ROAD TRAFFIC TRAUMA OUTCOME AT KENYATTA NATIONAL HOSPITAL: COMPARISON OF THE TRAUMA AND INJURY SEVERITY SCORE (TRISS) AND THE TRAUMA MORTALITY PREDICTION MODEL (TMPM).

PROPOSAL FOR DISSERTATION AS PART FULFILMENT OF THE REQUIREMENTS OF THE UNIVERSITY OF NAIROBI FOR AWARD OF THE DEGREE OF MASTER OF MEDICINE (MMED) IN GENERAL SURGERY

February 2012

By

Arnold Adili Wobenjo

Declaration

Candidate's declaration:

I hereby declare that this study is my original work and has not been presented at any other university.

Signed...Date 23/11/12 ....

Dr. Wobenjo A. Adili

MB ChB (Moi).

Registration number: H58/71036/07

Supervisors' declaration:

This dissertation has been submitted for examination with my approval as University Supervisor.

Signed... Date.......23/11/12

Professor Saidi Hassan

BSc (UoN), MBChB (UoN) MMed (UoN), FACS

Department of Human Anatomy,

University of Nairobi

Acknowledgements

I would like to thank my supervisor Prof. Saidi for support from the inception of the study to reading the manuscript. His suggestions, comments and criticism have been invaluable.

I would also like to thank my research assistant Mr. Protus and my fellow postgraduate students in general surgery and orthopaedics for their moral support.

And to all those that participated in the success of the study I am sincerely grateful.

List of abbreviations

AIS	Abbreviated Injury Scale
DALYs	Disability Adjusted Life Years
H-L	Hosmer-Lemeshow statistic
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
ISS	Injury Severity Score
KNH	Kenyatta National Hospital
MARC	Model Averaged Regression Coefficient
MTOS	Major Trauma Outcome Study
NSQIP	National Surgical Quality Improvement Program
NTDB	National Trauma Data Bank
QI	Quality Improvement
ROC	Receiver Operating curve
RTS	Revised trauma score
STATA	Statistics/Data analysis
TMPM	Trauma Mortality Prediction Model
TRISS	Trauma Injury Severity Score
WHO	World Health Organization

Table of Contents

Table of figures

Summary

Background: Road traffic trauma is an increasing problem whose management in Kenya has been suboptimal. The goal of improving health care quality and trauma care in particular, rely on the ability to accurately measure health care outcomes. Achieving this goal requires the use of validated risk adjustment models for benchmarking of hospital performance.

Objectives: Comparison of the trauma and injury severity score (TRISS) methodology and the trauma mortality prediction model (TMPM) in evaluation of the road traffic trauma outcomes at Kenyatta national hospital.

Design: Prospective descriptive study

Material and methods: Patients presenting at the accident and emergency of Kenyatta national hospital after road traffic trauma were prospectively studied. Data was collected on demographic factors, respiratory rate, blood pressure and Glasgow coma scale, injuries sustained and emergency disposition.

Data management/Analysis: Mortality was the dependent variable. The independent variables (TRISS AND TMPM models) were assessed by measures of discrimination (using the area under ROC) and calibration (using the Hosmer-Lemeshow [H-L] statistic). STATA 12 was used for analysis. In all analyses, confidence interval and significance level of *P* value were 95% and 0.05 respectively.

Results: A total of 210 patients with road traffic injuries were recruited into the study. Male comprised 78.6% of the study cohort. The mean age was 33.1 yrs (range 15-63). The means

systolic blood pressure was 115.5 (61-210), respiratory rate 20.9 (8-34) and Glasgow coma scale 13.7 (3-15). The mean injury severity score was 10.37 (2-34). Most patients (71.9%) were directly admitted in the orthopedic wards from the accident and emergency unit. TRISS exhibited significantly better discrimination (TRISS ROC= 0.786 (0.610 - 0.961); TMPM-ICD 9= 0.641 (0.479 - 0.802)) and calibration (TRISS H-L = 0.38; TMPM-ICD 9 H-L =16.9) compared to TMPM-ICD 9.

Conclusion: TRISS outperformed TMPM-ICD 9 for evaluation of road traffic casualties at KNH and should be used for benchmarking road traffic trauma outcomes at Kenyatta National hospital.

Introduction

Road traffic injuries are currently ranked 9th globally among the leading causes of disease burden, in terms of disability adjusted life years (DALYs) lost. The world health organization (WHO) predicts that road traffic accidents will rise from the ninth leading burden of disease to the third leading cause in 2020 worldwide (1). The developing world is disproportionately represented in this burden with more than 85% of the world's road fatalities and about 90% of the disability adjusted life years lost worldwide due to road traffic injuries occur in developing countries (1, 2).

In Kenya, there has been a five-fold increase in nonfatal casualties and a 4-5 fold increase fatalities due to road traffic crashes in a period of 30 years (3). Casualties affected by road traffic injuries account for between 45-60% of all surgical admissions in surgical wards in Kenya (3, 4). At Kenyatta national hospital (KNH), road traffic injuries were noted to account for 15% of all surgical admissions (5). Even though the overall mortality due to road traffic trauma at KNH is 6% (5), the mortality due to major trauma, injury severity score (ISS) >15 ranges from 35.6% (5) to 44% (6).

Data on the hospital management of trauma in East Africa is limited. Epidemiological studies and reports published from hospitals highlight that trauma due to road traffic accidents to be an increasing problem, with major mortality, morbidity and disability that is exerting a huge burden on the economy and health care system (7). Trauma is a devastating problem, beginning to rival infections and parasitic diseases in the toll they take of young lives in East Africa. More so, it has been claimed that someone involved in an accident in Kenya is nine times as likely to die as in the United States (8). Hence the need for hospitals to be committed to improving the outcome of trauma patients (7).

Donabedian defines the quality level of a service as having three essential aspects: the structure, the process and the outcome (9). Evaluating processes of care and outcomes of injured patients are important if improvements in the quality of care delivered to injured patients are to be accomplished.

