome⁶¹; besides, the use of continuous drugs is associated with several adverse effects, these effects are usually caused by prolonged immobility and may result in muscle atrophy, eye injuries, nerve injuries due to compression and deep vein thrombosis⁶². Thus, moderate analgesia, analgesia, and muscle relaxation therapy were required. In this study, the treatment regimens of analgesic,

sedative, and muscle relaxation varied among different hospitals, such as using diazepam or midazolam alone, diazepam combined with phenobarbital/ hibernation mixture /midazolam in dual therapy, propofol combined with magnesium sulfate/midazolam, and even triple therapy in severe tetanus⁶³⁻⁶⁶. The varying treatment regimens may be related to the variable severity of the patient's condition, individual differences in patient sensitivity to drugs, and the lack of relevant guidelines in China. The guidelines for managing accidental tetanus in adult patients can be referred to as the drugs of choice to provide sedation, spasm control, and muscle relaxation in tetanus patients are benzodiazepines with opioids. For complete spasm control, a combination of diazepam and vecuronium was necessary⁶². The combined application of Chinese and western medicine may be a new direction with value to explore. In a report, the combined application of Chinese and western medicine has a better effect on the control of tetanus convulsion and spasm than western medicine alone; it can reduce the dosage of western medicine, prolong the interval of administration, shorten the course of treatment, and strengthen the effect of sedation, spasmodic relief, and calm down, and play the role of Chinese and western medicine treatment complement each other⁶⁷.

4.5 Analysis of tracheotomy and outcomes

Due to persistent muscle spasm tetanus, tetanus, especially severe tetanus, is easily complicated by respiratory failure and airway management difficulties, so early tracheal intubation or tracheotomy to strengthen tracheal management is the key to saving the patient⁶⁸. In this study, the leading causes of death were the abandonment of treatment by family members due to critical condition, asphyxia, and respiratory failure, in which asphyxia and respiratory failure accounted for 45.78%, so early implementation of tracheotomy is the top priority for critical tetanus patients, it differs from a report that shock/multiple organ failure is the leading cause of death (72.9%)⁶⁹. In this study, the mortality of tetanus in the normal group was 11.21%, and the tracheotomy rate reached 58.42%; the tracheotomy rate and mortality were similar to that of Japan²⁶, and it is lower than a report from Brazil (44.5%)⁷⁰, tracheostomy rate is much greater than Ethiopia (10.5%), of which the mean case-fatality increased from 21% to 51% from 1996 to 2009⁷¹. The low mortality in China may be related to the significant development of intensive care medicine technology and equipment, which could meet the intensive care needs of tetanus patients. Because fully configured ICUs and ventilator supportive care are not readily available in these developing countries, even when such resources are available, they may not be utilized when patients cannot afford their cost. The mortality rate associated with tetanus remains high²⁶.

5. Perspectives

According to the results of this study, the key on the prevention and treatment of tetanus in China are shown as follows. First, the prevention and control situation of non-neonatal tetanus is still tricky, the focus should be on preventing adult tetanus from reducing its incidence. Second, the success rate of tetanus treatment in China, on the whole, is similar to that in developed countries, the focus of treatment should be on standardizing the use of sedative and spasmolytic drugs to reduce the adverse effects caused by excessive use. Details are as follows.

5.1. Popular science work and medical training at the grassroots

Since the patients mainly come from the grassroots, especially the rural areas, the causative agent of tetanus, *Clostridium tetani*, is widespread in the environment worldwide and cannot be eradicated⁷². To reduce the incidence of tetanus in China, the focus of work must be on the grassroots. Popularize tetanus prevention and treatment knowledge to the people, strengthen their awareness of prevention in tetanus, and labor protection at ordinary times, besides timely go to the hospital for standardized debridement and disinfection in a manner after injury, especially avoid treating wounds with native methods, which can increase the risk of tetanus infection, and prevent the minor damage from becoming severe diseases. As tetanus patients are mainly with light and minor injuries, they often do not go to tertiary hospitals, so the grass-roots hospitals are the first post of tetanus prevention and treatment, the understanding degree of

grass-roots physicians to tetanus and their ability to handle wounds, in a large extent, determine whether a patient will occur tetanus or if tetanus can get an early diagnosis. Therefore, it is necessary to strengthen the training in grass-roots hospitals, to improve their understanding of tetanus, correctly understand passive immunity and active immunity, and standardize wound management, which is essential to prevent tetanus⁶¹.

