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The Pattern and Outcome of Severe Trauma Using the Trauma and Injury Severity Score (TRISS) Methodology in a Dedicated Trauma Centre in Nigeria

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Authors' contributions

Both the authors made substantial contributions in the study design, implementation and write up. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Trauma is a leading cause of mortality and a major contributor of disability as measured by Disability Adjusted Life years lost to inury in various parts of the world. Pattern of injuries and quality of care given to trauma patients differ in various parts of the world. The quality of care given in a particular centre can be assessed and compared with that from other centres by utilising an established standard method of assessment such as the Trauma Research and Injury Severity Score (TRISS). In this observational study, the pattern of presentation of severe trauma and quality of care given to severely injured patients at a trauma centre in Nigeria is evaluated using the TRISS methodology. The findings are compared with those reported from other countries.

Methods: Data required for trauma demographics and TRISS calculation was extracted from the trauma registry of Teme Hospital, Port Harcourt Nigeria and analysed. Trauma demographics, type of care and the probability of survival of included patients were evaluated using the TRISS methodology.

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Results: Seven hundred and sixty two patients were seen with severe trauma but 746 patients had enough information required for analysis. Most of the trauma patients seen at the centre were males with a mean age ± standard deviation of 28.5 ± 11.3 years. Road traffic collision was the commonest cause of injury (41.2%) but gunshot injuries contributed a sizable number of the injuries (36.7%). The median Injury Severity Score (ISS) was 20 (range = 16 – 75) while the mean Revised Trauma Score (RTS) ± SD was 7.1 ± 1.3. The median probability of survival was 0.98 with a range between 0.00 and 0.99. The M, Z, and W statistics were 0.87, - 8.5, and -7.0 respectively. From TRISS analysis, 38 patients (5.1%) were expected to die but the observed mortality was 12.4%. Most mortality was related to severe head injuries.
Conclusion: Trauma burden is an identified problem at Teme Hospital Nigeria. Severe trauma constitutes only 12% of trauma cases seen at the centre but it is the main contributor to trauma deaths. The observed mortality is higher than the expected as calculated using TRISS methodology and this call for improvement in the quality of care at the centre.

Keywords: Severe trauma; injury severity score; TRISS methodology; mortality; outcome.

1. INTRODUCTION

Trauma is the leading cause of death in patients below the age of 45 years [1,2,3]. In the developed world trauma is next to cancer and cardio vascular diseases as the major causes of death [4,5]. In the developing world, trauma follows infectious diseases and malnutrition as the leading cause of death in children [6]. Apart from being a major cause of mortality, trauma is a leading cause of morbidity and contributes immensely to reduced quality of life measured by the disability adjusted life years (DALYs) per annum. Trauma has been described as a neglected disease of modern society [7,8] with a reported mortality of 7% to 45 % for the severely injured [9,10]. The quality of care the severely injured patient receives determines the outcome of the trauma incident and reflects the level of medical practice in the country. Because of variability in the quality of care and outcome of treatment of severely injured patients, the American college of Surgeons put forward the Advanced Trauma Life Support (ATLS) protocol as a standard for the early treatment of the severely injured [11]. This protocol has been adopted by most countries although some of its principles are currently being challenged.

Trauma is usually associated with huge cost to the patient, the family and the society. In most instances, the direct cost of trauma such as mortality, direct cost of treatment and loss of wages from prolonged length of hospital stay (LOS) may be quantifiable. The indirect cost of trauma resulting from physical disability, loss of time at work, adverse psychological, social and economic consequences of trauma may be difficult to quantify.

