Factors Influencing Mortality in Major Penetrating Trauma

Trauma Unit Charlotte Maxeke Johannesburg Academic Hospital

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of

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DECLARATION

I, Helena Maria Romeu Alves, 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.

Signed at..

Date..

Signature..

DEDICATION

This work is dedicated to my father who always believed in me, to my mother and Luis for their support, and the endless hours that I deprived them of my company and to Ziggy who, with his unconditional love, stayed and loved me in difficult times.

ABSTRACT

Aim: To determine variables related to the patients with penetrating injuries, with a calculated New Injury Severity Score (NISS) probability of survival equal to or greater than fifty percent (NISS Ps ≥50) to compare those who survived and those who died.

Design: A retrospective, cross-sectional, comparative study of patients admitted to the emergency centre of the Charlotte Maxeke Johannesburg Academic Hospital (C.M.J.A.H.) in the northern suburbs of Johannesburg with either gunshot wounds or stab wounds.

Only patients with NISS Ps ≥50 were used in the study. Data collected included age, ethnicity, systolic blood pressure, pulse rate, respiratory rate, pH, Glasgow Coma Scale, lactate, temperature, fluids infused, pre-hospital time, time spent in emergency unit, training and supervision, method of transport, mechanism of injury.

Main Results: Out of a total of 725 patients predicted survivors (NISS Ps>50), 9 died (1.25%). The patients who died had a lower systolic blood pressure ($P<0.0001$) lower Glasgow Coma Scale ($P<0.0001$) and lower pH ($P<0.0001$) compared to those who lived. Patients who died also received more transfusions and fluids those who lived.

Conclusions: This study shows that the emergency centre at C.M.J.A.H. is a good unit, but there is a clear trend which shows that specific variables, particularly those indicating circulatory collapse, should point to earlier surgical intervention.

This study shows the need for additional alerts to allow for faster decision making by surgeons regarding patients who are already compromised due to the severity of their injuries and prolonged pre-hospital times.

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Abbreviations

AIS - Abbreviated Injury Scores

ALS - Advanced Life Support

ATLS®® - Advanced Trauma Life Support®

BLS - Basic Life Support

C.M.J.A.H - Charlotte Maxeke Johannesburg Academic Hospital

COPD –Chronic Obstructive Pulmonary Disease

CVS- Cardio Vascular System

ER - Emergency Room

GSW - Gunshot wound

GCS - Glasgow Coma Scale

IC Drain - Intercostal drain

ICU – Intensive Care Unit

ILS - Intermediate Life Support

ISS - Injury Severity Score

NISS - New Injury Severity Score

PS - Probability of survival

RTS - Revised Trauma Score

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PREFACE

Every Wednesday morning at the C.M.J.A.H. trauma unit there is an academic meeting where the mortality and morbidity of the previous week is discussed. The patients that get an NISS Ps<50 are expected to die and are evaluated according to the pathologist's report of the post mortem.

Patients with Ps ≥50 were expected to live. The cut-off point of 50%, to decide what is preventable or not is an arbitrary consensus-derived point used for audit purposes. This 50% percentile is a calculated value for the United States of America. I believe that despite our limited resources, patients with Ps ≥ 50 should not have died.

Sometimes patients with NISS Ps ≥50 die, and are evaluated as acceptable and not preventable and there is no protocol violation. Our protocols are based on available evidence from literature.

Although the numbers in a year are low (1.25%), it is still a life that is lost and perhaps if we identify the factors that contributed to these deaths, another life in the same circumstances might be spared in the future.

Chapter 1- INTRODUCTION

Trauma is one of the four pandemics in South Africa[1], the others being Human Immunodeficiency Virus (HIV) Acquired Immunodeficiency Syndrome (AIDS) Tuberculosis (TB) and non-communicable diseases such as cardiovascular diseases, cancer and mental health disease. South Africa has high death rates from unnatural causes and the second highest homicide rate in the world second only to Colombia[2]. An estimated 70 000 South Africans are killed due to trauma every year, while over 1.5 million patients attend our hospitals because of trauma. In South Africa trauma is amongst the top three causes of death, and the leading consumer of hospital days and health facility budgets[3].

