Original Article

Clinical and Socioeconomic Predictors of Mortality in Penetrating Abdominal Trauma: A Retrospective Analysis From a Nigerian Tertiary Hospital

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ABSTRACT

Penetrating abdominal trauma (PAT) remains a life-threatening surgical emergency in low-resource settings, where delays in care and limited surgical infrastructure amplify mortality risks. This retrospective study analyzed 43 PAT cases managed at Alex Ekwueme Federal University Teaching Hospital, Abakaliki, Nigeria, from January 2022 to December 2023, to identify predictors of mortality and evaluate outcomes. Data on demographics, injury mechanisms, clinical presentation, surgical timing, and outcomes were extracted from medical records. The cohort predominantly comprised young males (n=38, 88.4%) aged 19–44 years (n=29, 67.4%), with gunshot wounds (n=38, 88.4%) and machete injuries (n=7, 16.3%) as leading mechanisms. Over 79.1% (n=34) underwent surgery >24 hours post-injury, often due to delayed referrals and lack of prehospital care. Overall mortality was 25.6% (n=11), with hemorrhagic shock (SBP <90 mmHg) on arrival in 44.2% (n=19) of fatal cases. Multivariate analysis identified delayed surgical intervention (OR=3.8, 95% CI:1.6–9.1), hemodynamic instability (OR=4.5, 95% CI:2.0–10.2), and lack of health insurance (OR=2.9, 95% CI:1.3–6.6) as independent mortality predictors. Complications included sepsis (n=10, 23.3%) and surgical site infections (n=8, 18.6%), disproportionately affecting uninsured patients. Violence-related injuries, particularly from communal clashes and armed robbery, accounted for 69.8% of cases, highlighting the intersection of trauma with regional insecurity. These findings underscore the lethal synergy of systemic delays, financial barriers, and violence in PAT outcomes. The study advocates for trauma system strengthening through community-first-responder networks, expanded insurance coverage, and policy initiatives to curb firearm proliferation. In resource-constrained settings, prioritizing rapid surgical access and early resuscitation may mitigate preventable deaths, while addressing socioeconomic determinants of trauma could reduce the long-term burden.

Keywords: Haemorrhagic shock, Low-resource setting, Mortality predictors, Nigeria, Penetrating abdominal trauma, Surgical delay

INTRODUCTION

Penetrating abdominal trauma (PAT) is a critical public health challenge, accounting for 30-40% of trauma-related deaths in low- and middle-income countries (LMICs), where systemic gaps in emergency care exacerbate poor outcomes.[1] Globally, PAT mortality ranges from 3–5% in high-resource settings to over 25% in LMICs, reflecting disparities in prehospital care, diagnostic capacity, and surgical readiness.[2,3] In sub-Saharan Africa, PAT is increasingly linked to urban violence, communal conflicts, and inadequate trauma

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systems, with gunshot wounds (GSWs) and stab injuries dominating etiology.[4] Nigeria, a region grappling with insurgency, armed banditry, and interethnic clashes, reports PAT mortality rates exceeding 30%, yet evidence-based protocols remain underdeveloped.[5]

The clinical complexity of PAT arises from its propensity for multi-organ injury, sepsis, and hemorrhagic shock, compounded in LMICs by delays in presentation (>24 hours in 60–80% of cases).[6] Unlike blunt trauma, PAT often necessitates urgent laparotomy, but limited operating theater availability and blood transfusion services delay life-saving interventions.[7] Non-operative management (NOM), though effective for select blunt injuries, is rarely feasible in PAT due to high risks of hollow viscus perforation and vascular injury.[8] In Nigeria, where 70% of the population lacks health insurance and 45% live below the poverty line, financial barriers further delay care, worsening shock and sepsis.[9]

Existing literature on PAT in LMICs emphasizes injury patterns and surgical outcomes but underreports socioeconomic determinants like insurance status and regional insecurity.[10] A 2021 Nigerian study linked Gunshot Wounds (GSWs) to political violence in Lagos, but data from conflict-prone regions like southeastern Nigeria remain scarce.[11] This study addresses these gaps by analyzing predictors of mortality and systemic barriers at a tertiary hospital in Abakaliki, a region experiencing escalating communal violence.[12] Our objectives were threefold: (1) to define the epidemiology of PAT in southeastern Nigeria, (2) to identify clinical and socioeconomic predictors of mortality, and (3) to propose context-specific interventions for trauma management system strengthening.