1.1 Trauma Scoring Systems and Outcome

A trauma scoring system converts the severity of injury to numbers, which helps health care providers and trauma care personnel assess quality assurance and quality control programmes [12,13,10]. For the process to be useful, the calculated numerical figures should then be translated into clinical relevance. This is one of the advantages of the TRISS methodology. Scoring methods most commonly used include the TRISS and A Severity Characterization of Trauma (ASCOT) [14,15]. The TRISS methodology utilizes logistic regression analysis to develop weighted coefficients for the Revised Trauma Score (RTS) [16], which is based on physiological parameters as blood pressure, respiratory rate and the Glasgow Coma Score (GCS) [17], and the Injury Severity Score (ISS) [12] derived from Abbreviated Injury Scale (AIS) [18]. The AIS anatomically categorises the injury based on location and severity. The TRISS methodology has been flawed because of several reasons. TRISS focuses on mortality as the primary outcome measure to assess the quality of care given to trauma patients but in real clinical situations the associated disability resulting from improper care may be enormous. Currently there is no universally accepted scoring system that incorporates characteristics of injuries, population differences, care processes and rehabilitation processes [10]. The TRISS methodology despite identified flaws, still remains a good scoring method and the most widely used.

Using TRISS methodology, the American College of Surgeons designed the Major Trauma Outcome Study (MTOS) to provide data required

to establish national norms for trauma care [16]. The MTOS was the first large, multi-institutional data base used to derive TRISS norms. To assess Trauma outcome of a particular unit, institution or registry, the M Z and the W statistics are determined and compared with MTOS data set. The M Statistics is used to determine the injury severity match between the test group and the MTOS patients [16]. An M statistics greater than 0.88 suggests a good match while that below 0.88 is a poor match and invalidates the calculated value of Z and W statistics [14,19]. The Z statistics compares outcome performance and represents a test of significance between the expected survivors as calculated from the Ps values of more than 0.50 and the actual survivors from the study groups. Figure less than +1.96 and greater than –1.96 is accepted as non-significant difference [14,19]. The W statistics is used to determine the actual number of patients that die or survive as predicted by TRISS per 100 number of patient treated by the assessed unit. This can be used to determine the clinical relevance of the TRISS.

2. METHODOLOGY

Study was approved by the Research and Ethical Committee of the hospital according to Helsinki Declaration 1975 (Ethical Committee Approval number: TH/MSF/PHC/HERC/06/03). Since this was a data based study and no direct intervention on the patients, consent to participate was also waived however the patients' anonymity and confidentiality was ensured throughout the study. Data were collated from the trauma registry which was prospectively developed at Teme Hospital, Nigeria from January 1, 2007 to December 31, 2007. Data relating to trauma demography, cause of injury, injury severity, and outcome was extracted. Information required to calculate TRISS such as the abbreviated injury scale (AIS) codes, vital signs; Glasgow Coma Score (GCS), was collated.

The appropriate sample size required to identify statistical significant differences, at a confidence level of 95%, alpha of 0.05 and (+/- 5) Confidence Interval (CI), was determine as 462 using the National Statistical Service statistical software freely available online [23]. Severe injury is defined as ISS higher than 15.

2.1 Inclusion Criteria

Data of all patients admitted during the period under evaluation with severe injury was evaluated, but only data from patients with enough information required to determine TRISS was analysed for probability of survival (Ps).

2.2 Exclusion Criteria

Cases with missing data required for calculation of TRISS were excluded from analysis.

2.3 Outcome Assessment

Primary outcome assessment was the number of patients that survived following treatment at the centre as compared to the number that was expected to die as predicted by TRISS methodology. Secondary outcome assessment was determined by the length of stay (LOS) in the hospital, the duration of soft tissue wound healing and the condition of the patients at the time of discharge from the hospital. The condition of patients at the time of discharge was stratified into the following categories: good and satisfactory, fair, poor, discharge against medical advice and transferred.

2.4 Statistics

Descriptive statistics such as mean and standard deviation, median and inter quartile range were determined for continuous variables whereas categorical variables are presented as proportions and percentages. Inferential statistics with Pearson's Chi square (X^2) and Fischer's exact test were used to tests for significance for observed differences for categorical variables while analysis of variance ANOVA was used as the test of significance for differences observed in variables with multiple subgroups. Student's t test was used to tests for significance for observed differences in the means of numerical variables.

