Original Article

Predictors of Early (<24-Hour) Mortality in Trauma Patients: A Multivariate Logistic Regression Analysis from a Nigerian Tertiary Hospital

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ABSTRACT

Trauma is a leading cause of death in Nigeria, with a significant proportion of fatalities occurring within the first 24 hours of hospital admission. While the overall burden is known, there is a lack of analytical studies identifying the specific factors that predict these early deaths, which is critical for improving triage, optimizing resource allocation, and developing targeted interventions in resource-limited settings. This study aimed to identify the independent predictors of early (<24-hour) mortality among trauma patients at a major Nigerian referral center. A retrospective analysis was conducted on data from 118 trauma patients who died in the Accident and Emergency department of Alex Ekwueme Federal University Teaching Hospital, Abakaliki, between January 1 and December 31, 2022. The primary outcome was death within 24 hours of presentation. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of early mortality from data on patient demographics, pre-hospital transport, injury characteristics, and initial physiological parameters. Of the 118 trauma deaths, 93 (78.5%) occurred within the first 24 hours. In the multivariate analysis, a Glasgow Coma Scale (GCS) score of <9 on admission (OR: 12.5; 95% CI: 4.2-37.1; P<0.001), the presence of a head and neck injury (OR: 8.3; 95% CI: 2.9-23.7; P<0.001), arrival at the hospital via informal transport (private car/bus or commercial tricycle) (OR: 4.1; 95% CI: 1.5-11.2; P=0.006), and systolic blood pressure <90 mmHg were significant independent predictors of early mortality. In conclusion, early trauma mortality in this Nigerian hospital is strongly predicted by the severity of brain injury and failures in the pre-hospital care system. These findings provide objective evidence for prioritizing interventions, including strengthening the chain of survival, enforcing safety laws to prevent severe head injuries, and urgently developing a formal emergency medical transport system. Clinically, these predictors can be used to rapidly identify high-risk patients for immediate, aggressive resuscitation and resource mobilization.

Keywords: Early Death, Logistic Regression, Mortality, Nigeria, Pre-hospital Care, Predictors, Trauma.

INTRODUCTION

Trauma represents an escalating global public health crisis, exacting a devastating toll on human life and societal well-being. Accounting for nearly 4.4 million deaths annually, traumatic injuries are responsible for approximately 8% of all global mortality, a figure that rivals the death toll from diseases like HIV/AIDS, tuberculosis, and malaria combined[1]. This epidemic of injury is particularly pernicious because it disproportionately affects the young and economically productive segments of society. For individuals aged 5 to 29, trauma is the 1

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airway, immobilizing the spine, and initiating fluid resuscitation. In Nigeria, this system is virtually non-existent for the vast majority of the population. There is no single, unified national emergency access number, and the availability of ambulances is critically low, estimated at a mere 0.4 per 100,000 people[13]. Consequently, the transport of the injured is a chaotic and unorganized process, reliant on the goodwill of bystanders using private cars, commercial buses, and unstable three-wheeled "keke" tricycles[14]. This "scoop and run" approach, devoid of any medical intervention, not only delays arrival at a definitive care facility but can actively worsen injuries. A simple closed fracture can become an open, contaminated one; a stable spinal injury can become a paralyzing one; and a compromised airway can lead to irreversible anoxic brain injury long before the hospital is ever reached[15]. This pre-hospital void means that patients often arrive at the emergency department in a state of advanced physiological collapse, having already passed the point of no return.

For those who survive the perilous journey to the hospital, they are confronted with a second wall of formidable, often fatal, obstacles. The Nigerian healthcare system is predominantly financed by out-of-pocket payments, with patients and their families bearing the cost of over 75% of all health expenditures[16]. This financial model is catastrophic in the context of emergency care. Treatment, from the provision of intravenous fluids and analgesics to life-saving diagnostic imaging and emergency surgery, is frequently withheld until payment is made[17]. These financial delays are not mere administrative inconveniences; in the time-sensitive world of trauma, they are an active cause of death. A patient with a ruptured spleen may bleed to death while relatives desperately try to raise funds for a CT scan or a laparotomy. This brutal reality was laid bare in a recent study at our hospital, which found that an astonishing 99.3% of abdominal trauma patients lacked any form of health insurance, leaving them completely vulnerable to these deadly delays[10]. This financial toxicity is compounded by a chronic scarcity of critical resources. The lack of available Intensive Care Unit (ICU) beds, unreliable access to blood products, and shortages of essential surgical supplies mean that even when a diagnosis is made and funds are available, the hospital may lack the fundamental capacity to provide the required standard of care[18].

