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Predicting Hospital Length of Stay among Pediatric Patients in University of Maiduguri Teaching Hospital

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ABSTRACT

Hospital Length of Stay (LOS) is a critical metric in healthcare management, reflecting the duration a patient spends in a hospital facility. In pediatric trauma cases, the length of stay (LOS) is a crucial measure that reflects the complicated relationship between the severity of the injury, the effectiveness of treatment, and the overall healthcare journey. Understanding and predicting the factors influencing LOS in this specific population are crucial for optimizing patient care, resource allocation, and healthcare system planning. This study investigates Hospital Length of Stay (LOS) among Pediatric Trauma Patients with the primary goal of understanding and predicting the factors influencing the duration of hospitalization for this demographic. The cross-sectional study is based on pediatric trauma patients admitted to the Emergency Department of the University of Maiduguri Teaching Hospital, Borno State, Nigeria, in 2023. Data encompass demographic characteristics, injury details, and LOS for patients under 17 years, derived from hospital records. The RTS scoring system, incorporating Glasgow Coma Scale, Systolic Blood Pressure, and Respiratory Rate, is used to predict pediatric trauma patients' LOS. Multiple regression analysis is employed to identify factors influencing LOS. Results of the study outlines the scoring criteria for RTS parameters and presents regression analyses highlighting significant predictors of LOS, such as Injury Type and Breath/Minute. The model's robustness is confirmed by the Coefficient of Determination (R Square = 0.960), signifying its effectiveness in explaining and predicting LOS variability.

Keywords: Length of Stay, Revise Trauma Score, Trauma, Pediatric Patient, Multiple Regression

INTRODUCTION

Trauma is one of the major health issues that affects people of all ages, causes death, and leaves people disabled. Trauma was predicted as the third leading cause of death globally as of 2020. More than half of unintentional injury-related fatalities involve youngsters under the age of 19. One of the main health risks to children's lives is pediatric trauma. Children who have been harmed depend on proper treatment, precise triage, and successful urgent surgery to survive. Numerous injury scoring systems, including anatomic, physiologic, and combined scores, have been used to predict patient outcomes like mortality (Dobson, 2020).

For determining trauma severity, anatomic scoring systems like the Injury Severity Score (ISS), New Injury Severity Score (NISS), and Revised Trauma Score (RTS) are used. Before the patient arrives at the hospital and in the emergency room, good clinical decisions can be made using simple trauma grading systems. These scoring systems can also be applied to the timely provision of medical assistance and the early preparation of the patient for surgery. Among adult and pediatric trauma patients, the ISS and NISS

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scores have shown a correlation with interesting outcomes such as mortality and length of hospital stay (Hoeke *et al.,* 2021).

There is, however, little data comparing the anatomic and physiological grading systems in determining whether trauma patients may require surgical procedures. On the other hand, there is insufficient data to determine which method—ISS, NISS, or RTS—is better at identifying patients who will benefit from surgery (Garg *et al.,* 2022). However, studies have revealed that almost half of injured individuals pass away within the first 48 hours. As quickly as possible following damage, emergency surgery should be done in clinical practice. One of the most significant concerns with individuals who have experienced severe shock is the timing of hemostatic surgery (Lamb *et al.,* 2023).

Early surgery for patients who need it reduces 1-year mortality and length of stay (LOS) in the hospital, according to certain studies. Trauma is the second most common cause of death across the board in some nations, like Iran, so it is important to pay closer attention to traumatic patients in order to give patients who need them the proper care at the right time. RTS was evaluated as a physiologic trauma score in this study and compared to ISS and NISS in pediatric trauma patients' outcomes, including death (Yoo *et al.,* 2019).

Length of Stay (LOS) is defined as the number of days that a patient is hospitalized in a hospital (Yaghoubi *et al.,* 2011). Length of stay is one of the most important indicators in assessing hospital performance. A shorter stay can reduce the costs per discharge and shift care from inpatient to less expensive post-acute settings. It can lead to a greater readmission rate, better resource management, and more efficient services.

It is an actual parameter used in identifying the use of health resources (Lim, 2009). Predicting LOS for an inpatient is a challenging but essential task for the operational success of a hospital. Since hospitals are faced with severely limited resources, including beds to hold admitted patients, predicting LOS will be useful to hospital administrators for more effective hospital resource planning and management. There has been considerable interest in controlling hospital costs. Therefore, LOS is considered an important measure of healthcare utilization and a determinant of hospitalization costs. Clinical trials, electronic patient records, and computer-supported disease management will increasingly produce huge amounts of clinical data. LOS reflects physicians' decisions for patients to remain in hospital or not. The social problems, lack of services, lack of facilities, fault detection devices and other problems of a patient can increase his/her length of stay (Jack, 2019). It is difficult for a manager to predict LOS, but it is essential and useful. In addition, many hospitals cannot predict or measure future admission requests (Hachesu *et al.,* 2013). If the inpatient LOS is predicted efficiently, the planning and management of hospital resources can be greatly enhanced. The purpose is to identify patterns affecting LOS that may help reduce costs. In recent years, the term 'data mining' has been increasingly used in medical literature; however, has been little research on predicting length of stay (Robinson *et al.,* 2016).

