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Clinical Characteristics and Factors Associated with In-Hospital Mortality Among Adult Tetanus Patients in Bangladesh: A Retrospective Cohort Study

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ABSTRACT

Introduction: Tetanus remains an important cause of preventable hospital mortality, particularly among unvaccinated adults in settings with limited intensive-care resources. Evidence regarding factors associated with mortality among adult tetanus patients in Bangladesh remains limited. **Aim:** To describe the clinical profile and identify factors associated with in-hospital mortality among adult tetanus patients admitted to an infectious disease hospital. **Methods & Materials:** A hospital-based retrospective observational cohort study was conducted among 51 patients aged at least 18 years with clinically diagnosed tetanus at the Department of Medicine, Infectious Diseases Hospital, Dhaka, Bangladesh from January 2025 to December 2025. Demographic, epidemiological, clinical, laboratory, treatment, complication, and outcome data were extracted and analyzed from hospital records. Categorical variables were compared using Fisher exact or Fisher-Freeman-Halton exact tests, while continuous variables were compared using Mann-Whitney U or Kruskal-Wallis tests. Multivariable analysis was not performed because only 14 deaths occurred. **Results:** All 51 patients were male. Thirty-seven patients survived and 14 died, giving an in-hospital mortality rate of 27.5%. Median age increased from 45.0 years among patients who recovered without complications to 57.5 years among those who died, (p=0.018). Mortality increased from 0% in Ablett grades I and II to 13.3% in grade III and 62.5% in grade IV, (p=0.003). Apnoeic spells were more frequent among patients who died than among survivors, 35.7% versus 8.1%, (p=0.028). Median haemoglobin was lower among deaths than survivors, 11.1 versus 12.0 g/dL, (p=0.047). At least one in-hospital complication occurred in 78.6% of deaths and 43.2% of survivors. Hypoxaemia, aspiration pneumonia, acute renal failure, and dysautonomia differed significantly across discharge-outcome categories. No pharmacological treatment was significantly associated with mortality. **Conclusion:** In-hospital mortality was substantial and was most closely associated with older age, higher Ablett severity, apnoeic spells, and serious in-hospital complications. Larger multicentre studies with adjusted analyses are required to confirm independent mortality predictors.

Keywords: *Adult Tetanus; In-Hospital Mortality; Ablett Grade; Apnoea*

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INTRODUCTION

Despite the availability of an effective vaccine, tetanus remains a severe and potentially fatal neurological infection where primary vaccination, booster coverage, wound care, and intensive supportive treatment are incomplete. Globally, substantial reductions in incidence and mortality were documented between 1990 and 2019, but a disproportionate burden persisted in low-sociodemographic-index settings and among males [1]. Within the Global Burden of Disease 2015 analysis, 56,743 tetanus deaths were estimated worldwide, including 36,806 deaths beyond the neonatal period; almost half of these post-neonatal deaths were estimated to occur in South Asia [2]. Although neonatal tetanus has received sustained programmatic attention, adult disease remains incompletely controlled, particularly among populations not reached by maternal immunization or regular booster programmes. Across hospital-based studies, a marked male predominance has repeatedly been observed. In a review of African hospital series, a median of 71% of non-neonatal tetanus patients were male, while gaps in vaccination among adolescent and adult men were highlighted as an explanation for this pattern [3]. Within South Asian cohorts, rural residence, farming occupations, uncertain vaccination histories, and traumatic wounds have frequently been reported, including in Indian and Bangladeshi hospital studies [4,5]. Such characteristics are relevant in Bangladesh, where predominantly male and rural hospital populations, together with low reported prior vaccination, have been documented, and where patients may present after severe manifestations have developed [4,6].