The Injury Severity Score (ISS) of each patient was calculated based on the pattern described by Baker et al [12] from the Abbreviated Injury Score (AIS) recorded of the three body regions with the most severe injury [18]. Using TRISS methodology the probability of patient survival (*Ps*) from the combination of both anatomical, physiological scores (ISS and RTS, respectively) and patients' reserve (Age and Injury type) was determined using logarithmic regression equation as described by Boyd et al. [14,16,20].

$Ps = 1/ (1+e^{-b})$, where $b = b0 + b1(RTS) + b2(ISS) + b3(Age\ Score)$

RTS and ISS were calculated as above and Age Score is either 0 if patient <55 years old or 1 if 55 and over. The coefficients b0 – b3 based on the type of trauma were used for calculation.

Coefficient	Blunt trauma or age <15 years	Penetrating trauma
b0	-0.4499	-2.5355
b1	0.8085	0.9934
b2	-0.0835	-0.0651
b3	-1.7430	-1.1360

The M, Z and W statistics was determined based on the pattern described by the MTOS in America [16].

3. RESULTS

The result shows that between 1 January 2007 and 31 December 2007, a total of 762 patients with ISS of 16 and above were seen at the Hospital. This figure represents 12.3% of the total number of patients with trauma seen at the hospital (n = 6180) and 36.3% (n= 2100) of the patients that required hospitalisation because of the severity of their injury. Of the identified number, 16 patients had incomplete data required for determination of ISS or RTS which are required to determine the Ps. Such patients with incomplete data were excluded from outcome analysis. Seven hundred and forty six (746) cases were analysed for this study.

3.1 Age Distribution

The bulk of the patients were in the age range of 21years and 30 years (51.6%), followed by those between the ages of 31years and 40 years. The extremes of age were the least affected. The Mean age ± SD was 28.5 years ± 11.3 years. The median age was 27 while the age of the patients ranged from 2 years to 95 years (Table 1). The number of patients within the age group 21-30 years was statistically significantly higher, compared to those with other age groups, χ^2 = 880.40, *P*-value = 0.001.

3.2 Cause of Injury

Most of the injuries were caused by road traffic collisions (RTA) (n=307{41.2%}), this is followed closely by gunshot wounds (GSW) (n = 274{36.7%}). Injuries from assault constituted 12.5% of the cases (n = 93), while injuries from falls and domestic accidents were seen in 25 (3.4%) and 23(3.1%) respectively (Table 2). Injuries arising from RTA were statistically significantly higher compared to other causes of Injury, [χ^2 = 1594.14, *P*-value = (0.001)].

Table 1. Age distribution

Age range	Frequency	%
0-10 years	27	3.6
11-20 years	110	14.7
21-30 years	385	51.6
31-40 years	137	18.4
41-50 years	57	7.6
51 years and above	30	4.0
Total	746	100.0

χ^2 = 880.40, P-value = 0.001

Table 2. Cause of injury

Cause	Nos.	%
Assault	93	12.5
Blast	8	1.1
Boat accident	3	0.4
Burns	5	0.7
Domestic accident	23	3.1
Fall	25	3.4
GSW	274	36.7
Industrial accident	8	1.1
RTA	307	41.2
Total	746	100.0

[χ^2 = 1594.14, P-value = (0.001)]

3.3 Distribution of Injury Severity Score (ISS)

The mean injury severity score was 23.6 ± 10.5, while the median ISS was 20 with a range between 16 and 75. The distribution of the ISS shows that most of the patients had ISS between 16 and 25 (n = 587 {78.7%}). Only 21.3% had ISS greater than 25 of which 5% (n = 36) had ISS greater than 45 (Table 3). This distribution was statistically significant compared to other ISS Range [χ^2 (p-value) = 1535.98 (0.001)].

