Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Tetanus Burden in a Ghanaian Tertiary Care Setting: A Retrospective Analysis of Clinical Presentations, Management, and Mortality Predictors (2020-2024)

Chris Oppong

wakris2001@yahoo.com

Emergency Medicine Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934

Emmanuel Kwasi Afriyie

Emergency Medicine Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934

Lawrence Nsohlebna Nsoh

Emergency Medicine Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934

Mercy Negble

Garden City University, University Road

Kwaku Gyasi Danso

Infectious Diseases Unit, Internal Medicine Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934

Nana Ama Serwaa Idun-Sam

Surgery Directorate, Ga East Municipal Hospital, Post Office WY 1895

Matilda Alambirigo

Oncology Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934

Research Article

Keywords: Tetanus, Case fatality rate, Predictors of mortality, Emergency medicine, Ghana, Sub-Saharan Africa, Vaccination

Posted Date: November 25th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11423079/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Tetanus Burden in a Ghanaian Tertiary Care Setting: A Retrospective Analysis of Clinical Presentations, Management, and Mortality Predictors (2020-2024)

Chris Oppong[1†*], Emmanuel Kwasi Afriyie[1†], Lawrence Nsohlebna Nsoh[1,2], Mercy Negble[3], Kwaku Gyasi Danso[4], Nana Ama Serwaa Idun-Sam[5], Matilda Alambirigo[6†]

1. Emergency Medicine Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934, Kumasi, Ashanti Region, Ghana
2. Emergency Medicine Department, 37 Military Hospital, Greater Accra, Ghana
3. Garden City University, University Road, Kenyase, Kumasi, Ghana
4. Infectious Diseases Unit, Internal Medicine Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934, Kumasi, Ashanti Region, Ghana
5. Surgery Directorate, Ga East Municipal Hospital, Post Office WY 1895, Kwabenya, Greater Accra, Ghana
6. Oncology Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934, Kumasi, Ashanti Region, Ghana

† These authors contributed equally to this article.

*** Corresponding Author:** Chris Oppong, Emergency Medicine Directorate, Komfo Anokye Teaching Hospital, Post Office Box 1934, Kumasi, Ashanti Region, Ghana. Email: wakris2001@yahoo.com

Qualifications: Chris Oppong (MBChB, FGCS), Emmanuel Kwasi Afriyie (DPDM, MpH, PhD), Lawrence Nsohlebna Nsoh (MBChB, MGCS), Mercy Negble (MpH), Kwaku Gyasi Danso (MBChB, MWACP), Nana Ama Serwaa Idun-Sam (MBChB), Matilda Alambirigo (MpH)

Abstract

Background: Tetanus remains a significant cause of morbidity and mortality in low- and middle-income countries despite being entirely preventable through vaccination. In Ghana, the last comprehensive study of adult tetanus outcomes was conducted two decades ago, and it is unknown whether outcomes have improved amid expanded vaccination programs, evolving wound care, and the establishment of emergency medicine as a recognised specialty. This study aimed to describe the demographic, clinical, and management characteristics of adult tetanus patients at a tertiary referral centre, determine the case fatality rate, and identify independent predictors of mortality.

Methods: A retrospective, single-centre study was conducted at the Emergency Department of Komfo Anokye Teaching Hospital in Kumasi, Ghana, among patients aged 15 years and older with a clinical diagnosis of tetanus admitted between August 2020 and August 2024. Data were extracted from electronic medical records using a standardised form and analysed with Stata version 14. Bivariate associations were assessed using Chi-square or Fisher's exact tests, and Firth's penalised likelihood logistic regression was used for multivariable analysis given the small sample size.

Results: Forty-seven patients were admitted with tetanus during the study period. The median age was 42.9 years, and 91.5% were male. Nail puncture was the predominant injury (40.4%), and 17.0% had no recorded portal of entry. The overall case fatality rate was 51.1%, with substantial year-to-year fluctuation (28.6% in 2020 to 75% in 2022). Independent predictors of mortality included management entirely in the emergency department without ward transfer (AOR=25.2), hospital stay of ⩽7 days (AOR= 65.2), and intubation (AOR=23.0); all eight intubated patients died. Tetanus immunoglobulin was administered to 74.5% of patients, and 25.5% received none.

Conclusion: Adult tetanus mortality in Ghana has not improved in two decades, remaining at approximately 51%. These outcomes reflect a failure of health-system configuration rather than clinical knowledge, with the absence of dedicated critical care capacity driving the universal fatality among intubated patients. Protocolized care pathways with designated high-dependency capacity and reliable post-exposure prophylaxis are urgently needed.

Keywords: Tetanus; Case fatality rate; Predictors of mortality; Emergency medicine; Ghana; Sub-Saharan Africa; Vaccination

Background

Tetanus is an acute, often fatal disease caused by the neurotoxin tetanospasmin produced by Clostridium tetani, a Gram-positive, spore-forming, obligate anaerobe found ubiquitously in soil and in the gastrointestinal tracts of humans and animals [1, 2]. The disease is characterized by generalized muscle rigidity and spasms, which may progress to respiratory failure, autonomic instability, and death [2]. The infection typically follows punctured wounds, skin ulcers, surgery, dental infections, abortion, or the umbilical cord of new-borns of non-immunised women, although in many cases the portal of entry cannot be identified [3, 4]. Animal bites, including snakebites and dog bites, are also recognised portals of entry, and international guidelines recommend routine tetanus prophylaxis following such injuries [5, 6]. Despite being entirely preventable through vaccination, tetanus persists as a significant cause of morbidity and mortality in low- and middle-income countries (LMICs), where access to vaccination, wound care, and critical care services remains limited [3, 7].

