The profile of penetrating chest injuries in the South African Private Sector

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Of

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DECLARATION

I, Pravani Moodley, declare that this research report is my own work. It is being submitted for the degree of Master of Science in Medicine (Emergency Medicine) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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The 8th day of July, 2016

DEDICATION

This work is dedicated to my loving and supportive parents, Mackey and Prindha Moodley, my brother Aveshan and my late fiancé Suven Chetty.

ABSTRACT

Background

Trauma is the second most common cause of death in South Africa and has been found to be the leading cause of death in young adults. Chest injury has been of interest for many years due to the evolving nature of presentations, potential for rapid deterioration, need for aggressive resuscitation and high mortality rate.

Methods

Data was retrospectively collected from the Netcare Trauma Bank server for the period 01 October 2006 to 01 October 2011 for all patients who presented with penetrating chest trauma. The demographic profile and presenting factors including Injury Scores were analysed. The burden of disease attributable to penetrating chest injury was then evaluated.

Main Results

A total of 455 patients who met the inclusion criteria were analysed. There was a male to female predominance of 7.5:1 with an average age of 35 years. The majority of patients presented over the weekend and the leading mechanism was gunshot wounds (higher ISS and NISS). Haemopneumothoraces accounted for the majority of injury pathology and an associated abdominal injury was the predominant extra thoracic injury. There were no statistically significant relationships between demographic or presenting factors and the severity of injury. A significant number of ED procedures and a considerable length of hospital stay contributed to the overall burden of disease.

Conclusion

Penetrating chest injuries is a significant contributor to the burden of injury and disease in South Africa.

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NOMENCLATURE

Abbreviations

ALS	Advanced Life Support
BLS	Basic Life Support
bpm	beats per minute
CHBAH	Chris Hani Baragwanath Academic Hospital
CPR	Cardiopulmonary Resuscitation
CVA	Central Venous Access
DPL	Diagnostic Peritoneal Lavage
ED	Emergency Department
EDT	Emergency Department Thoracotomy
FFP	Fresh Frozen Plasma
GCS	Glasgow Coma Scale
HC	High Care
HIGH CAP	High Capacity
ICD	Intercostal drain
ICU	Intensive Care Unit
ILS	Intermediate Life Support
ISS	Injury Severity Score
IV	Intravenous
KZN	Kwa-Zulu Natal
LAP	Laparotomy
LMA	Laryngeal Mask Airway
mmHg	Millimetres Mercury
ml	millilitres

NISS	New Injury Severity Score
RTS	Revised Trauma Score
SBP	Systolic Blood Pressure
USA	United States of America

Definitions

Priority 1 trauma patient

A priority 1 trauma patient has significant physiological and/or anatomical insult that requires immediate medical attention. Categorising this patient is a complex system involving the consideration of the age of the patient, mechanism of injury, anatomical area involved and physiological derangements.

Level 1 Trauma Centre

This is a trauma centre that serves as a regional resource centre and is integral to the trauma care system. It has the capabilities to provide care for every aspect of injury including 24 hour availability to all specialities and rehabilitation.[1]

Basic Life Support

These prehospital health care personnel provide basic medical care interventions including cardiopulmonary resuscitation.[2]

Intermediate Life Support

These prehospital health care personnel provide intermediate medical interventions including intravenous cannulation.[2]

Advanced Life Support

These prehospital health care personnel provide advanced skills including airway management, intubation, drug therapy and resuscitation.[2]

Abbreviated Injury Scale

This is an anatomically based grading system. Injuries are graded on a scale of 1 to 6 where 1 represents a minor injury and 6, a non-survivable injury.[3]

Injury Severity Score

The ISS is an anatomical based scale. It is used for those patients with multiple injuries to multiple body areas.[4]

It is calculated by first establishing an AIS score for each area. The three most severely injured body regions have their scores then squared. These are then added to produce the ISS.[4]

Revised Trauma Score

This is a physiological scoring system that allocates a coded value to each of the following parameters: Glasgow Coma Scale, Systolic Blood Pressure and Respiratory Rate.[5]

It correlates well with the probability of survival.[5]

New Injury Severity Score

This is a modification of the ISS. It is the sum of the square of the three highest scores regardless of the body region.

Disability-Adjusted Life Years

This is calculated by a predetermined formula and is the number of years lost due to disability for those people who are alive and living with the effects of their initial trauma or insult.

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PREFACE

This research project was aimed at describing the profile of penetrating chest injuries in the South African private sector and ascertaining the burden of injury attributable to it. My interest in the topic was heightened when I learned that intentional injury in South Africa outnumbered accidental injury and further, that penetrating injury was the leading mechanism.

Why then, have I chosen chest injury? It has a high associated mortality and morbidity, it contributes to injury in the most productive years of life and more importantly, despite a worldwide recognition of injury in South Africa, we have yet to use available data to allocate resources and implement preventative strategies as many other countries have done and with good effect.

Chapter 1 INTRODUCTION

1.1 Motivation and rationale for this research

Trauma is the second most common cause of death in South Africa. Of all trauma types and mechanisms, chest injury is unique because of the potential for rapid deterioration, the need for aggressive resuscitation and an associated high mortality rate. The motivation for this research was based on all of the above and the need to describe this injury pattern as it affects a population in its most productive years.

1.2 Statement of the problem

Little is known about penetrating chest injury in the South African Private Sector. As the South African government begins a transformation towards equal health care for both private and state facilities, it is important to establish demographic profiles for injury mechanisms and ascertain the burden of disease attributable to these mechanisms. This information will impact on local distribution of resources, national recognition and policy making.

1.3 Aim and objectives

1.3.1 Study aim

The aim of this study was to describe the profile and ascertain the burden of disease attributable to penetrating chest trauma in the South African Private Hospital Sector.

1.3.2 Study objectives

1. To describe the profile of patients with penetrating chest trauma with respect to the age, gender, race, time of presentation, day of presentation, mechanism of injury, level of pre hospital care, presenting SBP, presenting GCS, ISS, RTS and NISS.

2. To determine if age, gender, race, time of presentation, day of presentation, mechanism of injury and level of pre hospital care is associated with the ISS, RTS and NISS.
3. To ascertain the burden of disease of penetrating chest trauma by comparing the following: level of airway management, ED procedures, diagnostic investigations, blood/fluid products used, surgical management, length of hospital stay, length of stay in ICU/High Care, number of days ventilated and number of days requiring inotropes.

Chapter 2 LITERATURE REVIEW

Introduction

The significance of chest injuries has been appreciated for thousands of years. They were first described as early as 3000 BC in the Edwin Smith Surgical papyrus and thereafter found mention from the time of the Gladiators to the Napoleonic wars.[6]

Unfortunately, it has been through the experiences of the World Wars and more recent military and civil conflict, that treatment guidelines were developed and the magnitude of the injury acknowledged.[6]

South Africa's contribution to the burden of injury is of great importance .[7] Trauma is the second most common cause of death in our country and has been found to be the leading cause of death in young adults (aged 15 – 29 years).[8] In fact, we have been shown to have an injury death rate twice that of the global average.[8]

Chest injury has been of interest for many years due to the nature of presentations, the potential for rapid deterioration, the need for aggressive resuscitation and an associated high mortality rate.[8, 9]

Injuries are often described according to the mechanism of injury. They are broadly categorized as blunt or penetrating. Blunt injury may result from various causes including motor vehicle accidents, pedestrian vehicle accidents, assault with a blunt object, fall from heights and blast type injuries.[10] Penetrating injury occurs when an object (knife, bottle, bullet, shrapnel etc.) pierces the skin and enters the tissues of the body.[10]

Penetrating injury is further categorised as low, medium or high velocity injuries.

Low velocity injuries include stab wounds. There is disruption and injury only to the structure that has been penetrated.[6]

Medium velocity injuries include bullet wounds from handguns. There is significantly less tissue damage when compared to a high velocity injury.[6]

High velocity injuries are those injuries that cause significant damage to surrounding tissue. This mechanism is most appreciated during military and other conflict.[6]

It is rather interesting, that over the past three decades in South Africa, penetrating injury still remains a significant mechanism.[8, 9]

We are unique when compared to the rest of Africa and the rest of the world where blunt injury is the leading mechanism.[8]

The exception to this, are those countries that are war torn or involved in civil conflict.[11]

An epidemiological study in Soweto, Johannesburg in the late 1980's already established strong links between trauma and interpersonal violence.[12]

Most injuries were due to a penetrating mechanism.

In the 1990's a trend towards gunshot wounds was described by Madiba and colleagues who reviewed all patients admitted to the King Edward VIII Hospital in Kwa-Zulu Natal (KZN) during 1994.[13] Interestingly, it was in 1994, that South Africa saw the dawn of a new democracy and although not documented in the article, one can infer a likely political association.

A second group of researchers from King Edward VIII Hospital further demonstrated a changing pattern of injury from 1983 to 1992.[14]

They found that stab wound injury had decreased by thirty percent (30%) and gunshot wounds had increased alarmingly by eight hundred and seventy three percent (873%). Injuries involving the chest had dramatically increased from three (3) per month in 1983 to three (3) per week in 1992.[14]

In 1991, a six month analysis of all patients with penetrating chest injuries as a result of a stab wound or other sharp objects was carried out in Cape Town.[15] There were two hundred and forty eight (248) deaths recorded in this period (both in hospital and out of hospital). It would have been interesting to know the deaths due to gunshot wounds and if the figures were comparable to the KZN figures during the same period.

In more recent years, and more specifically in the public health sector, the trend has been towards a dominance of stab wounds. Over three years at the Pietermaritzburg Metropolitan Complex in KZN, there were one thousand and sixty two (1062) stab wounds and one hundred and twenty four (124) gunshot wounds.[9]

Professor E Degiannis showed that the predominant mechanism in penetrating cardiac injuries was stab wounds when he conducted a retrospective study at the Chris Hani Baragwanath Academic Hospital, Johannesburg.[16]

In the African context, South Africa is very unique. In Tanzania at the Bugando Medical Centre, a total of one hundred and fifty (150) patients with chest injuries were seen.[17] Blunt trauma accounted for the majority of injury. This was similarly demonstrated in Cameroon and Uganda.[18, 19]

The only African country that has shown similar patterns to South Africa has been Nigeria. In the late 1990's, a crime surge in Northern Nigeria coupled with local

conflict over farms resulted in the predictable predominance of penetrating injuries.[20]

Several Injury Severity Scores have been developed over the years and stand as internationally accepted tools for the stratification of injury severity.[21]
Injury severity scores are thought to be a fundamental component of the assessment and prognostication in trauma patients.[22]

The AIS which is the basis for both the ISS and the NISS, has been used independently to stratify chest injuries over the years. It has been found that the inter rater agreement is higher for blunt versus penetrating injury.[22]
Another pitfall of both the AIS and the ISS is incorrectly scoring an injury and therefore falsely elevating both scores.