1.1 Statement of the problem

Charlotte Maxeke Johannesburg Hospital Trauma Unit is an accredited level one unit as per Trauma Society of South Africa[4]. The unit gains this accreditation because it is approved for Trauma Surgery sub-specialty training. We should be able to provide guidance and leadership to units undertaking trauma care in equivalent countries.

According to the World Health Organization, a preventable trauma death must meet three criteria: 1) The injury must be compatible with life; 2) the care received by the injured patient is suboptimal when compared with the standard of care; 3) There were errors identified at Mortality and Morbidity meetings that contributed to the patient's poor outcome[5]. The overall preventable death rate among trauma patients ranges from 1% to as high as 26%. The rates of preventable deaths among trauma patients in low and middle-income countries are substantially higher than in high-income countries[6].

1.2 Motivation and rationale for this study

The researcher noted that some patients who arrived at the unit and should have lived ended up dying and determined that it would be useful to understand the circumstances leading to these potential preventable deaths is it related to pre-hospital time and care? Is it related to the triage process, or is it related to the quality of care in the emergency department?

The patient is triaged by ambulance service personnel, sometimes incorrectly. After triage by ambulance service personnel, triage in the unit is performed mainly by junior doctors and nursing staff. This is because after hours and on weekends the work load increases substantially and, although they follow the physiologic parameters, they do not have the insight to appreciate the severity of the injury so sometimes the patient is not prioritised accordingly. . In addition, triage is an inherently inaccurate intervention, designed to ensure a false negative rate (over-triage) of at least 10%[7]

Only by critically examining our deficiencies we improve our performance and patient outcome

Chapter - 2

2.1 Literature Review

Penetrating injuries are part of the trauma epidemic. C.M.J.A.H. drains an area where crime and violence are high, mainly due to a dense population of illegal immigrants and drug lords. In an article from *Rose bank Killarney Gazette* from 9 September 2011[8], contact crime is on the decline in Hill brow, but drug and alcohol-related crime is on the increase. Wayne Ford from the Hill brow community policing forum (CPF), commented, "Considering the sheer size of the Hill brow population, the number of illegal immigrants, unemployment levels and the chronic overcrowding in flats, the crime statistics are remarkably good." According to the latest statistics from South Africa Police Services statistics[9] (period 1 April 2010 - 31 March 2011) a total of 2 071.487 serious crimes cases were reported in South Africa. In the trauma unit at C.M.J.A.H. the prevalence of penetrating injuries, versus blunt injuries, from 1 April 2008 to 31 March 2009 was 1 169 blunt injuries to 1 239 penetrating injuries, as per trauma unit Traumabank figures (unpublished unit data on file)

Two main groups of penetrating injuries present to our emergency unit, mostly gunshot wounds (GSW) and stab wounds Gunshot wounds are predominantly from hand guns Sometimes there are shotgun wounds and, in addition, there are the odd cases of penetrating wounds from rubber bullets. The stab wounds are mainly from knives, and there are occasional cases of a traditional weapon, like a panga, and broken bottles, but stab wounds from bottles seldom present with severe penetrating wounds.

In a recent paper dated March 2011 from Inkosi Albert Luthuli Central Hospital trauma unit in Kwazulu Natal,[10] it was concluded that penetrating injuries accounted for 33.7% of their admissions and from these 64.2% were GSWs. The mechanism of injury from a stab and a gunshot wound are completely different.

Bullets cause damage in three ways: the initial cut through tissues, penetration and the aftermath, cavitations due to the way bullets behave.
Cavitations are due to a shock wave type mechanism and this sequel is different because of the type of tissue that is affected. Some tissues are more elastic, like lungs, which returns to their initial form more readily than others, like the liver and brain that are inelastic so that the cavities do not recoil and are permanent.