Clinically, tetanus is diagnosed from characteristic features rather than a confirmatory laboratory test. Following toxin production by *Clostridium tetani* at a contaminated wound, trismus, dysphagia, generalized rigidity, painful spasms, opisthotonus, respiratory compromise, and autonomic instability may develop [7]. With progression, death may result from airway obstruction, apnoea, respiratory failure, dysautonomia, aspiration, secondary infection, or complications of prolonged immobilization. In a systematic review and meta-analysis of 22 studies involving 1,618 hospitalized adult patients, pooled mortality was 32.0%. Across the included studies, higher mortality was associated with age of at least 40 years, an incubation period below 7 days, a short onset period, Ablett grade III or IV disease, autonomic dysfunction, and the requirement for mechanical ventilation [8]. Collectively, these findings indicate that baseline severity and complications arising during hospitalization may both be relevant to prognosis. Across hospitals, considerable variation in mortality has nevertheless been reported. In Uganda, 48.8% of 459 hospitalized patients died, and most deaths occurred within seven days of admission [9]. In Bangladesh, 34.4% mortality was reported among 61 adults admitted to two specialized infectious disease hospitals; older age and an onset time of four days or less were independently associated with death [6]. Among 42 patients treated for severe tetanus without onsite intensive-care ventilation in another Bangladeshi hospital, 28.6% died [4]. By contrast, 2.8% mortality was reported among 180 patients managed using a structured intensive-care protocol in southern Vietnam, despite half requiring

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mechanical ventilation [10]. Within a Chinese intensive-care cohort, Ablett severity, leukocytosis, and autonomic dysfunction were associated with mortality, although the small number of deaths limited model precision [11]. Together, these observations suggest that mortality reflects an interaction between disease severity, age, respiratory and autonomic involvement, complications, and available supportive care. Despite the continuing burden, contemporary evidence from Bangladesh remains limited, and outcomes may differ across institutions because of variation in referral patterns, resources, and patient characteristics. Therefore, the present study was conducted to describe the demographic, epidemiological, clinical, laboratory, treatment, and complication profiles of adult tetanus patients admitted to an infectious disease hospital and to identify factors associated with in-hospital mortality.

METHODS & MATERIALS

This hospital-based retrospective observational cohort study was conducted among adult tetanus patients admitted to the Department of Medicine, Infectious Diseases Hospital, Dhaka, Bangladesh, between January 2025 and December 2025. Patients were followed from admission to discharge or in-hospital death. The study assessed demographic, epidemiological, clinical, laboratory, treatment, complication, and outcome variables, with in-hospital mortality as the primary outcome. All patients aged ≥18 years with a clinical diagnosis of tetanus and a documented final outcome were included. Patients <18 years and records with missing outcome data were excluded. A total of 51 patients met the inclusion criteria. No sample size calculation was performed as all eligible cases were included. Tetanus was diagnosed clinically based on typical features including trismus, muscle spasms, rigidity, dysphagia, risus sardonicus, and opisthotonus. Cases were classified as generalized or localized. Severity was graded using the Ablett classification (I–IV) based on admission findings. Data were extracted from hospital records using a structured form. Variables included age, sociodemographic factors, occupation, residence, smoking status, tetanus type, cause, wound site, incubation period, onset period, vaccination history, and prophylaxis. Incubation period was categorized as <7 or ≥7 days, and onset period as <3 or ≥3 days. Clinical variables included key symptoms and signs such as trismus, dysphagia, rigidity, spasms, autonomic features, and apnoeic spells. Any documented severity of trismus or dysphagia was considered present. Vital signs and Glasgow Coma Scale were recorded at admission. Laboratory variables included haemoglobin, WBC, platelets, glucose, creatinine, electrolytes, calcium, and ALT. Treatment data included sedatives, antibiotics, tetanus immunoglobulin, baclofen, magnesium, and other supportive therapies. Treatment comparisons were descriptive due to severity-based allocation. The primary outcome was in-hospital mortality. Secondary outcomes were discharge status: recovery without complication, recovery with complication, or death. Complications that resolved before discharge were still counted as in-hospital complications. Complications included aspiration pneumonia, hypoxaemia (SpO_2 <90%), renal failure, dysautonomia, bedsore, UTI, and DVT. A composite "any complication" variable was defined as at least one complication during admission. Data were checked for errors, duplicates, and inconsistencies before analysis. Corrections were applied to age, occupation coding, and outcome classification. Variable-specific denominators were used, and missing data were excluded only from relevant analyses. Previously imputed laboratory values were retained without further imputation. Categorical variables were summarized as frequency and percentage; continuous variables as median and interquartile range. Kruskal–Wallis test was used for age comparisons across outcome groups. Fisher–Freeman–Halton exact test was used for categorical variables, with Monte Carlo simulation where appropriate. Survivors and non-survivors were compared using Fisher's exact test and Mann–Whitney U test. All tests were two-sided with $p<0.05$ considered significant. Analyses were performed using [STATISTICAL SOFTWARE AND VERSION].