In an analysis of all trauma deaths over a 3 year period in Los Angeles County (USA), it was found that the AIS was a significant independent risk factor for the prediction of death.[23] It was found that a chest AIS score of 4 or more correlated with death mainly in the first hour of arrival to hospital. Interestingly, fatalities resulting from penetrating injuries were significantly more likely to have critical injuries to the chest and abdomen.[23]
This was similarly demonstrated in another single Level 1 Trauma Centre study in Rotterdam, Holland where it was found that a chest AIS score of 4 or more and a penetrating trauma mechanism was strongly linked to death within 1 hour of admission.[24]

Both the ISS and NISS are statistically important variables associated with mortality.[25, 26] There is also a strong association with both length of hospital stay and admission to ICU.[27]

The RTS also reliably predicts mortality.[27] In fact; a RTS score of less than 4.5 is associated with a 50% chance of death.

The value of trauma scores, apart from all that has been described, includes improved prehospital care, improved trauma systems, enhanced ability to evaluate care and provides a way to compare different trauma groups.[27]

Demographics

The demographic profile of penetrating chest injuries has remained quite predictable over the years.

As far back as the late 1970's and early 1980's, a staggering male to female ratio of 21.2:1 was described by Swann and colleagues in Glasgow.[28] They further described an at risk group comprising men in their 20's.

Around the same time in in Los Angeles, USA, a group of researchers had started a, what would eventually span 24 years, description of penetrating chest wounds.[29] They described a male to female ratio of 8.65:1 with a mean age of 23.6 years in their study population.

Years later, another study from Los Angeles demonstrated that the previously described ratio had increased to 10.64:1 with a mean age slightly higher (29 years).[30]

Interestingly, they found that only 2.9% of all patients were older than 55 years.

The Dutch then went on to retrospectively analyse hospital records for ten years during the 2000's. Not surprisingly, they found a male to female ratio of 6:1 with a median age of 32. [31]

A similar ratio (6.13:1) was described in a completely different environment. This time in Pakistan where in 2007, their experiences in the management of thoracic trauma at a teaching hospital was described.[32] They found, as many authors had before, that the majority of patients were between the ages of 21 and 30 years.

How do the African figures compare?

The male preponderance in chest trauma is also shown in studies from Tanzania, Cameroon and Nigeria.[17, 18, 20]

Remarkably the studies from Tanzania and Nigeria demonstrated similar ratios (3.8:1) and similar mean ages (32.17 years versus 32.28 years).[17, 20]

The third study from Cameroon differed only slightly in the ratio (4.2:1) and had a higher mean age of patients (41.86 years).[18]

Is South Africa any different?

In the early 1990's at the King Edward VIII Hospital in KZN, Madiba and colleagues described a male preponderance of 8:1 with a median age of 26.[13]

In the early 2000's at the CHBAH in Soweto, Johannesburg, researchers found that a phenomenal male to female ratio existed in their study group.[16]

The ratio observed was 13.63:1 with a mean age in males being younger than their female counterparts. (29 years versus 35 years)

A similar ratio (14.4:1) was seen in another KZN study in the late 2000's where, interestingly, the number in study group was almost eleven times that of the CHBAH study.[9]

An important component of demography is the interpersonal and gender violence that is often associated with trauma.
It has been called the "epidemiological transition".[33] A shift from communicable diseases to non-communicable diseases, injury and violence.

The World Health Organization defines interpersonal violence as the: "Intentional use of physical force or power against another person, or against a group or community that either results in, or has a likelihood of resulting in injury, death, psychological harm, maldevelopment and deprivation."[34]

The injury profile in South Africa is dominated by interpersonal and gender violence which is thought to be a result of urbanization and the socio economic disparities that exist.[35] South Africa is considered to be one of the top four areas worldwide with respect to deaths from interpersonal violence.[33]

As the figures may show a male to female preponderance, population based estimates identifies a lifetime prevalence of partner violence of 25% in adult woman.[8] The IMAGE study in the Limpopo province involved a system of micro loans and a violence/gender equity program.[8] There was a reported reduction in intimate partner violence by 55% over 12 months.

Stepping Stones was an initiative in the Eastern Cape directed at improving sexual health by focusing on gender equity within relationships.[8]

On completion, 38% of women reported a reduction in partner violence.

Patient Presenting Factors

Day of presentation to hospital

The studies have shown that irrespective of the geographical area or period of the year, the majority of penetrating chest wounds are encountered over the weekends, public holidays and over the festive season.[8, 12, 16, 28, 36, 37]

In South Africa, as far back as the late 1980's, there was a predominance of injury occurrence over the weekend and mostly at the start i.e. on a Friday.[12]

This was further corroborated in a study by Degiannis and colleagues in the early 2000's when he demonstrated that 75% of patients in his study group were admitted over the weekend.[16]

Elsewhere in the world, similar presenting patterns have also been demonstrated. As far back as 1978, two studies on stab wounds in a London and Glasgow Hospital revealed that most patients were seen over the weekends.[28, 36]

In recent years, this trend that had been established 20 years prior was demonstrated once again in a retrospective review at a London Hospital.[37]

Time of presentation to hospital

In the first London study mentioned previously, a huge portion of their patients (83%) presented between 18h00 to 06h00.[36] This was similar to an early South African study in Soweto that found that the majority of patients presented from 18h00 to

24h00.[12] In a later study, also in Soweto, they further narrowed their busiest time frame to 19h00 to 02h00, where 90 % of patients presented to hospital.[16]

Level of prehospital care

There are a few studies that describe the use and implications of the different levels of prehospital services in penetrating injury.[37, 38, 39]

Two American studies from Level 1 Trauma centres in North Philadelphia and Pennsylvania have shown some association. [38, 39]

The third study, conducted in London at King's College, also showed association.[37]

It is difficult to compare these studies as there is a huge disparity in the availability of resources between developed and developing countries.

There are, however, some similarities. Most patients are transported to hospital by ambulance.[37, 39]

In developed trauma systems, an advanced life support paramedic (ALS) is the first point of care for penetrating trauma patients.[39]

There has been debate and controversy about the value of an ALS paramedic in this subgroup of patients. Some authors have shown an increased likelihood of survival if you are transported by a BLS provider whilst others have shown an improved mortality rate if transported by ALS paramedics.[38, 39]

Relationship between the Level of Consciousness and Blood Pressures

The value of the initial SBP has been demonstrated as far back as the mid 1980's when a retrospective study by Naughton and colleagues showed that a SBP of greater than 90mm Hg was associated with a 87.5 % chance of survival.[38]

This was further demonstrated at an Illinois Hospital (USA) in the mid to late 2000's. The researchers looked specifically at the subgroup of penetrating injuries that required thoracotomy in the ED. They demonstrated that the predictors for survival were presenting GCS and obtainable vital signs.[26]

A low GCS was further validated in other studies to be an independent parameter to predict death after trauma.[40, 41, 42, 43]

Interestingly two of these studies also demonstrated that penetrating injuries were statistically significant predictors to influence survival.[41, 43]

In an attempt to estimate the magnitude of injury and its impact on the health burden in South Africa, a group of researchers used an existing Mortality Surveillance system coupled with a model designed by the Actuarial Society of South Africa. This was in the year 2000.[35]

They found that when compared to global averages, injuries were responsible for high numbers of disability adjusted life years. In addition, we have higher homicide rates for both men and women.[35]

There are also the financial implications associated with the management of patients with penetrating chest trauma.[30, 35, 42, 43, 44]

A study from G F Jooste Hospital in the Western Cape found that the cost of treating 21 patients with penetrating abdominal injuries over a 6 month period was 30 803 US dollars.[44] They looked at 5 cost variables including operating time, duration of hospital/high care stay, blood and pharmaceutical product use, laboratory services and diagnostic imaging. Interestingly, there were 128 patients presenting with both penetrating chest and abdominal injuries during the study period. These patients required both a thoracotomy and laparotomy during their initial management. By

excluding penetrating chest injuries, this study was limited and the burden of injury was underestimated.

An eleven year retrospective review of all chest trauma in Damascus found that 56% of patients required intercostal drain insertion, 6.4% required surgery, 8.6% ICU admission and an average length of mechanical ventilation of 7.2 days.[45]

In Karachi, Pakistan, a group of researchers analysed the 200 penetrating trauma patients in their 2 year study period. They found that the length of hospital stay could vary from 8 to 76 days with the average of 6.09 days in ICU versus 21 days in the ward. More than a quarter of their patients required thoracotomies.[46]

All of the above figures aside, the burden of injury and violence is not limited to the cost of hospitalisation. The true burden includes the physical, emotional and financial implications thereof and this can never truly be quantified.[47]

There is a strong scientific foundation for the prevention of injuries.[48] Many believe that screening for injury risk is an integral component of the care of a trauma patient.[48]

In developing countries like South Africa, both international and local recognition of the impact of trauma and injury to the health burden remains unrecognised when compared to the efforts directed at other health problems.[8, 35]

All of the four stages involved in developing violence prevention programmes, requires comprehensive surveillance data.[49, 50]

Whether it is, identifying the problem, disseminating the information, implementing strategies or sustaining these practices, evidence and data is at the cornerstone.[49] Some centres have and with good effect implemented violence prevention programmes using the available data at their institutions.[51, 52]

At the John Hopkins Medical Centre (USA), a study in 2006 found that most of the trauma encountered was as a result of penetrating injury and due to interpersonal violence. Their study was used to validate the need for violence prevention in their community.[51]

Another effort was a collaborative effort from the Society for Academic Emergency Medicine (USA) and other role players. They provided the youth that presented to their EDs with a list of services and resources available to them. They found an astounding reduction in the rate of re injury.[52]

Penetrating chest injuries is an important component to the overall burden of injury attributable to trauma in South Africa. It is a leading cause of death and disability. The value of describing the demographics and factors associated with the presentation in this group of patients is enormous.

MATERIALS AND METHODS

3.1 Ethics

This research was approved by the Human Research Ethics Committee of the Faculty of Health Sciences of the University of the Witwatersrand (protocol approval number M120539- see Appendix 1). Ethics was then approved by the Netcare Ethics Committee (see Appendix 2).

3.2 Study Design

This was a retrospective, cross sectional, descriptive and comparative study.

3.3 Study Setting and Population

Study Setting

Netcare Group of Hospitals in South Africa seeing major trauma.

Study Population

All priority 1 trauma patients with penetrating chest injuries who presented to the Netcare Group of Hospitals from 08h00 on the 01 October 2006 to 07h59 on the 01 October 2011.

Inclusion criteria:

All priority 1 trauma patients with penetrating chest injuries who presented to the Netcare Group of Hospitals from 08h00 on the 01 October 2006 to 07h59 on the 01 October 2011.

Exclusion criteria:

Patients with incomplete records: Patients were excluded if more than 5 data variables were missing.

Patients with penetrating injuries as a result of animal bites.

3.4 Study Protocol

3.4.1 Data collection

Data was extracted from the Netcare Trauma Bank server that currently uses Medibank software (Appendix 3). The data extracted from the Trauma Bank server was then transferred to an electronic data capturing system (Microsoft Excel™, Microsoft Corporation). There was no patient identifying data recorded on the data collection sheet. A spread sheet allocating a research data number to each case record was be kept by the supervisors.