5.2. Rational formulation of immunization schedule for adults

The actual global burden of disease is unknown as reliable figures are only collected for cases of neonatal tetanus, but in 2015 the disease caused an estimated 48,199 to 80,042 deaths⁷³; however, these deaths should have been prevented by an already available, inexpensive, and effective vaccine⁷⁴. One of the leading reasons is that the level of tetanus antibodies and protection rate of people over 40 years is extremely low in China; it is similar to developed countries, in which trends from countries with well-established immunization programs show increasing tetanus cases among the elderly, related to seroepidemiologic data showing declining immunity with advanced age³. Therefore, China must improve its national monitoring and reporting system, analyze antibodies against tetanus, formulate a rational immunization plan, and vaccinate people with low antibody levels. Since effective antibody concentrations only maintain ten years after vaccination in most people⁷⁵, it is necessary to Vaccination once every ten years.

5.3. standardizing the use of sedative and spasmolytic drugs

Given the side effects of long-term and excessive drug use, standardized treatment is essential to improve prognosis; the guidelines for the management of accidental tetanus in adult patients can be referred to. Unfortunately, it did not clarify how to choose drugs for patients with different grades of tetanus. Chinese have used traditional Chinese medicine for thousands of years, so combining Chinese and western medicine may be a new direction with value to explore.

6. Conclusions

In conclusion, the overall success rate of tetanus treatment in China has dramatically improved, the prevention and control situation of non-neonatal tetanus is still severe, and the focus of it should be put on the prevention of adult tetanus and standardizing the use of sedatives and spasmolytic drugs. Popularize tetanus prevention and treatment knowledge to the people, and strengthen training in grass-roots hospitals, the combined application of Chinese and western medicine may be a new direction with the value of exploring reducing the dosage of sedative and spasmolytic drugs.

Abbreviations

TAT tetanus antitoxin TIG tetanus immunoglobulin T: tracheotomy.

Declarations

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Author contributions

Yi Gou and Ke Feng conceived the idea. Yi Gou, Shengming Li wrote the draft of the manuscript, Xiaoping Hei, Bohui Lv collected data and literature. Junfei Zhang assisted with article interpretation and language edit. All the authors read and approved the final manuscript.

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Availability of data and materials

The full de-identified database will be made available for independent analysis on reasonable request to the corresponding author or as an appendix in the publishing journal.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1 Map of case distribution of tetanus in China