Due to the small number of deaths (n=14), multivariable logistic regression was not performed to avoid model overfitting. The analysis therefore focused on descriptive and univariable associations.

Ethical approval was obtained from IRB of the study hospital.

RESULTS

Overall, 51 adult male patients with tetanus were included in the analysis. Of these, 37 (72.5%) survived to discharge and 14 (27.5%) died in hospital. At discharge, 25 patients (49.0%) had recovered without complication and 12 (23.5%) had recovered with complication.

Across the three discharge groups, median age increased from 45.0 years (IQR 35.0-55.0) among patients who recovered without complication at discharge to 55.0 years (IQR 51.8-65.8) among those who recovered with complication and 57.5 years (IQR 46.2-65.0) among patients who died (p=0.018). Within the cohort, 30 patients (58.8%) were farmers, 46 (90.2%) lived in rural areas, 25 (49.0%) had primary education, and 45 (88.2%) were Muslim. Among patients aged older than 60 years, 6 of 13 (46.2%) died, compared with 1 of 7 (14.3%) aged 19-30 years; however, the categorical age-group distribution was not statistically significant (p=0.149). No other demographic or socioeconomic characteristic differed significantly across discharge outcomes (*Table I*).

Table I
Demographic and socioeconomic characteristics according to discharge outcome.

Characteristic	Total (n=51)	Recovered without complication at discharge (n=25)	Recovered with complication at discharge (n=12)	Died (n=14)	p-value
Age group					
19-30	7 (13.7%)	5 (20.0%)	1 (8.3%)	1 (7.1%)	0.149
31-45	15 (29.4%)	10 (40.0%)	2 (16.7%)	3 (21.4%)	
46-60	16 (31.4%)	8 (32.0%)	4 (33.3%)	4 (28.6%)	
>60	13 (25.5%)	2 (8.0%)	5 (41.7%)	6 (42.9%)	
Age, years, median (IQR)	50.0 (40.0-61.0)	45.0 (35.0-55.0)	55.0 (51.8-65.8)	57.5 (46.2-65.0)	0.018
Religion					
Islam	45 (88.2%)	20 (80.0%)	12 (100.0%)	13 (92.9%)	0.243
Hinduism	6 (11.8%)	5 (20.0%)	0 (0.0%)	1 (7.1%)	
Education					
Illiterate	15 (29.4%)	7 (28.0%)	5 (41.7%)	3 (21.4%)	0.579
Primary	25 (49.0%)	13 (52.0%)	3 (25.0%)	9 (64.3%)	
Secondary	7 (13.7%)	3 (12.0%)	3 (25.0%)	1 (7.1%)	
Higher secondary	1 (2.0%)	1 (4.0%)	0 (0.0%)	0 (0.0%)	
Graduate	3 (5.9%)	1 (4.0%)	1 (8.3%)	1 (7.1%)	
Marital status					
Single	8 (15.7%)	4 (16.0%)	1 (8.3%)	3 (21.4%)	0.862
Married	41 (80.4%)	20 (80.0%)	11 (91.7%)	10 (71.4%)	
Widowed	2 (3.9%)	1 (4.0%)	0 (0.0%)	1 (7.1%)	
Occupation					
Housewife	1 (2.0%)	1 (4.0%)	0 (0.0%)	0 (0.0%)	0.285
Business	10 (19.6%)	4 (16.0%)	2 (16.7%)	4 (28.6%)	
Service holder	4 (7.8%)	1 (4.0%)	3 (25.0%)	0 (0.0%)	
Farmer	30 (58.8%)	14 (56.0%)	7 (58.3%)	9 (64.3%)	
Other	6 (11.8%)	5 (20.0%)	0 (0.0%)	1 (7.1%)	
Monthly household income, BDT					
<7,500	17 (33.3%)	9 (36.0%)	4 (33.3%)	4 (28.6%)	0.963
7,501-10,000	9 (17.6%)	4 (16.0%)	3 (25.0%)	2 (14.3%)	
10,001-15,000	13 (25.5%)	6 (24.0%)	2 (16.7%)	5 (35.7%)	
>15,000	12 (23.5%)	6 (24.0%)	3 (25.0%)	3 (21.4%)	
Place of residence					
Urban	5 (9.8%)	3 (12.0%)	2 (16.7%)	0 (0.0%)	0.254
Rural	46 (90.2%)	22 (88.0%)	10 (83.3%)	14 (100.0%)	
Smoking history					
Current smoker	16 (31.4%)	10 (40.0%)	2 (16.7%)	4 (28.6%)	0.672
Former smoker	15 (29.4%)	6 (24.0%)	5 (41.7%)	4 (28.6%)	
Never smoker	20 (39.2%)	9 (36.0%)	5 (41.7%)	6 (42.9%)	

