Factors Predicting Outcome in Adult Trauma Patients Admitted to a Tertiary ICU

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Supervisor: Dr. NE Pearce

I, Reabetswe Bardott Ndaku, declare that the coursework Master's Degree mini-dissertation that I herewith submit in a publishable manuscript format for the Master's Degree

Qualification MMed (Surgery) at the University of the Free State is my independent work, and that I have not previously submitted it for a qualification at another institution of

Higher education.

This body of work acknowledges:

1. God, for strength for today and bright hope for tomorrow.

And is dedicated to:

2. My family, for binding up all the fragments of my life in capable love.
3. Dr. Pearce and the Bloemfontein Surgery department, for the opportunity to fulfill a dream.

Contents

Abstract

Introduction: Trauma remains an important cause of mortality and morbidity in South Africa. In our centre, intensive care unit access is under severe strain. There is limited data specifically in our centre documenting the factors contributing to mortality and increased length of stay in ICU.

Objectives: To elucidate the outcome (as measured by mortality and length of stay) of patients that are admitted to Intensive care unit following trauma.

Method: A cross-sectional study dating from 2011 to 2015. Ethical clearance obtained from University of the Free State committee: HSREC 46/2016. Data analysed by means of SPSS 15.0 with frequencies and percentages and standard deviations. Stepwise logistic regression analysis was performed and the odds ratios, 95% CI and p-values calculated for risk factors. A p-value of < 0.05 was considered statistically significant.

Results: The most prevalent mechanism of injury was assault (31%). Burns had the highest mortality rate (80%), primary orthopaedic patients had the longest length of stay recorded (128 days). Age was shown to be an independent predictor of outcome (p-value =0.016). Patients transferred from non-trauma centres did not have a statistically significant worse outcome (p-value = 0.58). Mortality rate of trauma patients admitted to ICU was 57.6%.

Conclusions: There is an association between neurosurgical admissions and poorer outcome. No correlation between non-trauma centres transfer-ins and worse outcome was established; this is possibly an indicator of adequate resuscitation, stabilisation and effective referral systems in place. Our mortality rate is higher than that of international centres and this would need to be further studied.

Word Count = 255

Keywords

List of abbreviations

CI:	Confidence interval
DOA:	Date of admission ICU: Intensive care unit
Dom.Violence:	Domestic violence
GCS:	Glascow coma scale
GSW:	Gun-shot wound
HSREC:	Health Sciences Research Ethics Committee
LOS:	Length of stay
Meditech:	Medical technology system data storage
MVA:	Motor vehicle accident
PVA:	Pedestrian vehicle accident
TBSA:	Total body surface area, of burn

List of appendices

A. HSREC ethics letter of approval
B. FSDoH letter of approval
C. Head of Department of Surgery letter of approval
D. Supervisor letter of approval
E. HSREC approved protocol
   E (i) Data Sheet attached to protocol
   E (ii) DoH Consent letter attached to protocol
   E (iii) Current ICU guidelines attached to protocol
F. HSREC approved Data Sheet
G. Instructions to authors of the SAMJ
H. TURNITIN Plagiarism summary report
I. Current Bloemfontein Multi-ICU admission guidelines

Chapter 1:

Introduction

Trauma remains the single most important cause of mortality and morbidity in South Africa. Unnatural causes account for up to 42% of mortality in the youth aged between 20-24 years. A category of external causes of injury is the highest cause of mortality. This category includes the following mechanisms: inhalations, flame and electrical burns, and drowning. Motor vehicle accidents are followed by assaults.[1]

With increasing burden of trauma results an increase in the demand for intensive care unit for injuries that warrant such specialized care. In our setting as is the international norm, intensive care services are not as readily available as should be for an institution of our capacity.

In our setting the intensive care unit is a multi-disciplinary Unit of only 9 Adult beds that cater for General Surgery, Trauma, Urology, Orthopaedics, Neurosurgery and Internal Medicine patients. Optimum utilization of a scarce resource is of paramount importance. In view of these infrastructural shortcomings, the intensive care unit has strict criteria that govern who can and cannot be admitted into the Unit.

If accurate factors that predict prognosis or outcome of especially trauma patients are established, this might impact the decision of which patients would best benefit from the limited resources, hence the influence upon the existing admission criteria/policy

Current Intensive care unit criteria are attached in the appendices.

Background

The overall mortality of trauma patients in Intensive Care Unit has been shown to be between 13.9 % - 66%. The morbidity of readmission being in patients with a low Glasgow coma scale and poor mobility on the first admission's discharge. Burns patients tend to have higher mortality rate, followed by neurosurgery patients. General surgery patients have however a longer ICU and total in hospital stay as opposed to other patients. The elderly has poorer outcomes. Gender has not been invariably shown to be a single predictor of mortality. [2,3,4,5]

- GENDER

Studies are more conflicting on the relevance of gender surviving trauma and the Intensive care unit. My hypothesis is that the outcome will be more influenced by the mechanism of injury. Gender acts as a surrogate marker of the intensity of the mechanism of injury sustained by males and thus males have poorer outcome. Women injuries are mainly due to domestic violence and suicide attempts, with more of them electing to burn and cut. In an attempt to silence the debate once and for all, Magnotti, Fischer and colleagues conducted a massive study of 11 375 and 24 331 females and males respectively. They found overall mortality rates to not be of significant difference, with men 5.2% and female 4.6 %.[3] However males proved to have higher morbidity as evidenced by length of in-hospital stay.

- AGE

Of the total deaths in South Africa in 2013, only 17% were in the youth between the ages of 19-34 years. Although the youth may be leading risky lives, they seem to live longer none the less.[1] the need then arises to asses and review the mechanisms of injury of the elderly and how they survive trauma and the Intensive Care Unit. My hypothesis is that patients older

will have lower rates of trauma presentations, however this will be the group with the highest mortality.

In 2002, Taylor, Tracey and colleagues found patients ≥ 65 years to have a two-fold increase in mortality secondary to trauma as opposed to their younger counterparts.[4]Adam and his colleagues had similar results in 2007, having taken 60 years as their definition of elderly they sought to discover what the outcome of trauma patients and ICU admission secondary to trauma is in this age group. In their sample of 120, of which 70 were males and 51 females; they had a protracted average hospital stay of 156 days, however a low mortality of 6%. Taking into account that this was in a first world setting where the trauma in elderly is mainly falls, the patients that were involved in Pedestrian accident were the majority of the mortality stay.[5]

More recently, in Makarere University in Uganda, age was shown as an independent predictor of mortality in trauma patients in ICU, mainly due to lack of physiological reserve.[6]

- DEPARTMENT
  - BURNS

    Predictors of outcome in burn patients is related to the Total Body surface burnt, the grading of the burns and whether there is inhalation injury or not. Secondary predictors include the adequacy of fluid resuscitation in the first 24 hours and the temperature of the patient at presentation.[6, 7]

    A cohort retrospective study of 102 patients done by Wang and colleagues found that in patients with massive burns (TBSA ≥70%) there was a 30.4 % mortality rate. The factors influencing mortality being: platelet count, sepsis and ventilator and ionotropic support dependency.[8] However Gupta and colleagues in India found the mortality rate in 75% TBSA and greater to be at 98.3% ,[7] which would most likely correlate with our South African Perspective if they were ICU candidates.

    In patients with lesser TBSA (20% TBSA-45%), the average length of stay in total from day of ICU admission to day of discharge to home is 42 days for <15%, 80 days for 15-45% and up to 146 days for massive burns, with 3 separate theatre slots for debridement and split skin grafts.