3.4.2 Outcome Measures

1. To describe the profile of patients with penetrating chest trauma with respect to the age, gender, race, time of presentation, day of presentation, mechanism of injury, level of pre hospital care, presenting SBP , presenting GCS, ISS, RTS and NISS.
2. To determine if age, gender, race, time of presentation, day of presentation, mechanism of injury and level of pre hospital care is associated with the ISS, RTS and NISS.
3. To ascertain the burden of disease of penetrating chest trauma by comparing the following: level of airway management, ED procedures, diagnostic

investigations, blood/fluid products used, surgical management, length of hospital stay, length of stay in ICU/High Care, number of days ventilated and number of days requiring inotropes.

3.4.3 Data Analysis

1. Data was analysed with the statistical and analytical software program, Statistical Package for Social Sciences (SPSS™).
2. The frequency distribution was presented for all categorical variables in graph or table format.
3. The median and interquartile range was provided as a descriptive statistic for continuous variables provided that the data was not skewed.
4. To determine if the ISS, RTS and NISS was associated with the age and time of presentation, multiple regressions were carried out as the response and predictor variables were all continuous.
5. To determine if the ISS, RTS and NISS was associated with gender, a 2 independent sample t-test was be carried out.
6. To determine if the ISS, RTS and NISS was associated with race, the day of presentation, mechanism of injury and level of pre hospital care, a one way Analysis of Variance (ANOVA) was carried out. If there was a significant difference, a pair wise comparison followed.
7. To ascertain the burden of disease, descriptive statistics were provided as frequency distribution for all categorical variables and as a measure of central tendency and dispersion for continuous variables.

3.4.4 Significance level

A $p < 0.05$ was considered to be significant for all statistical tests.

3.5 Methodological limitations of this study

The data was not captured by the researcher. It was therefore relied upon that it was captured correctly by the Netcare Trauma Bank users.

Chapter 3 RESULTS

There were 455 patients during the study period who met the inclusion criteria.

There were 442 patients with complete demographic data (age, gender and race)

A. Basic Demographic and Presentation Data

The mean age of patients (442) was 35.16 years.