Given this complex interplay of patient-related, injury-related, and system-related factors, a critical need arises to move beyond simple descriptive studies. While it is crucial to know the overall number of deaths, it is more important to understand which factors most powerfully predict them. Identifying independent predictors of early mortality through multivariate analysis allows for a more nuanced and actionable understanding of the problem. Such models can help clinicians to rapidly risk-stratify patients upon arrival, enabling them to prioritize the allocation of scarce resources--such as the single available ICU bed or the last unit of O-negative blood--to those with the highest statistical chance of benefiting. Furthermore, by quantifying the impact of systemic factors like pre-hospital transport, predictive modeling can provide policymakers with the robust, objective evidence needed to advocate for specific, high-impact interventions. While our previous work described the demographic and epidemiological landscape of trauma mortality at our institution, it did not employ analytical modeling to disentangle the complex web of factors leading to early death[12].

This study, therefore, aims to address this critical knowledge gap. By leveraging the same detailed data set, we will apply a more advanced analytical approach to ask a new and fundamentally different question. The primary objective of this study is to use multivariate logistic regression analysis to identify the specific socio-demographic, clinical, and systemic factors that independently predict trauma-related mortality within the first 24 hours of presentation at Alex Ekwueme Federal University Teaching Hospital. By doing so, we aim to provide actionable evidence to guide clinical practice and inform health policy to reduce the tragic and preventable toll of early trauma deaths in our region.

MATERIALS AND METHODS

Study Design

A retrospective analytical study was conducted using a preexisting dataset of trauma mortalities.

The study was designed to identify predictors of a specific outcome (early death) by analyzing the relationship between various patient and system-level variables.

Study Setting

The research was performed at the Accident and Emergency (A&E) Department of Alex Ekwueme Federal University Teaching Hospital, Abakaliki (AEFUTHA), Ebonyi State, Nigeria. AEFUTHA is the largest tertiary healthcare and academic institution in the state, serving as the primary referral center for a population of over 2.5 million people in Ebonyi and receiving complex trauma cases from neighboring states, including Benue, Enugu, Cross River, and Abia. Its A&E department is a 30-bed unit that functions as the first point of contact for all medical and surgical emergencies and operates continuously, 24 hours a day, seven days a week.

Study Population

The source population for this study comprised all 3,290 trauma patients who were managed at the A&E department of AEFUTHA during the study period. The specific study cohort consisted of the 118 patients who were admitted for trauma and subsequently died within the A&E department.

- Inclusion Criterion: All trauma patients, regardless of age or gender, who died in the A&E department after admission during the study period.
- Exclusion Criteria: Patients who were brought in dead (BID) (n=116) were excluded from this analysis because the exact time of their death could not be ascertained, and they did not undergo any in-hospital assessment or management, making their data unsuitable for predictive modeling.

Study Period

The data were collected over a continuous 12-month period, from January 1, 2022, to December 31, 2022.

Data Collection and Variables

Data for the 118 deceased patients were extracted from a comprehensive trauma registry maintained by the A&E department. This information was cross-validated and supplemented with details from individual patient case files, nursing report books, and admission/discharge records to ensure accuracy and completeness. A structured proforma was used for data extraction.

For this predictive analysis, the variables were categorized as follows:

1. Outcome Variable (Dependent Variable): The primary outcome was early mortality, defined as death occurring within the first 24 hours of arrival at the A&E department. This was coded as a binary variable:
   - 0 = Later Death (died ≥ 24 hours after admission)
   - 1 = Early Death (died < 24 hours after admission)
2. Predictor Variables (Independent Variables): Based on established trauma literature and clinical relevance in a low-resource setting, the following potential predictors were selected for analysis:

Patient Demographics:

Age Group: Categorized as <16, 16-39, 40-60, and >60 years.

Gender: Male or Female.

Pre-hospital System Factors:

Means of Transport: Categorized into Formal/Official (Ambulance, Police/Road Safety van) and Informal (Private Car/Bus, Commercial Tricycle 'Keke'). This variable serves as a proxy for the presence or absence of pre-hospital care.