    Common complications are wound sepsis and Acute Respiratory Distress Syndrome in the first world. [7] The commonest microbes cultured from the wounds are Pseudomonas and Acinetobacter.[7]

    In another study done in Padova, 50 patients were studied prospectively over 5 years. These were patients with severe burns (described as greater than 45% in the study), 44% died in ICU with a further 10% dying in the ward post ICU discharge.[9] Most of the deaths were due to sepsis complication. Their non survivors mean average stay was 36 days with the survivors mean average hospital stay being 18 days.[9]

    Early escharatomies and early grafting are cited as positive contributory factors of a favourable outcome.[7, 8, and 9]

    Self- inflicted burns also tend to have a poorer outcome, with 39% needing intensive care admission, 25% of which die. Flame is the instrument of choice in the self-harming burn population.[2]

  - NEUROSURGERY

Neurosurgical patients form a considerable burden of patients in ICU, with them having a second highest mortality in ICU; second only to burns. Most of these patients are young males with only 42% of the patients having operable and thus salvageable lesions.[10] Salomone and his colleagues found traumatic brain injury to account for 58% of all ICU mortalities.[11]

In Pakistan an audit was done of the mortality of patients in a neurosurgical intensive care unit. The results should however be extrapolated and applied with caution to our setting as it is firstly, an isolated neurosurgery unit which translates into lower sepsis risk and more specialized personnel delivering superior care. This study showed that of the 112 patients enrolled, 58 % died, with 31% dying in the first 24 hours.[12]

Factors influencing outcome are GCS at presentation, GCS at 24 hours, and age of the patients and mechanism of injury.[13, 14] A Glasgow Coma Scale of less than 9 at presentation had a mortality of 19% and skull base fracture being the injury with the highest mortality at 10 % in one study.[4]

In recent history, 60 patients were studied with traumatic brain injuries, 25 % of which died in ICU and a further 33% had prolonged length of stay described as 17 days in ICU.[15]

- ○ SURGERY

General surgery patients present with too many varied mechanisms and systems involved such as the chest, the soft tissues of the limbs and the abdomen. Overall, chest trauma patients who have warranted thoracotomy do poorer than abdominal trauma patients. Of the Abdominal trauma patients, gunshots have a longer hospital stay than blunt trauma patients. These said gunshot wounds to the abdomen also incur a higher mortality rate, second only to thoracotomies.[16, 17]

- ○ ORTHOPAEDICS

Limited data is available as to specifically and purely orthopaedic trauma patients admitted in Intensive care unit. Available data on the outcomes of trauma indicate that mortality in the elderly (>50 years) is as high as 89%, with the majority having increased length of stay. Of particular interest is that the Black/African race was found to be a predictor of mortality following spine trauma.[18]

- APACHE II SCORE

The APACHE II score was released in 1985. The maximum is 71 with 25 being a 50% predictor of mortality. It is calculated in the first 24 hours of admission and not recalculated again and is the sum of the acute physiology and chronic state.

This score has been verified in international literature as an independent predictor of outcome, especially mortality. Vassar found APACHE II to be a poorer predictor of mortality with its sensitivity being as low as 38%. [19] Furthermore in 2013 Aftab Haq and colleagues validated the APACHE II score (Table 1) to be poorer than APACHE III with its sensitivity at 28% for mortality prediction in ICU as compared to other models.[20]

Table 1: APACHE II score

PHYSIOLOGICAL VARIABLE	+4	+3	+2	+1	0	+1	+2	+3	+4
Temperature	$>41^0$	39-40.9^0		38.5-38.9^0	36-38.4^0	34-35^0	32-33.9^0	30-31.9^0	$\leq 29.9^0$
Mean Arterial Pressure	≥ 160	130-159	110-129		70-109		50-69		≤ 49
Heart Rate	≥ 180	140-179	110-139		70-109		55-69	40-54	≤ 39
Respiratory Rate	≥ 50	35-49		25-34	12-24	10-11	6-9		≤ 5
Oxygenation (mmHg)	≥ 500	350-499	200-349		<200				
a. Fi0$_2 \geq$0.5									
b. Fi0$_2 <$0.5					Po2>70	PO$_2$ 61-70		PO$_2$ 55-60	Po2<55
Arterial pH	≥ 7.7	7.6-7.69		7.5-7.59	7.33-7.49		7.25-7.32	7.15-7.24	<7.15
Serum HCO$_3$ (mmol/L)	≥ 52	41-51.9		32-40.9	22-31.9		18-21.9	15-17.9	<15
Serum Sodium (mmol/L)	≥ 180	160-179	155-159	150-154	130-149		120-129	111-119	$\leq$
Serum Potassium (mmol/L)	≥ 7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		<2.5
Serum Creatinine (mg/dL)	≥ 3.5	2-3.4	1.5-1.9		0.6-1.4		<0.6		
Haematocrit	≥ 60		50-59.9	46-49.9	30-45.9		20-29.9		<20
White Cell Count (x10^9/L)	≥ 40		20-39.9	15-19.9	3-14.9		1-2.9		<1
Glascow Coma Scale									
Score + 15 minus actual GCS									

Footnotes: Fi0$_2$ = Fraction of inspired oxygen, that is the concentration of oxygen inhaled in each breath. Glascow coma scale is a scale that measures level of consciousness. The total is 15 and the least a patient can score is 3, depending on whether they are intubated or not.

The APACHE II score is best used at discharge to evaluate/predict readmission to ICU. Our center currently uses the APACHE II score on admission of the trauma patients to ICU, hence the study uses this scoring tool.

This study used mechanical ventilation and sepsis as markers of morbidity.

Objective

The aim of this study was to correlate the outcome of patients that were admitted to the Intensive Care Unit (ICU) following trauma of any mechanism. In this study, outcome was measured by: 1) morbidity and 2) the length of stay in both the ICU and the total stay in the hospital.

The secondary aim was to:

- Illustrate which mechanisms of injuries are the most prevalent in our hospital setting and which have the highest fatalities.
- Compare how our institution fares with international norms

Hypothesis:

The Hypothesis was that:

- Older females would have a higher apache score and thus have a poorer outcome
- Orthopaedic and burn patients would have a shorter length of stay but a higher mortality

Studies in Africa have been done, however we sought to evaluate and review the Free-State perspective. Higgins and Thomas did also a similar study in 27 hospitals in South Africa, however this was not specifically on trauma patients.

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Chapter 2:

Factors Predicting Outcome in Adult Trauma Patients Admitted to a Tertiary ICU

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Abstract

Introduction: Trauma remains an important cause of mortality and morbidity in South Africa. In our centre, intensive care unit access is under severe strain. There is limited data specifically in our centre documenting the factors contributing to mortality and increased length of stay in ICU.

Objectives: To elucidate the outcome (as measured by mortality and length of stay) of patients that are admitted to Pelonomi Tertiary Hospital, Intensive Care Unit following trauma.

Method: A cross-sectional descriptive study was performed including files of patients admitted to the ICU at Pelonomi Tertiary Hospital between 2011 and 2015. Ethical clearance was obtained from University of the Free State Ethics committee: HSREC 46/2016. Data analysed by means of SPSS 15.0 with frequencies and percentages and standard deviations. Stepwise logistic regression analysis was performed and the odds ratios, 95% CI and p-values calculated for risk factors. A p-value of < 0.05 was considered statistically significant.

Results: The most prevalent mechanism of injury was assault (31%). Burns had the highest mortality rate (80%), primary orthopaedic patients had the longest length of stay recorded (128 days). Age was shown to be an independent predictor of outcome (p-value =0.016). Patients transferred from non-trauma centres did not have a statistically significant worse outcome (p-value = 0.58). Mortality rate of trauma patients admitted to ICU was 57.6%.

Conclusions: No correlation between non-trauma centres transfer-ins and worse outcome was established; this is possibly an indicator of adequate resuscitation, stabilisation and effective referral systems in place. Our mortality rate is higher than that of international centres and this would need to be further studied.

Introduction
Trauma remains an important preventable cause of mortality and morbidity in South Africa. Unnatural causes of death account for up to 42% of mortality in the youth aged between 20-24 years.[1] These causes of trauma include the following: motor vehicle accidents, assaults, all manner of burns (such as: inhalations, flame and electrical burns) and drowning.[1]

With increasing burden of trauma there is an increase in the demand for intensive care unit (ICU) for a sophisticated level of a care. In our centre as is in other developing countries, ICU services are under severe strain. [7,20,23,28]

In our setting at Pelonomi Tertiary Hospital, in the Free State, we have one Intensive Care Unit (ICU). This unit serves as a multidisciplinary unit admitting patients from trauma, surgery, orthopaedics, neurosurgery, urology and internal medicine. The unit comprises of only nine beds, seven of which are ventilator beds and the two serve as high care beds. There is availability of one extra bed for emergencies admissions.

Optimum utilization of a scarce resource is of paramount importance. In view of these infrastructural shortcomings, the ICU has strict criteria that govern whose prognosis warrants ICU admission. (Table 1)

Table 1: Rating and priority systems used for ICU admission

Rating system	
Level 1	Convincingly justifiable on scientific evidence alone
Level 2	Reasonably justifiable by available scientific evidence and strongly supported by expert critical care opinion
Level 3	Adequate scientific evidence is lacking but widely supported by available data and critical care expert opinion
Priority system	
Priority 1	These are critically ill, unstable patients in need of intensive treatment and monitoring that cannot be provided outside of the ICU. Usually, these treatments include ventilator support, continuous vasoactive drug infusions, etc. Priority 1 patients generally have no limits placed on the extent of therapy they are to receive
Priority 2	These patients require intensive monitoring and may potentially need immediate intervention. No therapeutic limits are generally stipulated for these patients. Examples include patients with chronic comorbid conditions who develop acute severe medical or surgical illness
Priority 3	These unstable patients are critically ill but have a reduced likelihood of recovery because of underlying disease or nature of their acute illness. Priority 3 patients may receive intensive treatment to relieve acute illness but limits on therapeutic efforts may be set such as no intubation or cardiopulmonary resuscitation
Priority 4[#]	These are patients who are generally not appropriate for ICU admission. Admission of these patients should be on an individual basis, under unusual circumstances and at the discretion of the ICU Director.