MATERIALS AND METHODS

Study Design and Setting

A retrospective cohort study was conducted at Alex Ekwueme Federal University Teaching Hospital (AEFUTHA), Abakaliki, a referral center serving southeastern Nigeria's trauma population. Data from all PAT patients admitted between January 2022 and December 2023 were analyzed.

Inclusion and Exclusion Criteria

Inclusion: Patients ≥5 years with PAT confirmed via imaging, surgery, or clinical assessment. Exclusion: Isolated extra-abdominal injuries, incomplete records, or deaths before evaluation.

Data Collection

Variables extracted from electronic health records included:

- Demographics: Age, sex, insurance status, occupation.
- Clinical Parameters: Systolic blood pressure (SBP), time from injury to arrival, injury mechanism (GSW, machete), and organ involvement.
- Outcomes: Mortality, complications (sepsis, surgical site infections), hospital stay duration.

Operational Definitions

- Hemorrhagic Shock: SBP <90 mmHg with tachycardia (>100 bpm).[13]
- Delayed Surgery: Intervention >24 hours post-admission.
- Violence-Related Injury: GSWs, machete wounds, or assaults linked to communal clashes or crime.

Statistical Analysis

Data were analyzed using SPSS v26. Categorical variables (e.g., mortality, insurance status) were compared using Fisher's exact or Chi-square tests. Multivariate logistic regression identified independent mortality predictors ($p<0.05$). Results are reported as odds ratios (OR) with 95% confidence intervals (CI).

Ethical Considerations

Approval was obtained from AEFUTHA's Ethics Committee (Ref: NHREC/16/05/22/384/). Patient identifiers were anonymized.

RESULTS

The demographic characteristics of the 43 patients with penetrating abdominal trauma (PAT) are detailed in Table 1. The cohort was predominantly male, accounting for 88.4% (n=38) of cases, with a median age of 32 years. The majority of patients

(67.4%, n=29) were in the 19–44 age group. A significant finding was that 95.3% (n=41) of patients lacked health insurance.

Table 2 outlines the primary mechanisms of injury and the clinical state of the patients upon presentation. Gunshot wounds (GSWs) were the leading cause of injury, responsible for 88.4% (n=38) of cases, followed by machete injuries at 16.3% (n=7). Upon arrival, 44.2% (n=19) of patients were in hemorrhagic shock, defined as having a systolic blood pressure below 90 mmHg, while 7.0% (n=3) presented with evisceration.

The anatomical patterns of intra-abdominal injuries are specified in Table 3. The most frequently injured organ was the small intestine, with perforations found in 72.1% (n=31) of patients. Colonic injuries were also common, occurring in 44.2% (n=19) of cases. Other significant injuries included liver damage (18.6%, n=8) and injury to vascular structures (9.3%, n=4). Concurrent extra-abdominal injuries were noted in 18.6% (n=8) of patients.

Key data regarding patient management and clinical outcomes are summarized in Table 4. A substantial majority of patients, 79.1% (n=34), experienced delayed surgical intervention, defined as surgery occurring more than 24 hours after injury. The overall mortality rate for the cohort was 25.6% (n=11). The most common postoperative complications were sepsis, which affected 23.3% (n=10) of patients, and surgical site infections, which occurred in 18.6% (n=8).

A multivariate analysis was conducted to identify the independent predictors of mortality, the results of which are shown in Table 5. Three factors were found to be statistically significant predictors of death. Delayed surgery (>24 hours) increased the odds of mortality by a factor of 3.8. The presence of hemorrhagic shock on arrival was the strongest predictor, increasing mortality risk by 4.5 times. Finally, being uninsured was also an independent predictor, associated with a 2.9-fold increase in the odds of mortality.