Injury Characteristics:

Cause of Trauma: Categorized as Road Traffic Accident (RTA) or Other (Assault, Falls, etc.).

Anatomical Location of Primary Injury: Categorized as Head and Neck Injury or Other Body Regions (Extremities, Chest, Abdomen).

Initial Physiological Status (on arrival):

Glasgow Coma Scale (GCS): Dichotomized into Severe Impairment (GCS < 9) and Moderate/Mild Impairment (GCS ≥ 9).

Systolic Blood Pressure (SBP): Dichotomized into Hypotensive (SBP < 90 mmHg) and Normotensive (SBP ≥ 90 mmHg).

Respiratory Rate (RR): Categorized based on RTS scoring bands (10-29, >29, 6-9, 1-5, 0 breaths per minute).

Statistical Analysis

All collected data were coded and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA).

The analysis was conducted in two stages:

1. Bivariate Analysis: To begin, descriptive statistics (frequencies and percentages) were calculated for all variables. A bivariate analysis was then performed to assess the association between each potential predictor variable and the binary outcome of early mortality. The Chi-square (χ^2) test or Fisher's exact test (for cells with expected counts <5) was used for this purpose. Variables with a p-value < 0.20 in the bivariate analysis were considered potentially significant and were selected as candidate variables for inclusion in the multivariate model. This liberal p-value was chosen to avoid the premature exclusion of variables that could be important predictors in the context of a multifactorial model.
2. Multivariate Analysis: A binary logistic regression model was developed to identify the independent predictors of early (<24-hour) mortality while controlling for the effects of confounding variables. All candidate variables identified from the bivariate analysis were entered into the model using the "Enter" method. This method was chosen to assess the contribution of all theoretically relevant factors simultaneously. The goodness-of-fit of the model was assessed using the Hosmer-Lemeshow test. The results of the regression analysis are presented as Adjusted Odds Ratios (aOR) with their corresponding 95% Confidence Intervals (CI). A p-value of less than 0.05 was considered statistically significant for the final model.

Ethical Considerations

Ethical approval for this study was obtained from the Health Research and Ethics Committee (HREC) of Alex Ekwueme Federal University Teaching Hospital, Abakaliki. As the study involved a retrospective review of anonymized records, the committee granted a waiver for individual patient consent. All data were handled with strict confidentiality, and patient identifiers were removed prior to analysis to protect privacy.

For transparency, we disclose that the dataset used for this analysis was derived from a larger study describing the overall epidemiology of trauma mortality at our institution, the primary findings of which have been published[12]. This current study represents a planned secondary analysis, employing a distinct, more advanced statistical methodology to answer a novel research question focused on identifying independent predictors of early mortality, which was not the objective of the primary descriptive paper.

RESULTS

Cohort Characteristics and Outcome

Of the 118 trauma patients who died in the Accident and Emergency department during the study period, the vast majority, 93 patients (78.5%), died within the first 24 hours of hospital admission (Early Mortality group). The remaining 25 patients (21.5%) died 24 hours or more after admission (Later Mortality group).

Bivariate Analysis of Factors Associated with Early Mortality

A comparative analysis of the characteristics of the Early Mortality and Later Mortality groups is presented in Table 1. In the bivariate analysis, several factors were significantly associated with death within 24 hours. Patients in the Early Mortality group were significantly more likely to have a Glasgow Coma Scale (GCS) score of less than 9 (65/93, 69.9% vs. 6/25, 24.0%, P<0.001), a primary injury to the head and neck region (75/93, 80.6% vs. 8/25, 32.0%, P<0.001), and a systolic blood pressure (SBP) below 90 mmHg on arrival (42/93, 45.2% vs. 4/25, 16.0%, P=0.008).

Furthermore, a critical systemic factor—the means of transport to the hospital—showed a strong association with the timing of death. A significantly higher proportion of patients who died early arrived via informal transport (private car/bus or commercial tricycle) compared to those who died later (80/93, 86.0% vs. 16/25, 64.0%, P=0.015). Age group, gender, and the general cause of trauma (RTA vs. other) did not show a statistically significant association with the timing of mortality in the initial bivariate analysis.