The global epidemiology of tetanus has changed substantially over the past three decades. GBD 2021 data show that the global age-standardised prevalence rate declined from 1.80 per 100,000 in 1990 to 0.48 per 100,000 in 2021, with males consistently bearing a higher burden than females [8]. However, these gains mask persistent regional disparities: approximately 82% of the global burden occurs in South Asia and Sub-Saharan Africa (SSA), where age-standardised prevalence rates in 2021 were 2.47 and 2.02 per 100,000, respectively, more than four times the global average [9, 10]. In SSA, incidence declined from 20 to 5 per 100,000 between 1990 and 2019, yet case fatality rates remain high at 30–50%. Projections suggest continued global decline through 2050, though uncertainty may widen in low-socio-demographic index (SDI) regions [10].

The epidemiology of tetanus in Ghana reflects broader regional patterns. A study conducted at Korle-Bu Teaching Hospital (KBTH) in Accra two decades ago reported a mortality rate of 50% among adult tetanus patients [11]. Conversely no comprehensive studies have examined whether outcomes have improved in the context of Ghana's evolving healthcare infrastructure, expanded vaccination programs, and the introduction of emergency medicine as a recognized specialty. This gap is particularly concerning given that immunization, wound management, and delayed

post-exposure prophylaxis remain key drivers of the disease in African subregions [12], and that thorough wound debridement with timely tetanus prophylaxis is a proven, low-cost intervention [5, 6]. Tetanus is therefore a tracer condition for health system performance: its persistence signals failures in primary prevention (vaccination), secondary prevention (wound management and post-exposure prophylaxis), and tertiary care (critical care capacity).

The clinical management of tetanus is complex and resource-intensive. Passive immunization with tetanus immunoglobulin (TIG) neutralizes unbound toxin and is a cornerstone of therapy, although optimal dosing remains debated [5, 6]. Antimicrobial therapy, typically metronidazole, eradicates vegetative bacteria and prevents further toxin production [13]. Muscle spasms are managed with benzodiazepines, notably diazepam, phenobarbitone, or chlorpromazine, while severe cases require neuromuscular blockade, mechanical ventilation, and intensive monitoring [14, 15]. In resource-limited settings, however, these interventions are often unavailable, and management is primarily supportive.

The clinical presentation of tetanus is highly variable, ranging from localized trismus to generalized spasms with opisthotonus and autonomic dysfunction [16]. Prognosis depends on multiple factors, including incubation period, interval from first symptom to treatment, severity of spasms, and presence of complications such as pneumonia or respiratory failure [3]. Identifying predictors of mortality is essential for risk stratification and resource allocation, particularly in settings where intensive care unit (ICU) beds are scarce.

This study was undertaken to address the critical evidence gap on adult tetanus in Ghana. Our study objectives were threefold: 1) to describe the demographic, clinical, and management characteristics of adult tetanus patients admitted to a tertiary referral centre over four years; 2) to determine the case fatality rate and identify independent predictors of mortality; and 3) to propose evidence-based recommendations for improving tetanus prevention and management at individual and health-system levels. By providing contemporary data, we aim to inform clinical practice, guide resource allocation, and advocate for policy changes to reduce the persistent burden of this preventable disease.

Methods

Study Design and Setting

This was a retrospective, single-centre study conducted at the Emergency Department (ED) of Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana. The study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational studies (see Supplementary File-Table 1) [17]. KATH is the second-largest tertiary referral centre in Ghana and serves as a training hub for emergency physicians and nurses in the West African sub-region. The ED has a 38-bed capacity and operates at an average daily bed occupancy of approximately 80%, with an average length of stay of 1.5 days. At the time of the study, the hospital did not have a dedicated ICU available to tetanus patients, a critical contextual factor that influenced management and outcomes.

Study Population and Eligibility Criteria

All patients aged ⩾15 years with a clinical diagnosis of tetanus admitted to the ED between August 1, 2020, and August 31, 2024, were eligible for inclusion. This age threshold was selected to align with the methodology of previous key studies on adult tetanus, including the multicenter ID-IRI study and an Ethiopian referral hospital study, which both defined their adult cohorts as patients older than 15 years [18, 19]. The diagnosis of tetanus was made clinically by the attending physician based on standard criteria: presence of trismus, generalized muscle rigidity, or spasms; history of wound or injury; and exclusion of alternative diagnoses such as meningitis, strychnine poisoning, dystonic reactions. Patients who presented exclusively for tetanus vaccination following an injury without any symptoms suggestive of tetanus were excluded. No patients were excluded based on comorbidity, pregnancy status, or prior vaccination history.

Data Collection

Data were extracted from the hospital's electronic medical records (EMR) system using a standardized data collection form developed for this study. The form was piloted on the first five

records and refined for clarity and completeness. Data collected included 1) Demographic characteristics: age, sex, occupation, locality (rural/urban); 2) Injury-related variables: place of injury, mechanism of injury, presence of identifiable portal of entry; 3) Clinical presentation: presenting symptoms (spasms, neck stiffness, trismus, opisthotonus, diaphoresis, difficulty breathing, fever), incubation period where documented, comorbidities; 4) Management variables: tetanus immunoglobulin type (ATS vs. HTIG) and timing, antimicrobial therapy, muscle relaxants (diazepam, phenobarbitone), intubation status; and 4) Outcomes: length of hospital stay, disposition (discharged, transferred, died), complications. Data were entered into a secure, password-protected electronic database. To ensure data quality, a second reviewer independently verified a random 20% sample of records; discrepancies were resolved by consensus.