Footnotes: [#] these patients can be placed in the following categories: 1) little or no anticipated benefit from ICU care based on low risk of active intervention that could not safely be administered in a non-ICU setting (too well to benefit from ICU care). Examples include patients with peripheral vascular surgery, hemodynamically stable diabetic ketoacidosis, mild congestive heart failure, conscious drug overdose, etc. and 2) Patients with terminal and irreversible illness facing imminent death (too sick to benefit from ICU care). For example: severe irreversible brain damage, irreversible multi-organ system failure, metastatic cancer unresponsive to chemotherapy and/or radiation therapy.

The overall mortality of trauma patients in ICU has been shown to be between 14 % - 46%.[10, 12] Patients that have a worse outcome in ICU include burns patients, patients with a low Glasgow Coma Scale (GCS), the elderly and patients that are readmitted. High mortality rate in descending order of likelihood is seen in the following groups: burns patients, neurosurgery patients, general surgery patients and least frequently orthopaedic patients.[2-5]

Gender

Studies are more conflicting on the relevance of gender surviving trauma ICU admission. Magnotti et.al conducted a large study of 35 000 (males 24 000 and females 11 000) and did not find overall mortality rates to be of significant difference (men=5.2%, female=4.6 %).[3] However males proved to have higher morbidity as evidenced by an increased LOS (42 days vs. 11 days, p-value = 0.304).[3] this remains a point of interest.

Age

In 2002, Taylor ET. al found patients $\geq$ 65 years to have a two-fold increase in mortality secondary to trauma as opposed to their younger counterparts.[4] Adam et.al had similar results in 2007, having taken 60 years as their definition of elderly.[5] In their sample of 120, comprising 70 males and 50 females, they had a LOS of 156 days, however a low mortality of 6%. Taking into account that this was in a first world setting where the trauma in elderly is mainly from falls. [5]

More recently, in Makerere University in Uganda, age was shown as an independent predictor of mortality in trauma patients in ICU. Their hypothesis was that the elderly patients had a worse outcome due to lack of physiological reserve.[6]

Department

Burns

Factors that have been shown to be associated with mortality on admission are: Total Body Surface Area (TBSA) burnt the depth of the burns and the presence of an associated inhalation injury. High in-hospital mortality is associated with: inadequacy of fluid resuscitation in the first 24 hours and a low temperature of the patient after 24 hours.[6-7]

A cohort retrospective study of 102 patients by Wang et.al in China found that in patients with massive burns (TBSA $\geq$70%) there was a 30 % mortality rate. The factors influencing mortality being: platelet count, sepsis and prolonged ventilation.[8] However Gupta et.al in India found the mortality rate in 75% TBSA and greater to be 98%.[7]

In patients with TBSA between 20% and 45%, the average length of stay in ICU admission is 42 days for <15%, 80 days for 15-45% and 146 days for massive burns (>50%).[8]

In another study done in Padova, Italy: 50 patients were studied prospectively over 5 years.

These were patients with severe burns (described as greater than 45% in the study), 44% died in ICU with a further 10% dying in the ward post ICU discharge.[9] Sepsis was the cause of death in most cases. In the study : mean length of stay (LOS) was 36 days amongst the population that died as opposed to 18 days in the population that survived.[9]

Neurosurgery

Neurosurgical patients form a considerable burden of patients in ICU, with them having a second highest mortality rate in ICU; second only to burns. Most of these patients are young males with only 42% of the patients having operable and thus a good prognosis.[10] Salomone et.al found traumatic brain injury to account for 58% of all ICU mortalities.[11]

A Pakistan neurosurgery ICU mortality audit showed the following: a 58 % mortality rate, 31% of the mortalities were in the first 24 hours.[12] Factors influencing outcome were: mechanism of injury, age of the patient, GCS at presentation and GCS at 24 hours.[13-14]

Surgery

General surgery patients present with varied mechanisms of injury. Multiple systems tend to be involved such as: the chest, soft tissue (non-burns) injuries, and abdominal injuries. Overall, chest trauma patients who have warranted thoracotomy do worse than abdominal trauma patients.[16]

Of the abdominal trauma patients, gunshots have an increased LOS compared to blunt trauma patients (4 days vs. 9 days, p-value <0.0001). Gunshot wounds to the abdomen also incur a higher mortality rate, second only to thoracotomies (4.2% vs. 5.8%, p-value = 00018).[16-17]

Orthopaedic Surgery

Limited data is available as to isolated orthopaedic trauma patients admitted to ICU. Available data on the outcomes of trauma indicate that mortality in the elderly (>50 years) is as high as 89%, with the majority having increased length of stay (LOS =38 days). [18]

Of particular interest is that the black race was found to be a predictor of increased mortality rate following spine trauma.[18]

The rationale for this study was to elucidate what could influence 1) the mortality of patients and 2) to predict which patients would stay longer in ICU. We anticipated that this would contribute to the selection protocol and criteria to enable the best management of limited resources. Similar studies have been performed in Africa and South Africa, however none have been performed in the Free State. We sought to evaluate and review mortalities and predictors of ICU length of stay in the local setting.[23, 24, 26-28]

Aims and objectives

The aim of this study was to determine the outcome of patients that are admitted to the Intensive Care Unit (ICU) following trauma of any mechanism. In this study, outcome was measured by 1) mortality and 2) the length of stay in ICU. The secondary aims were to determine which mechanisms of injuries are the most prevalent in our hospital setting and which have the highest in hospital mortality rates and to compare how our institution fares with international norms relating to mortality and morbidity outcomes.

The researchers hypothesised that older patients would have a poorer outcome due low physiological reserve and that males would have a poorer outcome due to sustaining higher

impact injuries. Further, they hypothesised that burn patients would have a shorter length of stay but a higher mortality rate due to only severe burns and inhalation burns being admitted to ICU.

Methods

A retrospective descriptive study was performed, by means of a file review. All consecutive files of adult patients seen at Trauma Resuscitation Bay between 1 January 2011 to 31 December 2015 were reviewed. Inclusion criteria were: 1) Age ≥ 13 years, 2) Admitted directly from Trauma Unit, to ICU or via theatre (but never admitted in the ward) and 3) Length of ICU stay ≥ 24 hours

The study was approved by the Ethics committee of the University of Free State. (HSREC 46/2016).

Data was collected from files obtained through records department, ICU admission book storage department, trauma admission book and the electronic filing system (Meditech©). Data was captured simultaneously (at the location of the file) onto the Excel sheet that serves as a second copy of all data.

Methods analysed by means of SPSS 15.0 with frequencies and percentages for categorical data and means and standard deviations or medians and percentiles will be calculated per group. Groups were compared by means of 95% confidence intervals. Stepwise logistic regression analysis was performed and the odds ratios, 95% CI and p-values calculated for each risk factor in the final model. A p-value of < 0.05 was considered statistically significant. Graphs and tables were used to plot the results.

Results

A pilot study, including the first file per year over the original seven year study period, was retrieved and analysed. Following the pilot study, modifications were made to the protocol and data sheet. The original protocol included files from 2009, but this was changed, as APACHE I was used prior to 2011. Readmission data was also excluded following the pilot study. Using the modified protocol and data sheet, the following results were obtained.

In total 732 files who fulfilled the above criteria were retrospectively reviewed, 411 files were excluded due to missing data and 321 patient files were entered into the study. In total 321 files were included in the study. Of the study population 80.4 % (n= 258/321) were male and 19.6% (n=63/321) were females. There were more participants seen in December and January across all five years however the month to month variance was not statistically significant (p-value = 0.068).