Notes: Values are n, column percentage, unless otherwise stated. Age is presented as median (IQR). The Kruskal-Wallis test was used for age; Fisher-Freeman-Halton exact tests with 100,000 Monte Carlo samples were used for categorical variables. Missing values were excluded from hypothesis tests.

At presentation, generalised tetanus was recorded in 48 patients (94.1%), a post-traumatic cause in 47 (92.2%), and an extremity wound in 50 (98.0%). Mortality was 50.0% (2/4) among patients with post-surgical tetanus and 25.5% (12/47) among those with post-traumatic tetanus, although this difference was not statistically significant (p=0.300). Mortality was 31.0% (9/29) among patients with an onset period of at least 3 days and 22.7% (5/22) among those with a shorter onset period (p=0.546). For incubation period, mortality was 40.0% (6/15) below 7 days and 22.2% (8/36) at 7 days or longer (p=0.301). Only 2 patients (3.9%) reported prior tetanus vaccination, and neither died; 8 patients (15.7%) had received post-injury prophylaxis, of whom 3 (37.5%) died (*Table II*).

Table II
Clinical and epidemiological characteristics according to in-hospital mortality.

Characteristic	Total (n=51)	Survived (n=37)	Died (n=14)	p-value
Type of tetanus				
Generalised	48 (94.1%)	35 (94.6%)	13 (92.9%)	1.000
Local	3 (5.9%)	2 (5.4%)	1 (7.1%)	
Cause of tetanus				
Post-traumatic	47 (92.2%)	35 (94.6%)	12 (85.7%)	0.077
Post-surgical	4 (7.8%)	2 (5.4%)	2 (14.3%)	
Wound site				
Extremities	50 (98.0%)	36 (97.3%)	14 (100.0%)	1.000
Trunk	1 (2.0%)	1 (2.7%)	0 (0.0%)	
Onset period				
<3 days	22 (43.1%)	17 (45.9%)	5 (28.6%)	0.516
>=3 days	29 (56.9%)	20 (54.1%)	9 (64.3%)	
Incubation period				
<7 days	15 (29.4%)	9 (24.3%)	6 (35.7%)	0.301
>=7 days	36 (70.6%)	28 (75.7%)	8 (64.3%)	
Prior tetanus vaccination				
Yes	2 (3.9%)	2 (5.4%)	0 (0.0%)	1.000
No	49 (96.1%)	35 (94.6%)	14 (100.0%)	
Tetanus prophylaxis after injury				
Yes	8 (15.7%)	5 (13.5%)	3 (21.4%)	0.668
No	43 (84.3%)	32 (86.5%)	11 (78.6%)	

Notes: Values are n, column percentage. Two-sided Fisher exact tests were used; Fisher-Freeman-Halton exact tests were used for variables with more than two categories. Missing values are displayed but were excluded from hypothesis tests.