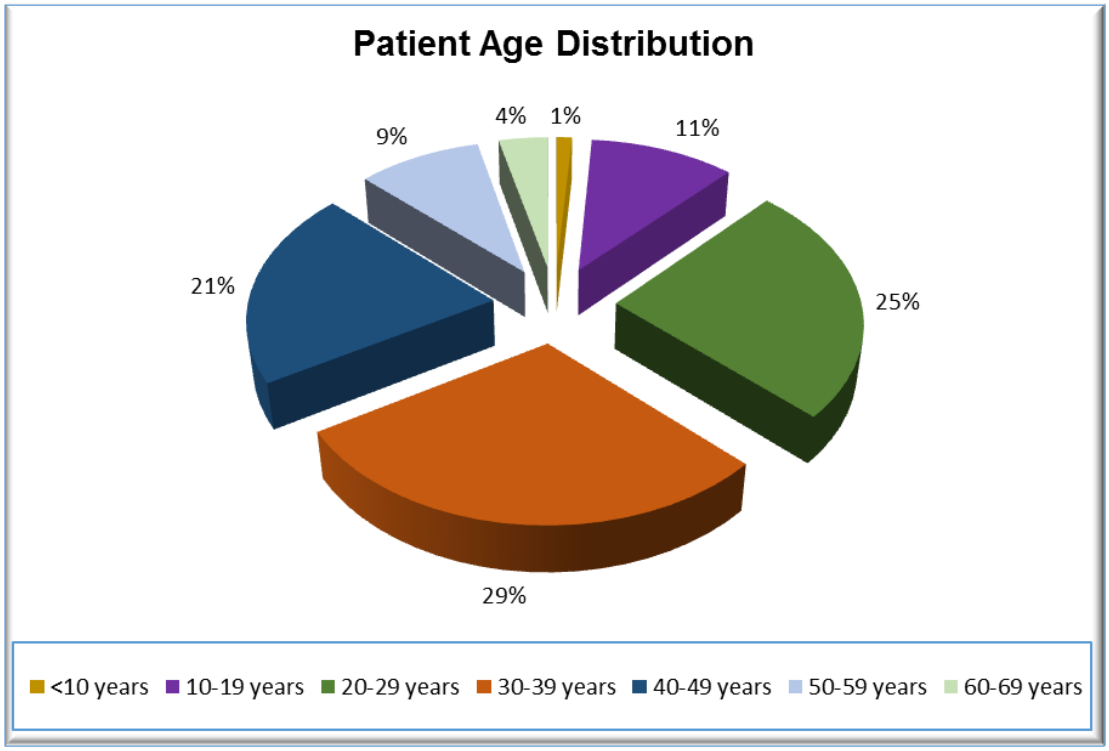

Figure 1. Frequency distribution of the age of patients

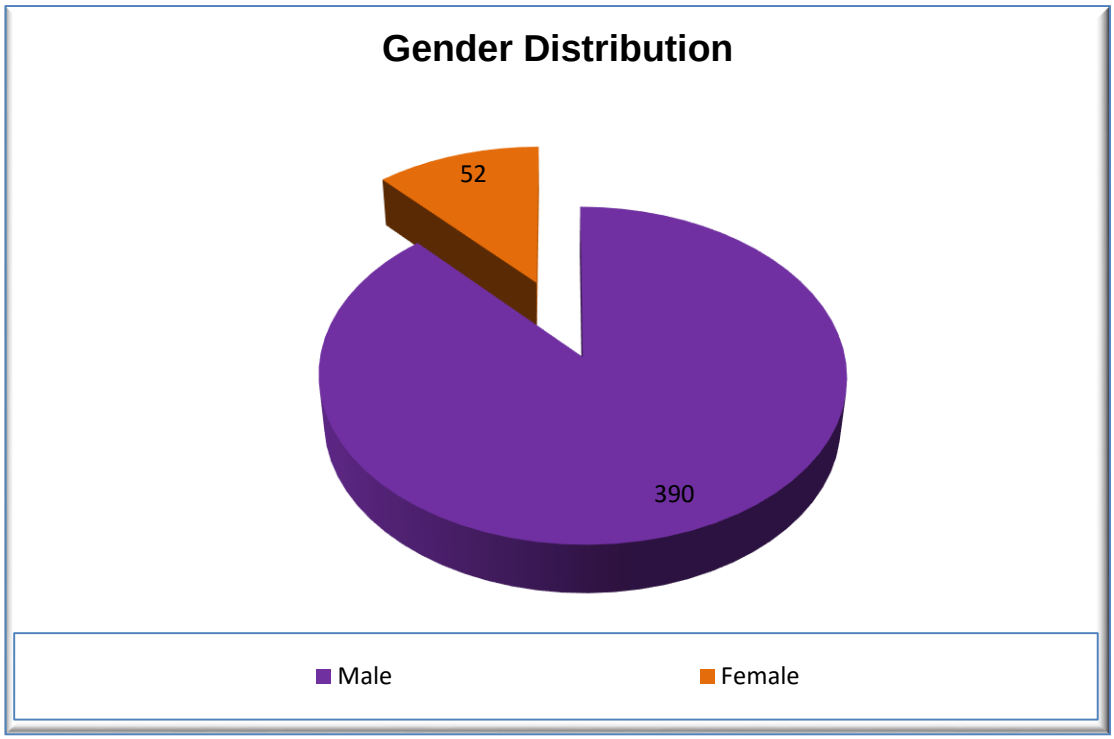

Figure 2. Gender distribution of patients

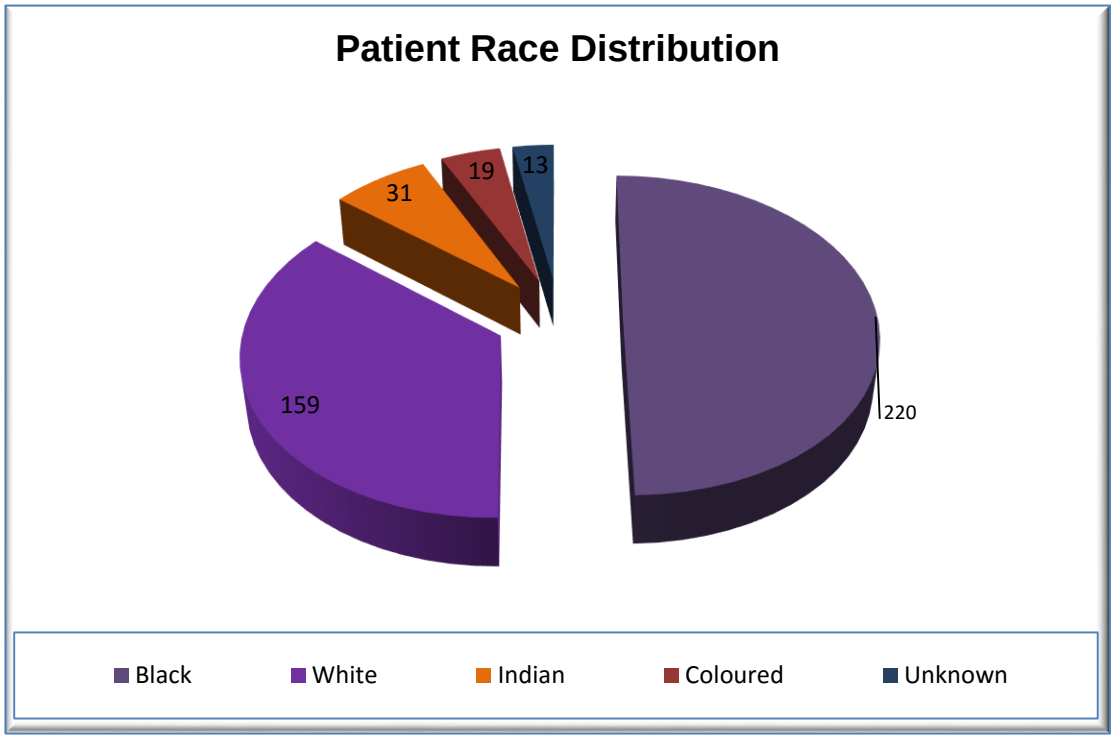

Figure 3. Race distribution of patients

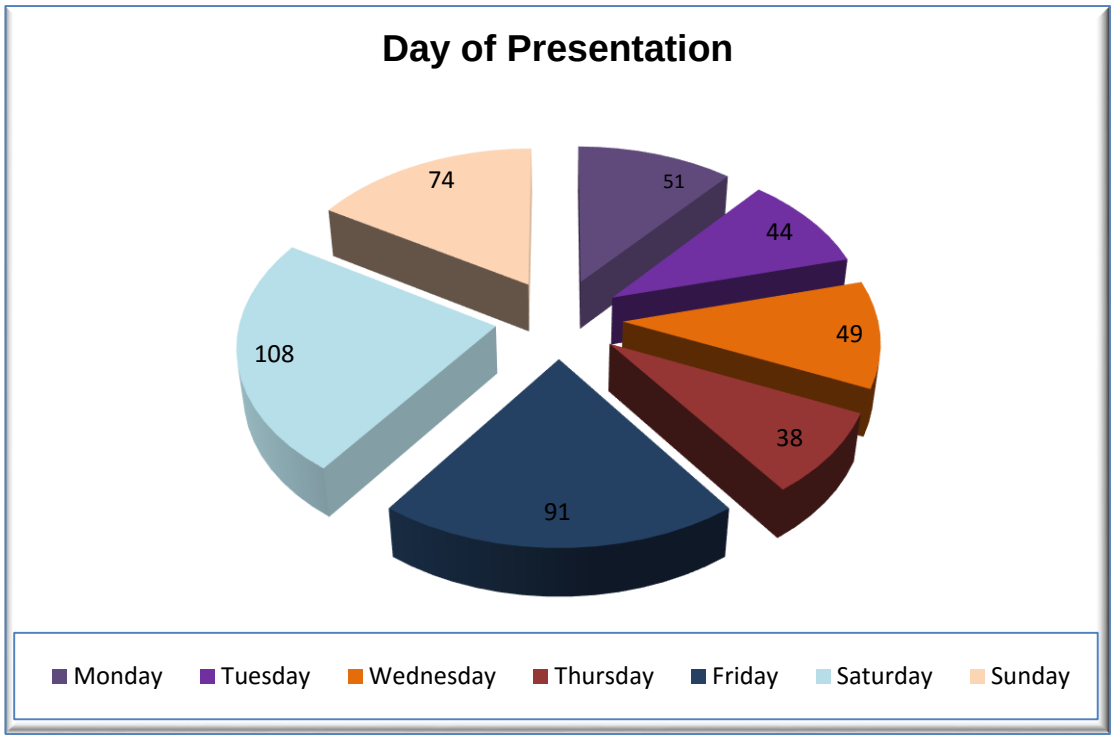

Figure 4. Distribution of the days of presentation

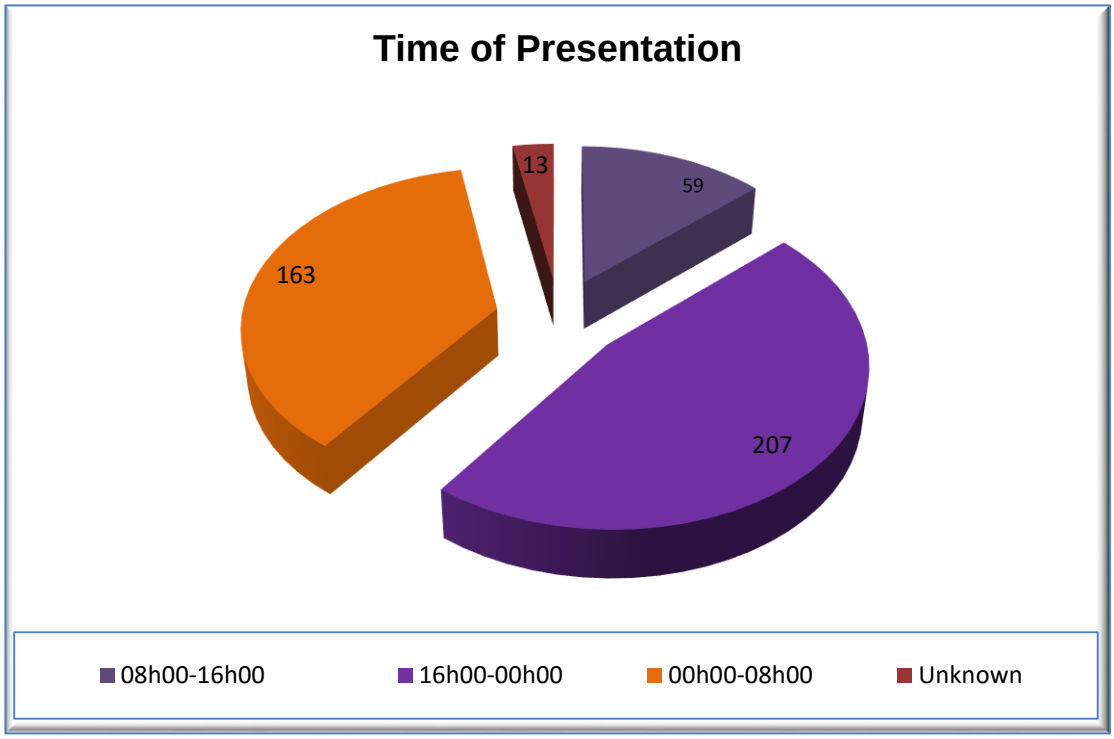

Figure 5. Distribution of time of presentation

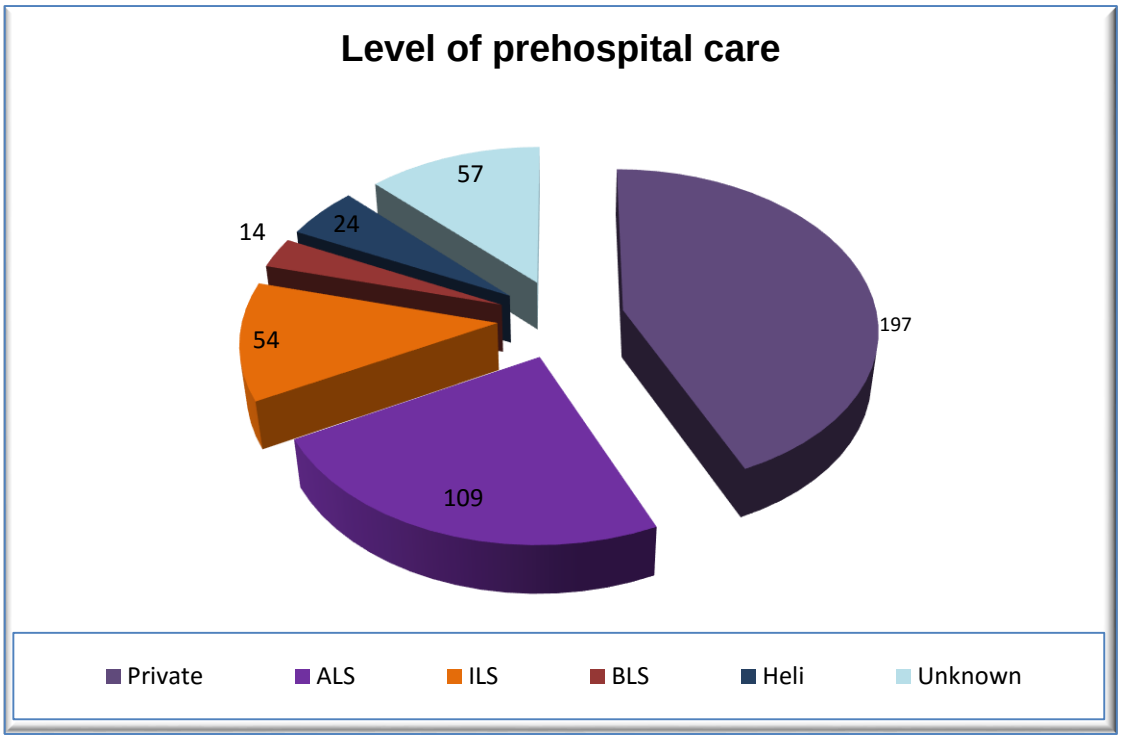

Figure 6. Frequency distributions of the level of pre hospital care

B. Hospital Admission Characteristics

Table 1. Length of stay in ward and High Care, days in ICU, days ventilated and days on inotropes

	N 209	Minimum	Maximum	Median	Interquartile Range
Length of stay in ward	82	1	96	4	2 - 7
Length of stay in HC	19	1	13	3	2 - 3
Days in ICU	25	1	16	3	1 – 4
Days ventilated	11	1	34	3	1 – 8.5
Days inotropes	10	1	11	3.5	1.25 – 8.75

Table 2. Deaths in ED and Patient transfers

	N 83	Gunshot wound	Stab knife	Other
Death in ED	24	17	7	0
Transferred from ED	59	28	29	2

C. Injuries

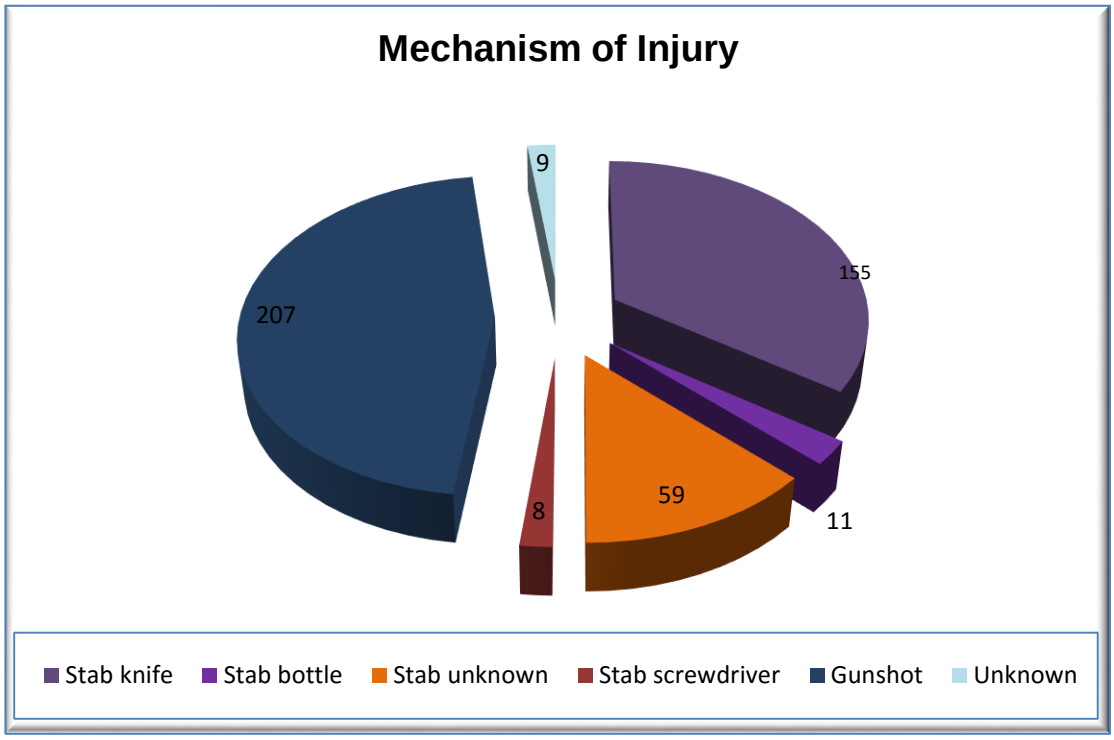

Figure 7. Distribution of mechanism of injury

Table 3. Distribution of the types of injury

Types of injury	Responses	
	N = 455	Percent
Penetrating wound with no underlying pathology	184	40.40%
Haemopneumothorax	125	27.50%
Pneumothorax	74	16.30%
Abdominal injury	66	14.50%
Haemothorax	60	13.20%
Rib fractures	34	7.50%
Bony injuries	33	7.30%
Lung contusion	24	5.30%
Diaphragmatic injury	20	4.40%
Pericardial effusion	14	3.10%
Penetrating neck injury	13	2.90%
Myocardial laceration	12	2.60%
Vascular injury	11	2.40%
Lung laceration	9	2.00%
Spinal cord injury	9	2.00%
Bronchus injury/tracheal injury	7	1.50%
Tension pneumothorax	7	1.50%
Head injury	6	1.30%
Cardiac Tamponade	6	1.30%
Pneumomediastinum	1	0.20%

D. Measurements and Scores

Table 4. Descriptive Statistics of Measurements and Injury Scores

	N	Minimum	Maximum	Median	Interquartile Range
Systolic Blood Pressure	432	0	223	123	97 – 142.25
GCS	436	3	15	15	15 – 15
ISS	444	1	75	9	4 – 13.25
Initial RTS	455	0	7.8	0	0 – 7.8
ER RTS	454	0	7.8	7.8	7.1 – 7.8
NISS	429	0	75	10	4 - 22

There were 88 patients with SBP <= 90 mmHg (shock).