The fragmentation process in the tissues can be caused either by pieces of the metal jacket of the bullet "shrapnel" or by spikes of fragmented bone due to bullet impact.
In the stabbing mechanism the kinetic energy is delivered by initial contact only, therefore the impact to the tissues is less than in gunshot wounds.
From the different mechanism and kinetic energy delivered, the outcomes are different because the injuries from a gunshot are more severe and more complicated to deal with than those from a stab wound.[11]

Due to large numbers of patients that are transported to the emergency units there is a need to triage them and decide where they must be transported to, so that their survival outcome improves. Patients are triaged using scoring systems. If the patient has a poor outcome on scene then they should not be transported to a trauma one level centre and compromise the limited resources that are available which can be utilized rather for a patient with a better prognosis.

The concept of grading severity of trauma was devised in the United States of America in 1969 by automobile and insurance companies due to claims that arose after car accidents[12].

At present, age, magnitude of injury and physiological compromise expressed as the Revised Trauma Score (RTS) and magnitude of injury, expressed as Injury Severity Score (ISS) or New Injury Severity Score (NISS) constitute the most accepted variables used in calculating Probability of Survival (Ps), for penetrating trauma.

While age, magnitude of injury and physiological compromise are known to be the principal factors in causing mortality after trauma[13], the impact of co-morbidities and system factors impacting on the delivery of care are less clear[14].

This study analysed patients using trauma scores[15]. Modern trauma scoring methodology uses the assessment of the severity of anatomical injury plus a quantification of physiologic derangement and age, to obtain a score that correlates with clinical outcomes. There are two different types of scales applicable to the emergency department.

1. Physiological scoring systems - Revised trauma score (RTS) which is a physiological scoring system and good predictor of survival. It is scored on the first set of parameters obtained from the patient Glasgow Coma Scale

the Systolic Blood Pressure and Respiratory Rate .This is calculated using the resources available online at : http:// www.trauma.org/ index.php/main/article/386/.

2. Anatomical Scoring Systems - AIS, ISS, and NISS. The AIS is a simple numerical method for grading and comparing injuries by severity. The ISS is defined as the sum of squares of the highest AIS grade in the three most severely injured body regions. NISS is a modified ISS based on three most severe injuries regardless of body regions.

2.1.1 Physiological scoring systems

The Revised Trauma Score which is derived from the Trauma Score (TS) is traditionally used as a tool to triage patients according to their degree of physiological compromise. The TS uses the Glasgow Coma Score (GCS), systolic blood pressure (SBP) and respiratory rate (RR) and the score values range between 0-12.

Because each of the factors (GCS, SBP, RR) comprising the TS showed a different weight in predicting mortality, a multivariate analysis was performed to match these parameters with survival using the USA Major Trauma Outcome Study, which contained more than 100 000 patient records at the time. Each factor was accorded a co-factor to derive the Revised Trauma Score[16].

2.1.2 Anatomical scoring systems

Abbreviated injury Score (AIS) The AIS is derived by consensus from the data base of the Association of the Study of Automotive Medicine whereby individual injuries are classified as minor, moderate, severe, life threatening, and given a numerical value (1-5). A value of 6 was deemed universally fatal, e.g. crushed skull, and so on. The AIS does not reflect the combined effects of multiple injuries, but forms the foundation for the ISS. Baker et al[17]introduced the ISS in 1974 as a means of summarising multiple injuries in a single patient.

2. 1.3 Injury severity score (ISS).

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale (AIS) score and is selected to one of six body regions (Head, Face, Chest, Abdomen, Extremities - including Pelvis - and External). Only the highest AIS score in each body region is used. The three most severely injured body regions have their score squared and added together to produce the ISS score. The ISS roughly correlates with survival where an ISS of 1 is considered minor injury, and the maximum ISS (75) is considered incompatible with survival.[12] This system has limitations as only one injury per body region can be selected and sometimes another injury from a body region that is not as severely affected has to be included. The ISS takes no account of physiologic variables

By combining the RTS and ISS with age and separating blunt from penetrating injury, TRISS Score was derived to calculate the probability of survival against a data base of more than 100,000 major injuries in a cohort study (USA Major Trauma Outcome Study) The Ps was then loosely defined as the Probability of Survival for a patient with a given magnitude of injury, degree of physiological compromise and age, when compared to a similar hypothetical patient in Major Trauma Outcome Study, that was a study with a large number of patients and safely used as benchmark (MTOS)[15.] A Ps 60 therefore indicated that 60% of patients with these characteristics would have survived, had they been admitted to a contributing United States of America trauma tertiary (Level 1) trauma centre.