Table 3. Distribution of injury severity score

ISS range	Nos.	%
16 to 25	587	78.7
25 to 35	78	10.5
36 to 45	45	6.0
Greater than 45	36	4.8
Total	746	100.0

[χ^2 = 1535.98, (p-value) = (0.001)]

3.4 Distribution of Probability of Survival (Ps) using TRISS

The mean Ps was 0.90 ± 0.19, while the median Ps was 0.98 with a range between 0.00 and 0.99. The distribution of Ps shows that 71% (n = 528) of the patients had Ps between 0.96 – 1.0, while only 19 patients (2.5%) had a Ps 0f 0 – 0.25 (Table 4).

3.5 Average Length of Hospitalization (LOH)

The mean duration of hospitalisation was19 days, while the median duration is 7 days (Range = 0 to 231 days). The distribution of length of hospitalisation shows that about 50% (n=372) of the patients were discharged from admission within the first week while up to 15% (n= 116) patients were hospitalised for more than 4 weeks (Fig. 1).

3.6 Condition of the Patients at Time of Discharge

Only 45.8 % (n = 342) of the patients had good or satisfactory result at the time of their discharge from the hospital or the fracture clinic. Ninety patients (12.4%) died in the hospital while 55 patients (7.4%) had poor result at discharge from the hospital. Twenty four patients (3.2%) of the patients discharged themselves from the hospital against medical advice, whereas 4 patients absconded from hospital while receiving treatment (Table 5).

3.7 Relationship between ISS and the Condition at Discharge

Over 61% (n = 485) of the patients within the ISS range between 16 and 25 had a good or fair outcome as at time of discharge from the hospital whereas only 4% (n = 37) of patients in the same ISS range died. On the contrary, 23 out of the 36 patients with ISS greater than 45 died. There is statistical difference between the mean ISS of those that survive (22) and those that died (36), $p < 0.05$.

3.8 Mortality by Body Location of Main Injury

Head injury was the highest contributor to overall mortality (4.2%) and presented the highest case fatality rate (18%). Injuries to the extremity contributed 3.6% of the overall mortality and 9.3% case fatality. There was no mortality recorded from injuries to the face.

M Statistics:

M statistics is calculated by the summation of the lesser of the Ps value between the study group and the MTOS baseline group i.e. M = S1+ S2 + S3 + S4 + S5 + S6.

S = a or b depending which is lesser. M statistics = 0.87

Z Statistics:

$Z = (A – E) / \sqrt{\Sigma Pi (1 – Pi)}$

Where

A = Actual survivors
E = Expected survivors based on Ps value > 0.50
Pi = Predicted Ps of each patient from the baseline.
Z = - 8.45

W Statistics:

$W = (A – E) / (n/100)$

A = Actual number of survivors
E = Expected number of survivors based on Ps > 0.50
N = Number of patients analysed.

W = -7.0

Table 4. Distribution of Ps values

Ps range	Nos.	%	Ps (study group) a	Ps (MTOS base line) b	M = Σ (S1 –S6)S*
0 – 0.25	19	2.5	0.025	0.036	S1 = 0.025
0.26 – 0.50	18	2.4	0.024	0.017	S2 = 0.017
0.51 – 0.75	50	6.7	0.067	0.029	S3 = 0.029
0.76 – 0.90	64	8.6	0.086	0.044	S4 = 0.044
0.91 – 0.95	67	9.0	0.090	0.045	S5 = 0.045
0.96 – 1.00	528	70.8	0.708	0.828	S6 = 0.708
Total	746	100.0	100.0	100	M = 0.868

**S = a or b depending which is smaller*

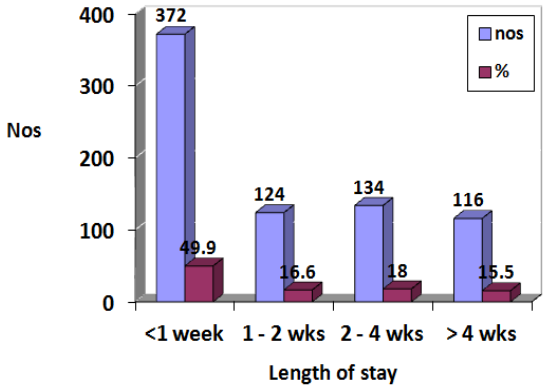

Fig. 1. Length of hospitalization

Table 5. Condition of patient at discharge

	Condition at discharge	Nos.	%
Survived	Absconded	4	0.5
	DAMA*	24	3.2
	Fair	205	27.5
	Good	342	45.8
	Poor	55	7.4
	Transferred	26	3.5
Dead		90	12.1
	Total	746	100.0