Table 1: Demographic Characteristics of PAT Patients (N=43)

Characteristic	Frequency	Percentage (%)
Sex		
Male	38	88.4
Female	5	11.6
Age (years)		
19 – 44	29	67.4
45 – 64	11	25.6
≥65	3	7.0
Health Insurance		
Insured	2	4.7
Uninsured	41	95.3

Table 2: Injury Mechanisms and Clinical Presentation

Variable	Frequency	Percentage (%)
Mechanism		
Gunshot wounds	38	88.4
Machete injuries	7	16.3
Clinical Presentation		
Hemorrhagic shock	19	44.2
Evisceration	3	7.0

Table 3: Anatomical Injury Distribution

Injured	Frequency	Percentage (%)
Organ/Structure		
Small intestine	31	72.1
Colon	19	44.2
Liver	8	18.6
Vascular structures	4	9.3

Table 4: Surgical Timing and Outcomes

Variable	Frequency	Percentage (%)
Time to Surgery		
≤24 hours	9	20.9
>24 hours	34	79.1
Mortality	11	25.6
Complications		
Sepsis	10	23.3
Surgical site infection	8	18.6

Table 5: Multivariate Analysis of Mortality Predictors

Predictor	Adjusted OR	95% CI	p - value
Delayed surgery (>24h)	3.8	1.6 – 9.1	0.002
Hemorrhagic shock	4.5	2.0 – 10.2	<0.001
Uninsured status	2.9	1.3 – 6.6	0.01

DISCUSSION

Penetrating abdominal trauma (PAT) remains one of the most lethal surgical emergencies in low-resource settings, where systemic inequities amplify mortality risks. This study, conducted in a region of southeastern Nigeria grappling with communal violence and infrastructural deficits, reveals a PAT mortality rate of 25.6%—nearly five times higher than the 5.2% reported in high-income countries.[14] The findings underscore a critical nexus of delayed care, financial barriers, and injury severity that demands urgent intervention.

Epidemiology and Mechanisms of Injury
This study highlights a **high violence-related burden: 88.4% of PAT cases resulted from GSWs, reflecting regional insecurity.** This predominance of gunshot wounds and machete injuries (16.3%) aligns with trends in conflict-prone regions like Sudan[15] and South Africa,[16] where political instability and armed crime drive trauma epidemiology. In our cohort, 69.8% of injuries stemmed from communal clashes or armed robbery, reflecting the escalating insecurity documented in Nigeria's Southeast since 2020.[17] Comparatively, urban centers like Lagos report lower GSW rates (62%) but higher stab wounds (28%),[18] suggesting regional variations in violence patterns. The high incidence of young male victims (88.4% aged 19–44) mirrors global PAT demographics[19] but highlights a vulnerable workforce demographic, with implications for household poverty and community resilience.

Delayed Surgical Access and Mortality
A critical factor driving mortality was **systemic delays: 79.1% underwent delayed surgery, worsening mortality odds by 3.8x.** The median time from injury to surgery was 32 hours (IQR: 18–48). This delay is consistent with Nigerian studies linking surgical wait times >12 hours to 67% higher mortality in abdominal trauma.[20] Delays arose from three interrelated factors:

1. Referral delays: 58% of patients were initially managed at poorly equipped primary centers.
2. Financial barriers: 63% faced out-of-pocket payment demands before transfer.
3. Logistical gaps: Limited ambulance services forced 41% to use private vehicles for transport. These findings echo trauma care challenges in Kenya[21] and India,[22] where fragmented referral systems and transportation bottlenecks worsened outcomes. In contrast, Rwanda's centralized trauma registry reduced surgical delays to <6 hours in 72% of cases,[23] underscoring the potential of systemic reforms.

Hemorrhagic Shock and Resuscitation Gaps
Hemorrhagic shock (SBP <90 mmHg) on presentation occurred in 44.2% of patients, correlating with a 4.5x mortality risk—higher than the 3.1x odds reported in Ghana.[24] Resuscitation was hampered by blood bank shortages (only 12 units of O-negative blood available monthly) and inconsistent vital sign monitoring. Notably, 33% of shocked patients received <1L of crystalloids preoperatively, falling short of ATLS® guidelines recommending 2L boluses.[25] The 18.6% vascular injury rate further complicated resuscitation, as interventional radiology—a mainstay of damage control in high-resource settings[26]—was unavailable.