2. 1.4 New injury severity score (NISS)

This system was developed in 1997 (Osler et al. 1997)[18]. The NISS was developed due to a need to score multiple injuries in the same body region as this was not possible with ISS[19].

As an example, a GSW of the abdominal cavity on the ISS score could only account for the severest injury on that compartment (abdominal aorta has a score of 5^2). With the NISS scoring system we can now score all the injuries of the abdominal cavity (diaphragm, pancreas, aorta, liver, and inferior vena cava) and the score may be $5^2+5^2+5^2$ (75). NISS has become the one that best correlates with penetrating injuries. If we score the patient using NISS, the patient will have a near fatal injury (Ps 20%), but if using ISS would have severe injury with perhaps a Ps (ISS) of 50% or more. Realistically, the patient would be unlikely to survive with such an injury. The cut-off point of 50% to decide what is preventable or not is an arbitrary consensus-derived point used for audit purposes[20].

As an example how the scoring systems work let us consider patient AB:

The patient sustained a gunshot wound of the chest.

On admission his physiological variables were: SBP -80mmHg; RR-28/ minute Pulse- 110/minute; GCS 15/15

Injuries sustained- Left lower lobe of liver, perforation of diaphragm, bilateral haemopneumothorax, through and through laceration of liver, laceration of duodenum and a GSW in the right thigh. If we compare how the patients score in the different systems we can see their limitations.

Table 1- Comparative scores for one patient using different scoring systems

	RTS	ISS	NISS
Total Score	12	75	75
Score	6.8174	26 Ps -97%	41 Ps-78%

RTS =Revised Trauma Score; ISS= Injury Severity Score; NISS=New Injury Severity Score.; PS= Probability of survival.

The discrepancy of survival using different scoring systems is evident using the example above and NISS is the scoring system that better predicts penetrating trauma[19].

2.1.5 Factors affecting survival

The scores available today, although they give an idea of predicted outcome, do not take into consideration factors such as those listed below:

3. Age[21]
4. Sex[22]
5. Hypothermia[23,24,25]
6. Occult hypo-perfusion[26',27]

7. Fluids (resuscitation)[28]

8. Pre-hospital time[28, 29]

9. Time spent in the emergency unit[30, 31, 32]

10. Level of training of doctors resuscitating trauma patients[33]

11. Resuscitation by a team of doctors and nurses all present at the same time (horizontal organisation), as opposed to the conventional system of (vertical) referral [32]

2. 1.6 Age - Trauma occurring in the extremes of age is associated with increased mortality, particularly in the age groups under 5 years, and over 55 years, due to immature organ systems and senile changes, respectively.

In fact in penetrating trauma after the age of 55, the mortality increases steadily for each age group[21].

The trauma team doctor has to take into consideration the physiologic and anatomical differences induced by age. These are co-morbidities that can cause unexpected outcomes. These are outlined on table 2[34, 35]

Table 2 Common co-morbidities present in patients presenting to emergency departments

Elderly	Paediatric
Airway compromised by: a. False teeth b.Loose teeth c. Osteoarthritis c-spine	**Airway:** a. Short, small b. Anteriorly located
Chest – C.O.PD.: a. Restricted compliance due to pain b. Decreased vital capacity	**Chest:** a. Very compliant b. Prone to lung contusions
CVS: a. Hypertension b. Hypertensive medication c. Ischemic heart diseases d. Diabetes Mellitus	

Age is an important factor as a predictive outcome in the scoring system[21].

Though the original calculation of Ps uses age 54 as a cut-off point in calculation, the concept of biological age vs. numerical age, and the physiological immaturity of the very young should also be considered. For example, triage protocols based on large outcome studies use extremes of age e.g. 5 years or less, and 65 years or more. This is clearly at variance with the cut-off point of 54 years used in calculating Ps.

2.1.7 Sex - The Sex hormones may play a role in regulating posttraumatic immunosuppressant factors. In younger trauma patients females aged 15 to 45, the outcome was more favourable than in males, but there was no difference in outcome after the age of 45 years[22] .