Statistical Analysis

Statistical analyses were performed using Stata version 14 (StataCorp, College Station, TX, USA). Continuous variables were summarized as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on distribution. Normality was assessed using the Shapiro-Wilk test and visual inspection of histograms. Categorical variables were summarized as frequencies and percentages. Bivariate associations between categorical variables and the primary outcome died vs. survived were assessed using the Chi-square test or Fisher's exact test where expected cell counts were less than 5. Crude odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Variables with $p < 0.10$ in bivariate analysis or those deemed clinically relevant were considered for inclusion in the multivariable model.

Given the small sample size (n = 47) and the potential for complete separation, we employed Firth's penalized likelihood logistic regression for the multivariable analysis. This method reduces small-sample bias and provides finite estimates even when separation occurs [20, 21]. The final model included age group, disposition (ED admission vs. transfer), length of stay (⩽7 days vs. >7 days), intubation, and clinical symptoms (spasm, neck stiffness). Adjusted odds ratios (AORs) with 95% CIs were reported, and statistical significance was set at $p < 0.05$. Missing data were handled using complete-case analysis. The number of missing observations is reported for each variable where applicable.

Ethical Considerations

The study was approved by the Institutional Review Board of the Research and Development Unit at KATH (*KATH IRB/AP/176/24*). As a retrospective review of existing medical records, the requirement for informed consent was waived. All data were anonymized prior to analysis, and patient confidentiality was maintained throughout.

Results

Sociodemographic Characteristics

Between August 2020 and August 2024, 47 patients were admitted to the ED with a clinical diagnosis of tetanus. The median age was 42.9 years (IQR: 27.6 (25.4 - 53.0)). The majority of patients (91.5%, n = 43) were male, yielding a male-to-female ratio of approximately 10.8:1. The modal age group was 40-49 years (25.5%), followed by 50–59 years (23.4%). Farmers constituted the largest occupational group (34.0%), followed by students (23.4%) and artisans (14.9%). Slightly more than half of the patients (55.4%) resided in urban areas. The most common place of injury was the sidewalk (46.8%), followed by the workplace (14.9%), home (10.6%), and farm (10.6%). Nail puncture was the predominant cause of injury (40.4%), followed by road traffic accidents (17.0%), wood puncture (10.6%), and ulcers/burns (8.5%). Notably, 17.0% of cases had no record of injury before admission (see Table 1).

Table 1: Sociodemographic and injury-related characteristics of patients admitted with tetanus at Komfo Anokye Teaching Hospital, Ghana (n = 47)

Variable	Category	Frequency (%)
Sex	Female	4 (8.5)
	Male	43 (91.5)
Age		**Median:** 42.9 (IQR: 27.6)
	15–19	8 (17.0)
	20–29	7 (14.9)
	30–39	5 (10.6)
	40–49	12 (25.5)
	50–59	11 (23.4)
	60+	4 (8.5)
Occupation	Student	11 (23.4)
	Farmer	16 (34.0)
	Artisan	7 (14.9)
	Small-scale miner	6 (12.8)
	Trader	5 (10.6)
	Driver	2 (4.3)
Place of injury	Home	5 (10.6)
	Sidewalk	22 (46.8)
	Farm	5 (10.6)
	Workplace	7 (14.9)

Variable	Category	Frequency (%)
	No record of injury	8 (17.0)
Locality	Rural	21 (44.6)
	Urban	26 (55.4)
Cause of injury	Nail puncture	19 (40.4)
	Road traffic accident	8 (17.0)
	Wood puncture	5 (10.6)
	Ulcer/Burns	4 (8.5)
	Domestic casualty	3 (6.4)
	No record of injury	8 (17.4)

Clinical Presentation

The most common presenting symptoms were spasms (68.1%, n = 32), neck stiffness (65.9%, n = 31), and trismus (57.4%, n = 27). Less common presentations included opisthotonus (27.7%), difficulty breathing (23.4%), diaphoresis (17.0%), and fever (12.8%). The mean incubation period, documented in 28 patients, was 9 ± 4.7 days. Patients who died more frequently presented with neck stiffness (40.4% vs. 25.5%), trismus (34.0% vs. 23.4%), and difficulty breathing (14.9% vs. 8.5%) compared with survivors (see Table 2).