Multivariate Logistic Regression Analysis of Predictors for Early Mortality

To identify the independent predictors of early (<24-hour) mortality, all variables with a p-value < 0.20 in the bivariate analysis were included in a binary logistic regression model. The results of this analysis are presented in Table 2. After adjusting for the effects of other variables in the model, four factors remained as significant, independent predictors of dying within 24 hours.

The most powerful predictor was the patient's neurological status on arrival. A patient presenting with a Glasgow Coma Scale score of less than 9 had 12.5 times the odds of dying within 24 hours compared to a patient with a GCS of 9 or higher (aOR: 12.51; 95% CI: 4.23-37.01; P<0.001). The anatomical location of the injury was also a critical predictor. Patients with a primary head and neck injury had 8.3 times the odds of early death compared to those with injuries to other body regions (aOR: 8.33; 95% CI: 2.91-23.74; P<0.001). The pre-hospital system factor of transport method remained a highly significant predictor in the final model. Patients who arrived at the hospital via informal transport had 4.1 times the odds of early mortality compared to those brought in by a formal or official vehicle (aOR: 4.10; 95% CI: 1.51-11.18; P=0.006). Finally, initial physiological instability was a key predictor. Patients who were hypotensive (SBP < 90 mmHg) on admission had 3.5 times the odds of dying within 24 hours compared to those who were normotensive (aOR: 3.52; 95% CI: 1.19-10.43; P=0.023).

The Hosmer-Lemeshow test indicated a good model fit (χ^2 = 8.15, P = 0.419), suggesting that the model's predictions are not significantly different from the observed outcomes.

Table 1: Bivariate Analysis of Characteristics of Trauma Patients by Timing of Mortality (N=118)

Variable	Early Death (<24h) n=93 (%)	Later Death (≥24h) n=25 (%)	Total n=118 (%)	P-value
Age Group (years)				0.654
<16	6 (6.5)	1 (4.0)	7 (5.9)	
16-39	50 (53.8)	15 (60.0)	65 (55.1)	
40-60	25 (26.9)	5 (20.0)	30 (25.4)	
>60	7 (7.5)	2 (8.0)	9 (7.6)	
Unknown	5 (5.4)	2 (8.0)	7 (5.9)	
Gender				0.731
Male	78 (83.9)	21 (84.0)	99 (83.9)	
Female	15 (16.1)	4 (16.0)	19 (16.1)	
GCS on Admission				<0.001*
<9 (Severe)	65 (69.9)	6 (24.0)	71 (60.2)	
≥9 (Mild/Moderate)	28 (30.1)	19 (76.0)	47 (39.8)	
SBP on Admission				0.008*
<90 mmHg (Hypotensive)	42 (45.2)	4 (16.0)	46 (39.0)	
≥90 mmHg (Normotensive)	51 (54.8)	21 (84.0)	72 (61.0)	
Anatomical Location of Injury				<0.001*
Head and Neck	75 (80.6)	8 (32.0)	83 (70.3)	
Other Body Regions	18 (19.4)	17 (68.0)	35 (29.7)	
Means of Transport				0.015*
Informal (Car/Bus/Keke)	80 (86.0)	16 (64.0)	96 (81.4)	
Formal/Official (Ambulance/Police)	13 (14.0)	9 (36.0)	22 (18.6)	
Cause of Trauma				0.310
RTA	78 (83.9)	19 (76.0)	97 (82.2)	
Other (Assault, Falls, etc.)	15 (16.1)	6 (24.0)	21 (17.8)	

*Statistically significant (P<0.05). GCS = Glasgow Coma Scale; SBP = Systolic Blood Pressure; RTA = Road Traffic Accident.

Table 2: Multivariate Logistic Regression Analysis of Independent Predictors of Early (<24-Hour) Mortality

Predictor Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval (CI)	P-value
GCS on Admission (<9 vs. ≥9)	12.51	4.23 – 37.01	<0.001*
Anatomical Location of Injury (Head/Neck vs. Other)	8.33	2.91 – 23.74	<0.001*
Means of Transport (Informal vs. Formal/Official)	4.10	1.51 – 11.18	0.006*
SBP on Admission (<90 vs. ≥90 mmHg)	3.52	1.19 – 10.43	0.023*
Age Group (ref: 16-39 years)			0.812
Cause of Trauma (RTA vs. Other)	1.29	0.45 – 3.69	0.637

*Statistically significant (P<0.05). Model controlled for all variables listed. aOR = Adjusted Odds Ratio.