Across Ablett grades, the case fatality rate increased from 0% in grades I and II to 13.3% in grade III and 62.5% in grade IV. Of the 14 deaths, 10 (71.4%) occurred among the 16 patients with grade IV disease. Overall discharge outcome differed significantly according to Ablett grade (p=0.003) (*Table III*).

Table III
Ablett severity grade and in-hospital outcome.

Ablett grade	Total, n (%)	Recovered without complication, n (% within grade)	Recovered with complication, n (% within grade)	Died, n (% within grade)	Case fatality rate	p-value
I, mild	1 (2.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	0.0%	0.003
II, moderate	4 (7.8%)	4 (100.0%)	0 (0.0%)	0 (0.0%)	0.0%	
III, severe	30 (58.8%)	16 (53.3%)	10 (33.3%)	4 (13.3%)	13.3%	
IV, very severe	16 (31.4%)	4 (25.0%)	2 (12.5%)	10 (62.5%)	62.5%	

Notes: Percentages within individual Ablett grades are row percentages. The overall association was assessed using the Fisher-Freeman-Halton exact test with 100,000 Monte Carlo samples.

At presentation, trismus of any severity was present in 50 patients (98.0%), generalised rigidity in 49 (96.1%), dysphagia in 47 (92.2%), and neck stiffness in 46 (90.2%). Apnoeic spells were recorded in 5 of 14 patients who died (35.7%) and 3 of 37 survivors (8.1%; p=0.028). In contrast, spasticity was less frequently recorded among deaths than survivors, 71.4% versus 94.6% (p=0.041). Urinary retention was more frequent among deaths than survivors, 78.6% versus 48.6%, although the difference did not reach statistical significance (p=0.066). No other presenting sign or symptom differed significantly by mortality status (*Table IV*).

Table IV
Presenting clinical signs and symptoms according to in-hospital mortality.

Clinical sign or symptom	Total present (n=51)	Present among survivors (n=37)	Present among deaths (n=14)	p-value
Trismus, any severity	50 (98.0%)	36 (97.3%)	14 (100.0%)	1.000
Dysphagia, any severity	47 (92.2%)	35 (94.6%)	12 (85.7%)	0.300
Risus sardonicus	37 (72.5%)	27 (73.0%)	10 (71.4%)	1.000
Spasticity	45 (88.2%)	35 (94.6%)	10 (71.4%)	0.041
Neck stiffness	46 (90.2%)	35 (94.6%)	11 (78.6%)	0.120
Generalised rigidity	49 (96.1%)	36 (97.3%)	13 (92.9%)	0.478
Abdominal rigidity	42 (82.4%)	31 (83.8%)	11 (78.6%)	0.692
Opisthotonus	18 (35.3%)	14 (37.8%)	4 (28.6%)	0.744
Prolonged spasms	45 (88.2%)	32 (86.5%)	13 (92.9%)	1.000
Fever	28 (54.9%)	21 (56.8%)	7 (50.0%)	0.757
Hypertonia	36 (70.6%)	27 (73.0%)	9 (64.3%)	0.732
Hyperreflexia	33 (64.7%)	22 (59.5%)	11 (78.6%)	0.326
Apnoeic spells	8 (15.7%)	3 (8.1%)	5 (35.7%)	0.028
Palpitation	5 (9.8%)	5 (13.5%)	0 (0.0%)	0.305
Urinary retention	29 (56.9%)	18 (48.6%)	11 (78.6%)	0.066

Notes: Values are n, column percentage. Two-sided Fisher exact tests were used. Trismus and dysphagia were considered present at any recorded severity.

Across the recorded vital signs, no statistically significant differences were observed between survivors and patients who died. Median Glasgow Coma Scale score was 12.0 (IQR 11.0-13.0) among deaths and 13.0 (IQR 12.0-15.0) among survivors (p=0.131). Among laboratory measurements, median haemoglobin was lower among deaths than survivors, 11.1 g/dL (IQR 7.4-12.3) versus 12.0 g/dL (IQR 12.0-12.1; p=0.047). No other laboratory measurement differed significantly by mortality status (*Table V*).

Table V
Vital signs and laboratory investigations according to in-hospital mortality.