There were 62 patients with GCS <= 9.

E. Burden of Injury

Table 5. Descriptive statistics of the volume of fluid, blood and FFP used

	N	Minimum	Maximum	Median	Interquartile Range
Volume Fluid Crystalloids	393	50	9500	500	300 – 500
Volume Fluid Colloids	107	100	3000	500	500 – 500
Blood Units	48	1	13	2	1 – 3.25
FFP	9	1	11	2	2 - 4

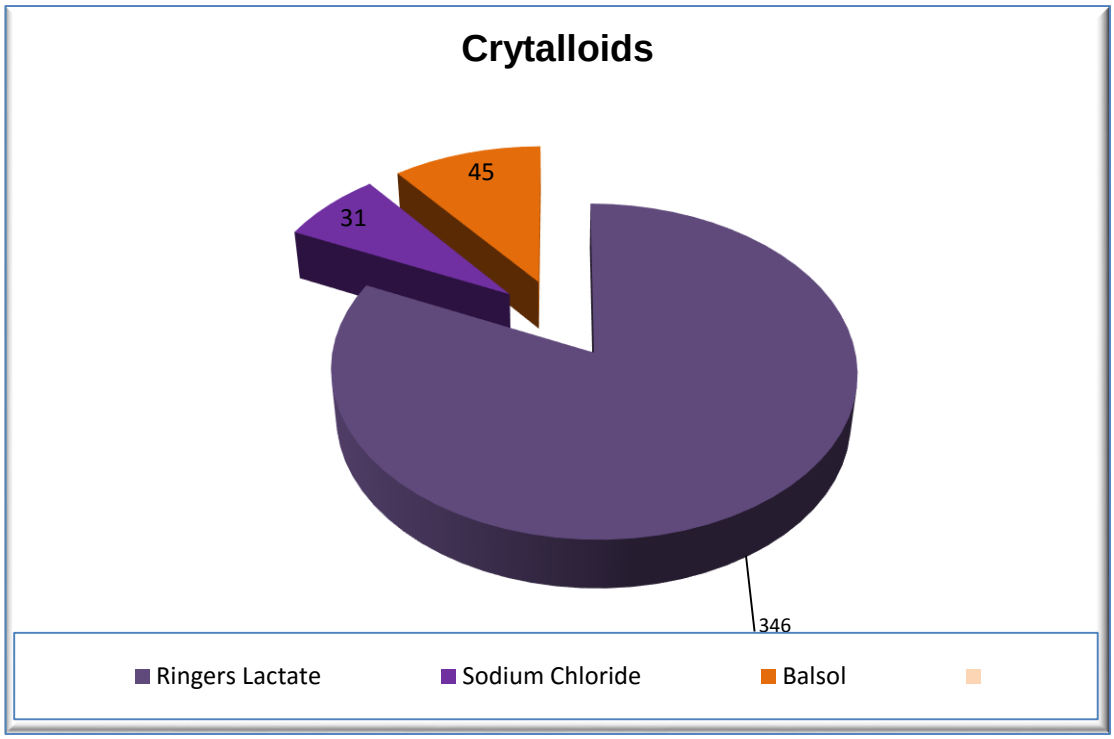

Figure 8. Distribution of the types of crystalloid fluids used

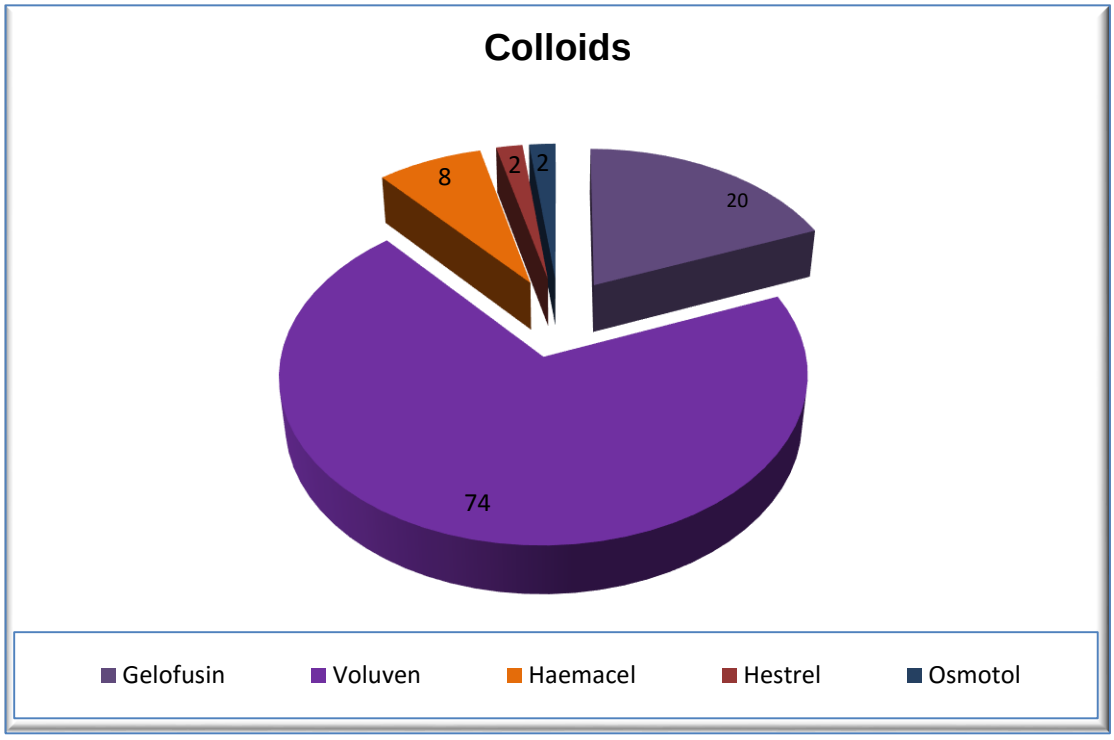

Figure 9. Distribution of the types of colloid fluid used

Table 6. Distribution of procedures

Types of procedures	Responses	
	N= 424	Percent
IV access	359	84.70%
ICD	208	49.10%
CVA	122	28.80%
Suture	122	28.80%
X-ray	67	15.80%
CPR	19	4.50%
High cap	17	4.00%
Surgical	9	2.10%
EDT	6	1.40%
Pericardiocentesis	5	1.20%
Lap ED	2	0.50%
Thoracotomy	2	0.50%
Venous cut down	2	0.50%
DPL	1	0.20%
Laparotomy	1	0.20%
Sternotomy	1	0.20%

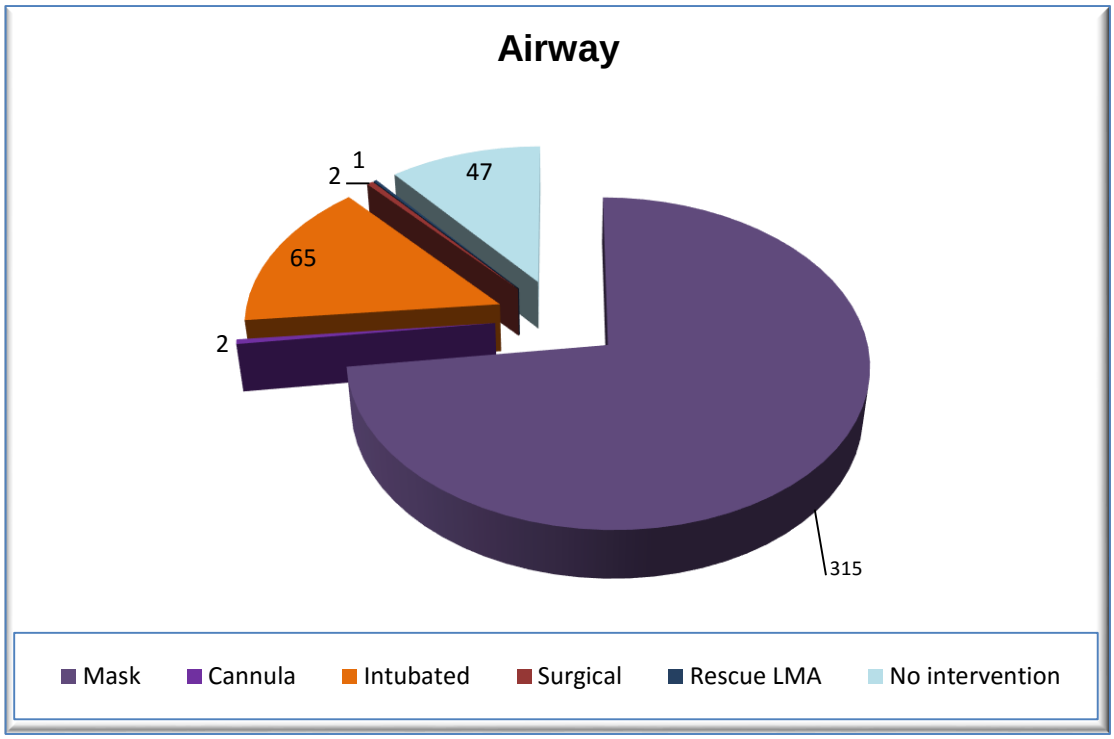

Figure 10. Distribution of the level of airway management

F. Relationships

In this section, the associations between age, gender, race, time of presentation, day of presentation, mechanism of injury and level of pre hospital care and the ISS, RTS and NISS was explored.

The question asked was: “Do group means differ on some form of composite of ISS, RTS and NISS after controlling for age and time of presentation (covariates)?” Group variables were gender, race, day of presentation, mechanism of injury and level of pre hospital care. This was analysed with a Multivariate Analysis of Covariance (MANCOVA).

The correlation between the dependent variables and covariates was first analysed. If the data showed that the dependent variables were all strongly correlated, this then strengthened the argument for a composite.