Improving health care quality requires accurate measurement of health care outcomes. Achieving this goal for trauma patients requires the use of validated risk-adjustment models that can be used to adjust for differences in patient case mix and severity-of-disease across health institutions whose performance is being benchmarked(10). Risk-adjustment models makes it possible to compare the performance of different hospitals that have different patient case mixes. Comparing crude mortality rates across hospitals without first adjusting for differences in patient case mix is a meaningless exercise since differences in observed mortality rates may simply reflect the differences in patient populations across hospitals (10, 11).

Accurately specifying injury severity is a critical component of any injury severity model. Injury scores are based on 1 of the following 2 coding schemes: the Abbreviated Injury Score (AIS) or the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes(Appendix 1). (12) The study aims to compare AIS based approach TRISS (Trauma Injury Severity Score) versus ICD 9-CM based approach TMPM-ICD 9 (Trauma Mortality Prediction

Model based on ICD 9) in evaluation road traffic trauma outcome. These prediction models are designed to make it possible to compare a hospital's observed outcomes and expected outcomes to assess quality of care (11).

Literature review

Improving the quality of trauma care and decreasing the pain and suffering inflicted by injury on the population is the goal of all of those who care for trauma patients. The drive to improve the quality of care of trauma patients is recognized in many areas, and trauma centers, in particular, are extending their efforts in the area of quality improvement (QI) (13). The methods that have been successful for trauma QI include: morbidity and mortality conferences, panel reviews of preventable deaths, tracking of audit filters (including complications and sentinel events), and statistical methods (including calculation of risk-adjusted mortality rates) (14).

Trauma mortality

Mortality review as an outcome measure for evaluating the care of injured individuals predates virtually every other approach to improving trauma care. Trauma systems and surgeons have always used mortality assessment as the fundamental element in programs designed to evaluate current practice and to push for further development of an organized approach to trauma care (15).

In the classic description trauma deaths have a tri-modal distribution (16). *Immediate deaths* occur immediately after trauma and are due to non-salvageable injuries like rupture of the heart or great vessels. *Early deaths* occur during the first six hours and are due to evolving conditions like hemorrhagic injuries of abdominal organs or expanding intracranial mass lesions. *Late deaths* occur after days or weeks and are due to sepsis and multiple organ failure.

Early deaths are considered preventable, since they may be avoided if injuries are promptly identified and treated. Therefore, surgeons turned to mortality and morbidity methodology to critically analyze failures of care, with particular attention to deaths of the second peak (16).

Preventable deaths in a mature trauma system are likely to be as low as 7%, in contrast to non-regionalized trauma care, where preventable deaths have been estimated at higher than 30 % (17).

Risk adjusted mortality

The National Surgical Quality Improvement Program (NSQIP) is based on the definition of expected outcomes (E), to which are compared observed outcomes (O) (18). The O/E ratio thereby becomes an objective metric for comparison to established, risk-adjusted standards. The determination of the "expected" component of the equation is the core of this concept. A number of factors, such as mortality, incidence of adverse events, or patient care-related morbidity, can be measured. Results suggesting that the performance does not meet expectations are then used to stimulate a focused assessment of the process of care with intent to improve outcome (19).

Improving outcomes depends on the ability to accurately compare performance across trauma centers. Therefore, accurate statistical adjustment is crucial if trauma centers are to be compared. In practice, quantifying injury requires: a language that divides the continuous landscape of human injury into a set of discrete injuries; a measure of severity for each injury; and a model that summarizes the combined severity of all the injuries that an individual patient has sustained as a single numeric value (20). These three tasks were accomplished simultaneously when Baker et al adapted the abbreviated injury scale (AIS) listing of injuries and its attendant expert-assigned severities, and defined the injury severity score (ISS) as the sum of the squares of the severities of the single worst injury in each of the 3 most injured body regions (21). The ISS quickly became the standard measure of trauma and was soon incorporated as the dosage of trauma in more comprehensive models of mortality following trauma for example trauma and injury severity score (TRISS). (22) The ISS has proven remarkably durable. Although alternative measures of injury have been proposed (such as new injury severity score, ICD 9 based injury severity score) none has displaced the ISS (20).

Trauma and injury severity score (TRISS)

TRISS was introduced in 1983 by Champion et al (23) and later described in detail by Boyd et al. (22) The major trauma outcome study (MTOS) database was used to develop the Trauma Injury Severity Score (TRISS) methodology, a scoring system that predicts the probability of survival based on indices of physiologic derangement, anatomic injury severity, and age. TRISS uses a weighted combination of patient age above or below 55 years, Injury Severity Score (ISS) (provides anatomic description of injury) and Revised Trauma Score (RTS) (which is a physiologic injury score composed of systolic blood pressure, respiratory rate, and the Glasgow Coma Scale) to predict a patient's probability of survival following traumatic injury. TRISS coefficients (which give the variable weights) were estimated from ordinary logistic regression models in 1987 (22), and revised in 1995 using the American College of Surgeons Committee on Trauma coordinated Major Trauma Outcome Study (MTOS) database (24).

The TRISS model probability of survival can be estimated from the logit:

$$Ps = 1/(1 + e^{-b})$$

Where

$$b = b_o + b_1(RTS) + b_2(ISS) + b_3(AGE)$$

RTS= revised trauma score

ISS= Injury severity score

AGE= coded age value

Where b_0 is constant for the mechanism of injury, b_1 is the coefficient associated with RTS and mechanism of injury, b_2 is the coefficient associated with ISS and mechanism of injury, and b_3 is the coefficient associated with age and mechanism of injury. Since road traffic trauma is caused by blunt mechanism the coefficients for blunt injury will be used.

Coefficients (b_0 = -2.2470; b1=0.9544; b2= -0.0768 and b3 =-1.9052) are derived from Major Trauma Outcome Study, a registry of several thousands of trauma patients used to generate predicted adult death rates (24).

The revised trauma score (RTS) (25) is a physiologic index of injury severity computed from coded values (0-4) of Glasgow coma scale(GCS), systolic blood pressure (SBP) and respiratory rate (RR) obtained on emergency department admission (table 1). These values are multiplied by weights determined by logistic regression of a baseline data set. RTS takes on values between 0 and 7.8408. higher values are associated with improved prognosis.