Investigation	Total median (IQR)	Survived median (IQR)	Died median (IQR)	p-value
Pulse, beats/min	82.0 (76.0-88.0)	84.0 (75.0-88.0)	82.0 (76.0-87.5)	0.905
Systolic blood pressure, mmHg	120.0 (110.0-130.0)	120.0 (110.0-130.0)	120.0 (112.5-130.0)	0.227
Diastolic blood pressure, mmHg	70.0 (70.0-77.5)	70.0 (70.0-80.0)	70.0 (70.0-70.0)	0.120
Temperature, C	37.0 (36.9-37.2)	37.0 (36.9-37.2)	37.1 (36.9-37.2)	0.679
Respiratory rate, breaths/min	18.0 (16.0-20.0)	18.0 (16.0-18.0)	18.0 (16.0-20.0)	0.335
Glasgow Coma Scale score	13.0 (11.0-14.0)	13.0 (12.0-15.0)	12.0 (11.0-13.0)	0.131
Haemoglobin, g/dL	12.0 (11.4-12.2)	12.0 (12.0-12.1)	11.1 (7.4-12.3)	0.047
White cell count, cells/uL	7800 (7800-8300)	7800 (7800-7800)	8050 (7425-9000)	0.312
Platelet count, cells/uL	279056 (260000-279056)	279056 (279056-279056)	263000 (235500-301514)	0.219
Random blood glucose, mmol/L	6.0 (5.3-6.7)	6.0 (5.3-6.7)	6.0 (5.2-6.3)	0.676
Serum creatinine, mg/dL	1.09 (1.00-1.25)	1.09 (1.00-1.22)	1.09 (1.09-1.37)	0.225
Serum calcium, mg/dL	8.0 (8.0-8.0)	8.0 (8.0-8.0)	8.0 (7.9-8.2)	0.700
Serum sodium, mmol/L	135.6 (135.0-136.0)	135.6 (135.6-136.0)	135.6 (129.9-135.9)	0.324
Serum potassium, mmol/L	3.85 (3.75-3.90)	3.85 (3.85-3.90)	3.85 (2.97-3.90)	0.540
Alanine aminotransferase, IU/L	36.0 (32.1-41.6)	36.0 (30.0-40.2)	36.0 (36.0-43.0)	0.488

Notes: Values are median (IQR). Two-sided Mann-Whitney U tests were used. Variable-specific n values reflect nonmissing observations in the supplied analysis dataset. Laboratory values previously imputed in the source workbook were retained; no additional imputation was performed.

During admission, at least one complication was recorded in 27 patients (52.9%). Complications occurred in 11 of 14 deaths (78.6%), 11 of 12 patients who recovered with complication at discharge (91.7%), and 5 of 25 patients who recovered without complication at discharge (20.0%; p<0.001). Hypoxaemia was recorded in 8 deaths (57.1%), 7 patients who recovered with complication (58.3%), and 1 patient who recovered without complication (4.0%; p<0.001). Aspiration pneumonia also differed across outcome groups, occurring in 5 deaths (35.7%), 7 patients who recovered with complication (58.3%), and 2 patients who recovered without complication (8.0%; p=0.004). Acute renal failure, dysautonomia, and bedsore were also associated with discharge outcome, with p-values of 0.023, 0.037, and 0.011, respectively (*Table VI*).

Table VI
In-hospital complications according to discharge outcome.

Complication	Total (n=51)	Recovered without complication at discharge (n=25)	Recovered with complication at discharge (n=12)	Died (n=14)	p-value
Any in-hospital complication	27 (52.9%)	5 (20.0%)	11 (91.7%)	11 (78.6%)	<0.001
Aspiration pneumonia	14 (27.5%)	2 (8.0%)	7 (58.3%)	5 (35.7%)	0.004
Hypoxaemia, SaO2 <90%	16 (31.4%)	1 (4.0%)	7 (58.3%)	8 (57.1%)	<0.001
Acute renal failure	5 (9.8%)	0 (0.0%)	3 (25.0%)	2 (14.3%)	0.023
Dysautonomia	4 (7.8%)	0 (0.0%)	1 (8.3%)	3 (21.4%)	0.037
Bedsore	3 (5.9%)	0 (0.0%)	3 (25.0%)	0 (0.0%)	0.011
Urinary tract infection	3 (5.9%)	2 (8.0%)	1 (8.3%)	0 (0.0%)	0.595
Deep vein thrombosis	1 (2.0%)	0 (0.0%)	1 (8.3%)	0 (0.0%)	0.235
Other complication	6 (11.8%)	2 (8.0%)	3 (25.0%)	1 (7.1%)	0.386