Length of stay can be viewed through three different theoretical frameworks. This accounts, in part, for the different ways in which LOS data have been analyzed in the medical literature. First, LOS can be thought of as a continuous outcome (despite its discrete nature), hence the use of linear regression and log-transformed linear regression to analyze LOS in the clinical

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literature. Second, LOS can be treated as duration data; hence the use of survival models to model time to hospital separation. Furthermore, the event of interest can be seen as time to medically planned discharge, rather than time to hospital separation. Patients who die post-operatively, but prior to discharge can then be treated as censored observations. All that is known about their planned duration in hospital is that it was at least as long as the observed hospital stay. Third, LOS can be seen as a count of the number of days that the patient remained in hospital post-operatively. If one treats LOS as count data, then analyses using generalized linear models for count data are appropriate.

Statement of the Problem

Pediatric trauma represents a significant public health concern, with injuries being a leading cause of morbidity and mortality in children worldwide. Timely and accurate prediction of outcomes, such as mortality, hospital length of stay (LOS), and the need for surgery, is crucial for optimizing patient care, resource allocation, and healthcare system efficiency. Despite advancements in pediatric trauma care, there is a critical need for robust predictive models that can assist physicians in the early identification of high-risk patients and guide appropriate interventions.

Pediatric trauma cases exhibit considerable heterogeneity, ranging from minor injuries to life-threatening conditions. The unique physiological and anatomical characteristics of pediatric patients, coupled with diverse injury mechanisms, contribute to the complexity of predicting outcomes accurately. Understanding and incorporating these complexities into predictive models are imperative for enhancing their clinical utility. Current predictive models in pediatric trauma often focus on individual outcomes, such as mortality or LOS, without considering the interplay between these factors. The aim of the study is to Hospital Length of Stay among Pediatric Trauma Patients.

MATERIALS AND METHODS

This is a cross sectional study which is based on the pediatric trauma patients who were admitted in emergency Department of University of Maiduguri Teaching Hospital, Borno State, Nigeria in 2023. The data used are: demographic characteristics (age, sex), injury (type of injury, mechanism, breadth per minute, systolic blood pressure, Glasgow coma whether the patient has undergone surgery or not), and patient's Hospital Length of Stay. All traumatic patients under 17 years, who were referred to emergency Department of UMTH Maiduguri, Borno State in 2023 were included in sample. The required data was derived from the hospitals' record Departments to compute the RTS scoring systems for predicting the pediatric trauma patients' LOS. RTS is based on Glasgow Coma Scale (GCS), Systolic Blood Pressure and Respiratory Rate and it ranges from 0 to 7.8408. The formula of RTS is given by:

$$RTS = 0.9368 \times GCS\ Score + 0.7326 \times \log(SBP) + 0.2908 \times RR$$

Where

GCS Score is the numeric value obtained from the Glasgow Coma Scale assessment, SBP is the systolic blood pressure, and RR is the respiratory rate. Multiple regression analysis was also used to determine the factors that best predict Hospital Length of Stay.

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RESULTS

Characteristics of Pediatric Trauma Patients

The characteristics of the trauma patients such as age of patients, gender, injury area and mechanism of injury were presented in table 1:

Table 1: Demographic Characteristics of the Respondents

S/N	Characteristics	Age Group	Frequency	Percent
1.	Age Group	Less than 4 years	1	3.6%
		4-7 years	10	35.7%
		8-11 years	10	35.7%
		12-15 years	6	21.4%
		greater than 15 years	1	3.6%
2.	Gender	Male	17	60.7%
		Female	11	39.3%
3.	Mechanism	Road Traffic Accident	13	46.4%
		Fall From Height	4	14.3%
		Assault	8	28.6%
		Fighting	1	3.6%
		Arrow Shoot	2	7.1%
4.	Injury Area	Back	1	3.57%
		Bruises	3	10.71%
		Hand	10	35.71%
		Head	7	25.00%
		Leg	5	17.86%
		Neck	2	7.14%

Table 1 outlines the distribution of trauma patients across distinct age groups, providing insights into the demographic composition of the dataset.The majority of trauma cases are found in the 4-7 years and 8-11 years age categories, each comprising 35.7% of the total sample. In contrast, the 12-15 years age range contributes to 21.4% of the patients, while those less than 4 years and greater than 15 years represent smaller proportions at 3.6% each. With one patient each, these extreme age groups, together with the intermediate 12-15 years range, collectively form the remaining segments of the dataset. Among the total of 28 individuals, 17 are male, representing 60.7% of the sample indicating the prevalence of males in the dataset. In contrast, females account for 11 individuals, constituting 39.3% of the total. The predominant cause of trauma is Road Traffic Accidents (RTA), constituting 46.4% of cases with 13 individuals affected. Falls from height follow as the second most common mechanism, contributing to 14.3% of cases involving 4 individuals. Assault emerges as a substantial cause, accounting for 28.6% of cases with 8 individuals affected. Fighting represents a less frequent mechanism, contributing to 3.6% of cases, involving only 1 individual. Arrow Shoot is the least common cause, contributing to 7.1% of cases with 2 individuals affected. Regarding the injury area, hand injuries are the most prevalent, constituting 35.71% of the total injuries with a frequency of 10. The head follows closely behind, representing 25.00% of injuries with a frequency of 7. Bruises are moderately common, making up 10.71% of injuries with a frequency of 3. Other injury areas include the leg 5(17.86%), neck 2(7.14%) and the back, which has the lowest frequency at 3.57%, with only one reported injury.