Revised trauma score= 0.9368(GCS) + 0.7326(SBP) + 0.2908(RR)

Figure 1: Revised trauma score codes

Glasgow coma scale (GCS)	Systolic blood pressure (mmHg)	Respiratory rate (breaths/min)	Revised trauma score (RTS) coded value
15-13	>89	>29	4
12-9	89-76	29-10	3
8-6	75-50	9-6	2
5-4	49-1	5-1	1
3	0	0	0

The injury severity score (ISS) is an index of anatomic injury severity that takes values from 1 to 75. Higher scores indicate more severe injuries. The ISS is based on the Abbreviated injury severity scale (AIS). The AIS is a list of several hundred injuries, each with an assigned severity score that can range from 1(minor injuries) to 6(injuries that are nearly always fatal). To compute the ISS, a patient injuries are sorted into six body regions: head and neck, face, chest, abdominal and pelvic contents, extremities and pelvic girdle, and external. If the patient has an AIS 6 injury, the ISS is 75 by definition. Otherwise, the highest AIS severity score in each of the 6 body regions is identified, and the squares of the largest three are added to obtain the ISS (21).

TRISS was developed as a quality control measure to allow a comparison of survival after trauma between different centers as well as in a given center over time. It was believed that such a quality control tool would permit a more objective assessment of the impact of the implementation of trauma systems, centralization of trauma care, and allocation of resources (26).

Using the TRISS methodology at KNH for major trauma, Kizito (6) found out that out of the 75 deaths, 42 were unexpected..

The trauma mortality prediction model (TMPM).

The development and validation of the Trauma Mortality Prediction Model (TMPM) have been described by Osler et al. (10,20) The TMPM is a statistical model that takes any number of injuries that a patient may have sustained (expressed as international classification of diseases (ICD)-9 codes) and produces a prediction of mortality. The TMPM is based on empirical estimates of injury severity derived using the national trauma data bank (NTDB). The TMPM is similar to the ISS in that both base their predictions solely upon anatomic injuries (12).

Prediction by the TMPM proceeds in two stages: Stage one involves replacing each ICD-9 code by a measure of its severity called the Model Averaged Regression Coefficient (MARC) values. The MARC values express the relative severity of each individual on a scale from -1.9835 (trivial injury) to 4.0318 (mortal injury). The MARC values were derived from the NTDB version 7 using a regression procedure.

The second stage involves the calculation of the predicted mortality for a patient using the formula:

$$P(death) = Probit[C_0 + C_1*I_1 + C_2*I_2 + C_3*I_3 + C_4*I_4 + C_5*I_5 + C_6*S + C_7*I_1*I_2]$$

Where:

P(death) is the probability of death

Probit is the probit function (available in statistical software packages and Excel.)

I_1 , I_2 , ... I_5 are the MARC values for the five worst injuries, ordered with the greatest MARC value (worst injury) first, the second greatest MARC value second, up to the fifth worst injury. (The TMPM considers only the worst five injuries that a patient has sustained.) Note that the term $C_7*I_1*I_2$ represents the interaction of the worst and second worst injuries that a patient has sustained.

S is an indicator variable set equal to 0 if the worst two injuries occur in different body regions and set equal to 1 if the worst two injuries occur in the same body region.

And C_0 to C_7 are coefficients as follows: C_0 = -(2.217565); C_1 = 1.406958; C_2 = 1.409992; C_3 = 0.5205343; C_4 = 0.4150946; C_5 = 0.8883929; C_6 = -0.0890527; and C_7 = -0.7782696

Limitations of TMPM are a) NTDB is not a population based and draws its patients from a self selected group of trauma and non trauma patient. Therefore the study results are not necessarily generalizable outside of the study data set and needs to be replicated (12) and b) Use of ICD codes is thought to have an inherent lack of specificity, especially with regard to head injuries and injuries to vascular solid organs.

Comparing model perfomance

The statistical performance of models can be assessed to select the best model whose predictions most closely match observed patient outcomes. Once the better model is selected, it can then be used as a yardstick to measure hospital quality, with the caveat that there are no perfect models (10).

Model performance is usually quantified using discrimination (using the area under the ROC curve) and calibration (the Hosmer-Lemeshow statistic) (10, 20, 27).

Discrimination is the ability of an index to classify patients correctly as survivors or nonsurvivors. The receiver operating characteristic curve is a measure of discrimination. The area under ROC is defined as the area under a graph of sensitivity X (1 - specificity), an ROC area of 1 represents perfect prediction; whereas an ROC area of 0.5 represents prediction no better than chance and thus a test with no value whatsoever. The area under the receiver operating characteristic curve is calculated as the proportion of the time that a patient who survives is assigned a higher probability of survival than a patient who dies in the hospital (10, 20, 27).

Calibration is the level of agreement between actual and model-predicted number of survivors and deaths in various risk strata. Hosmer-Lemeshow (H-L) statistic is used to measure the calibration. The H-L statistic measures a logistic function's predictive calibration across the range of probabilities (Ps's). It is based on comparisons of the actual and expected numbers (i.e., based on model predictions) of survivors and deaths for all Ps deciles. Values of H-L $\leq$15.5 do not reject the hypothesis that the model provides an adequate fit of the data ($P < 0.05$) (27).

The TMPM-ICD 9 has an ROC area of 0.880 with an H-L statistic of 29.3. (11) The TRISS model has an ROC area of 0.857 (29) -0.976 (28) and H-L statistic of 41.66 (24)-225.22 (29) depending on the data set. The discrimination of the TRISS model improves when local data set is used in the development of the coefficients compared to using the MTOS coefficients (24, 29). In the absence of a trauma registry in Kenya, the MTOS coefficients will be used.

The addition of age, gender and mechanism of injury has been shown to improve the performance of the TMPM model substantially (ROC improves from 0.901 to 0.925 and the H-L statistic from 58 to 19. (20) The addition of the motor component of GCS was found to markedly improve the calibration curve for ISS to the extent that the calibration curves for the augmented TMPM and the augmented ISS were virtually indistinguishable. (12) Since, the TRISS model has age, mechanism of injury, ISS and RTS; it could be the better model in outcome prediction.

Rationale and Study objectives

Rationale

Road traffic trauma is an increasing problem whose management in Kenya has been suboptimal.