Neurosurgery had the most admissions to the unit with 39.0 %(n=125/321), General surgery 30.8% (n=97/321), orthopaedic surgery 19.2% (n=62/321) and burns 11.0% (n= 37/321). Figure 1 provides information on these and other mechanisms of injury.
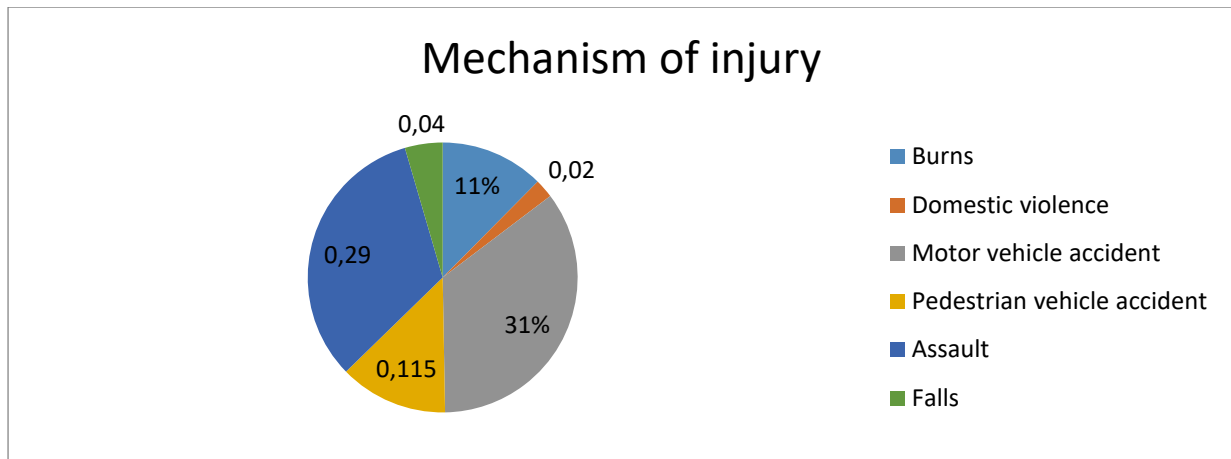
Fig.1: Illustrates mechanisms frequency. Of the 11 % (n= 36/321) burns, n=33/36 had associated inhalation injury

Age

The minimum age was 14 years (we excluded those under 13 years) and maximum, 86 years. The mean was 36.25 years and median was 33.00 years. Table 2 provides information on the mean age at death.

Table 2: Mean age at death.

Mortality	N	Mean	Std.deviation	Std.error mean
Discharged from ICU	185	35	12.822	0.943
Died in ICU	136	37.95	15.460	1.326

The mean age at death was higher at 37.95 years (that is the patients were older) than the mean age of the patients discharged (35 years). Age correlated with poorer outcomes as evidenced by a p-value = 0.016.

Gender

The correlation between gender and mortality was not statistically significant (p-value = 0.73). Table 3 provides more information on the percentage of deaths per gender group.

Table 3: Gender- Mortality cross tabulation.

	Gender	
Mortality	Males	Females
Discharged from ICU	60.1% (n=154/258)	47.60% (n=25/63)
Died in ICU	39.8% (n=104/258)	52.4% (n=38/63)

Department

Table 4 provides information on the number and percentage of deaths in each department.

Table 4: Mortality rate per department and total number of mortalities.

Mortality	Department			
	Neurosurgery	Surgery	Burns	Orthopaedics
Survivors % within department	57.0% (n=71/125)	60.3% (n=58/97)	19.4% (n=7/37)	63.6% (n=39/62)
Deaths % within department	43.0% (n=54/125)	39.7% (n=39/97)	80.6% (n=30/37)	36.4% (n=23/62)

Non-Trauma-Centre transfer-in patients

The following figures 2.1 and 2.2, provide information on the total number of transfers and what their outcome was.
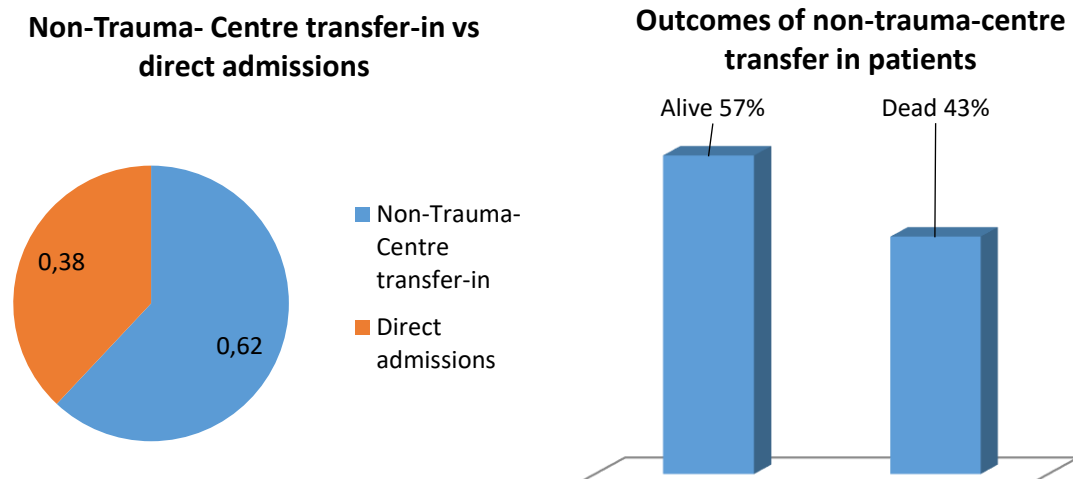

Fig. 2.1, 2.2: Illustrating total number (in percentage) of transfer in patients and their mortality outcome.

Sepsis

Of the 321 participants, 73.83 % (n= 237/321) developed sepsis in ICU and 81.6 % (n=262/321) were mechanically ventilated. The minimum ventilation day(s) was 1 and maximum 71 days with a mean of 8.23 (SD 10.486).

Of the ventilated patients (258/321), more men developed sepsis (82/258, 32%) as opposed to the women (64/258, 25%), though the difference between genders was not statistically significant (p-value =0.261).

The sepsis-mortality correlation was not statistically significant (p-value=0.216).

Readmission

Only 1.87% (n=6/321) of the participants were re-admitted to ICU, a number too small for any statistical analysis.

Mortality

Total mortality rate was 57.6% (n= 185/321) of all trauma related admission.

Discussion

In keeping with data currently available in South Africa, more young men are involved in trauma-related admissions than women, although our data did not prove this.[1]

Age as predictor of outcome

The youth, patients younger than 35 years of age stayed in ICU for a shorter time, irrespective of gender or mechanism of injury involved, and whether they were ventilated or not. Age in our study was an independent predictor of outcome in relation to length of stay, p-value=0.016. Likewise, young patients had better outcomes in terms of mortality, p-value=0.016.

Gender as predictor of outcome

Mean length of stay in ICU for women tendered to be lower than for men (7.78 days vs. 6.98 days). In this study male gender was not shown to be independent predictor of mortality; which is in keeping with international norm where gender has not been found to be an independent predictor of outcome.[3]

Mechanism as predictor of outcome

Our centre assault was the highest mechanism resulting in mortality (31%). A study done at King Edward Hospital, KwaZulu-Natal, South Africa audited 2037 patients and found that violent injuries[24] (penetrative and blunt assault only) accounted for 38.9% of all admissions, with admissions due to violence contributing 67.3% and 55.7% to red-code and orange-code injuries respectively. In this study one patient with multiple mechanisms of injury counted in all the different categories of violence. This means that violence-related injuries form a considerable part of the work-load of the trauma unit.[24] in this study we did not find mechanism of injury to be an independent predictor of mortality (p-value=0.092). Further knowledge of the time of the incident, and the weapons used to cause injury would help to eliminate possible confounding variables, and to ascertain mechanism as an independent predictor. However this information would be difficult as patients are often under the influence of alcohol and other drugs of abuse when they report for treatment, which complicates history taking and documentation. Injury severity score has been subject to more study, and could give more information in future studies.

Department as predictor of outcome

The highest mortality rate was reported for burns patients (80.6%) followed by neurosurgery patients (43.0%), surgical patients (39.7%) and, lastly, orthopaedic surgery patients (36.4%). In the southern African context, Tobi et.al studied the outcomes of traumatic brain injuries in ICU: In total, they report a mortality rate of 52.2%.[23] Also, the 182 patients in their sample contributed to 14% of the ICU admission burden, and had a significantly increased LOS (> 21 days); in this study the male gender also correlated with higher mortality. These findings correlate with a Kenyan study, by Opondo et.al, which found a mortality rate of 54%. Yusuf et.al. In Nigeria found 70% mortality in a resource-depleted ICU.[26]Our results could be influenced by the fact that 13% of the neurosurgery mortalities were polytrauma patients that were also among the surgery participants. Burns have fewer admissions than reported in literature in the first world countries. Chayla et.al, in a Tanzanian study similar to our own found similar admission statistics with burns (2.9% of all trauma ICU admissions).[28]

Length of stay

In our study, in contrast to other studies, a longer LOS did not correlate with worse outcomes. A similar trend was demonstrated in a large retrospective study based on national trauma bank data in India, by Kisat et.al. : They found an inverse relationship between LOS and mortality rate among 600 000 patients with > 85% survival maintained in the patients who stayed longer than 40 days. Further, they demonstrated that critically injured adults usually die within the first 7 days, and for those who did not develop sepsis, the tide usually turned and they survived.[25] In this study a longer time between arrival and being admitted to ICU correlated with worse outcomes (p –value <0.035). Mean LOS for participants who were transferred in was 7.74 days, which was not found to be statistically different than direct admission patients (9.26 days, p-value=0.31). However, these statistics have to be correlated further, according to the different centres and distances in kilometers between the primary centre and our referral centre. Our hypothesis is that the distance self-selected patients, with some patients dying in transit; only the ones with good prognostic factors arrived at our centre.