**DAMA = Discharge against medical advice*

4. DISCUSSION

Trauma is a leading cause of death among people aged below 45 years worldwide [2,3]. In developing countries like Nigeria, trauma is a leading contributor of increased mortality rates [6,21]. Among the persons that survive the trauma event a significant number are left disabled resulting from poorly treated or non treated injuries [22,6,21]. These groups contribute to the high levels of DALYs seen in the developing countries [6,21]. This study shows that the total number of patients seen at the Hospital during the period under study was 6180. Of these, 43% (n = 2100) had injuries severe enough to require hospitalization. Seven hundred and sixty two of these patients (12.3%) had ISS greater than 15 and they were the patients recruited for the study. This figure is similar to that reported by Yates et al. in the UK MTOS which showed that 17% of patients had ISS more than 15 [22]. A later report by Christensen et al on analysis of outcome and cost of blunt trauma in England and Wales shows that 33% of patients had ISS more than 16 [23]. The recorded number of patients with severe trauma in this study is comparatively high considering the size and level of the hospital when in relation to the criteria by the American college of Surgeons [11].

The mean age incidence of 28 years ± 11.3 years observed in this study is similar to that from Kenya (31 yrs) and other developing countries such as 31 years in India [24], 28 years in Iran [25], 33 years in Pakistan [26]. Obalum and colleagues had observed a mean age incidence of 32.2 years from Nigeria [27] while Sholagberu et al. had reported a mean age incidence of 36.3 years for trauma deaths in Nigeria [28]. This finding is indicative that trauma and indeed severe trauma remains the disease of the young active males in their prime.

The commonest cause of injury observed in this study was road traffic collisions (41.2%), followed closely by gunshot injuries (36.7%). Traffic related injury was the commonest injury reported in most studies across the globe [16,24,25,27, 28]. Motorcyclist locally called *Okada*, who are often not properly trained on the skill of motorcycle riding, contributed to a great extent the number of injuries in this study. The role of road traffic accidents in the aetiology of severe injuries may not be unconnected to the increasing number of vehicles on the roads, poor road networks, inadequate road safety legislation [29] as well as increasing use of alcohol by young road users [30].

A special observation from this study is the role of GSW as a cause of severe injury. The observed figure of 36.7% appears to be among the highest reported in any series in a country not involved in a war. This figure is different from those from earlier reports from Nigeria [28,31,32,33] as well as that from the US MOTS [16]. The reason for this may be related to the upsurge in the incidence in militancy and armed agitation recorded in the Niger Delta, Nigeria during the period of the study.

The mean ISS ± SD of 23.6 ± 10.5 and the median ISS of 20 with range of 16 to 75 indicate that the bulk of the patients had moderate severe injuries. Only about 21.3% of the patients had ISS higher than 25. The ISS distribution is similar to that observed in earlier studies from Nigeria by [28,31,32,] and that from France by Orliaguate et al. [34].

The distribution of the calculated probability of survival (Ps) using the MTOS regression

equation and coefficients shows that the mean Ps ± SD was 0.90 ± 0.19 (median Ps was 0.98 and range = {0.00 and 0.99}) and that the bulk of the patients (70.8%) had Ps value of 0.96 ± 1.0. The observed M statistics of 0.87 shows a significant variation in the characteristics between the patients in this study and those in the MTOS (US). This difference in M statistics invalidates the subsequent analysis of Z and W statistics in this study using the criteria of the MTOS US [14,15]. However, the MTOS study included patients with ISS lower than 15.