Injured patients arriving alive at the hospital and then subsequently dying provide a tangible and objective measure for evaluating the efficiency of trauma centers and systems of care. It is important for a trauma center to critically evaluate its outcomes from the process of care (15).

In addition, a trauma center intending to perform an effective review of its service, as well as for the scientific study of trauma, it is important to have an accurate benchmark of mortality risk. This benchmark serves as a predictor of mortality or "expected" outcome for patient presenting with injuries. The expected result can then be compared to the "actual" outcomes in order to provide quality assurance of care provision. For many years, this benchmark has been the Trauma and Injury Severity Score (TRISS) (30). With the development of new models, based on ICD 9 CM such as ICISS (International Classification of Diseases, 9th revision Injury Severity Score) and TMPM-ICD9, there is need for assessment of the statistical performance of these models to select the best model whose predictions most closely match observed patient outcomes. Once the better model is selected, then it can be used as a yardstick to measure hospital quality (10).

TMPM is a new risk adjustment model that has yet to be tested outside the NTDB data set from which it was developed, hence the need for validation using dataset from different environments.

Research question

Is there a significant difference between TRISS and TMPM ICD 9 in predicting the outcome of patients presenting with road traffic trauma at KNH.

Objectives

Main objective

Compare TRISS and TMPM ICD 9 in the evaluation of road traffic trauma outcome at KNH

Specific objectives

- To determine the outcome of patients with road traffic trauma admitted at KNH
- To determine the expected outcome using the TRISS methodology
- To determine the expected outcome using the TMPM ICD 9 model
- Compare the predicted outcomes of TRISS methodology and TMPM ICD 9 model

Methodology

Materials

Study design: Prospective descriptive study

Study duration: 4 months (from July 2011 to November 2011)

Setting: Kenyatta National Hospital (KNH) is a 2,000-bed teaching and referral hospital located in Nairobi.

Study population: Patients presenting to the accident and emergency with road traffic trauma. Road traffic trauma was defined as injury involving motor vehicles, bicycles, motorcycles and pedestrians.

Sample size

$N = z^2pq/d^2$

Where

N= sample size

z= standard normal variant corresponding to the 95% confidence interval, and is 1.96

p=expected prevalence of patients with road traffic trauma admitted at the KNH. Previous study showed a prevalence of 15% (5)

q=1-p

d=the required precision of estimate (0.05)

$n= (1.96)^2 x0.15 (1-0.15)/ (0.05)^2$

=197 patients

Inclusion criteria

All patients aged ≥ 15 years of age admitted due to road traffic trauma or died after receiving any evaluation or treatment.

Exclusion criteria: Patients that were dead on arrival and transferred patients.

Data collection

A data sheet was formulated to collect data regarding the age, gender, respiratory rate, blood pressure, Glasgow coma scale, documentation of injuries and emergency disposition. The ISS was calculated by using the Abbreviated Injury Scale (AIS)-2005 score chart and the highest AIS in each of the following six areas: head and neck, face, chest and thoracic spine, abdomen, lumbar spine and pelvic contents, bony pelvis, and limb and body surface was used. The squares of the highest scores in three body areas were then added together. The patients after being recruited were followed up at 2 weeks to find out if they had survived or died. Patients that had been discharged and had left the hospital were contacted by phone.

The ICD 9 CM codes were be coded for each of the injuries sustained by the patient.

To calculate P(s) TRISS calculator (www.trauma.org/js/trisscalc.html) was used.

The probability of death by TMPM model was calculated using the TMPM calculator (TMPM Calculator v1.002.x.s developed by Glance et al (10))

Data analysis

Data collected was entered and cleaned in Microsoft Excel. Statistical analysis was done using Statistics/Data analysis (STATA) 12.0 (StataCorp, USA).

The independent variables were TRISS and TMPM and mortality was the dependent variable.

Discrimination and calibration were the statistical methods used to evaluate the performance of TRISS and TMPM ICD 9 (11, 18, 24). Model discrimination was evaluated by the area under ROC. Values of >0.9 represent high accuracy; 0.70 – 0.89 represent moderate accuracy and <0.69 low accuracy for discrimination between survivors and non survivors. The area under ROC for TRISS and TMPM were compared using global chi square test for statistical significance.

Model calibration was evaluated by the Hosmer-Lemeshow (H-L) goodness of fit test between the observed and expected risk of mortality in a 10 risk strata to assess the predictive ability of the models for mortality.

In all analyses, confidence interval and significance level of *P* value of 95% and 0.05 were chosen respectively.

Ethical considerations

Approval to conduct the study was sought from The Department of Surgery, University of Nairobi, and the KNH Ethics and Research Committee.

An informed consent was obtained from the patients and caretakers after the benefits of the study were explained to the patients/caretakers. The participants/caretakers were informed that participation is voluntary and they could withdraw from the study at any point without provision of services from the hospital being interrupted. Confidentiality and privacy was observed.

Results

The study cohort comprised of 210 patients, which was predominantly male (78.6%). The mean age was 33.1± 10.959) with a peak between the ages of 22-32. (Fig. 2 and 4). The systolic blood pressure, the respiratory rate and the Glasgow coma scale means are shown in figure 2 below. Severe injuries (ISS greater or equal to 16) constituted 19% of the study population. The overall mortality rate was 6.7%.

Figure 2: Patients' demographics and injury characteristics

Age	33.1 (15-63)*
Male	165 (78.6%)
Female	45 (21.4%)
Systolic blood pressure	115.5 (61-210)*
Respiratory rate	20.9 (8-34)*
Glasgow coma scale	13.7 (2-15)*
ISS mean	10.37 (2-34)*
Minor injuries (ISS 1-15)	170 (81%)
Severe injuries (ISS >15)	40 (19%)
TRISS mean	98.34 (3.11)#
TMPM mean	0.031(0.07)#
Mortality	14 (6.7%)
Loss to follow up	2 (0.9%)

***Range**

#standard deviation

10 patients age was unknown (TRISS could not be calculated). 3 of the patients with missing age died.