Mechanical ventilation

Mechanical ventilation correlated with poorer outcomes in mortality (p=value 0.0012), and increased LOS (63 days vs. 9 days, p-value 0.006). Our results contradict those of a study that reviewed outcomes of major-trauma patients who required prolonged mechanical ventilation and found a correlation between increased LOS with a median of 50 days a mortality rate of only 6.5%.[31]

Too many variables account for mechanical ventilation, as different patients in the population group are ventilated for a myriad of reasons and periods, thus it is difficult to isolate mechanical ventilation as an independent predictor of mortality.

Sepsis

Only three participants developed sepsis without having being ventilated, two of which were burns patients. This finding seems to suggest a correlation between mechanical ventilation and sepsis however an audit of the different septic foci, and day on ventilator when the sepsis

developed would be prudent to ascertain such a relationship, as not all of the sepsis cases involved well-studied ventilator-associated pneumonia.

More ventilated male patients (32%) developed sepsis than female patients (25%); however, this finding was not statistically significant (p-value=0.26100). Studies have shown that the male gender is an independent risk factor for sepsis after trauma.[29-30] in our study a higher sepsis rate was found in assault patients. Although there is no data to suggest this: we postulate sepsis could have been caused by the assault wound itself from weapons of questionable sterility. No statistical difference was found in the incidence of sepsis rate in non-trauma-centre transfer in patients and the direct admission patients (p-value=0.083); this difference could be extrapolated as a marker of prompt, appropriate transfer from the referral centre. Surprisingly, we failed to demonstrate a correlation between increased LOS and sepsis (p-value=0.74).

Non-trauma centre transfer

In the literature, non- trauma centres are expected to transfer-in worse resuscitated patients and these non-trauma-centre experience higher mortality and morbidity amongst their patients. The minimum time gap between admissions at trauma resuscitation bay to admission in ICU was 30 min and maximum time was 37 hours with a mean of 8.67 hours (SD 7.01014).

A nationwide population-based study in Taiwan that involved 2497 patients, found that non-trauma-centres patients have a risk of dying and morbidity that is 1.89 times more than for those patients seen primarily at trauma-centres. (Our results, as shown in figure 2.1 and figure 2.2 are different).

Mortality

Our mortality rate was higher than reported by most international centres (57.6% vs. 46%).[10,12] A retrospective study of adults hospitalised in both Level 1 and Level 2 trauma centres, by Megan et.al. in 2013 to evaluate complications and in-hospital mortality of trauma patients treated in ICU found a 10.7% mortality rate for non-complicated patients (i.e. did not develop sepsis) and a rate of 16.9% for patients who did develop sepsis.[33] Most international literature cites mortality rates between 8% and 17%, closer to home, however, in Tanzania and Uganda, mortality rates of 32.7% and 38% respectively are reported in similar studies. Adneken in Nigeria reports a 52.3% mortality rate. [6, 28, 34]

Limitations of the study

The retrospective nature of the study was a limitation, as more adequate history of mechanism of injury and, time of injury, prospectively analysed would be of assistance.

More than half of the trauma-ICU admissions in our study period had missing data (and were thus, excluded) and that may have influenced our results.

Future research

The question of why neurosurgery patients have a higher probability of mortality and morbidity in relation to the GCS at presentation, intra-cerebral findings and diagnosis, should be answered to contextualise our findings.

This study reviewed rather a heteregenous cohort, we recommend future studies to have a more homogenous group and to asses Burns as a separate cohort.

Conclusion

Trauma still poses a serious burden of mortality and ICU admissions in South Africa, and our centre is no different. We could not establish a specific injury that predisposes a patient to a worse outcome than another injury. Patients from non-trauma centres did not correlate with an increased LOS or mortality rate, or a higher sepsis rate; which is possibly an indicator of adequate resuscitation and, stabilisation and the presence of effective referral systems around our centre in particular.

Elderly females were not shown to have poorer outcomes. Burn patients proved our hypothesis in that they had a higher mortality rate in our institution. This can be studied in the future as a specific cohort and separate factors predicting this high mortality.

Our mortality rate is considerably higher than international trends and this finding needs to be elucidated further. Due to inadequate numbers, the study cannot make recommendations to effect a difference in current ICU admission criteria.

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Appendix A: HSREC ethics letter of approval

UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0001187
FWA00012784

14 September 2016

DR RB NDAKU
C/O DR NE PEARCE
DEPT GENERAL SURGERY
FACULTY OF HEALTH SCIENCES
UFS

Dear Dr RB Ndaku

HSREC NR 46/2016
DR RB NDAKU
DEPT GENERAL SURGERY
PROJECT TITLE: FACTORS PREDICTING OUTCOME IN ADULT TRAUMA PATIENTS ADMITTED TO A TERTIARY ICU

1. You are hereby kindly informed that the Health Sciences Research Ethics Committee (HSREC) approved the above project with note to why the previously stipulated conditions of conditional approval were not met. This is seen as an administrative issue, and not an ethical issue. This decision will be ratified at the next meeting to be held on 20 September 2016.

2. The Committee must be informed of any serious adverse event and/or termination of the study.

3. Any amendment, extension or other modifications to the protocol must be submitted to the HSREC for approval.

4. A progress report should be submitted within one year of approval and annually for long term studies.

5. A final report should be submitted at the completion of the study.

6. Kindly use the **HSREC NR** as reference in correspondence to the HSREC Secretariat.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite). Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences

Yours faithfully

DR SM LE GRANGE
CHAIR: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE

Health Sciences Research Ethics Committee
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www.ufs.ac.za

23

Appendix B: FSDoH letter of approval

health
Department of
Health
FREE STATE PROVINCE

03 May 2016

Dr RB Ndaku
C/O Dr NE Pearce
Dept. of General Surgery
Faculty of Health Science
UFS

Dear Dr RB Ndaku

Subject: Factors predicting outcome in adult trauma patients admitted to a tertiary ICU.

- Permission is hereby granted for the above – mentioned research on the following conditions:

- Serious adverse events to be reported and/or termination of the study

- Ascertain that your data collection exercise neither interferes with the day to day running of Pelonomi Hospital nor the performance of duties by the respondents or health care workers.

- Confidentiality of information will be ensured and no names will be used.

- Research results and a complete report should be made available to the Free State Department of Health on completion of the study (a hard copy plus a soft copy).

- Progress report must be presented not later than one year after approval of the project to the Ethics Committee of the University of the Free State and to Free State Department of Health.

- Any amendments, extension or other modifications to the protocol or investigators must be submitted to the Ethics Committee of the University of the Free State and to Free State Department of Health.

- **Conditions stated in your Ethical Approval letter should be adhered to and a final copy of the Ethics Clearance Certificate should be submitted to khusenj@fshealth.gov.za or sebeelats@fshealth.gov.za before you commence with the study**

- No financial liability will be placed on the Free State Department of Health

- Please discuss your study with the institution managers/CEOs on commencement for logistical arrangements

- Department of Health to be fully indemnified from any harm that participants and staff experiences in the study

- Researchers will be required to enter in to a formal agreement with the Free State department of health regulating and formalizing the research relationship (document will follow)

- You are encouraged to present your study findings/results at the Free State Provincial health research day

- Future research will only be granted permission if correct procedures are followed see http://nhrd.hst.org.za

Trust you find the above in order.

Kind Regards

Dr D Motau
HEAD: HEALTH
Date:

Appendix C: Head of Department of Surgery letter of approval

UNIVERSITY OF THE
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VRYSTAAT
YUNIVESITHI YA
FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

11 October 2019

To Whom it may concern,

Re: Dr Ndaku

I approve of her submission of her research - Factors predicting outcome in adult trauma patients admitted to a Tertiary ICU - for marking

Dr N Pearce
HOD Surgery

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Appendix D: Supervisor letter of approval

UNIVERSITY OF THE FREE STATE
UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

11 October 2019

To Whom it may concern,

Re: Dr Ndaku

I approve of her submission of her research - Factors predicting outcome in adult trauma patients admitted to a Tertiary ICU - for marking

Dr N Pearce
Supervisor

<u>TITLE</u>

Factors predicting outcome in adult Trauma Patients admitted to a Tertiary Intensive Care Unit.