DISCUSSION

This study transitioned from a general description of trauma mortality to a focused, analytical investigation aimed at identifying the independent predictors of death within the critical first 24 hours. Our findings provide robust, quantitative evidence that early trauma mortality in our setting is not a matter of chance but is powerfully predicted by a combination of severe neurological injury and systemic failures in the pre-hospital chain of survival. The multivariate analysis definitively identified four factors as independent predictors: a Glasgow Coma Scale (GCS) score below 9, the presence of a head and neck injury, arrival via informal transport, and systolic hypotension on admission. These findings offer a new level of insight beyond our initial descriptive work, providing an evidence-based roadmap for clinical triage and public health policy.

The most significant finding of this study is the overwhelming predictive power of severe neurological injury. A low GCS score on admission was the single strongest predictor, increasing the odds of early death by over twelve-fold. This was strongly corroborated by the finding that a primary head and neck injury independently increased the odds of early death by more than eight-fold. This is not surprising, as severe traumatic brain injury (TBI) initiates a devastating cascade of primary and secondary insults. The primary injury--the direct damage from impact--is often compounded by a rapidly evolving secondary injury process, including cerebral edema, intracranial hypertension, and reduced cerebral perfusion, which can lead to brain herniation and death within hours[19]. Our initial descriptive paper highlighted that head injuries were the most common cause of death; this new analysis quantifies that risk, demonstrating that the presence of a head injury is not just an associated finding but a powerful, independent driver of early mortality. This underscores the catastrophic public health failure of non-enforcement of helmet laws for motorcycle riders, who constitute a huge proportion of RTA victims in our environment[20].

Perhaps the most critical and actionable insight from our regression model is the role of the pre-hospital system, or lack thereof. The finding that arrival via informal transport (private car, bus, or commercial tricycle) independently quadrupled the odds of early death is a stark indictment of the current state of emergency care. This variable is more than just a descriptor of a vehicle; it is a proxy for the complete absence of trained medical intervention during the "golden hour." Patients transported informally receive no on-site hemorrhage control, no airway management, no spinal immobilization, and no shock management. This directly contributes to the other predictive factors identified in our model. A patient with a survivable extremity fracture and a scalp laceration can bleed into a state of irreversible hemorrhagic shock (hypotension) during a 30-minute journey in the back of a car. A patient with a moderate head injury can aspirate and suffer secondary anoxic brain damage, causing their GCS to plummet. Our model provides the statistical proof that this chaotic "scoop and run" approach is an active contributor to mortality. This elevates the call for a formal Emergency Medical Services (EMS) system from a well-meaning recommendation to a data-driven imperative for saving lives[13,14].

The predictive power of hypotension (SBP <90 mmHg) on admission further reinforces this narrative of systemic failure. While hypotension is a well-known marker of severe injury, in our context, it often represents the endpoint of a prolonged period of unmanaged hemorrhage that began at the roadside. It signifies that the patient has exhausted their physiological reserves by the time they reach the hospital door. This finding connects the dots between the pre-hospital void and in-hospital challenges. A patient arriving in shock requires immediate, massive resuscitation with blood products and often emergency surgery. As noted in other studies, these resources are frequently delayed by financial constraints and availability issues, allowing the shock state to become irreversible[17,18]. The predictive capacity of this single physiological parameter highlights the urgent need to address both pre-hospital hemorrhage control and the in-hospital barriers that prevent timely resuscitation.

The clinical implications of these findings are immediate and practical. In a resource-constrained A&E department where multiple critically injured patients may arrive simultaneously, this predictive model provides a rapid, evidence-based triage tool. A patient arriving via informal transport with a documented head injury and a low GCS must be recognized as being at the highest possible risk of imminent death. This justifies the immediate mobilization of the entire trauma team and the allocation of scarce resources, such as the on-call surgeon, limited blood products, and the sole ICU bed, to that patient. It allows for a shift from a "first come, first served" to a "most at risk, first served" approach, optimizing the potential for salvage in a challenging environment.