Most patients (71.9%) were dispatched to the orthopedic wards from the accident and emergency unit as shown in figure 3 below. There were a total of 397 injuries (an average of 1.89 per patient). 66.75% of the injuries were located in the extremities (limbs) followed by 19.9% located in the brain and/or skull.

Figure 3: Emergency dispatch

Emergency dispatch	Number (percentage)
Orthopedic wards	151 (71.9%)
Surgical wards	24 (11.4%)
Theatre	24 (11.4%)
ICU	11(5.2%)

According to TMPM (n=208) and TRISS (n=200), 0 and 3 patients were expected to die respectively. The observed and expected outcomes were used to determine the specificity and sensitivity of the models as illustrated in figure 5. Both models have high sensitivity with low specificity.

TRISS exhibits statistically significantly better ROC (0.786 p=0.0069) compared to TMPM ICD 9 (0.641).

Figure 4: Age distribution

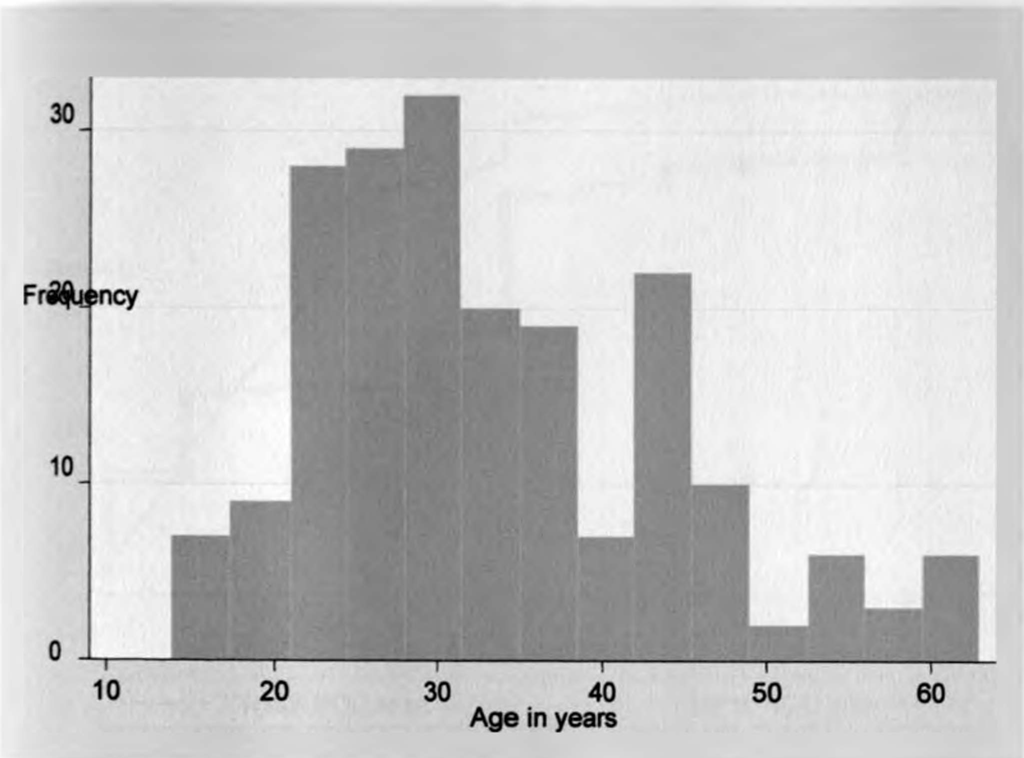
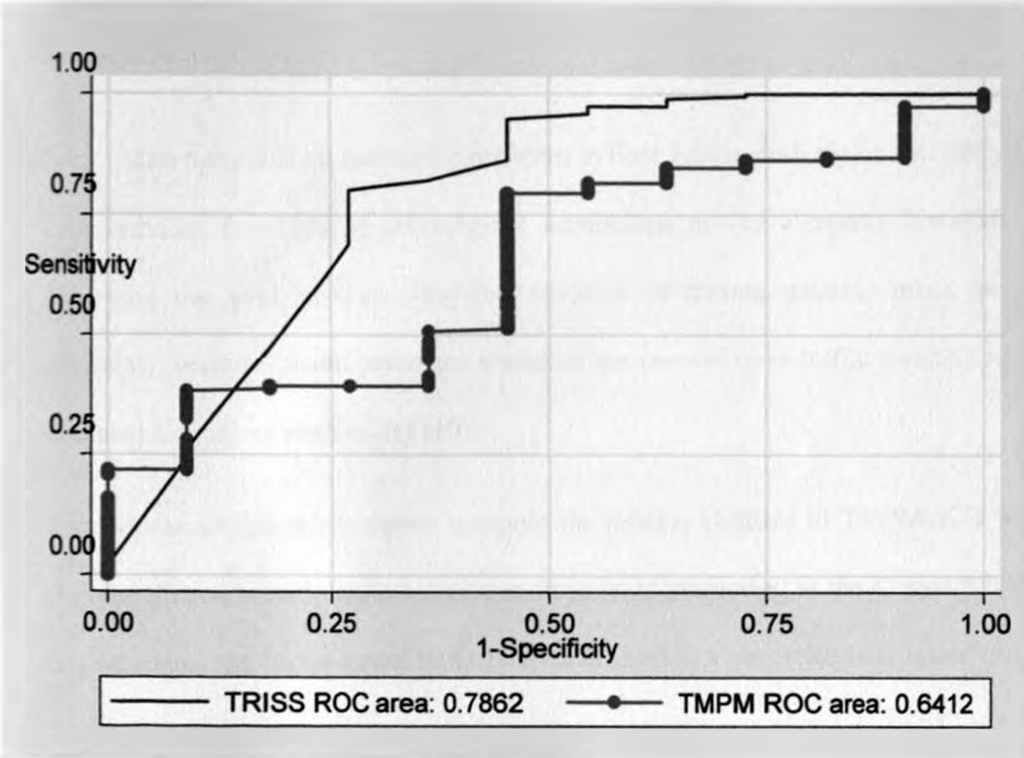


Figure 5: Sensitivity and specificity

	TRISS	TMPM
Sensitivity	99.47%	100%
Specificity	27.27%	0.0%
Positive predictive value	95.92%	93.27%
Correctly classified	95.50%	93.27%

Figure 6: ROC curves



With regard to calibration, TRISS showed better H-L statistic than TMPM-ICD 9. (Figure 7) The H-L statistic of 0.38 with p=0.999 shows that the model fit the study cohort with a good predictive value.