<u>RESEARCHER</u>

NDAKU RB

MBCHB

REGISTRAR: DEPARTMENT OF SURGERY, UNIVERSITY OF THE FREE-STATE

CONTACT DETAILS:

      Cell number: 073 829 7005

      Email address: ndakureah@gmail.com

<u>SUPERVISOR</u>

PEARCE NE

MMED, FCS, Cert. VASCULAR SURGERY

ACTING HEAD: DEPARTMENT OF SURGERY, UNIVERSITY OF THE FREE-STATE

CONTACT DETAILS:

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<u>INTRODUCTION</u>

Trauma remains the single most important cause of mortality and morbidity in South Africa. Unnatural causes account for up to 42% of mortality in the youth aged between 20-24 years. A category of external causes of injury is the highest cause of mortality. This category includes the following mechanisms: inhalations, flame and electrical burns, and drowning. Motor vehicle accidents are followed by assaults.[1]

With increasing burden of trauma results an increase in the demand for intensive care unit for injuries that warrant such specialized care. In our setting as is the international norm, intensive care services are not as readily available as should be for an institution of our capacity.

In our setting the intensive care unit is a multi-disciplinary Unit of only 9 Adult beds that cater for General Surgery, Trauma, Urology, Orthopaedics, Neurosurgery and Internal Medicine patients. Optimum utilization of a scarce resource is of paramount importance. In view of these infrastructural shortcomings, the intensive care unit has strict criteria that govern who can and cannot be admitted into the Unit.

If accurate factors that predict prognosis or outcome of especially trauma patients are established, this might impact the decision of which patients would best benefit from the limited resources, hence the influence upon the existing admission criteria/policy

Current Intensive care unit criteria are attached in the appendices.

BACKGROUND

The overall mortality of trauma patients in Intensive Care Unit has been shown to be between 13.9 % - 66%. The morbidity of readmission being in patients with a low Glascow coma scale and poor mobility on the first admission's discharge. Burns patients tend to have higher mortality rate, followed by neurosurgery patients. General surgery patients have however a longer ICU and total in hospital stay as opposed to other patients. The elderly has poorer outcomes. Gender has not been invariably shown to be a single predictor of mortality. [2,3,4,5]

- BURNS

Predictors of outcome in burn patients is related to the Total Body surface burnt, the grading of the burns and whether there is inhalation injury or not. Secondary predictors include the adequacy of fluid resuscitation in the first 24 hours and the temperature of the patient at presentation.[6, 7]

A cohort retrospective study of 102 patients done by Wang and colleagues found that in patients with massive burns (TBSA ≥70%) there was a 30.4 % mortality rate. The factors influencing mortality being: platelet count, sepsis and ventilator and ionotropic support dependency.[8] However Gupta and colleagues in India found the mortality rate in 75% TBSA and greater to be at 98.3% ,[7] which would most likely correlate with our South African Perspective if they were ICU candidates.

In patients with lesser TBSA (20% TBSA-45%), the average length of stay in total from day of ICU admission to day of discharge to home is 42 days for <15%, 80 days for 15-45% and up to 146 days for massive burns, with 3 separate theatre slots for debridement and split skin grafts.

Common complications are wound sepsis and Acute Respiratory Distress Syndrome in the first world. [7] The commonest microbes cultured from the wounds are Pseudomonas and Acinetobacter.[7]

In another study done in Padova, 50 patients were studied prospectively over 5 years. These were patients with severe burns (described as greater than 45% in the study), 44% died in ICU with a further 10% dying in the ward post ICU discharge.[9] Most of the deaths were due to sepsis complication. Their non survivors mean average stay was 36 days with the survivors mean average hospital stay being 18 days.[9]

Early escharatomies and early grafting are cited as positive contributory factors of a favourable outcome.[7, 8, and 9]

Self- inflicted burns also tend to have a poorer outcome, with 39% needing intensive care admission, 25% of which die. Flame is the instrument of choice in the self-harming burn population.[2]

- GENDER

Studies are more conflicting on the relevance of gender surviving trauma and the Intensive care unit. My hypothesis is that the outcome will be more influenced by the mechanism of

injury. Gender acts as a surrogate marker of the intensity of the mechanism of injury sustained by males and thus males have poorer outcome. Women injuries are mainly due to domestic violence and suicide attempts, with more of them electing to burn and cut. In an attempt to silence the debate once and for all, Magnotti, Fischer and colleagues conducted a massive study of 11 375 and 24 331 females and males respectively. They found overall mortality rates to not be of significant difference, with men 5.2% and female 4.6 %.[3] However males proved to have higher morbidity as evidenced by length of in-hospital stay.

- AGE

Of the total deaths in South Africa in 2013, only 17% were in the youth between the ages of 19-34 years. Although the youth may be leading risky lives, they seem to live longer none the less.[1] the need then arises to asses and review the mechanisms of injury of the elderly and how they survive trauma and the Intensive Care Unit. My hypothesis is that patients older will have lower rates of trauma presentations, however this will be the group with the highest mortality.

In 2002, Taylor, Tracey and colleagues found patients ≥ 65 years to have a two-fold increase in mortality secondary to trauma as opposed to their younger counterparts.[4]Adam and his colleagues had similar results in 2007, having taken 60 years as their definition of elderly they sought to discover what the outcome of trauma patients and ICU admission secondary to trauma is in this age group. In their sample of 120, of which 70 were males and 51 females; they had a protracted average hospital stay of 156 days, however a low mortality of 6%. Taking into account that this was in a first world setting where the trauma in elderly is mainly falls, the patients that were involved in Pedestrian accident were the majority of the mortality stay.[5]

More recently, in Makarere University in Uganda, age was shown as an independent predictor of mortality in trauma patients in ICU, mainly due to lack of physiological reserve.[6]

NEUROSURGERY

Neurosurgical patients form a considerable burden of patients in ICU, with them having a second highest mortality in ICU; second only to burns. Most of these patients are young males with only 42% of the patients having operable and thus salvageable lesions.[10] Salomone and his colleagues found traumatic brain injury to account for 58% of all ICU mortalities.[11]

In Pakistan an audit was done of the mortality of patients in a neurosurgical intensive care unit. The results should however be extrapolated and applied with caution to our setting as it is firstly, an isolated neurosurgery unit which translates into lower sepsis risk and more specialized personnel delivering superior care. This study showed that of the 112 patients enrolled, 58 % died, with 31% dying in the first 24 hours.[12]

Factors influencing outcome are GCS at presentation, GCS at 24 hours, and age of the patients and mechanism of injury.[13, 14] A Glascow Coma Scale of less than 9 at presentation had a mortality of 19% and skull base fracture being the injury with the highest mortality at 10 % in one study.[4]

In recent history, 60 patients were studied with traumatic brain injuries, 25 % of which died in ICU and a further 33% had prolonged length of stay described as 17 days in ICU.[15]

SURGERY

General surgery patients present with too many varied mechanisms and systems involved such as the chest, the soft tissues of the limbs and the abdomen. Overall, chest trauma patients who have warranted thoracotomy do poorer than abdominal trauma patients. Of the Abdominal trauma patients, gunshots have a longer hospital stay than blunt trauma patients. These said gunshot wounds to the abdomen also incur a higher mortality rate, second only to thoracotomies.[16, 17]

ORTHOPAEDICS

Limited data is available as to specifically and purely orthopaedic trauma patients admitted in Intensive care unit. Available data on the outcomes of trauma indicate that mortality in the elderly (>50 years) is as high as 89%, with the majority having increased length of stay. Of particular interest is that the Black/African race was found to be a predictor of mortality following spine trauma.[18]

APACHE II SCORE

The APACHE II score was released in 1985. The maximum is 71 with 25 being a 50% predictor of mortality. It is calculated in the first 24 hours of admission and not recalculated again and is the sum of the acute physiology and chronic state.