Table 2: Clinical Presentation of Tetanus Patients at Admission (n = 47)

Clinical Feature	**Present, n (%)**	**Absent, n (%)**	**Died n (%)**	**Survived n (%)**	**Crude OR**	**p-value**
Spasms	32 (68.1)	15 (31.9)	17 (36.2)	15 (31.9)	1.30	0.76
Neck stiffness	31 (65.9)	16 (34.1)	19 (40.4)	12 (25.5)	3.48	0.06
Trismus	27 (57.4)	20 (42.6)	16 (34.0)	11 (23.4)	2.18	0.245
Opisthotonus	13 (27.7)	34 (72.3)	6 (12.8)	7 (14.8)	0.76	0.75
Difficulty breathing	11 (23.4)	36 (76.6)	7 (14.9)	4 (8.5)	1.96	0.51
Diaphoresis	8 (17.0)	39 (83.0)	5 (10.6)	3 (6.4)	1.58	0.72
Fever	6 (12.8)	41 (87.2)	4 (8.5)	2 (4.3)	1.44	0.68

Clinical Management

Tetanus immunoglobulin was administered to 35 patients (74.5%); of these, 19 (40.4%) received anti-tetanus serum (ATS), and 16 (34.0%) received human tetanus immunoglobulin (HTIG). Twelve patients (25.5%) did not receive immunoglobulin. Among those who received it, 14 (29.8% of the total cohort) received it in a timely manner, while 21 (44.7%) received it late. Antimicrobial therapy was administered to 44 patients (93.6%), with metronidazole alone (44.7%), ceftriaxone alone (19.1%), or both (29.8%) being the most common regimens. Muscle relaxants were used in all 47 patients, with diazepam alone (51.1%), phenobarbitone alone (27.7%), or both (21.3%). Intubation was required in 8 patients (17.0%), and 36 patients (76.6%) were transferred to the infectious disease ward, while 11 (23.4%) were managed entirely in the ED.

In bivariate analysis, tetanus immunoglobulin administration showed a protective trend (OR = 0.25; $p = 0.09$), with 42.8% mortality among those who received immunoglobulin compared with 69.2% among those who did not. HTIG appeared more protective than ATS (OR = 0.41 vs. 1.00), although this difference was not statistically significant ($p = 0.31$). Intubation was universally fatal: all 8 patients (17.0%) who required intubation died (OR = 24.21; $p = 0.004$). Patients managed entirely in the ED had markedly higher mortality compared with those transferred to the ward (OR = 23.0; $p < 0.001$). Antimicrobial and muscle relaxant choices were not significantly associated with mortality (see Table 3).

Table 3: Management and Treatment Characteristics of Tetanus Patients (n = 47)

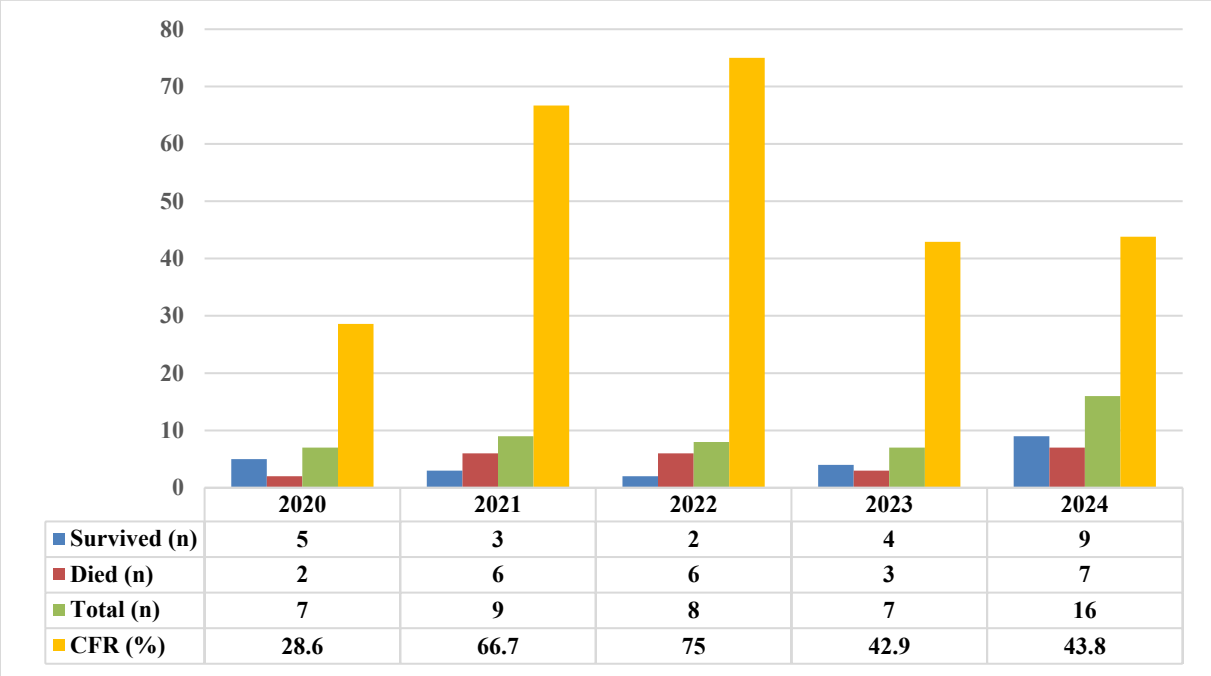
Management Variable	Category	n (%)	Died (n, %)	Survived (n, %)	Crude OR	p-value
Tetanus immunoglobulin	Received	35 (74.5)	15 (31.9)	20 (42.6)	0.25	0.09
	Not received	12 (25.5)	9 (19.1)	3 (6.4)	1.00	—
	Subtotal	**47 (100)**	**24 (51.1)**	**23 (48.9)**		
Type of immunoglobulin	ATS	19 (40.4)	10 (21.3)	9 (19.1)	1.00	—
	HTIG	16 (34.0)	5 (10.6)	11 (23.4)	0.41	0.31
	None	12 (25.5)	6 (12.8)	3 (6.4)	1.80	0.69
	Subtotal	**47 (100)**	**21 (44.7) ***	**23 (48.9)**		
Timing of immunoglobulin	Timely	14 (29.8)	7 (14.8)	7 (14.8)	0.67	0.76
	Not timely	21 (44.7)	8 (17.0)	13 (27.7)	1.00	—
	Subtotal	**35 (74.5)**	**15 (31.9)**	**20 (42.6)**		
Antimicrobial therapy	Metronidazole	21 (44.7)	11 (23.4)	10 (21.3)	1.00	—
	Ceftriaxone	9 (19.1)	4 (8.5)	5 (10.6)	0.73	0.68
	Both	14 (29.8)	7 (14.8)	7 (14.8)	0.91	0.89