2.1.8 Hypothermia - Hypothermia is defined as a core temperature of 35°C or below. In the trauma patient it is part of the "lethal triad"[23, 24, 25], the others being acidosis and coagulopathy. Temperatures in South Africa can get very low, especially at night, in particular parts of the country.

Coagulopathy is caused by hypothermia in trauma patients at a core temperature below 34°C[36]. Since enzyme systems are temperature dependent, hypothermia causes a delay in the onset of thrombin generation, whereas acidosis causes both a delay in the onset of thrombin generation and impairment in thrombin generation rate. The reaction time (latency time for initial clot formation) of the thromboelastogram (TEG) was prolonged in the hypothermia and the combined groups, (hypothermia and coagulopathy) but not in the acidosis group[36].

An adult trauma patient victim with a temperature of 32°C or below[37] has a predicted mortality of 100% excluding other parameters like shock, resuscitation fluids or degree of injury severity scores[38]. It independently predicts mortality.

Apart from hypothermia-induced by exposure at the scene of injury, a decrease in core temperature is a common event in emergency units during the initial assessment. Hypothermia occurs because of prolonged exposure, infusion of cold fluids, un-warmed environment, inhaling cold gas during ventilation, etc[39].

Ferrara et al. demonstrated that trauma patients that presented with the lethal triad, hypothermia, acidosis, coagulopathy and had massive transfusions had a mortality rate of 90%[40].

Hypothermia is also a risk factor for Multiple Organ Dysfunction (MOD), but not mortality.[18, 41]

2.1.9 Occult hypo perfusion – Occult hypo-perfusion is a condition whereby a victim of major trauma may present with pulse rate (< 120.min), SBP (>90 mmHg,) and urine volume (>0.5 cc/kg/hr) after resuscitation. But if the patient has a raised serum lactate level (> 4 mol/l) it indicates residual (occult) hypo-perfusion and anaerobic metabolism in the tissues. Occult hypo-perfusion at 24 hours after admission is a significant cause of MODS and increased need for blood transfusion, major surgery, increased ICU days, and death[42].

In a study by Frischknecht A, et, al[43] they concluded that patients with early deaths had significantly higher lactate and base deficit levels at hospital and ICU admission as compared to early survivors. Furthermore, an elevated lactate level >6 mmol/L on hospital admission, and the inability to achieve a lactate level <4 mmol/L until ICU admission, indicating a decreased lactate clearance, were significant risk factors for early mortality in the current analysis.

Lactate is considered to be the gold standard for assessing the degree of tissue hypo-perfusion after trauma [26, 27].

2.1.10 Fluids administration

Patients that arrive at the emergency unit with a systolic blood pressure <90 mmHg, or a heart rate >130 are deemed to be in shock. In a relatively young population with good compensatory mechanisms, decreased systolic blood pressure is a late finding.[57] The pulse rate due to a paradoxical mediated bradycardia also gives a false sense of security, since no tachycardia is present as a warning mechanism[57]. In a paper from Cedars -Sinai medical center, trauma and critical division they suggest to raise the bar for systolic blood pressure for the elderly. The optimal definition of hypotension was systolic blood pressure of 100 mm Hg for patients 20 to 49 years, 120 mm Hg for patients 50 to 69 years, and 140 mm Hg for patients 70 years and older. The optimal systolic blood pressure for improved mortality in hemorrhagic shock increases significantly with increasing age. Elderly trauma patients without major head injuries should be considered hypotensive for systolic blood pressure less than 140 mm Hg.[44]

There are multiple factors that may contribute to the coagulopathy observed in the trauma patient. Immediately after injury, hypo perfusion may cause coagulopathy as a result of increased anti-coagulation and hyper-fibrinolysis via increased activated protein C production. The development of hypothermia, hypocalcaemia and acidosis can each further contribute to worsening of this initial coagulopathic state. Traumatic coagulopathy is a hypo-coagulable state. Patients who survive their early hypo-coagulable state can progress to Disseminated Intravascular Coagulation (DIC) which is a hypercoagulable state, possibly due to release of thromboplastins or diffuse endothelial injury secondary to inflammation[45].