This score has been verified in international literature as an independent predictor of outcome, especially mortality. Vassar found APACHE II to be a poorer predictor of mortality with its sensitivity being as low as 38%. [19] Furthermore in 2013 Aftab Haq and colleagues validated the APACHE II score to be poorer than APACHE III with its sensitivity at 28% for mortality prediction in ICU as compared to other models.[20]

PHYSIOLOGICAL VARIABLE	+4	+3	+2	+1	0	+1	+2	+3	+4 POINTS
Temperature	>41^0	39-40.9^0		38.5-38.9^0	36-38.4^0	34-35^0	32-33.9^0	30-31.9^0	≤29.9^0
Mean Arterial Pressure	≥160	130-159	110-129		70-109		50-69		≤49
Heart Rate	≥180	140-179	110-139		70-109		55-69	40-54	≤39
Respiratory rate	≥50	35-49		25-34	12-24	10-11	6-9		≤5
Oxygenation(mmHg)	≥500	350-499	200-349		<200				
a.FI02≥0.5									
b.FI02<0.5					Po2>70	Po2 61-70		Po2 55-60	Po2<55

Arterial Ph	≥7.7	7.6-7.69		7.5-7.59	7.33-7.49		7.25-7.32	7.15-7.24	<7.15
Serum HCO₃	≥52	41-51.9		32-40.9	22-31.9		18-21.9	15-17.9	<15
Serum Sodium	≥180	160-179	155-159	150-154	130-149		120-129	111-119	≤
Serum Potassium (mmol/L)	≥7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		<2.5
Serum Creatinine (mg/dL)	≥3.5	2-3.4	1.5-1.9		0.6-1.4		<0.6		
Haematocrit	≥60		50-59.9	46-49.9	30-45.9		20-29.9		<20
White cell Count	≥40		20-39.9	15-19.9	3-14.9		1-2.9		<1
Glascow Coma Scale									
Score + 15 minus actual GCS									

Fi02 = Fraction of inspired oxygen, that is the concentration of oxygen inhaled in each breath.

Glascow coma scale is a scale that measures level of consciousness. The total is 15 and the least a patient can score is 3, depending on whether they are intubated or not.

APACHE II score is best used at discharge to evaluate/predict readmission to ICU. Our center currently uses the APACHE II score on admission of the trauma patients to ICU, hence the study uses this scoring tool.

This study will use mechanical ventilation and sepsis as markers of morbidity.

OBJECTIVE

The aim of this study is to correlate the outcome of patients that are admitted to the Intensive Care Unit (ICU) following trauma of any mechanism. In this study, outcome is measured by: 1. Morbidity and 2. The length of stay in both the ICU and the total stay in the hospital. The secondary aims would be to:

- Illustrate which mechanisms of injuries are the most prevalent in our hospital setting and which have the highest fatalities.
- Compare how our institution fares with international norms

The Hypothesis is that:

- Older females will have a higher apache score and thus have a poorer outcome
- Orthopaedic and burn patients will have a shorter length of stay but a higher mortality

Studies in Africa have been done, however we seek to evaluate and review the Free-State perspective. Higgins and Thomas did also a similar study in 27 hospitals in South Africa, however this was not specifically on trauma patients.

STUDY DESIGN

A cross-sectional study.

STUDY SAMPLE

Few patients are admitted to the ICU straight from trauma, as such the study would have to run over more than five years were a prospective analysis undertaken. Future studies can follow prospectively to compare and review how far, in terms of outcome the Institution is.

On average 156 patients are seen monthly at the Trauma department, however only 2 on average are admitted to ICU.

Seven years ago, the noting of patient notes in the trauma unit was changed to a more comprehensive record. For this reason, this study will only look at files from the previous seven years to limit incomplete data.

In a similar study, Hefny and colleagues[6] looked at 202 patients; similarly, this study will look at an estimated 168 patients over the seven years.

The Inclusion criteria will be the following:

- Age > 13 years and including 13 years
- Straight from Trauma Unit, to ICU or via theatre, but never admitted in the ward
- Admitted in ICU > 24 hours

The Exclusion criteria will be the following:

- Patients younger than 13 years
- Patient that are transferred from the general ward to ICU
- Incomplete data/record

MEASUREMENT

The study will consist of retrospectively identified, consecutive trauma admissions. The medical files, electronic and paper will be retrospectively looked into by the Researcher mentioned on the first page. The trauma statistics book will be used to see which patients were transferred to ICU. Only files of patients that are already either discharged or dead will be used.

Data will be collected by the researcher weekly. This will be done from the computers in the Trauma Resuscitation bay at Pelonomi hospital. Files will also be viewed and thus data collected room the trauma and ICU file storage rooms that is located on the second floor of the above-mentioned hospital. Data will be captured simultaneously (at the location of the file) onto the Excel sheet that serves as a second copy of all data.

Information that will be captured on data forms is the following:

Demographics

PM number

Age

Gender

Date of Admission

Time of Arrival

Referred in or local

Trauma Rhesus

Mechanism of injury

Time of Injury

 Time of ICU consult

 Time/date of ICU admission

In ICU

Apache at admission

mechanical ventilation

sepsis

date of ICU discharge

In the ward

date of hospital discharge

if ICU readmission, date of ICU
admission

Data Form abbreviations:

MVA =Motor Vehicle Accident

PVA = Pedestrian Vehicle
Accident

GSW = Gunshot Wound

DOM = Domestic

MEASUREMENT AND METHODOLOGICAL ERRORS

Time:

- The commencement of the study will rely on the consent from the relevant institutions, and ethics approval. That might take time and result in unprecedented delays.

Data Integrity:

Data will be typed on paper and also entered onto an Excel sheet to preserve it.

Missing data:

- Poor documentation of diagnosis, meditech discharge summaries will affect the completeness of data. Both computer and paper file notes will be checked to verify any data that might be missing.

PILOT STUDY

A pilot study will be conducted with one file from each of the seven years. The first file of each year will be selected. These data sheets will be included in the data analysis once any errors (if there be) have been corrected.

DATA ANALYSIS

This will be undertaken by Department of Biostatistics of the University of the Free State:

Frequencies and percentages for categorical data and means and standard deviations or medians and percentiles will be calculated per group. Groups will be compared by means of 95% confidence intervals. Stepwise logistic regression analysis will be performed and the odds ratios, 95% CI and p-values will be calculated for each risk factor in the final model.

A p-value of < 0.05 will be considered statistically significant.

Graphs and tables will be used to plot the results.

VALUE OF THE STUDY

Should this study establish a significant predicting factor in a particular group of patients, this information may be used to amend appropriately the ICU admission criteria.

TIME SCALE

The project is anticipated to run over two years to completion.

Planning	: September 2015 2016
Ethics approval	: May 2016
Data collection	: June 2016-March 2017
Data analysis	: April-Dec 2017
Writing of article	: Jan 2018- June 2018

BUDGET

Stationery (Paper, Pens and 5x hardcover files to store data forms), all to the value of R500.00

Data will be collected at place of work of the Researcher, therefore no transport will be used.

The budget for the entire will be funded by the Researcher.

ETHICAL ASPECTS

Data will be captured on the data sheet in the hospital premises and stored in a data file in a locked cupboard in the residence of the Investigator until such a time as is required for data analysis by the Department of Biostatistics.

No doctor or any member of nursing staff will be interviewed, data will strictly be obtained from the Medi-tech system and from the files kept in Trauma Resuscitation Unit and the Intensive Care Unit.

Data will be captured at the Hospital, only the research team (Researcher, Study Leader and Biostatistician) will have access to these data sheet.

Only the Hospital Number of the patients will be captured, not the name nor the date of birth, to ensure confidentiality of the participants

The said hospital number will be captured for legitimacy; however, it will not be coded for.

Ethics approval of the protocol will be obtained from the Ethics Department of the UFS.

Hospital numbers of the patients will be noted but not coded for.

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APPENDICES

E (i) Data sheet

E (ii) Consent letter, Department of Health

E (iii) Current ICU admission criteria

Appendix E (i)

FACTORS PREDICTING OUTCOME IN ADULT TRAUMA PATIENTS ADMITTED TO A TERTIARY

DATA FORM NUMBER						
PM NUMBER						not coded
AGE	⬜⬜ yrs				⬜	1
GENDER	M 1	F 2			⬜	2
DATE OF ADM	DD MM YY				⬜⬜	3
TIME OF ARRIVAL	HH MM (24HR)				⬜ : ⬜	4
TRANSFER	Y 1	N 2			⬜	5
MECHANISM OF INJURY						
MVA	⬜		1		⬜	6
PVA	⬜		2		⬜	7
ASSAULT	⬜		3		⬜	8
BURNS	⬜	TBSA	4		⬜	9
INHALATION	Y 1	N 2	5		⬜	10
GSW	⬜		6		⬜	11
FALLS	⬜		7		⬜	12
DOM.VIOLENCE	⬜		8		⬜	13
DEPARTMENT						
NEUROSURGERY	⬜				⬜	14
SURGERY	⬜				⬜	15
BURNS	⬜				⬜	16
ORTHOPAEDICS	⬜				⬜	17
TIME OF INJURY	HH MM				⬜ : ⬜	18
TIME OF ICU CONSULT	HH MM				⬜ : ⬜	19
DATE OF ICU ADMISSION	DD MM YY				⬜⬜⬜	20
APACHE AT ADMISSION	⬜⬜				⬜⬜	21
MECHANICAL VENTILATION	Y 1	N 2	NO.OF DAYS		⬜	22
					NO. OF DAY	23
SEPSIS	Y 1	N 2			⬜	24
DATE OF ICU DISCHARGE	DD MM YY				⬜⬜⬜	25
DATE OF HOSPITAL DISCHARGE	DD MM YY				⬜⬜⬜	26
DATE OF DEATH	DD MM YY				⬜⬜⬜	27
ICU READMISSION	Y 1	N 2			⬜	28
DATE OF ICU READMISSION	DD MM YY				⬜⬜⬜	29

<div style="text-align: right">

Ndaku RB
12 Mon Cherie. Anna Nettling Pohl
Langenhovenpark
Bloemfontein.
9300

</div>

Office of the MEC
Bophelo House
Free State Department of Health

Dear Dr Malakoane

PERMISSION TO CONDUCT RESEARCH IN PELONOMI TERTIARY HOSPITAL AS PART OF MMED TRAINING.