Table 7. Correlation analysis of dependent variables and covariates

		Age	Time of presentation	ISS	Initial IRS	NISS
Age	Pearson Correlation		0.034	0.08	0.095	0.1
	P-value		0.47	0.08	0.047	0.04
	N	442	442	441	442	441
Time of presentation	Pearson Correlation		1	0.04	0.064	0.03
	P-value			0.37	0.18	0.51
	N	442		441	442	441
ISS	Pearson Correlation			1	-0.028	0.91
	P-value				0.547	0
	N	444			454	440
Initial RTS	Pearson Correlation				1	0.01
	P-value					0.82
	N	455				441
NISS	Pearson Correlation					1
	P-value					
	N	441				

Table 8. Results of Analysis of Covariance

Source	Dependent Variable	Sig.
Corrected Model	ISS	0.02
	Initial RTS	0.01
	NISS	0.02
Intercept	ISS	0
	Initial RTS	0
	NISS	0
Age	ISS	0.76
	Initial RTS	0.68
	NISS	0.76
Time of presentation	ISS	0.31
	Initial RTS	0.83
	NISS	0.29
Gender	ISS	0.6
	Initial RTS	0.42
	NISS	0.31
Race	ISS	0.42
	Initial RTS	0.97
	NISS	0.24
Day of presentation	ISS	0.45
	Initial RTS	0.9
	NISS	0.35
Mechanism of injury	ISS	0.88
	Initial RTS	0.84
	NISS	0.95
Level of pre hospital care	ISS	0
	Initial RTS	0
	NISS	0

Table 8 shows that ISS, NISS and RTS differed significantly across the different levels of pre hospital care (P-value less than 0.05).

Further, a series of T test or Analysis of Variance (ANOVA), depending on whether the group variable had two or more levels was investigated. The relationship of each independent (predictor) variable with each of the dependent (response) variables was explored.

To test whether the means of ISS, NISS and RTS differed across the two levels of gender, two independent samples T test were carried out. In this test, the Null Hypothesis (H0) was that there was no difference in the means of the different measures (scores) across gender groups. The Alternative Hypothesis (H1) was that there was a difference. To test whether the means of NISS, ISS, and RTS differed across the race groups, day of presentation, mechanism of injury and level of pre hospital care, an ANOVA was used. The Null Hypothesis (H0) was that there was no difference in the means of ISS, NISS and RTS across the groups. The alternative Hypothesis (H1) was that at least two groups differ.

Table 9. Results of two Independent Sample Tests across gender

	Gender	Minimum	Maximum	Mean	Standard Deviation	P-value
ISS	Male	1	75	10.73	9.946	0.439
	Female	1	50	11.88	10.697	
Initial RTS	Male	0	8	3.427	3.747	0.901
	Female	0	8	3.358	3.678	
NISS	Male	0	75	14.44	14.426	0.392
	Female	0	66	16.29	15.845	

Table 10. Results of Analysis of Variance across different races

	Race	Minimum	Maximum	Mean	Standard Deviation	P-value
ISS	Black	1	75	10.48	10.51	0.628
	White	1	50	11.52	9.695	
	Indian	1	26	8.935	8.326	
	Coloured	1	41	12.32	9.25	
	Unknown	1	41	11.54	10.997	
Initial RTS	Black	0	7.8	3.185	3.714	0.017
	White	0	7.8	3.788	3.744	
	Indian	0	7.8	4.7	3.802	
	Coloured	0	7.8	2.453	3.445	
	Unknown	0	7.8	1.2	2.929	
NISS	Black	0	75	13.59	13.973	0.101
	White	0	66	16.96	15.988	
	Indian	0	34	10.45	10.356	
	Coloured	1	57	15.16	13.238	
	Unknown	0	57	14.08	15.256	

Table 10 shows the results of the ANOVA on the ISS, NISS and RTS across the different race groups. It can be seen that the Null Hypothesis, which was the hypothesis of no difference, was rejected except for the RTS.

After performing an ANOVA assessing the null hypothesis that all groups have equal means, a pairwise comparison was done.

Table 11. Pairwise comparisons between gender groups

Dependent variable	Level of pre hospital care	Level of pre hospital care	Mean difference	P-value
Initial RTS	Indian	Unknown	3.5	0.044

The results of the pairwise comparisons showed that the difference in the means of RTS lay between Indian patients and those with an Unknown race group.

Table 12. Results of Analysis of Variance across different days of presentation

	Day of presentation	Minimum	Maximum	Mean	Standard Deviation	P-value
ISS	Monday	1	33	11.39	7.95	0.555
	Tuesday	1	36	9.159	9.132	
	Wednesday	1	41	12.29	11.525	
	Thursday	1	27	10.05	7.211	
	Friday	1	41	9.548	8.278	
	Saturday	1	75	11.82	12.909	
	Sunday	1	42	10.76	8.711	
Initial RTS	Monday	0	7.8	3.88	3.767	0.503
	Tuesday	0	7.8	4.077	3.754	
	Wednesday	0	7.8	2.892	3.651	
	Thursday	0	7.8	3.689	3.941	
	Friday	0	7.8	3.653	3.743	
	Saturday	0	7.8	3.017	3.689	
	Sunday	0	7.8	3.142	3.717	
NISS	Monday	0	48	15.42	12.291	0.572
	Tuesday	0	57	12.96	14.209	
	Wednesday	0	57	16.36	16.155	
	Thursday	1	66	14.45	13.647	
	Friday	0	57	12.3	12.052	
	Saturday	0	75	16.39	17.895	
	Sunday	0	57	14.07	12.987	

Table 12 indicates that none of the injury scores (ISS, NISS and RTS) were affected by the day of presentation.

Table 13. Results of Analysis of variance across different mechanisms of injury

	Mechanism of injury	Minimum	Maximum	Mean	Standard Deviation	P-value
ISS	Stab Knife	1	33	9.714	7.05	0.005
	Stab bottle	1	11	6.727	3.58	
	Stab Unknown	1	75	8.678	11.859	
	Gunshot	1	75	12.8	11.309	
	Industrial Accident	9	18	13.33	4.509	
	Screwdriver	1	9	4.75	3.882	
	Other	1	25	12.75	10.21	
	Unknown	1	11	4.6	4.98	
Initial RTS	Stab Knife	0	7.8	3.15	3.716	0.137
	Stab bottle	0	7.8	1.955	3.373	
	Stab Unknown	0	7.8	2.886	3.777	
	Gunshot	0	7.8	3.919	3.726	
	Industrial Accident	0	7.8	3.833	3.902	
	Screwdriver	0	7.8	2.838	3.922	
	Other	0	0	0	0	
	Unknown	0	7.8	3.12	4.272	
NISS	Stab Knife	0	50	12.07	10.039	0
	Stab bottle	1	22	8.182	5.776	
	Stab Unknown	0	75	10.98	15.132	
	Gunshot	0	75	18.46	17.063	
	Industrial Accident	9	22	14.67	6.658	
	Screwdriver	0	18	6.125	5.89	
	Other	1	29	15.67	14.048	
	Unknown	1	22	7	9.028	

Table 14. Pairwise comparisons between different mechanisms of injury

Dependent variable	Level of pre hospital care (I)	Level of pre hospital care (J)	Mean difference	P-value
ISS	Gunshot	Stab Knife	3.083	0.024
NISS	Gunshot	Stab Knife	6.392	0.001
		Stab Unknown	7.477	0.021

In **Table 13**, it can be seen that the mechanism of injury affected the ISS and NISS. **Table 14** shows that this difference mainly existed between gunshot wounds and stab with a knife.

Table 15. Analysis of variance across different levels of pre hospital care

	Level of pre hospital care	Minimum	Maximum	Mean	Standard Deviation	P-value
ISS	Private	1	75	9.194	8.749	0
	ALS	1	75	12.88	11.884	
	BLS	1	10	3.643	3.713	
	ILS	1	29	9.611	6.45	
	Heli	1	41	21.04	11.958	
	Unknown	1	41	11.21	9.432	
Initial RTS	Private	0	7.8	1.495	3.014	0
	ALS	0	7.8	5.225	3.467	
	BLS	0	7.8	3.9	4.047	
	ILS	0	7.8	6.452	2.767	
	Heli	0	7.8	3.475	3.385	
	Unknown	0	7.8	3.346	3.736	
NISS	Private	0	75	11.22	11.687	0
	ALS	0	75	18.48	16.658	
	BLS	1	11	4.071	3.832	
	ILS	1	50	12.65	9.519	
	Heli	0	66	33.5	18.65	
	Unknown	0	66	16.09	15.098	

Table 16. Pairwise comparisons between different levels of pre hospital care

Dependent variable	Level of pre hospital care (I)	Level of pre hospital care (J)	Mean difference	P-value
ISS	Heli	Private	11.848	0
		ALS	8.161	0.003
		BLS	17.399	0
		ILS	11.431	0
		Unknown	9.831	0
Initial RTS	Private	ALS	3.729	0
		ILS	4.956	0
		Unknown	1.85	0
	Unknown	ALS	1.879	0.007
		ILS	3.106	0
	ILS	Heli	2.977	0.003
NISS	Heli	Private	22.281	0
		ALS	15.023	0
		BLS	29.429	0
		ILS	20.852	0
		Unknown	17.409	0

Chapter 4 DISCUSSION

The first part of the discussion is an overview of the main results. This will then be followed by a discussion and an analysis of these results.

4.1 Summary of Results

Basic Demographic Data

The demographic findings reflect a young male majority. A male to female ratio of 7.5:1 was found. The average age of patients was 35 years old with 54% of patients in the 20-39 years old age group.

As far as race demographics, almost half (220/442) of the patients with a documented race group were black.

Mechanism of Injury

449 patients had documented injury mechanism. 9 were documented as "penetrating" and are therefore reflected as unknown.

Gunshot wounds accounted for 46% of injury mechanism followed by stab wounds due to knives (34%).

Presenting Factors

The injury profile dominated over the weekend with the majority of patients seen on Saturday (108 patients). It was found that 207 patients presented within the time period 16h00 to 00h00.

The data showed that the majority (43%) of patients in this Private Hospital Sector were transported by privately owned vehicles whilst 24% of patients were managed by an ALS paramedic.

Injury Patterns

455 patients had complete data regarding the patterns of injury. Some patients had more than one type of injury. The majority of patients sustained a penetrating chest wound with no underlying pathology (40.4%).The most common injury isolated to the chest cavity was a haemopneumothorax (27.5%).The most common associated system injury was an associated abdominal injury (14.5%).

Injury Scores

The maximum ISS and NISS scores recorded was 75. The highest initial RTS recorded was 7.8. This was similar to the ED RTS where the highest score documented was also 7.8.

Systolic Blood Pressure and Presenting GCS

The median systolic blood pressure was 123 mmHg. It was noted that 20.3% (88/432) of patients presented with hypotension (SBP <= 90 mmHg).
Although the median GCS was 15, 14.2% (62/436) of patients had a documented initial GCS of <= 9.

Burden of Injury

When evaluating the burden of injury, the number of procedures performed, volumes of fluid, blood and FFPs administered and the length of hospital ward, ICU and HC stay was considered. Data regarding disposition of patients was available for 209 patients only.
During the study period, it was noted that 65 patients required intubation. Of interest, is the finding that only 11 patients were ventilated in ICU.