Notes: Values are n, column percentage. Fisher-Freeman-Halton exact tests with 100,000 Monte Carlo samples were used. Recovered without complication describes status at discharge; resolved complications during admission remain recorded. Complications with zero events were omitted.

All patients received diazepam or midazolam. Metronidazole was administered to 50 patients (98.0%), antibiotics to 48 (94.1%), tetanus immunoglobulin to 46 (90.2%), baclofen to 38 (74.5%), and barbiturates to 27 (52.9%). Across the treatment comparisons, no statistically significant difference was observed between survivors and patients who died. The largest absolute difference involved baclofen, which was administered to 30 of 37 survivors (81.1%) and 8 of 14 patients who died (57.1%; p=0.147) (*Table VII*).

Table VII
Pharmacological treatment according to in-hospital mortality.

Therapeutic agent	Total (n=51)	Survived (n=37)	Died (n=14)	p-value
Diazepam or midazolam	51 (100.0%)	37 (100.0%)	14 (100.0%)	—
Metronidazole	50 (98.0%)	36 (97.3%)	14 (100.0%)	1.000
Antibiotic	48 (94.1%)	36 (97.3%)	12 (85.7%)	0.179
Tetanus immunoglobulin	46 (90.2%)	33 (89.2%)	13 (92.9%)	1.000
Baclofen	38 (74.5%)	30 (81.1%)	8 (57.1%)	0.147
Barbiturate	27 (52.9%)	19 (51.4%)	8 (57.1%)	0.762
Magnesium	3 (5.9%)	3 (8.1%)	0 (0.0%)	0.552
Other pharmacological agent	1 (2.0%)	1 (2.7%)	0 (0.0%)	1.000

Notes: Values are n, column percentage, except drug count, which is median (IQR). Two-sided Fisher exact tests were used for treatments and the Mann-Whitney U test for drug count. Treatment comparisons are descriptive.