The observed M statistics of 0.87 in this study despite including only severely injured patients is in keeping with the observation of Joosse et al. who reported M statistics greater than 0.88 in studies from the developing countries of Asia [35]. The results of trauma outcome published by TARN showed that M and Z statistics of two major hospitals in Wales (Moriston Hospital, and Cardiff Hospital) and Royal London Hospital in England were 0.83, 2.8; 0.86, 1.8; and 0.79, 2.1 respectively. These figures indicate that the quality of care in England and Wales compared better than that observed in this study and even compared better than that reported by the MTOS from the US.

The median length of hospitalization of 7 days (range 0 – 231days) is comparable to 9 days reported by Christensen et al. [23] from the UK. The American NTDB report observed an average length of hospitalisation of 8.9 days for patients within an ISS range of 16 to 24 and 13.6 days for ISS higher than 24 [36]. The length of hospitalization of more than 4 weeks in up to 15% of the patients would impact significantly on the cost of care for these groups of patients who are already living in a poverty challenged economy. When the length of stay was related to the ISS, it was observed that the length of stay positively correlated with increasing ISS.

A review of the condition of the patients at discharge from the hospital revealed that up to 73% of the patients treated had good and fair outcome whereas 90 patients (12.4%) died and 62 patients had poor result. Statistical analysis shows that there is a significant difference between the patients that had good or fair outcome and those that had poor outcome or died ($p < 0.05$).

Despite that this study included patients with higher ISS, the mortality (12.4%) observed in this study was lower than the 31% and 42% from earlier results published from Nigeria [32,37]. The observed mortality compared better than 21% reported from India [24], (29%) from Indonesia [35] and 15% reported by from Hong Kong [38]. The reason for the observed mortality may be related to the fact that treatment in the facility where this study was undertaken was free as such funds did not delay treatment at the centre as may be the case in most other studies from other centres in the developing countries.

The observed Z and W statistics of (–8.4) and (-7.0) respectively for the expected and actual survivors of treated patients show that the result is significantly different from that of MTOS US [16] and those published by NTARN UK from Moriston hospital (W= 2.8), Cardiff Hospital (W= 1.8) and Royal London Hospital (W = 2.1). The result however compares better to the Z and W statistics of (-14.16), (-10.42) respectively reported from India [24]. The difference between the observed mortality (n = 90) and the expected mortality (n = 38) based on the TRISS methodology, cast doubt on the ability of TRISS to accurately predict survivability of severely injured patients. Various authors had shown TRISS to be a poor predictor of survival following low level falls and injuries resulting from motorcycle or pedestrian crashes [39] and in this study a good number of the injuries resulted from motorcycle related crashes and falls.

5. CONCLUSION

The burden of trauma is universal. Mortality and morbidity from trauma can be high especially if appropriate care is not provided. Severe injuries constitute about 12% of trauma seen in this study and the active young male between the ages of 15 years and 40 years are the most affected. Road Traffic related injuries remain the major cause of trauma observed at the centre. Gunshot injuries also contributed a sizable proportion of the trauma burden. Despite that the average Ps for the severely injured patients being 0.91, the mortality of 12.4% observed calls for improvement in the quality of care given at the centre.

The W statistic indicates that for every 100 persons treated of severe injury at the hospital, up to 7 persons died unexpectedly. The Z and W statistics show that there is a significant difference between the actual patient that survived and those predicted to survive based on the criteria from the MTOS in the US. This study also highlights the benefits and the need for a

local and regional trauma registry which will provide information on trauma incidence and outcome in the region.

ETHICS APPROVAL

Study was approved by the Research and Ethical Review Committee of International Centre for Advanced Medical Care and Development (ICAMCAD) who are the developers of the registry.

CONSENT

It is not applicable.

AVAILABILITY OF DATA AND MATERIAL

The data that support the findings of this study are available from the authority of International Centre for Advanced Medical Care and Development (ICAMCAD) but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the authority of International Centre for Advanced Medical Care and Development.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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