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Table 2: Scoring Criteria for Revised Trauma Assessment Parameters

S/N	Clinical Parameter	Category	Score	Coefficient
1.	Respiratory Rate (Breaths per Minutes)	>29	4	0.707
		10-29	3	
		06-09	2	
		01-05	1	
		0	0	
2.	Systolic Blood Pressure	>89	4	0.832
		76-89	3	
		50-75	2	
		01-49	1	
		0	0	
3.	Glasgow Coma Scale	13-15	4	0.601
		09-12	3	
		06-08	2	
		04-05	1	
		3	0	

Table 2 provided the calculation of the Revised Trauma Score (RTS) (which is a scoring system that helps medical practitioners in assessing the severity of trauma in patients to quickly evaluate the patient's condition and to decide the treatment priorities required for that particular patient) based on three key clinical parameters: respiratory rate, systolic blood pressure, and Glasgow Coma Scale. Each parameter is categorized into specific ranges, and scores are assigned accordingly. For respiratory rate, higher scores are given for lower rates, with a maximum score of 4 for rates greater than 29 breaths per minute. Systolic blood pressure follows a similar pattern, with higher scores for higher blood pressure values, reaching a maximum score of 4 for values greater than 89 mmHg. The Glasgow Coma Scale scores are assigned based on the patient's level of consciousness, with higher scores for more responsive patients, reaching a maximum score of 4 for a GCS of 13-15. Coefficients accompany each score, reflecting the relative importance of each parameter in predicting trauma severity. These coefficients, derived from statistical analyses, determine the weight of each parameter in the overall RTS calculation.

Table 3: Regression Analysis on Hospital Length of Study among Pediatric Patients

Sources of Variation	Sum of Squares	df	Mean Square	F	p-value
Regression	10123.716	7	1446.245	67.899	0.000
Residual	425.99800	20	21.3000		
Total	10549.714	27			

Table 3 presented the results of a regression analysis on hospital length of stay among pediatric patients. The F-statistic is 67.899, suggesting that the regression model significantly explains variability in the dependent variable. The p-value of 0.000 indicated that, the model as a whole is statistical significance of the regression model.

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Table 4: Regression Coefficient

Variables	Unstandardized Coefficient		Std. Coefficient	t	p-value
	B	S.E.	Beta		
(Constant)	-48.091	9.937		-4.840	0.000
Gender	1.608	1.963	0.040	0.819	0.422
Age	0.290	0.303	0.051	0.959	0.349
Injury Type	9.725	2.889	0.604	3.366	0.003
Mechanism	-0.189	0.746	-0.012	-0.253	0.803
Breath/Minute	4.329	0.982	0.866	4.408	0.000
Systolic Blood Pressure	-0.233	0.124	-0.194	-1.885	0.004
Glasgow Coma	1.260	0.858	0.282	1.468	0.158
Surgery	1.527	14.401	0.024	0.106	0.917

Table 4 presented the regression coefficients of the model predicting hospital length of stay among pediatric patients. Among the predictor variables, Injury Type has unstandardized coefficient of 9.725, suggesting a significant impact on length of stay. Additionally, Breath/Minute shows a significant positive effect (coefficient = 4.329, p-value = 0.000), indicating that an increase in breaths per minute is associated with a higher predicted length of stay. Systolic Blood Pressure has a negative coefficient (-0.233, p-value = 0.004), suggesting a negative relationship with length of stay. Other variables, such as Gender, Age, Mechanism, Glasgow Coma, and Surgery, do not show statistically significant associations with length of stay based on their respective p-values. The correlation coefficient (R) between observed and predicted LOS is 0.980, signifying a robust positive linear relationship. The Coefficient of Determination (R Square) is 0.960, indicating that around 96% of the variability in LOS is accounted for by the model.

CONCLUSION

In conclusion, this study has investigated the intricateness of hospital length of stay (LOS) among pediatric trauma patients, seeking to determine the factors influencing the length of hospitalization among pediatric patients Through comprehensive analyses of admission characteristics, scoring systems like the Revised Trauma Score (RTS), and regression models, the study revealed the demographic characteristics and injury mechanisms presented in our findings which shed light on patterns and prevalence within the pediatric trauma patient unit. The identified predictors, such as Injury Type and Breath/Minute, contribute to our understanding of the determinants of LOS. The robustness of the regression model, as evidenced by high correlation and Coefficient of Determination, highlights its efficacy in explaining and predicting variability in LOS. These findings hold significant implications for healthcare professionals, informing clinical decision-making, resource allocation, and patient care strategies tailored to the unique needs of pediatric trauma cases.

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