DISCUSSION

The present study identified substantial in-hospital mortality among adult tetanus patients, with 14 of 51 patients dying, corresponding to a case-fatality rate of 27.5%. This estimate was lower than the 34.4% mortality reported in the previous multicentre adult study from Bangladesh, but remained within the pooled mortality estimate of 32.0%, 95% CI 27.1%–37.0%, reported by Chen et al [8]. Higher mortality has been described in severe adult cohorts, including 44.5% in a Brazilian intensive-care unit, whereas mortality of 2.8% was observed in a specialist intensive-care cohort in southern Vietnam [10,12]. These differences probably reflect variation in severity, referral pathways, access to ventilation, and patient selection. Older age was associated with adverse discharge outcome. Median age increased from 45.0 years among patients who recovered without complication to 55.0 years among those who recovered with complication and 57.5 years among patients who died. A similar association was demonstrated in the previous Bangladesh study, where age of at least 40 years was associated with mortality after adjustment, adjusted HR 4.03 [6]. Consistent evidence was found in the adult meta-analysis, where age of at least 40 years was associated with a 1.89-fold higher mortality risk [8]. Increasing age was also retained in the adjusted model among severe adult cases in Brazil [12]. Reduced physiological reserve and poorer tolerance of respiratory or autonomic complications may contribute to worse outcomes among older patients. Disease severity showed the clearest relationship with mortality. Case fatality increased from 0% in Ablett grades I and II to 13.3% in grade III and 62.5% in grade IV, while 10 of 14 deaths occurred among patients with grade IV disease. This finding was consistent with the pooled association between Ablett grade III or IV and mortality, RR 3.40, reported by Chen et al [8]. Severe Ablett classification was also associated with mortality in the Chinese cohort studied by Cheng et al., although its estimates were imprecise and the prediction model contained statistical limitations. In a more recent Anhui cohort, mortality reached 44.4% in grade IV disease [11,13]. These findings support Ablett grading as a practical method for early clinical risk stratification. Apnoeic spells were more common among patients who died than among survivors, 35.7% versus 8.1%, and mortality reached 62.5% among affected patients. Few open-access adult studies have measured this feature using an identical definition; however, respiratory compromise forms part of severe tetanus classifications and has consistently been linked to poor outcome. Mechanical ventilation was associated with mortality in the meta-analysis by Chen et al., but this should be interpreted as a marker of respiratory failure rather than a harmful effect of ventilation [8]. The low mortality observed in Vietnam, despite half of patients requiring ventilation, suggests that timely airway protection and respiratory support may modify the prognosis of severe disease [10]. Spasticity was less frequently documented among deaths than survivors, producing an unexpected inverse univariable association. No reliable evidence was identified that spasticity protects against mortality, and presenting clinical manifestations were not significantly different between survivors and deaths in the previous Bangladesh cohort [6]. This result may reflect small cell counts, differences in documentation, overlap between spasticity, rigidity, and spasms, or chance from multiple comparisons. Urinary retention was also more frequent among deaths but was not statistically significant; because it may be influenced by autonomic dysfunction, medication, immobilization, or catheter use, it should be considered exploratory. Median haemoglobin was lower among patients who died, 11.1 g/dL, than among survivors, 12.0 g/dL. This association was not reproduced in the earlier Bangladesh study, where laboratory findings were generally similar between outcome groups [6]. Leukocytosis rather than haemoglobin was associated with mortality in the Chinese cohort, although that analysis had modelling limitations [11]. Because previously imputed laboratory values were retained and the p-value was close to 0.05, the haemoglobin finding should be interpreted cautiously. In-hospital complications were strongly related to outcome. At least one complication occurred in 78.6% of deaths, compared with 43.2% of survivors. Hypoxaemia, aspiration pneumonia, acute renal failure, and dysautonomia were concentrated among adverse outcomes. In the previous Bangladesh study, any complication was more frequent among deaths, although the association was not significant after adjustment [6]. Dysautonomia has shown one of the most consistent associations with mortality, with a pooled RR of 4.84 in the adult meta-analysis, and it remained associated with mortality in the severe Brazilian ICU cohort [8,12]. These complications should be viewed as manifestations or mediators of severe disease rather than purely baseline risk factors. Reported vaccination was uncommon, with only two patients having a history of prior vaccination and eight receiving post-injury prophylaxis. A similarly low prevalence was documented in the earlier Bangladesh cohort [6]. No mortality association could be established because the vaccinated group was very small; the finding instead indicates a major preventive gap among adult men. No pharmacological treatment was significantly associated with mortality, but treatment was allocated according to severity, making causal interpretation inappropriate.

LIMITATIONS

This study was limited by its single-centre design, small sample size, and the low number of deaths, which prevented reliable multivariable analysis and limited the precision of subgroup comparisons. Some laboratory values had been imputed in the source dataset, and retrospective extraction from hospital records may have introduced missing information and variation in clinical documentation. Therefore, the identified associations should be interpreted as exploratory and may not be generalizable to other hospitals or patient populations.

CONCLUSION

In-hospital mortality among adult tetanus patients was substantial, affecting more than one-quarter of the study population. Older age, very severe disease according to the Ablett classification, apnoeic spells, and the occurrence of serious in-hospital complications were the most clinically

relevant characteristics associated with adverse outcome. Lower haemoglobin and the inverse association observed for spasticity require cautious interpretation because of the small sample, prior laboratory imputation, and absence of adjusted analysis. Early severity assessment, close respiratory and autonomic monitoring, prompt management of complications, and strengthening of adult tetanus vaccination and post-exposure prophylaxis may contribute to improved outcomes.

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CONFLICT OF INTEREST
None declared.

ETHICAL APPROVAL
The study was approved by the Institutional Ethics Committee.

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