My name is Ndaku RB. I am one of the Registrars in the Department of Surgery, University of the Free State. As part of the MMed program, we are required to conduct a research project. I would hereby like to apply for grant of permission to conduct a study in Pelonomi Tertiary Hospital.

My project is proposed to be conducted at Pelonomi Tertiary Hospital over a period of three years. Only patient files will be used and is subject to preliminary approval by the Ethics Committee of the University of the Free State.

Title of the study: FACTORS OUTCOME IN ADULT TRAUMA PATIENTS ADMITTED TO A TERTIARY ICU

The study Protocol is attached for your convenience and perusal.

For any further clarity please contact me on:

E-mail: ndakureah@gmail.com
Cell: 073 829 7005

Regards

Ndaku RB
MBChB: MP 0748811

LEVELS OF RECOMMENDATIONS FOR THE INTENSIVE CARE UNIT

The Intensive Care Unit serves as a place for monitoring and care of patients with potentially severe physiological instability requiring technical and/or artificial life support. The level of care in an ICU is greater than that available on the floor or Intermediate Care Unit.

RATING SYSTEM

Level 1: Convincingly justifiable on scientific evidence alone

Level 2: Reasonably justifiable by available scientific evidence and strongly supported by expert critical care opinion

Level 3: Adequate scientific evidence is lacking but widely supported by available data and critical care expert opinion

PRIORITY SYSTEM

Priority 1: These are critically ill, unstable patients in need of intensive treatment and monitoring that cannot be provided outside of the ICU. Usually, these treatments include ventilator support, continuous vasoactive drug infusions, etc. Priority 1 patients generally have no limits placed on the extent of therapy they are to receive.

Priority 2: These patients require intensive monitoring and may potentially need immediate intervention. No therapeutic limits are generally stipulated for these patients. Examples include patients with chronic comorbid conditions who develop acute severe medical or surgical illness.

Priority 3: These unstable patients are critically ill but have a reduced likelihood of recovery because of underlying disease or nature of their acute illness. Priority 3 patients may receive intensive treatment to relieve acute illness but limits on therapeutic efforts may be set such as no intubation or cardiopulmonary resuscitation.

Priority 4: These are patients who are generally not appropriate for ICU admission. Admission of these patients should be on an individual basis, under unusual circumstances and at the discretion of the ICU Director. These patients can be placed in the following categories:

- Little or no anticipated benefit from ICU care based on low risk of active intervention that could not safely be administered in a non-ICU setting (too well to benefit from ICU care). Examples include patients with peripheral vascular surgery, hemodynamically stable diabetic ketoacidosis, mild congestive heart failure, conscious drug overdose, etc.

Patients with terminal and irreversible illness facing imminent death (too sick to benefit from ICU care). For example: severe irreversible brain damage, irreversible multi-organ system failure, metastatic cancer unresponsive to chemotherapy and/or

Appendix F: HSREC approved modified Data Sheet post Pilot Study

FACTORS PREDICTING OUTCOME IN ADULT TRAUMA PATIENTS ADMITTED TO A TERTIARY ICU

DATA FORM NUMBER		
PM NUMBER		not coded
AGE ____ yrs		1
GENDER M 1 F 2		2
DATE OF ADM DD MM YY		3
TIME OF ARRIVAL HH MM (24HR)		: 4
TRANSFER Y 1 N 2		5

MECHANISM OF INJURY

MVA	1	6
PVA	2	7
ASSAULT	3	8
BURNS TBSA	4	9
INHALATION Y 1 N 2	5	10
GSW	6	11
FALLS	7	12
DOM.VIOLENCE	8	13

DEPARTMENT

NEUROSURGERY	14
SURGERY	15
BURNS	16
ORTHOPAEDICS	17

TIME OF INJURY HH MM	: 18
TIME OF ICU CONSULT HH MM	: 19
DATE OF ICU ADMISSION DD MM YY	20
APACHE AT ADMISSION	21
MECHANICAL VENTILATION Y 1 N 2 NO.OF DAYS	22
	NO. OF DAY 23
SEPSIS Y 1 N 2	24
DATE OF ICU DISCHARGE DD MM YY	25
DATE OF HOSPITAL DISCHARGE DD MM YY	26
DATE OF DEATH DD MM YY	27
ICU READMISSION Y 1 N 2	28
DATE OF ICU READMISSION DD MM YY	29

Appendix G: Instructions to Authors of the SAMJ

SAMJ instructions to authors

Accepted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction, which will delay publication.

General:

- Manuscripts must be written in UK English.
- The manuscript must be in Microsoft Word format. Text must be single-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes).
- Please make your article concise, even if it is below the word limit.
- Qualifications, *full* affiliation (department, school/faculty, institution, city, country) and contact details of ALL authors must be provided in the manuscript and in the online submission process.
- Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.
- Include sections on Acknowledgements, Conflict of Interest, Author Contributions and Funding sources. If none is applicable, please state 'none'.
- Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dL).
- Litres is denoted with an uppercase L e.g. 'mL' for millilitres).
- Units should be preceded by a space (except for % and ºC), e.g. '40 kg' and '20 cm' but '50%' and '19ºC'.
- Please be sure to insert proper symbols e.g. μ not u for micro, a not a for alpha, b not B for beta, etc.
- Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160.
- Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'
- Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.

Appendix H: TURNITIN Plagiarism summary Report

Factors Predicting Outcome in Adult Trauma Patients Admitted to a Tertiary ICU

ORIGINALITY REPORT

14%	12%	13%	11%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.learnicu.org Internet Source	7%
2	phcfm.org Internet Source	1%
3	Meghan Prin, Guohua Li. "Complications and in-hospital mortality in trauma patients treated in intensive care units in the United States, 2013", Injury Epidemiology, 2016 Publication	1%
4	preview-bmcemergmed.biomedcentral.com Internet Source	1%
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| 12 | Lansky, A.J.. "Outcomes of percutaneous and surgical revascularization in women", Progress in Cardiovascular Diseases, 200401/02
Publication | <1% |

| 13 | ccforum.biomedcentral.com
Internet Source | <1% |

| 14 | ICU Resource Allocation in the New Millennium, 2013.
Publication | <1% |

| 15 | "Encyclopedia of Intensive Care Medicine", Springer Nature, 2012
Publication | <1% |

| 16 | journal.publications.chestnet.org
Internet Source | <1% |

| 17 | Martin A. Croce. "Does Gender Difference Influence Outcome?", The Journal of Trauma Injury Infection and Critical Care, 11/2002 | <1% |

Publication

18	Evidence-Based Critical Care, 2015. Publication	<1%
19	Submitted to University of Leeds Student Paper	<1%
20	"Poster Sessions 602-806", Intensive Care Medicine, 2004 Publication	<1%

| Exclude quotes | On | Exclude matches | < 5 words |
| Exclude bibliography | On | | |

Appendix I: Current Bloemfontein Multi-ICU admission guidelines

LEVELS OF RECOMMENDATIONS FOR THE INTENSIVE CARE UNIT

The Intensive Care Unit serves as a place for monitoring and care of patients with potentially severe physiological instability requiring technical and/or artificial life support. The level of care in an ICU is greater than that available on the floor or Intermediate Care Unit.

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hemodynamically stable diabetic ketoacidosis, mild congestive heart failure, conscious drug overdose, etc.

- Patients with terminal and irreversible illness facing imminent death (too sick to benefit from ICU care). For example: severe irreversible brain damage, irreversible multi-organ system failure, metastatic cancer unresponsive to chemotherapy and/or radiation therapy.

END