Figure 7: Model distribution and calibration

Model	Area under ROC (95% CI)	H-L statistic (p value)
TRISS	0.786 (0.610 - 0.961)	0.38 (0.999)
TMPM	0.641 (0.479 - 0.802)	16.94(0.0757)
	Area under ROC p value 0.0069	

Discussion

Road traffic trauma is an increasing problem in East Africa with major morbidity and mortality. They account for 15% of all surgical admissions at the Kenyatta National Hospital (5). Achieving the goal of improving the outcome of trauma patients relies on the ability to accurately measure health outcomes which in the case of road traffic trauma requirc thc use of validated risk adjustment model (10).

The purpose of this study was to compare the relative abilities of TMPM-ICD 9 and TRISS to evaluate the road traffic trauma outcome in patients presenting at the Kenyatta National hospital and determine the better model that can then be used as a yardstick to measure quality of care of road traffic casualties.

It is important to note that the coefficients for TRISS were developed from MTOS (24) while the coefficients used to develop TMPM ICD 9 (10) were developed from NTDB version 7 (32). The demographics of the study population are similar to other studies done at KNH (5). Most patients in the MTOS (24), current study and NTDB version 7 (32) were in the 15-55 age group: 73.5%, 95.4% and 60.8 % respectively. However, the patients with ages greater than 55 were 15.5%, 4.5% and 26.4% for the MTOS study, current study and the NTDB version 7. This demonstrates that the MTOS and NTDB version 7 had a significant number of patients that were over 55 years. Age over 55 has been associated with higher case fatality rate (24, 32).

The overall mortality rate was 6.7% for the current study and 9% and 4.96% for MTOS and NTDB respectively. The mean injury severity score was 10.37 for the current study compared to 12.8 for the MTOS. (24) Moreover, the patient with minor injuries (ISS 1-15) and severe injuries (ISS >15) were 81% and 19% for the current study compared to 77.6 % and 22.4% for the

NTDB version 7. The injury case mix is similar; however, the mortality rates for the two categories of injuries were 3% and 22.5% for the current study compared to 1.2% and 15.6 % for the NTDB version 7. The difference in the outcomes between these study populations could be attributed to the improvement in trauma care in the developed world where the NTDB data was collected. Locally, the mortality rate in the severe injury group has shown a reduction from 35.6% (5) reported in a study conducted in 1999.

Most patients had injuries in the extremities which correlate with the high emergency disposition to the orthopedic wards.

The results have demonstrated greater TRISS model discrimination and calibration than TMPM-ICD 9. With respect to discrimination TRISS had a better ROC than TMPM ICD (0.786 vs. 0.641) with a p=0.0069. However, the TRISS ROC is lower than previously published studies where the range was 0.857(29) – 0.976 (28). This demonstrates that TRISS had moderate accuracy in discriminating between survivor and non survivors in patients admitted with road traffic injuries at KNH. This could be attributed to the use of MTOS coefficients which were not developed locally as previous reports (27, 29) have shown improvement in the performance of TRISS with the use of locally derived coefficients. In addition, the MTOS coefficients were developed in the 1980s and one would assume that the quality of health care has improved since, given the difference in mortality between the current study and the MTOS dataset.

The performance of TMPM ICD 9 could have been affected by improvement in health care which has seen a decrease in mortality in the developed world in comparison to the developing world (17). TMPM had a sensitivity of 100% and specificity of 0% meaning that none of the patient was expected to die.

With regard to calibration, TRISS had H-L statistic of 0.38 (p=0.999) is among the best reported. This is in contrast to many previous reports (28, 29, 33). This, however, could be due to the small sample size compared to the other studies that have used trauma registries. The H-L statistic has been shown to be dependent on the sample size: for a small sample the test has been shown to likely indicate that the model fits and for a large data set, even if the model fits it may fail (27, 29, 31).

This study has a number of limitations. Even though the study sample size was calculated before the beginning of the study, a larger sample size could probably have given some difference in the outcome and hence the performance of the models. The other limitations include the possibility of wrongfully coding the ICD 9 codes and missing data especially age in the current study and its impact in the calculation of TRISS.

Conclusion and Recommendations

Conclusion

TRISS model outperformed TMPM ICD 9, in terms of calibration and discrimination, in evaluating outcome of patients admitted at Kenyatta national hospital with road traffic injuries.

Recommendations

1. Use of TRISS methodology as a yardstick for quality of care of road traffic casualties at KNH

2. Development of a trauma registry that will be the database upon which different models can be compared and used to develop local coefficients.

3. Repeated evaluation of risk adjustment models in the pursuit for the best possible tools for quality improvement.

References

1. Murray CJL and Lopez AD. The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020. Boston: World Health Organization and the World Bank, Harvard University Press. 1996
2. Pratte D. Road to Ruin: Road Traffic Accidents in the Developing World. *NEXUS* 1998;13: 46-62.
3. Odero W. Road traffic accidents in Kenya: an epidemiological appraisal. *East Afr Med J.* 1995;72(5):299-305
4. Odero W, Khayesi M, Heda PM. Road traffic injuries in Kenya: magnitude, causes and status of intervention. *Inj Control Saf Promot.* 2003; 10(1-2):53-61.
5. Saidi HS, Macharia WM, Atinga JEO. Outcome for Hospitalized Road Trauma Patients at a Tertiary Hospital in Kenya. *Eur J Trauma* 2005;31: 401-6
6. Kizito D. The Value of trauma assessment scoring in predicting outcome of patients presenting with major trauma to Kenyatta National Hospital. MMed thesis. University of Nairobi; 2003.
7. Otieno T, Woodfield JC, Bird P, Hill AG. Trauma in rural Kenya. Injury. *Int. J. Care Injured* 2004; 35:1228—1233
8. Anonymous. Accidents in the Third world. World Development Forum. 3:1985; 2.
9. Donabedian A: The role of outcomes in quality assesment and assurance. *Qual Rev Bull* 1992, 18:356-360
10. Glance LG, Osler TM, Mukamel DB, Meredith W, Wagner J, Dick AW. TMPM-ICD9. A Trauma Mortality Prediction Model Based on ICD-9-CM Codes. *Ann Surg* 2009;249:1032-9
11. Glance LG, Osler TM, Dick AW. Evaluating Trauma Center Quality: Does the Choice of the Severity-Adjustment Model Make a Difference? *J of Trauma* 2005;58(6):1265-1271
12. Glance LG, Osler TM, Mukamel DB, Meredith W, Dick AW. Expert Consensus vs. Empirical Estimation of Injury Severity Effect on Quality Measurement in Trauma *Arch Surg.* 2009;144(4):326-332