Management Variable	Category	n (%)	Died (n, %)	Survived (n, %)	Crude OR	p-value
	None	3 (6.4)	2 (4.3)	1 (2.1)	1.82	0.61
	Subtotal	**47 (100)**	**24 (51.1)**	**23 (48.9)**		
Muscle relaxants	Diazepam	24 (51.1)	12 (25.5)	12 (25.5)	1.00	—
	Phenobarbitone	13 (27.7)	6 (12.8)	7 (14.8)	0.86	0.83
	Both	10 (21.3)	6 (12.8)	4 (8.5)	1.50	0.68
	Subtotal	**47 (100)**	**24 (51.1)**	**23 (48.9)**		
Intubation	Yes	8 (17.0)	8 (17.0)	0 (0.0)	24.21	0.004
	No	39 (83.0)	16 (34.0)	23 (48.9)	1.00	—
	Subtotal	**47 (100)**	**24 (51.1)**	**23 (48.9)**		
Disposition	Transferred to ward	35 (74.5)	12 (25.5)	23 (48.9)	1.00	—
	ED only	12 (25.5)	12 (25.5)	0 (0.0)	23.0	<0.001
	Subtotal	**47 (100)**	**24 (51.1)**	**23 (48.9)**		

***Abbreviations**: ATS = Anti-Tetanus Serum; HTIG = Human Tetanus Immunoglobulin; ED = Emergency Department; OR = Odds Ratio.*
****** The "Type of immunoglobulin" row sums to 21 deaths rather than 24 because 3 patients who did not receive immunoglobulin (the "None" category) are counted under the "Tetanus immunoglobulin → Not received" row.*

Mortality and Temporal Trends

A total of 47 tetanus cases were recorded over the four-year period, with 23 survivors and 24 deaths, yielding an overall case fatality rate (CFR) of approximately 51%. Mortality varied considerably across years, ranging from 28.6% in 2020 to 75% in 2022, with no consistent upward or downward temporal trend. The lowest CFR occurred in 2020, with 2 deaths among 7 cases; 28.6%, followed by a sharp rise in 2021 with 6 deaths among 9 cases; 66.7% and a peak in 2022 of 6 deaths among 8 cases; 75%. CFR then declined to 42.9% in 2023, with 3 deaths among 7 cases and remained relatively stable at 43.8% in 2024, with 7 deaths among 16 cases. Notably, 2024 recorded the highest case count (n = 16), nearly double the annual average of the preceding years, alongside a moderate CFR. Overall, this demonstrates substantial year-to-year fluctuation in tetanus mortality without a clear monotonic trend, though the persistence of CFRs above 40% in four of five years highlights the continued severity of tetanus in this setting (see Figure 1).



	2020	2021	2022	2023	2024
Survived (n)	5	3	2	4	9
Died (n)	2	6	6	3	7
Total (n)	7	9	8	7	16
CFR (%)	28.6	66.7	75	42.9	43.8

Note. CFR = case fatality rate. Figure 1 presents yearly distribution of survival and mortality among adult tetanus patients at ED-KATH, Ghana (2020-2024).

Predictors of Mortality

As illustrated in the forest plot (see Figure 2), the multivariable Firth's penalized logistic regression model identified four factors as independent predictors of mortality. Patients admitted and managed entirely in the ED without transfer to a ward had markedly increased odds of death (AOR = 25.2; 95% CI: 5.20-120.40; $p < 0.001$). A hospital stay of ≤7 days was strongly associated with mortality (AOR = 65.2; 95% CI: 7.20–592.8; $p = 0.001$). Intubation was independently associated with mortality (AOR = 23.0; 95% CI: 1.23-429.0; $p = 0.030$). Compared with the reference age group (15–19 years), patients aged 30-39 years (AOR = 0.03; 95% CI: 0.001-0.57; $p = 0.020$) and 50-59 years (AOR = 0.08; 95% CI: 0.007-0.93; $p = 0.043$) had significantly lower odds of survival. Neck stiffness showed a trend toward increased mortality (AOR = 3.48; 95% CI: 0.97-12.54; $p = 0.07$), as did spasms (AOR = 1.30; 95% CI: 0.38-4.43; $p = 0.07$), though neither reached statistical significance.