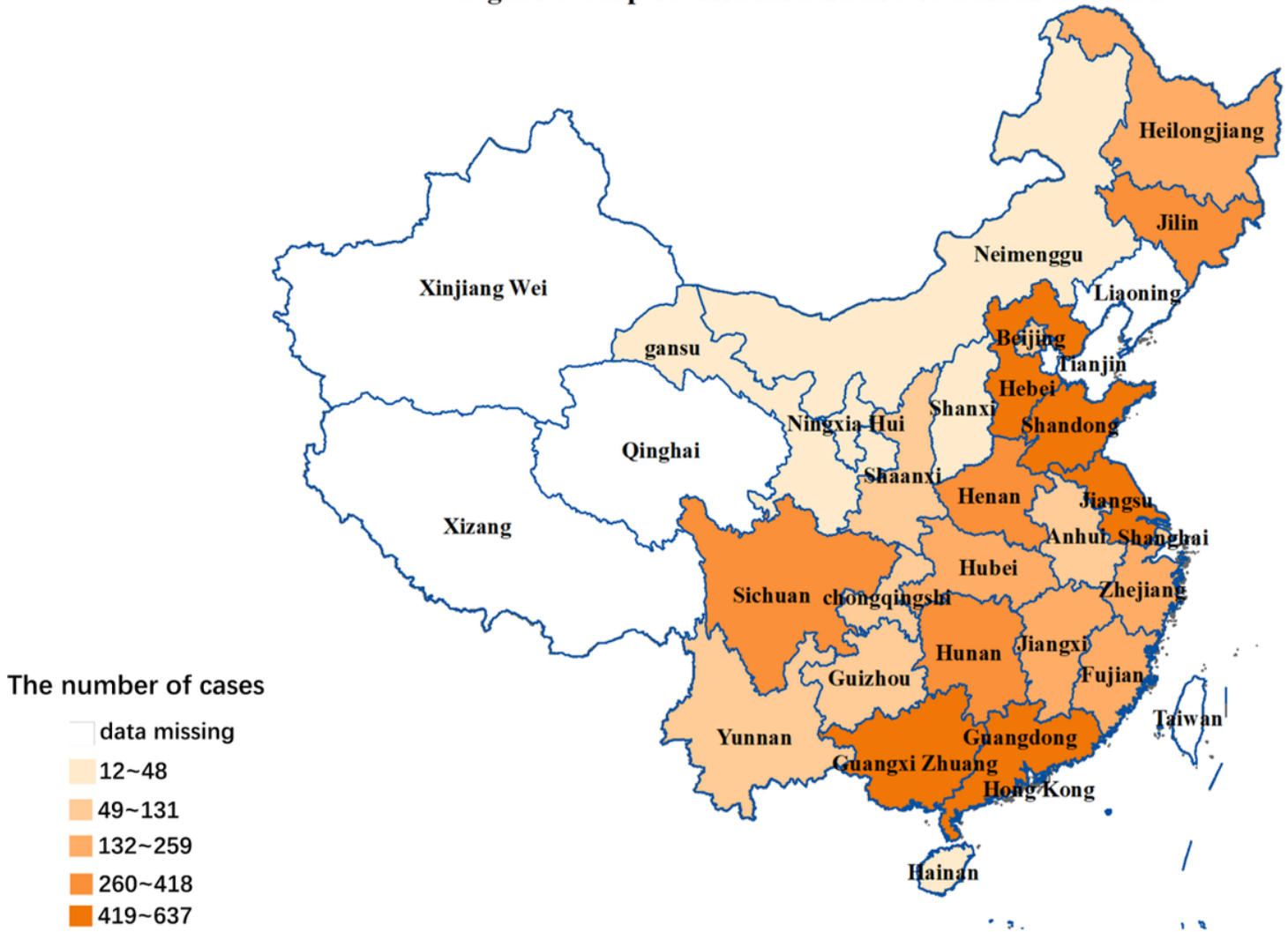


Figure 1

Map of case distribution of tetanus in China

This figure mainly described, nearly 20 years, the distribution of 6084 cases of Non-neonatal Tetanus in China from the literature included in this study, in which the cases of Hebei, Guangdong and Shandong were the largest number of 637, 621 and 568. Unfortunately, the data of Xinjiang, Tibet, Liaoning, Tianjin, Qinghai, Taiwan, Hong Kong and Macao are missing.