13. Rutledge R, Osler T, Emery S, Kromhout-Schiro S. The end of the Injury Severity Score (ISS) and the Trauma and Injury Severity Score (TRISS): ICISS, an international classification of diseases, ninth revision-based prediction tool, outperforms both ISS and TRISS as predictors of trauma patient survival, hospital charges, and hospital length of stay. *J Trauma*. 1998;44:41-47
14. WHO. Guidelines for trauma quality improvement programmes. WHO 2009
15. Fallon WF; Barnoski AL; Mancuso CL; Tinnell CA; Malangoni MA. Benchmarking the Quality-monitoring Process: A Comparison of Outcomes Analysis by Trauma and Injury Severity Score (TRISS) Methodology with the Peer-review Process. *J Trauma* 1997;42(5): 810-817
16. Chiara 0, Cimbanassi S, Pitidis A and Vesconi S. Preventable trauma deaths: From panel review to population based-studies. *World Journal of Emergency Surgery* 2006; 1:12
17. Cameron PA, Gabbe BJ, McNeil JJ. The importance of quality of survival as an outcome measure for an integrated trauma system. *Injury, Int. J. Care Injured*. 2006;37:1178-1184
18. Khuri SF. The NSQIP: a new frontier in surgery. *Surgery* 2005;138(5): 837-43
19. Leaphart CL, Graham D, Pieper P, Celso BG, Tepas JJ. Surgical quality improvement: a simplified method to apply national standards to pediatric trauma care. Journal of Pediatric *Surgery* 2009;44:156–159
20. Osler TM, Glance LG, Buzas JS, Mukamel DB, Wagner J, Dick AW. TMPM-ICD9. A Trauma Mortality Prediction Model Based on Anatomic injury scale. *Ann Surg* 2008;247:1041-104
21. Baker SP, O'Neill B, Haddon W, et al. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma*. 1974; 14:187–196.
22. Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. *J Trauma* 1987; 27:370–8.
23. Champion HR, Sacco WJ, Hunt TK. Trauma severity scoring. *World J Surg* 1983;7:4—11
24. Champion HR., Copes WS, Sacco WJ, Lawnick MM, Keast SL, Bain LW Jr, Flanagan ME, Frey CF. The Major Trauma Outcome Study: Establishing national norms for trauma care. *J Trauma*. 1990 ;30(11):1356-65

25. Champion HR, Sacco WJ, Copes WS. A revision of trauma score. *J Trauma* 1989;29: 623-629.
26. Garber BG; Hebert, PC; Wells G; Yelle JD. Validation of Trauma and Injury Severity Score in Blunt Trauma Patients by Using a Canadian Trauma Registry. *J of Trauma* 1996;40(5): 733-737
27. Hannan EL, Farrell LS, Gorthy SF, Bessey PQ, Cayten CG, Cooper A, et al. Predictors of mortality in adult patients with blunt injuries in New York State: A comparison of the Trauma and Injury Severity Score (TRISS) and the International Classification of Disease, ninth revision-based Injury Severity Score (ICISS). *J Trauma* 1999; 47:8-14.
28. Schluter PJ. Trauma and Injury Severity Score (TRISS): Is it time for variable re-categorizations and re-characterizations? *Injury, Int. J. Care Injured* 2011;42: 83–89
29. Willis CD, Gabbe BJ, Jolley D, Harrison JE, Cameron PA. Predicting trauma patient mortality: ICD (or ICD 10AM) versus AIS based approaches. *ANZ J. Surg* 2010;80(11): 802-806
30. Wong SSN, Leung GKK. Injury Severity Score (ISS) vs. ICD-derived Injury Severity Score (ICISS) in a patient population treated in a designated Hong Kong trauma centre. *McGill J Med.* 2008;11(1): 9–13
31. Chan YH, Biostatistics 202: Linear regression analysis. *Singapore Med J* 2004; 45(4):149-153.
32. Clarke DE and Fantus RJ (Eds). National Trauma Data Bank Annual Report 2007. American College of Surgeons.

Appendices

Appendix 1|: Data collection form

Study no ....

IP No. ....›.................

Age ....

Sex Male...... Female.........

Date of injury .... Time of injury ....

Time of reporting to hospital ....

Vital signs Pulse rate.......... Bp................ Respiratory rate.......

GCS Eye...................... Verbal .... Motor ....

Area of injury and Abbreviated injury score

AIS body region	Worst injury	Highest AIS	AIS^2
Head and neck			
Face			
Chest			
Abdomen/pelvis			
Extremities/bony pelvis			
External (skin)			

TRISS(Calculated using the TRISS calculator) =

Emergency department disposition Wards........ ICU............ Theatre

Diagnosis(List all ICD codes)

ICD 9 code	Description of injury

Trauma mortality prediction model

Appendix 2: Consent form

ROAD TRAFIC TRAUMA OUTCOME AT KENYATTA NATIONAL HOSPITAL: COMPARISON OF THE TRAUMA AND INJURY SEVERITY SCORE (TRISS) AND THE TRAUMA MORTALITY PREDICTION MODEL (TMPM).

Research study

You are invited to participate in a research study of road traffic trauma outcome at the Kenyatta National Hospital being conducted by Dr. Adili Wobenjo, a postgraduate student at the University of Nairobi.