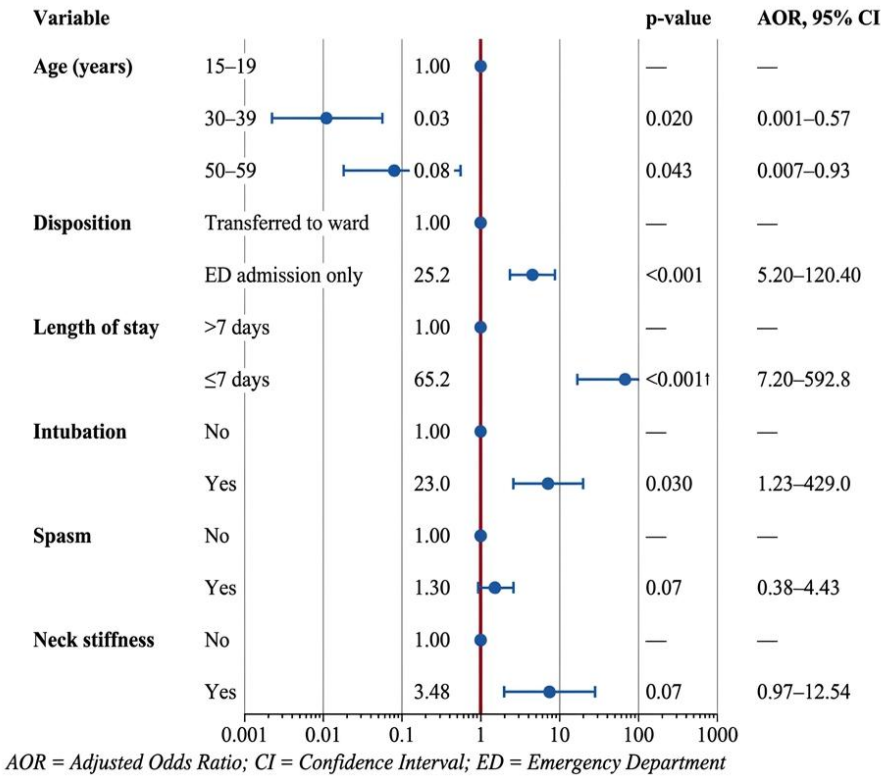


Figure 2: Forest plot of AORs for key predictors of mortality

Discussion

This study asked whether adult tetanus outcomes at a Ghanaian tertiary referral centre have improved amid expanded vaccination programs, evolving wound care, and the establishment of emergency medicine as a recognised specialty. Among the 47 adults admitted to the ED of KATH over four years, the case fatality rate was approximately 51%, virtually identical to the 50% reported at KBTH two decades earlier [11]. Three clinical findings carry the interpretation. First, intubation was universally fatal (8/8). Second, patients managed entirely in the ED died at markedly higher rates than those transferred to a ward (AOR 25.2). Third, one in four patients received no tetanus immunoglobulin, and among those who did, most received it late. The knowledge to treat tetanus was present, as every patient received a muscle relaxant and 93.6% received antimicrobials. What was absent was the care pathway that converts that knowledge into survival.

The persistence of approximately 50% mortality across two decades cannot be attributed to insufficient clinical knowledge. Every patient in this cohort received a muscle relaxant, and 93.6% received antimicrobial therapy. Clinicians knew what to do. This interpretation is supported by a systematic review and meta-analysis of adult tetanus in Africa, which found a pooled case fatality rate of 43.2% (95% CI: 36.9–49.5%) across 27 studies involving 3,043 patients [22]. Our findings situate Ghana within that pattern. Clinically, this matters because it reframes the target of improvement: the deficit is not in recognising tetanus or in choosing diazepam over phenobarbitone, but in the monitoring, escalation, and respiratory support that determine whether a patient with severe spasms survives the second week.

The universal mortality among intubated patients is the most informative finding and demands careful interpretation. In settings with functioning critical care, ventilated tetanus patients have mortality of 10–30% [14]. Our finding does not indicate that intubation is inherently futile; it indicates that intubation without a dedicated ICU is not the same intervention. The African meta-analysis found that mechanical ventilation was unavailable in 26% of included studies, and where available, ICU admission was often not utilised because patients could not afford the costs [22]. This means intubation in our setting functioned as a marker of terminal deterioration rather than a therapeutic escalation, with direct implications for how the procedure is counselled, timed, and resourced. The 25-fold higher odds of death among patients managed entirely in the ED

reinforce this interpretation. The system lacked the intermediate and critical care tiers required to bridge emergency stabilisation and recovery. Severe tetanus requires prolonged access to emergency medical resources, with a mean EICU length of stay of 18.1 days, and mechanical ventilation independently prolongs ICU stay [14]. The absence of those tiers means the ED becomes the terminal care setting by default rather than by design. The treatment heterogeneity observed across antimicrobials, muscle relaxants, and TIG timing points to the same gap: without a standardised facility protocol, management varies by clinician rather than by severity.

The WHO position paper emphasises that where mechanical ventilation is unavailable, close monitoring to reduce spasms and prevent respiratory failure is critical [23]. Our data suggest monitoring capacity and protocol standardisation are precisely what is missing. The absence of reliable national surveillance data compounds the problem, as Ghana cannot manage what it does not measure. The demographic profile sharpens the prevention message. The cohort was 91.5% male, and nail puncture was the predominant injury (40.4%) which ordinary injuries for which timely post-exposure prophylaxis is recommended [5, 6]. Similar findings from Cameroon and Ethiopia consistently identify young adult males as the most affected group, with case fatality rates ranging from 32% to 49% in comparable resource-limited settings [24, 25]; the Lagos University Teaching Hospital reported a lower-case fatality rate of 16.3%, which may reflect differences in case mix or management capacity [26]. These are the patients who should never have developed tetanus. Their presence in a tertiary ED signals that prevention is failing upstream, at the point of wound care and vaccination, and that the tertiary centre is absorbing a burden that primary and secondary prevention should have eliminated.