From a policy perspective, this study provides powerful ammunition for advocacy. It moves the conversation beyond generalities to specific, quantified risks. The argument for enforcing mandatory helmet laws is strengthened when it can be stated that a head injury increases the odds of early death by over 800%. The argument for investing in a national ambulance service is more compelling when data shows that its absence increases the odds of death by 400%. This evidence is crucial for engaging with ministries of health, transport, and finance to make the case that investing in trauma care and prevention is not a cost, but an essential strategy for preserving human capital and promoting national development.

Strengths and Limitations

The primary strength of this study lies in its analytical design. By employing multivariate logistic regression, we were able to move beyond the simple descriptive associations of our initial paper to identify independent predictors, thereby providing a higher level of evidence and a more nuanced understanding of the drivers of early mortality. This quantification of risk associated with specific, modifiable factors is the principal new contribution of this work.

However, the study is not without limitations. First, its retrospective nature makes it susceptible to information bias from incomplete or inaccurately recorded data. Second, being a single-center study, the findings, while likely representative of many tertiary centers in Nigeria, may not be generalizable to all healthcare settings in the country. Third, the dichotomization of continuous variables like GCS and SBP, while necessary for clinical utility and model stability, may result in a loss of some data granularity. Finally, we were unable to capture crucial time-based variables, such as the precise interval from injury to hospital arrival, which is a key confounder that a prospective study could address.

CONCLUSION

In conclusion, this study demonstrates that early trauma mortality at our center is not a random event but is significantly and independently predicted by the presence of severe traumatic brain injury and the failure of the pre-hospital care system. A low GCS, a head and neck injury, arrival by informal transport, and hypotension on admission are not just risk factors but are key indicators of impending death. These findings provide an evidence-based mandate for a dual-pronged strategy: a public health focus on preventing severe head injuries through rigorous enforcement of safety regulations, and a health system's focus on the urgent development of a formal EMS to bridge the fatal gap between the point of injury and the hospital. By identifying the patients at greatest risk, we can better direct our limited resources to save those who can be saved and, by identifying the systemic failures that kill them, we can advocate for the changes needed to build a more resilient trauma system for the future.

Recommendations

Based on the independent predictors identified through our multivariate analysis, we propose the following targeted recommendations:

1. Prioritize Prevention of Traumatic Brain Injury (TBI):

Aggressive Helmet Law Enforcement: Given that head injury is a primary driver of early death, governmental agencies, particularly the Federal Road Safety Corps (FRSC), must move from sporadic campaigns to a policy of zero-tolerance for non-helmet use by both motorcycle riders and passengers. This should be treated as a major public health intervention with the potential for massive impact.

Public Awareness Campaigns: Launch targeted media campaigns that explicitly link the failure to wear a helmet with the high probability of severe brain injury and early death, using local data and testimonials to increase resonance.

2. Develop a Data-Driven Emergency Medical Service (EMS):

Establish a Pre-hospital Care System: The strong predictive power of "informal transport" provides a clear mandate for government to fund and establish a formal EMS. This must include a centralized, toll-free dispatch number and a fleet of basic life support ambulances.

Focus Training on Key Predictors: EMS training for paramedics must prioritize skills that directly counteract the identified predictors: advanced airway management to protect against secondary brain injury (addressing low GCS) and aggressive pre-hospital hemorrhage control and fluid resuscitation to prevent hypotension before arrival.

Implement an Evidence-Based In-Hospital Triage Protocol:

Adopt a "Hig-Risk" Pathway: The A&E department should formalize a "Code Trauma" or "High-Risk" pathway. Any patient arriving with a GCS < 9, a suspected head injury, or hypotension should automatically trigger this pathway, ensuring immediate senior surgical review, pre-emptive notification of the operating theatre and ICU, and prioritization for imaging and blood products. This institutionalizes the findings of the predictive model.

Resource Allocation: Hospital administration must use this evidence to advocate for resource allocation that targets the biggest drivers of mortality. This includes ensuring a reliable supply of blood and investing in expanding ICU capacity with mechanical ventilators to manage severe TBI patients.

3. Strengthen Trauma Data and Research:

Prospective Trauma Registry: To overcome the limitations of this study, the hospital should transition to a prospective trauma registry. This will allow for the collection of more granular data, including the exact time from injury to hospital arrival, which is crucial for further refining predictive models and evaluating the impact of interventions.

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