Purpose of the study: The purpose of the study is to assess the use risk adjustment models, by comparing TRISS and TMPM in evaluation of road traffic trauma outcome at KNH. Once the best model is identified it will be used as a yardstick to assess the quality of road traffic trauma care.

Risks and benefits: There will be no direct benefit to you upon participation in the study and no physical or mental harm will be imposed on you during the study.

Confidentiality: Information related to you will be treated in strict confidence to the extent provided by law. Your identity will be coded and will not be associated with any published results. The records of this study will be kept private. Any written results will discuss group findings and will not include information that will identify you. Research records will be stored securely and only researchers and individuals responsible for research oversight will have access to the records.

Voluntary participation and withdrawal from the study: Your decision whether or not to participate will not prejudice you or your medical care. If you decide to participate, you are free to withdraw your consent, and to discontinue participation at any time without prejudice to you or effect on your medical care.

Contacts: you should feel free to ask questions now or at any time of the study. If you have any questions about this study you can contact Dr Adili Wobenjo, phone no. 0721-985818, email adilihw@yahoo.com. If you have any questions concerning the rights of human research participants, contact the Chairperson, the KNH Ethics and Research Committee at 020-2726300.

I have read and fully understand the consent form. I sign it freely and voluntarily.

______________________ ______________

Signature of Participant/Next of kin Date

I certify that I have personally explained this document before requesting that the participant to sign it.

______________________ ______________

Signature of Researcher Date

Appendix 3: Kibali cha kushiriki

MATOKEO YA MAJERUHI WA AJALI WA BARABARANI KATIKA HOSPITALI KUU YA KENYATTA:

Utafiti: Unaalikwa kushiriki kwa utafiti wa matokeo ya majeruhi wa ajali za barabarani katika hospitali kuu ya Kenyatta. Utafiti unafanywa na Daktari Adili Wobenjo.

Lengo la utafiti: Lengo la utafiti huu ni kutafuta njia bora kati ya TRISS na TMPM kwa kutabiri matokeo ya majeruhi wa ajali. Baada ya njia bora kupatikana, itatumiwa kuboresha malezi ya majeuhi wa ajali za barabarani

Hakutakuwa na majeraha yoyote kwa washirika

Siri: Maelezo yako yatakuwa siri na matokeo ya utafiti yataelezwa kwa ujumla.

Kushiriki: Kushiriki kwako kwa utafiti huu ni kwa hiari yako. Una uhuru wa kukataa kushiriki, na kukataa kwako hakutatumiwa kukunyima tiba.

Maswali: Ukiwa na swali lolote kuhusu utafiti huu unaweza kumuuliza Daktari Adili Wobenjo kwa nambari ya simu 0721-985818, ama na barua pepe adilihw@yahoo.com. Ukiwa na swali kuhusu haki za mtafiti, unaweza kuwasiliana na Mwenyekiti, KNH ERC katika nambari 020-2726300

Nimesoma na kuelewa kibali hiki. Ninaweka sahihi kwa hiari yangu.

__________________________ ________________

Sahihi ya mshirika/jamii ya mshirika Tarehe

Nimeeleza kwa ukamilifu lengo la utafiti kabla ya kumuomba kuweka sahihi.

__________________________ ________________

Sahihi ya mtafiti Tarehe

Appendix 4: Overview of icd-9-cm codes

- 800-804 Fracture Of Skull
- 805-809 Fracture Of Spine And Trunk
- 810-819 Fracture Of Upper Limb
- 820-829 Fracture Of Lower Limb
- 830-839 Dislocation
- 840-848 Sprains And Strains Of Joints And Adjacent Muscles
- 850-854 Intracranial Injury, Excluding Those With Skull Fracture
- 860-869 Internal Injury Of Chest, Abdomen, And Pelvis
- 870-879 Open Wound Of Head, Neck, And Trunk
- 880-887 Open Wound Of Upper Limb
- 890-897 Open Wound Of Lower Limb
- 900-904 Injury To Blood Vessels
- 905-909 Late Effects Of Injuries, Poisonings, Toxic Effects, And Other External Causes
- 910-919 Superficial Injury
- 920-924 Contusion With Intact Skin Surface
- 925-929 Crushing Injury
- 930-939 Effects Of Foreign Body Entering Through Orifice
- 940-949 Burns
- 950-957 Injury To Nerves And Spinal Cord
- 958-959 Certain Traumatic Complications And Unspecified Injuries
- 960-979 Poisoning By Drugs, Medicinals And Biological Substances
- 980-989 Toxic Effects Of Substances Chiefly Nonmedicinal As To Source
- 990-995 Other And Unspecified Effects Of External Causes
- 996-999 Complications Of Surgical And Medical Care, Not Elsewhere Classified

Appendix 5: Ethical approval

KENYATTA NATIONAL HOSPITAL
Hospital Rd. along, Ngong Rd.
P.O. Box 20723, Nairobi.
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP", Nairobi.
Email: KNHplan@Ken.Healthnet.org

25th July 2011

Ref: KNH-ERC/ A/185

Dr. Adili Wobenjo
Dept. of Surgery
School of Medicine
University of Nairobi

Dear Dr. Wobenjo

RESEARCH PROPOSAL: "ROAD TRAFFIC TRAUMA OUTCOME AT KENYATTA NATIONAL HOSPITAL: COMPARISON OF THE TRAUMA AND INJURY SEVERITY SCORE(TRISS) AND THE TRAUMA MORTALITY PREDICTION MODEL(TMPM)" (P256/6/2011)

This is to inform you that the KNH/UON-Ethics & Research Committee has reviewed and **approved** your above cited research proposal. The approval periods are 25th July 2011 24th July 2012.

You will be required to request for a renewal of the approval if you intend to continue with the study beyond the deadline given. Clearance for export of biological specimens must also be obtained from KNH/UON-Ethics & Research Committee for each batch.

On behalf of the Committee, I wish you a fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of the data base that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Yours sincerely

PROF A N GUANTAI
SECRETARY. KNH/UON-ERC

c.c. The Deputy Director CS, KNH
The Dean, School of Medicine, UON
The Chairman, Dept.of Surgery, UON
The HOD, Records, KNH
Supervisor: Prof. Saidi Hassan, Dept.of Human Anatomy, UON