Strengths and limitations

This study has several strengths. It provides contemporary, real-world data from the second-largest tertiary referral centre in Ghana, filling an evidence gap that has persisted for two decades. The four-year period captures year-to-year variation, including the marked increase in case counts in 2024, and Firth's penalised likelihood logistic regression is appropriate for the small sample and the presence of complete separation. Several limitations qualify these findings. The single-centre, retrospective design and small sample (n = 47) limit statistical power and precision. Data were incomplete for key variables including incubation period, vaccination history, and portal of entry; complete-case analysis may introduce bias if missingness is not

random. The absence of a dedicated ICU at the time of the study means the findings may not be generalisable to settings with critical care capacity. Finally, the health-system interpretation we advance is a framework for understanding the data rather than a set of formally tested hypotheses.

Conclusion

Tetanus remains a highly lethal disease in Ghana, and its lethality has not diminished in two decades. The 51% case fatality rate in this cohort, the universal mortality among intubated patients, and the 25-fold higher mortality among ED-managed patients all point to the same conclusion: these outcomes reflect a failure of health-system configuration, not clinical knowledge. Addressing these failures would improve outcomes not only for tetanus but for the many critical illnesses that depend on the same infrastructure and pathways. Two directions for future research follow directly from this study: a prospective, multi-centre cohort with standardised data collection to establish national incidence and case fatality estimates, and an implementation study evaluating whether a protocolised tetanus care pathway with designated high-dependency capacity reduces mortality in a comparable Ghanaian setting.

List of Abbreviations

AOR	Adjusted Odds Ratio
ATS	Anti-Tetanus Serum
CFR	Case Fatality Rate
CI	Confidence Interval
ED	Emergency Department
EMR	Electronic Medical Records
GBD	Global Burden of Disease
HTIG	Human Tetanus Immunoglobulin
ICU	Intensive Care Unit
IRB	Institutional Review Board
IQR	Interquartile Range
KATH	Komfo Anokye Teaching Hospital
LMICs	Low- and Middle-Income Countries
OR	Odds Ratio
SD	Standard Deviation
SDI	Socio-Demographic Index
SSA	Sub-Saharan Africa
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
TIG	Tetanus Immunoglobulin

Author Contributions

1. Conception or design of the work - CO, LNN, MN, and MA
2. Data collection - CO, LNN, KGD, MA and EKA
3. Data analysis and interpretation - MA, MN and EKA
4. Drafting the article - CO, MA and EKA
5. Critical revision of the article - CO, LNN, MA, NAS and EKA
6. Final approval of the version to be submitted- All authors reviewed and approved the final version of the article.

Reflexivity Statement

This study was conducted by a multidisciplinary team of clinicians, a biostatistician, and a hospital administrator who is also a researcher. The team represented multiple institutions, including KATH, the study site, as well as 37 Military Hospital, Garden City University, and Ga East Municipal Hospital. Authors CO, LNN, KGD and NAS are directly involved in managing patients, including those with tetanus. This shared clinical context provided valuable insight into patient care and systemic challenges but also introduced potential professional proximity. To mitigate bias, data extraction and analysis were performed independently by team members not involved in direct patient care (EKA, MN and MA), and all interpretations were reviewed by the full team to ensure balanced and objective reporting.

Data Availability Statement

The dataset for this study is available from the corresponding author upon reasonable request.

Funding

No specific funding was received for any part of this quantitative paper.

Acknowledgements

The authors would like to express their sincere gratitude to all stakeholders at the ED of KATH for their invaluable technical assistance and support throughout the conduct of this study. The authors are also grateful to the hospital's records staff for their assistance in accessing and retrieving the electronic medical records used in this research. Finally, the authors acknowledge the patients whose clinical data formed the basis of this study; while individual consent was not required for this retrospective review, their contributions to the medical record have enabled insights that may improve care for future patients.

Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval for this study was obtained from the Institutional Review Board of the Research and Development Unit at KATH (KATH IRB/AP/176/24).