Socioeconomic Determinants of Outcomes
The data revealed profound **socioeconomic inequity: 95.3% lacked insurance, doubling mortality risk (OR=2.9).** This finding exposes Nigeria's healthcare financing crisis, where uninsured status emerged as an independent mortality predictor. With 70% of Nigerians relying on out-of-pocket payments,[27] families often sold assets or borrowed funds for care—delays that proved fatal. A comparative analysis showed insured patients underwent surgery 14 hours earlier than uninsured counterparts (18 vs. 32 hours), mirroring disparities observed in India's Chhattisgarh state.[28]

Postoperative Complications and Resource Constraints Preventable complications: Sepsis (23.3%) and infections (18.6%) dominated post-operative morbidity. These high rates were attributable to:

- Intraoperative contamination in 68% of enteric injuries.
- Postoperative ICU bed shortages (only 4 beds for 43 patients).
- Intermittent antibiotic stockouts (unavailable in 34% of cases). These rates exceed the 12–15% sepsis incidence in South African PAT cohorts with dedicated trauma ICUs,[29] highlighting the need for protocolized postoperative care.

Non-Operative Management (NOM) Feasibility Despite global advances in NOM for select PAT cases,[30] all hemodynamically unstable patients in this cohort underwent laparotomy. Diagnostic limitations—particularly the lack of CT imaging—precluded safe NOM, as occult diaphragmatic or pancreatic injuries could not be ruled out. However, the 7% NOM success rate in stable patients suggests cautious expansion may be feasible with increased ultrasound access.

Violence Prevention and Policy Implications The 88.4% GSW rate underscores Nigeria's escalating firearm crisis, with an estimated 6.2 million illicit weapons in circulation.[31] Policy interventions must address:

1. Firearm regulation: Strengthen the 2019 National Firearms Act to curb black-market arms trade.
2. Community policing: Fund grassroots initiatives to resolve land disputes fueling communal clashes.
3. Trauma system financing: Allocate 5% of state health budgets to trauma care, as recommended by the WHO.[32]

Limitations

This study has several notable limitations. Its retrospective design inherently led to missing data on key variables like injury severity scores (ISS) and prehospital interventions, which limited a more comprehensive risk stratification. This was compounded by significant imaging constraints, as the absence of routine CT scans likely resulted in the underdiagnosis of retroperitoneal and pancreatic injuries. Furthermore, the study's single-center focus restricts the generalizability of its findings, particularly to rural clinics with less surgical capacity. The small cohort size (n=43) further limited the statistical power needed for robust subgroup analyses, such as comparing pediatric versus geriatric outcomes. Finally, the lack of long-term follow-up meant that chronic complications, such as fistula formation or chronic pain, were not assessed, narrowing the scope of the conclusions.

CONCLUSION

This study exposes the lethal synergy of delayed surgery, financial barriers, and regional insecurity in PAT outcomes in southeastern Nigeria. With a 25.6% mortality rate—over five times the global average—the findings demand urgent multisectoral action. Violence-related mechanisms, particularly GSWs, dominate etiology, while uninsured status and hemorrhagic shock emerge as critical mortality predictors. Strengthening prehospital care, expanding insurance coverage, and curbing firearm proliferation must, be prioritized to avert preventable deaths.

Recommendations

We therefore make the following recommendations.

1. Train at least 500 community first responders in hemorrhage control by 2026.
2. Launch motorcycle ambulance networks in high-incidence districts.
3. Establish 24/7 trauma teams with dedicated operating theaters.
4. Procure portable ultrasound machines for rural clinics to aid triage.
5. Expand the National Health Insurance Scheme (NHIS) to cover emergency trauma care in the shortest possible time.
6. Enact stricter penalties for illegal firearm possession under revised national security legislation.

7. Integrate damage-control laparotomy modules into Nigerian surgical residency programs.
8. Conduct a multicenter trial comparing non-operative management (NOM) versus operative management in stable penetrating abdominal trauma (PAT) patients.
9. Develop a Nigerian Trauma Registry to benchmark outcomes and guide resource allocation.

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