Figure 2 Injury site and proportion

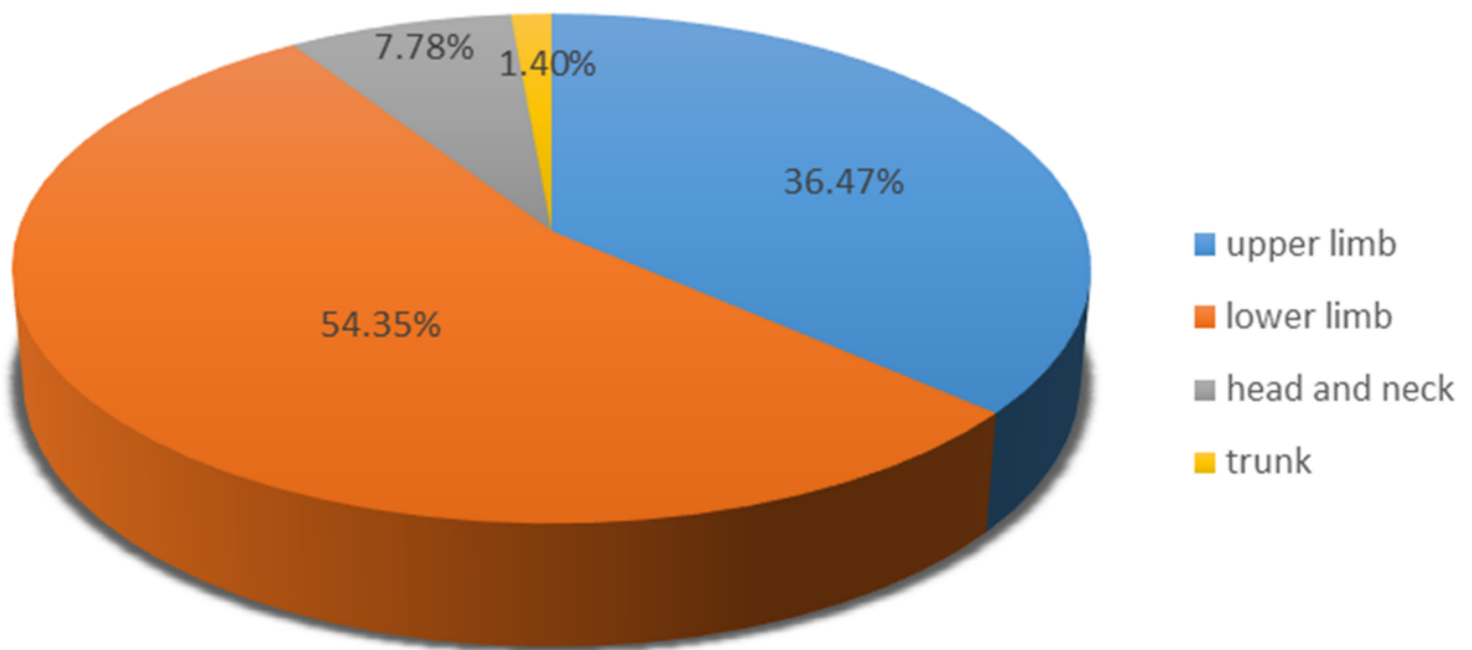


Figure 2

Injury sites and proportion

In this study, the total number of injury sites were recorded was 1258 cases. This figure described the proportion of injury sites such as the lower extremities, the upper extremities and the head and neck and trunk. The lower extremities were the highest percentage, accounting for 54.35% (699/1258), followed by the upper extremities that are 36.47% (469/1286). The head and neck, and trunk accounted for a smaller portion, 7.75% and 1.40%, respectively.