References

1. Hodgins HP, Chen P, Lobb B, Wei X, Tremblay BJ, Mansfield MJ, Lee VC, Lee P-G, Coffin J, Duggan AT: **Ancient Clostridium DNA and variants of tetanus neurotoxins associated with human archaeological remains**. *Nature Communications* 2023, **14**(1):5475.
2. Yamoah P, Bangalee V, Oosthuizen F: **A review of the safety of vaccines used in routine immunization in Africa**. *African Health Sciences* 2020, **20**(1):227.
3. Khan MAS, Hasan MJ, Rashid MU, Kha Sagar S, Khan S, Zaman S, Sumon SM, Basher A, Hawlader MDH, Nabi MH: **Factors associated with in-hospital mortality of adult tetanus patients–a multicenter study from Bangladesh**. *PLoS Neglected Tropical Diseases* 2022, **16**(3):e0010235.
4. Slifka AM, Park B, Gao L, Slifka MK: **Incidence of tetanus and diphtheria in relation to adult vaccination schedules**. *Clinical Infectious Diseases* 2021, **72**(2):285-292.
5. Rui-feng C, Li-song H, Ji-bo Z, Li-qiu W: **Emergency treatment on facial laceration of dog bite wounds with immediate primary closure: a prospective randomized trial study**. *BMC emergency medicine* 2013, **13**(Suppl 1):S2.
6. Rizzo A, Rhee P: **Unified Treatment Algorithm for the Management of Crotaline Snakebite in the United States: Results of an Evidence-Informed Consensus Workshop**. In: *50 Landmark Papers Every Acute Care Surgeon Should Know.* edn.: CRC Press; 2019: 233-234.
7. Sudarshan R, Sayo AR, Renner DR, De Saram S, Godbole G, Warrell C, Duong HTH, Thwaites CL, Mehta AR, Coughlan C: **Tetanus: recognition and management**. *The Lancet Infectious Diseases* 2025.
8. Li J, Liu Z, Yu C, Tan K, Gui S, Zhang S, Shen Y: **Global epidemiology and burden of tetanus from 1990 to 2019: A systematic analysis for the Global Burden of Disease Study 2019**. *International Journal of Infectious Diseases* 2023, **132**:118-126.
9. He L, Liu C, Nie X, He J, Deng D, Zhou W, Zheng X: **Global analysis of tetanus incidence and mortality in children under 5 years: findings from the Global Burden of Disease Study 2021**. *BMJ Paediatrics Open* 2025, **9**(1):e003326.
10. Liu T, Liu M, Yang G, Ye Q, Sun T, Zhang X, Liu A, Song R, Luo C, Huang X: **Global burden, trends, and projections of tetanus for 2050: Based on the 2021 Global Burden of Disease Study**. *Chinese Journal of Traumatology* 2026.
11. Hesse I, Mensah A, Asante D, Lartey M, Neequaye A: **Characteristics of adult tetanus in Accra**. *West African Journal of Medicine* 2003, **22**(4):291-294.
12. Paison F, Ubuzima P, Nshimiyimana E, Habumugisha J, Atukunda S, Ayebare F, Munyurangabo G, Amikoro B, Su B: **Therapeutic advances in Marburg virus disease: from experimental treatments to vaccine development**. *Annals of Medicine and Surgery* 2025, **87**(5):2784.
13. Vitiello A, Sabbatucci M, Zovi A, Salzano A, Ponzo A, Boccellino M: **Advances in therapeutic strategies for the management of Clostridioides difficile infection**. *Journal of Clinical Medicine* 2024, **13**(5):1331.
14. Karnad DR, Gupta V: **Intensive care management of severe tetanus**. *Indian Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine* 2021, **25**(Suppl 2):S155.
15. Ordak M, Zmysłowska A, Bielski M, Rybak D, Tomaszewska M, Wyszomierska K, Kmiec A, Garlicka N, Zalewska M, Zalewski M: **Pharmacotherapy of patients taking new psychoactive substances: a systematic review and analysis of case reports**. *Frontiers in psychiatry* 2021, **12**:669921.
16. Mahmoud T, Shawky JA, Abdelwahab NA: **Atypical Presentation of Tetanus**. *Afro-Egyptian Journal of Infectious and Endemic Diseases* 2024, **14**(3):259-264.

17. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP: **The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies**. *The lancet* 2007, **370**(9596):1453-1457.
18. Tosun S, Batirel A, Oluk AI, Aksoy F, Puca E, Bénézit F, Ural S, Nayman-Alpat S, Yamazhan T, Koksaldi-Motor V *et al*: **Tetanus in adults: results of the multicenter ID-IRI study**. *Eur J Clin Microbiol Infect Dis* 2017, **36**(8):1455-1462.
19. Derbie A, Amdu A, Alamneh A, Tadege A, Solomon A, Elfu B, Mekonnen D, Mezgebu Y, Worku S, Biadglegne F: **Clinical profile of tetanus patients attended at Felege Hiwot Referral Hospital, Northwest Ethiopia: a retrospective cross sectional study**. *Springerplus* 2016, **5**(1):892.
20. Firth D: **Bias reduction of maximum likelihood estimates**. *Biometrika* 1993:27-38.
21. Firth D: **Bias reduction of maximum likelihood estimates**. *Biometrika* 1995, **82**(3):667-667.
22. Woldeamanuel YW, Andemeskel AT, Kyei K, Woldeamanuel MW, Woldeamanuel W: **Case fatality of adult tetanus in Africa: Systematic review and meta-analysis**. *Journal of the Neurological Sciences* 2016, **368**:292-299.
23. mondiale de la Santé O, Organization WH: **Tetanus vaccines: WHO position paper–February 2017= Note de synthèse: position de l'OMS sur les vaccins antitétaniques–février 2017**. *Weekly Epidemiological Record= Relevé épidémiologique hebdomadaire* 2017, **92**(6):53-76.
24. Sangwe Clovis N, Palle JN, Linwa EMM, Ndung Ako F, Tabe Benem-Orock V, Chichom Mefire A: **Factors associated with mortality in patients with tetanus in Cameroon**. *Science Progress* 2023, **106**(1):00368504221148933.
25. Tesfaw M, Engedaw HA, Alene T, Yadita ZS: **Mortality and Associated Factors Among Adult Tetanus Patients Admitted at Public Hospitals in Bahir Dar City, Ethiopia: A Cross‐Sectional Study**. *Health Science Reports* 2026, **9**(3):e71988.
26. Bankole IA, Danesi MA, Ojo OO, Okubadejo NU, Ojini FI: **Characteristics and outcome of tetanus in adolescent and adult patients admitted to the Lagos University Teaching Hospital between 2000 and 2009**. *Journal of the neurological sciences* 2012, **323**(1-2):201-204.