When you take into account that 24 patients died in the ED and the considerable number (59) of patients transferred, this may actually be an accurate reflection. The majority of patients, however, required simple and inexpensive airways adjuncts. A staggering 315 patients required the application of a face mask only.

Large volumes of crystalloid fluids compared to colloid fluids were used during the initial management of patients. Despite the differences in both the volume of fluids administered and the number of patients who received these fluids, the median volume of fluid administered for both colloids and crystalloids was the same (500mls). A total of 48 patients received blood transfusions with the maximum number of units given to a single patient being 13. A further 9 patients also received FFPs.

When analysing the procedures performed in this study group, it was found that 359 patients required IV access, 122 required CV access, 208 required an ICD insertion and 8 patients required thoracotomies (6 EDT vs 2 in theatre thoracotomies). Although only 8 thoracotomies were performed, 19 patients received CPR. The low number of X-rays ordered is a likely statistical anomaly as this is the first line imaging of penetrating chest trauma in most settings.

A total of 126 (126/209) patients required hospital admission. These admissions were predominantly to the general ward (82) followed by ICU (25) and High Care (19).

The median number of days admitted to the ward was 4 days which was interestingly not much higher than the median days admitted to both ICU and HC

(3). During the ICU admission, 11 patients were intubated and ventilated and 10 required the use of an inotrope.

There were 24 deaths in the ED of which gunshot wounds predominated (70.8%). It was also found that 59 patients were transferred to other health facilities.

Relationships Demonstrated

There were no statistically significant relationships demonstrated between the age of the patient, gender, day of presentation and time of presentation when compared to the ISS, NISS and RTS. The relationship demonstrated by the effect of race on the RTS is a statistical anomaly as it compares the Indian race group to the Unknown group which was a significant number.

The relationship demonstrated between stab wounds with a knife and gunshot wounds and the ISS and NISS was an expected result. These injuries are associated with worse injury patterns.

It was surprising to find that there was no relationship demonstrated between the day of presentation and the injury scores.

Statistically significant relationships were established across all levels of prehospital care using both the Analysis of Variance and a pairwise comparison. It was also shown that patients with higher ISS and NISS scores were often transported by privately owned vehicles.

4.2 Discussion of Results

Basic Demographic Data

The male majority in this study reflects the findings of several other studies.[9, 13, 16, 17, 18, 20, 28, 29, 30, 31, 32.] The average age of patients was much higher than in other South African studies.[13, 16.] These studies however, were public health sector based.

Very few studies have categorised their patient population according to race.[12]

The predominance of black patients in this study group is interesting. The black and coloured majority in a study by Butchard in the late 1990's was to be expected based on the geographical location of the study population, that being Soweto and the surrounding areas.[12] Similarly a later study by Livingston and colleagues also demonstrated a black predominance.[56]This again was a disproportionate reflection as there was a demographic bias based on the area that the facility served. The race demographics in this study are unlikely to be biased. The results could likely reflect the effects of urbanisation and the socio economic divide as the study population included all Netcare Hospitals in South Africa seeing major trauma.[35]

Mechanism of Injury

The findings of this study are similar to the findings of Muckart and colleagues who demonstrated a changing pattern of injury mechanisms in the early 1980's.[14]

It is very different from other recent South African studies that have shown a stab injury majority.[9, 16]

Possible explanations for this result is the fact that the private hospital sector may see more injuries related to workplace injury, attempted hijackings and injuries

related to attempted robberies. There is a tendency to use firearms in these circumstances.

The significance of this mechanism of injury is the considerable economic burden to the health system and society of firearm related injuries.[56, 57, 58]

Presenting Factors

This study showed similar results of several other studies confirming injury dominance over the weekends. [8, 12, 15, 16, 28, 36, 37]

Most patients presented in the exact time frame seen in South Africa more than 20 years prior.[18]

The finding that most patients arrived via private transport and only 24% with an ALS paramedic is a likely reflection of the overwhelming burden on resources especially over the weekends when most patients present coupled with the high demand of a limited number of ALS paramedics. This is very unlike high resource environments.[38]

Injury Patterns

When compared to other studies, this study has shown a common trend in the pathologies following penetrating chest injury.[12, 13, 14, 18, 20, 28, 32, 38, 44]

In fact it was described more than 20 years ago that there was often a penetrating chest wound with no underlying pathology. Butchart and colleagues demonstrated that a fair portion of patients present with an open or superficial wound of the chest.[12]

The most common chest injury requiring immediate intervention was a haemopneumothorax. This was also seen in other global studies.[13, 18, 20, 32, 45]

Careful consideration of a co-existing abdominal injury was also demonstrated and strengthens the need to be highly cognisant of this injury.[14, 28, 38, 44]

Injury Scores

The information gathered from the initial ISS and NISS is limited. If the user deems an injury critical or fatal, irrespective of any other injury documented, he will automatically score 75. This is therefore prone to user bias.

This highlights the need to prioritise penetrating chest injury patients.

The difference between the initial RTS score and the ED RTS further validates that these patients are at risk for rapid and often fatal decline.

Systolic Blood Pressure and Presenting GCS

The concept of secondary triage was designed to use certain criteria to predict the needs of a trauma patient prior to their arrival in hospital.[59, 60]

This should result in the more efficient use of resources and hence better patient outcome.[59, 60]

The American College of Surgeons originally developed a list of 6 such criteria including SBP < 90 mmHg, gunshot wound to the chest, blood transfusion and a GCS < 8.[60]

This was further modified to the Loma Linda Rule where the variables found to provide the highest yield were assessed. These included a penetrating mechanism, SBP < 90 mmHg and a heart rate > 100 bpm.[60]

With this in mind, the 88 patients with SBP < 90 mmHg in this study required the presence of a surgeon on arrival to hospital. The others could have been managed without the presence of a surgeon. The challenge in South Africa, unfortunately

are the large number of patients that arrive by private vehicles and hence cannot be risk stratified prior to arrival.

Burden of Injury

The primary mechanism of injury in this study was gunshot injury. These injuries are known to have a massive economic impact.[56, 57, 58]

Gunshots are the third most costly aetiology of injury and the fourth most expensive form of hospitalization.[56]

In this study 70.83% of the ED deaths were attributable to gunshot wounds.

Most patients did not require intubation and ventilation. This result was not surprising as it has been well established in the past that blunt chest injury is generally associated with prolonged ventilation and ICU stay when compared to penetrating chest injury.[17] Having said this, there have been other studies that have demonstrated longer ICU stays and longer periods of ventilation in penetrating injury.[13, 30, 32, 43, 45, 46, 47]

Brasel and colleagues have argued that the length of hospital stay is greatly influenced by non-clinical factors and consideration should be given to other factors such as placement in a home or rehabilitation facility. We should therefore adjust for these factors before using length of stay as a quality measure.[54]

A 3 month retrospective review by Hardcastle and colleagues in 2006 at the Tygerberg Hospital in the Western Cape aimed to estimate the minimum cost of gunshot injuries.[57] They demonstrated a similar demographic and presenting

profile to the findings of this study. The average length of stay in both hospital and ICU were also comparable. However, the most significant finding was that thoracoabdominal wounds accounted for 59% of all gunshot wounds. They convincingly showed that gunshot wounds had the greatest economic impact when compared to stab wounds and even blunt trauma. This was achieved by using information from the National Health Reference Price List, Emergency Medical Services Price List and Blood Transfusion Services Price List.[57]

When compared to other studies, this study has shown that fewer patients required theatre and thoracotomies.[13, 30, 32, 42, 44, 45, 46, 47] If one considers that 19 patients had CPR for penetrating chest injuries and only 6 patients had ED thoracotomies, this is an unusual finding. It also highlights the controversies regarding CPR in penetrating chest injuries and the need for surgical or Emergency Physician presence in managing high risk patients.

The majority of patients required the performance of simple ED procedures. IV access, suturing, CV access and ICD insertion accounted for the majority of procedures.

The fluid management of trauma patients has been a widely debated topic for years.[61, 62] As far back as 1994, a landmark article by Bickell boldly stated that aggressive fluid resuscitation in patients with thoracoabdominal penetrating injuries, was associated with an increased mortality rate.[61, 62] Bickell also went on to state that the aim of management should be operative control of the bleeding and early use of blood products.[62]

Duke et al also found that a restricted fluid approach improved both the length of hospital stay and ICU mortality.[62]

In this study it was found that a considerable number of patients received crystalloid fluids, the maximum amount given to a single patient being 9500ml. The maximum volume of colloid given to a single patient was 3000ml. These are considerably large volumes to be administered to a single patient.

Colloids are contentious. They are associated with the risks of anaphylaxis, coagulopathy and renal dysfunction.[62]

Whilst looking at absolute figures can never truly estimate the burden of disease, it does give us an indication of the use of resources.

Relationships Demonstrated

The finding of a relationship between the race of a patient and the RTS was not statistically significant ($p > 0.005$) even though a pairwise comparison found this to be present particularly for Indian patients.

Race has been previously looked at in the context of trauma when a 5 year audit of a National Trauma bank in the USA found that African American and Hispanic patients were more likely to sustain penetrating trauma and had an increased likelihood of death associated with trauma.[55]

The relationship demonstrated between the mechanism of injury and the ISS and NISS is similar to a 2009 study by Seamon et al who also found higher ISS scores for gunshot wounds versus stab wounds with a knife.[41]

It was also demonstrated that ALS paramedics responded to those patients who were critically ill (ISS and NISS scores of 75) and BLS providers responded to less severely injured. However, it is alarming to note that some patients with ISS and NISS scores of 75 presented to hospital with a private vehicle. These were critically injured patients. This can be viewed as a reflection on a burdened health care system.

4.3 Limitations

- This study only looked at penetrating chest injury in the private hospital sector.
- The results may not reproducible for the public health sector.
- There was missing data from the trauma bank and incorrect entries may have skewed some of the results.

4.4 Strengths

- The data was entered into a data collection sheet directly from the Netcare Trauma Bank by the researcher only.
- Despite some missing data, a reliable and validated data capturing tool was used.
- Using a 5 year period allowed for an adequate patient number to be evaluated.

4.5 Potential benefits from this study

- To recognise an at risk group of the population and direct resources for education and prevention.
- The understanding of common pathology following penetrating chest injury will help guide education and training of medical students and doctors.
- To provide a platform for further research in an attempt to better evaluate the burden of injury. This will strengthen the argument for more resources and the implementation of preventative strategies.

CONCLUSION

The demography of this study reflected the typical trauma population of a young male predominance.

Patients presented predominantly over the weekends and hence highlight the need for better staffing during these predictably busier periods.

The Private Hospital Sector sees a large number of gunshot wounds to the chest that are associated with a higher mortality rate.

Overall, the management of penetrating chest injuries requires an organized approach and efficiency in simple procedures.

There was no association between the day or time of presentation and the severity of injury. This further supports the idea that one must always be prepared to expect a severely injured patient with penetrating chest injuries.