Figure 3 wound management 24h after injury and proportion

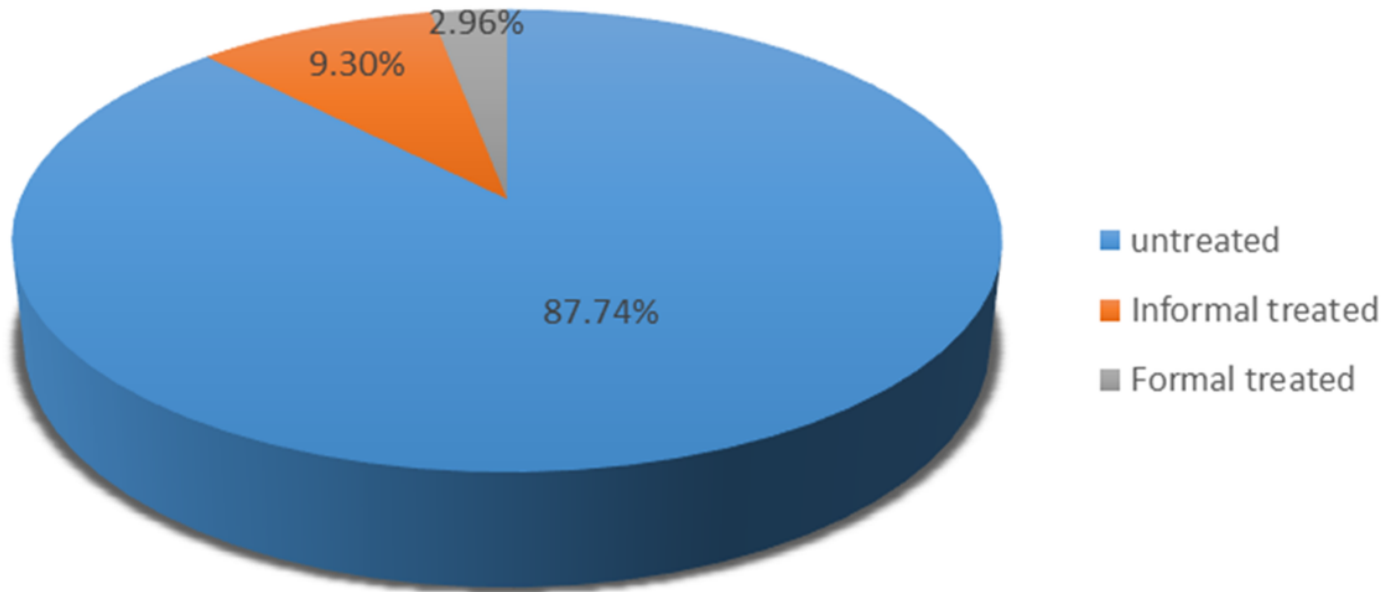


Figure 3

Wound management 24h after injury and proportion

In this study, the overall amounts of wound management 24 h after injury recorded was 775 cases. This figure described the methods and their proportion of Wound management 24 h after injury. 87.74% (680/775) of patients did not deal with their wounds 24 h after injury, 9.30% of patients deal with their wounds by themselves, and 2.96% of patients sought formal wound treatment in the hospital.

Figure 4 causes of death and proportion

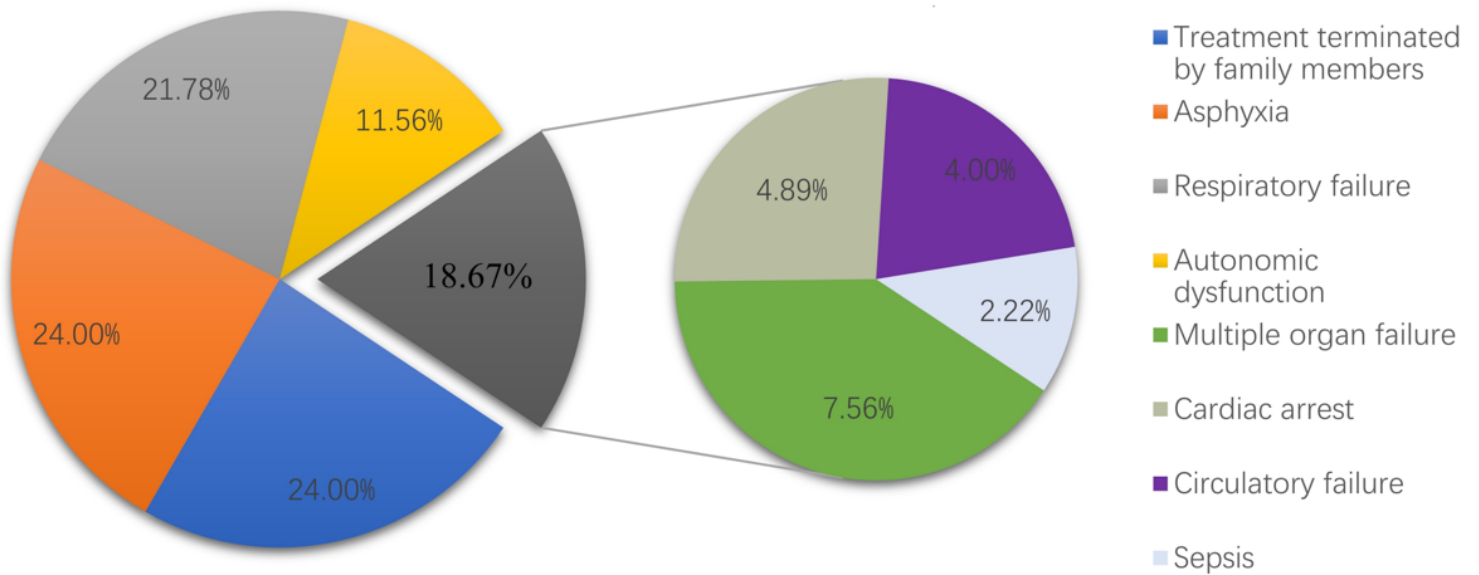


Figure 4

Causes of death and proportion

In this study, a total of 4305 cases were detailed records of patient outcomes. This figure showed the causes of death and their proportion. The leading causes of death included treatment terminated by family members (24.00%), asphyxia due to persistent spasms (24.00%), respiratory failure (21.78%), autonomic dysfunction (11.56%), and others (18.67%).