RECOMMENDATIONS

- The infrastructure of the health system needs to be relooked at in order to optimise the available resources.
- All medical personnel working in Emergency Departments should be trained and evaluated regularly on the management of penetrating chest injuries. This includes including procedures and protocols.
- Protocols should be in place for the management of penetrating chest injuries and should include prehospital activation.
- The Loma Linda Rules should be used as part of prehospital triage so as to optimise the use of limited resources and hence optimise patient outcome.
- Further research is needed in both the public and private health sectors. This will further help to estimate the burden of disease.

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Appendix 1 Human Research Ethics Committee clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Pravani Moodley

CLEARANCE CERTIFICATE	**M120539**
PROJECT	The Profile of Penetrating Chest Injuries in The Profile of Penetrating Chest Injuries in the South African Private Sector
INVESTIGATORS	Dr Pravani Moodley.
DEPARTMENT	Division of Emergency Medicine
DATE CONSIDERED	25/05/2012
+DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 25/05/2012 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Prof Roger Dickerson

DECLARATION OF INVESTIGATOR(S)
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix 2 Netcare Research Ehics Committee Clearance

Netcare Limited

Tel: + 27 (0)11 301 0000
Fax: Corporate +27 (0)11 301 0499
76 Maude Street, Corner West Street, Sandton, South Africa
Private Bag X34, Benmore, 2010, South Africa

RESEARCH COMMITTEE FINAL APPROVAL OF RESEARCH

Approval number: UNIV-2012-0018

Dr Pravani Moodley

E mail: moodley.pravani@gmail.com

Dear Dr Moodley

RE: THE PROFILE OF PENETRATING CHEST INJURIES IN THE SOUTH AFRICAN PRIVATE SECTOR

The above-mentioned research was reviewed by the Research Committee's delegated members and it is with pleasure that we inform you that your application to conduct this research at Netcare Trauma Bank, has been approved, subject to the following:

i) Research may now commence with this FINAL APPROVAL from the Academic Board of Netcare (Research Committee).

ii) All information with regards to Netcare will be treated as confidential.

iii) Netcare's name will not be mentioned without written consent from the Academic Board of Netcare (Research Committee).

iv) All legal requirements with regards to patient rights and confidentiality will be complied with.

v) Insurance will be provided and maintained for the duration of the research. This cover provided to the researcher must also protect both the staff and the hospital facility from potential liability

vi) In accordance with MCC approval, that medicine will be administered by or under direction of the authorised Trialist

vii) The research will be conducted in compliance with the GUIDELINES FOR GOOD PRACTICE IN THE CONDUCT OF CLINICAL TRIALS IN HUMAN PARTICIPANTS IN SOUTH AFRICA (2000)

viii) Netcare must be furnished with a STATUS REPORT on the progress of the study at least annually on 30th September irrespective of the date of approval from Academic Board of Netcare (Research Committee) as well as a FINAL REPORT with reference

Appendix 3 Netcare Medibank Patient Report

Used with permission from the Medibank Coordinating team.

Enter the MediBank number found to the far left of the DEMOGRAPHICS main screen (the number column) of the patient you require a report for. A report will print as follows:

Report Date: 10/25/06 **Individual Patient Report** Report Time: 20:40:03

Unknown Male Alpha

Page: 1 Of 5

Demographics

Arrival Date: 4/10/2006 **Patient Number:** 3,882 **Hospital Number:** HN1234567

Gender: Male **Race:** Black **Age:** 34 **Residential Suburb:** Hillbrow

Non Trauma Case? No **Priority:** P1

Incident

How It Happened: Gunshot (handgun) **Mechanism:** Penetrating

PreHospital

EMS Service: JHB EMS **Ambulance Number:** AMB1 **Scene Time:** 0:21 **Transport Time:** 0:11

Pulse: 135 **Respiritory Rate:** 34 **BP:** 90 **PreHospital GCS:** 15 **PreHospital RTS:** 7.6

Highest Level of Airway Management: O2 Mask **Doc. on Scene?:** No

IV Access: 1 line

Crystaloid: Ringers lactate **Volume:** 200 ml

Colloid: Nil **Volume:** 0 ml

Drugs Used:

Nil

Other Used:

Fully immobilised

Transferred? N **Transferred From:**

Emergency Unit Admission

Highest Level of PreHospital Care: Ambulance BLS **Arrival Date:** 4/10/2006 **Arrival Time:** 8:53

Time Spent in Emergency Unit Days hh:mm): 0 0:42

Resus Team

Title	Name	Activated	Arrived	Present?	Notes
Consultant Surg	Consultant's Name	8:53	8:57	Yes	
Registrar	Registrar's Name	8:53	9:10	Yes	Busy In OT

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Report Date: 10/25/06 **Individual Patient Report** Report Time: 20:40:03

Unknown Male Alpha

Registered Nurs	Sister 1's Name	8:53	8:53	Yes
Registered Nurs	Sister 2's Name	8:53	8:53	Yes
Registered Nurs	Sister 3's Name	8:53	8:53	Yes
Radiographer	Radiographers	8:53	9:00	Yes

Emergency Unit Assesment and Management

Emergency Unit Doctor: Doctor 1 **ATLS Trained:** Yes

Temperature: 36.7 **Pulse:** 124 **Respiritory Rate:** 45 **BP:** 90 **Ventilator Rate:**

Admission GCS: 10 **Admission RTS:** 6.6

Highest Level of Airway Management: Oral ETT **IV Access:** 2 X 14G, subclavian

Crystalloids: Ringers lactate **Volume:** 2,000 ml **Units of Blood:** 4

Colloids: Gelofusin **Volume:** 500 ml **Units of FFP:** 4

Disposition: ICU via Theatre

Comorbidity:

Tuberculosis

Alcohol

Drugs Used:

Morphine

ATT [Tet Tox]

Augmentin

Emergency Unit Procedures	Code
IC Drain R	1141
Endotracheal intubation	
Nasogastric tube	
Central line R	1218
Peripheral line L	1215
Urinary catheter - male	1996

Diagnostic Investigations

X-Ray [chest] - POSITIVE

X-Ray [pelvis] - NAD

X-Ray [C-spine] - NAD

Report Date: 10/25/06 **Individual Patient Report** Report Time: 20:40:03

Page: 3 Of 5

Unknown Male Alpha

Injury Severity Scores

ISS Prehospital Probability Of Survival:	98 %	**Injury Severity Score (ISS):**	25
ISS Admission Probability Of Survival:	95 %		
NISS Prehospital Probability Of Survival:	85 %	**Injury Severity Score (NISS):**	41
NISS Admission Probability Of Survival:	67 %		

Injuries

Injury Description	AIS Score
Diaphragm, laceration (grade II)	3
Small bowel, laceration (grade III, > or = 50% circumference, no transection)	3
Liver, laceration (grade III, moderate, depth > 3cm)	3
Haemo-pneumothorax (penetrating) R	3
Inferior vena cava, laceration (major)	4
Kidney, laceration (grade IV,major, extending through renal cortex, medulla and collecting system) R	4

ICD10 Diagnosis

Description	Code
Injury of liver or gallbladder	S36.1
Injury of small intestine	S36.4
Injury of inferior vena cava	S35.1
Injury of kidney	S37.0
Traumatic haemopneumothorax	S27.2

Procedures

Date: 4/10/2006 **Time:** 9:45 **Location:** Theatre **Doctor:** Surgeon's Name

Procedure	Code
Small bowel, repair	1645
Kidney, nephrectomy	1895
Liver, repair	1757
Damage control	
Vein (major), repair	1396
Laparotomy	1809
Surgical Team	
Surgeon's Name	Consultant Surgeon

Report Date: 10/25/06

Individual Patient Report

Report Time: 20:40:03

Unknown Male Alpha

Assistant's Name — Assistant
Anaesthetist's Name — Anaesthetist

ICD10 Complications

Date: 4/10/2006 **Location:** ICU

Description	Code
Airway: Unintentional extubation	2502

Date: 11/10/2006 **Location:** ICU

Description	Code
Pulmonary: ARDS	J80

ICU Summary

Admission Date: 4/10/2006 **Admission Time:** 10:30 **ICU Doctor:** ICU Doctor's Name

Reasons For ICU Admission

Trauma unspecified
Shock unspecified

ICU Admission Scores:

SAPSII Score: 62 **SAPSII Predicted Death Rate:** 71.86 %
KES Final Score: 1.10 **KES Predicted Death Rate:** 75.03 %
APACHE II Final Score: 28 **APACHE II Predicted Death Rate:** 63.90 % **APACHE II Adjusted Death Rate:** 37.52 %

Daily SOFA Scores

Date	Score:
4/10/2006	10
6/10/2006	9
9/10/2006	6
11/10/2006	8
13/10/2006	14
16/10/2006	13

Other Daily Info

Date	Ventilated	Mode:	Enteral Nutrition	Inotropes	Dialysis	Cholesterol	Magnesium	IL6
4/10/2006	Yes	Invasive[tube]	Nil [No TPN]	Yes	No	0.00	0.00	0.00
5/10/2006	Yes	Invasive[tube]	Nil [Only TPN]	Yes	No	0.00	0.00	0.00
6/10/2006	Yes	Invasive[tube]	Nil [Only TPN]	No	No	0.00	0.00	0.00

Report Date: 10/25/06 **Individual Patient Report** Report Time: 20:40:03

Unknown Male Alpha

7/10/2006	Yes	Invasive[tube]	Nil [Only TPN]	No	No	0.00	0.00	0.00
8/10/2006	Yes	Invasive[tube]	Supplemental	No	No	0.00	0.00	0.00
9/10/2006	Yes	Invasive[tube]	Supplemental	No	No	0.00	0.00	0.00
10/10/2006	Yes	Invasive[tube]	Supplemental	No	No	0.00	0.00	0.00
11/10/2006	Yes	Invasive[tube]	Supplemental	No	No	0.00	0.00	0.00
12/10/2006	Yes	Invasive[tube]	Supplemental	Yes	No	0.00	0.00	0.00
13/10/2006	Yes	Invasive[tube]	Supplemental	Yes	Yes	0.00	0.00	0.00
14/10/2006	Yes	Invasive[tube]	Supplemental	Yes	No	0.00	0.00	0.00
15/10/2006	Yes	Invasive[tube]	Supplemental	No	Yes	0.00	0.00	0.00
16/10/2006	Yes	Invasive[tube]	Nil [Only TPN]	Yes	No	0.00	0.00	0.00

Cultures

Date Sent	Culture Type	Organism	Treatment	From	To	Successful?
11/10/2006	Sputum	Nosocomial pneumonia	Tazocin	12/10/2006	16/10/2006	No

Performance Review

Date: 18/10/2006 **Judgement:** Potentially Preventable [Accepable]

Perfomance Review Descriptions:

Trauma death

Comments

PM: Peritonitis, fatty changes in liver, oedematous lungs, bilateral pneumonia, evidence of renal failure.

Hospital Outcome

Discharge Date: 16/10/2006 **Days In Hospital:** 12 **Days In ICU:** 12 **Ventilated Days:** 12

Days In HighCare: 0 **Inotrope Days:** 6 **TPN Days:** 4 **Dialysis Days:** 2

Disposition: Died **Discharge Service:** Mortuary **Death Location:** N/A

Appendix 4 Plagiarism Report: Write Check