Although the resuscitation of a bleeding patient is to control the bleed; the fluid resuscitation protocol is to infuse an initial two litres of crystalloid[46]. Ringers lactate is the crystalloid of choice in the unit as it provides a better buffer for metabolic acidosis. Normal Saline is also acceptable if Ringers Lactate is not available as it is only limited to two litres, thus reducing the risk of hyperchloremic acidosis compared to when large volumes are infused.

Initial crystalloid administration is limited as over infusion might have adverse outcomes like cerebral oedema by increasing intracranial pressure (ICP), pulmonary oedema if there is a contused lung and it might produce abdominal compartment syndrome.

The use of crystalloids and colloids is used mainly to buy time for blood and fresh frozen plasma to become available. Ringers Lactate remained the fluid of choice in most centres and the recommended fluid of the ATLS® course throughout the 1980s, 1990s, and early 2000s. It was the most reasonable choice as it induces relatively less inflammation and immune dysfunction, causes fewer electrolyte abnormalities, is economically better, and is widely available for clinical use.

Blood component therapy for patients in hemorrhagic shock who do not respond to initial fluid resuscitation: the standard of care has historically been to begin infusion of blood products after infusion of 1 to 2 L of LR. In fact, the ATLS® protocol recommends infusion of packed red blood cells (pRBCs) if the prescribed 2 L of Ringers Lactate fails to reverse signs of shock. Although blood supplied in packed cells has lost its oxygen-carrying capacity, it is still the fluid of choice, until the day that haemoglobin-based oxygen carrying fluids are freely available and economical viable.

Haemoglobin-based oxygen carriers have been developed commercially as universally compatible, free of infectious risk, and blood substitutes that do not require refrigeration and have long shelf-lives. Different formulations differ in the mammalian source of the haemoglobin and how it is cross-linked as well as in storage and length of shelf-life. Of the HBOCs tested thus far, only Hemopure or HBOC-201 (13 g/dL glutaraldehyde polymerized bovine haemoglobin) has remained in contention for clinical use[47]. Today is still largely used for patients that, owing to religious beliefs are not allowed blood transfusions, like the Jehovah's Witnesses.

Recombinant Factor VIIa (VIIa) Novo Seven [48]is currently licensed for use in haemophiliacs with antibodies to Factor VIII. Factor VIIa is a trypsin-like serine protease. Factor VIIa lowers the Prothrombin Time and reduces visible coagulopathic haemorrhage following trauma. Factor VIIa reduces blood transfusion requirements in blunt trauma patients (who have already received 8 units of blood) and there is a similar trend in penetrating injury.

It is not yet licensed to be used in the trauma patient, but has been used in war situations with good results[49].

It is still a very expensive product.

The role of hypotensive resuscitation was vastly investigated by Bickell[50]. They aim to limit the volume of fluid given and maintain the SBP as low as is considered safe in the specific situation[51].

Titration of fluid bolus from 25 ml to 500 ml has been suggested. This contrasts markedly with traditional fluid resuscitation (give 2 L of crystalloid and aim for normotension) or delayed resuscitation (no fluid given until surgery). The Israeli military commence hypotensive resuscitation when one of the following three conditions is documented:

- Altered sensorium
- Radial pulse cannot be palpated
- Systolic blood pressure less than 80 mm Hg.

There are no randomised controlled trials in humans that evaluate the blood pressure (mean arterial or systolic) that should be targeted during hypotensive resuscitation guidelines suggesting titrating small volumes of crystalloids to a SBP target of between 80-90 mm Hg.

Hypotensive resuscitation can be achieved by goal-directed resuscitation or by controlled resuscitation. Adjusting infusion rates, targeting Mean Arterial Pressures (MAPs) of 40 mmHg, as opposed to 80 mmHg or higher, results not only in decreased blood loss but also in better splanchnic perfusion and tissue oxygenation[52] less acidemia, haemodilution, thrombocytopenia, and coagulopathy[53] decrease apoptotic cell death and tissue injury and improved survival[54].

2.1.11 Time to definitive care –Time is critical for the successful treatment of trauma, and prevention of death, by reducing time of bleed, oxygen deficit and contamination of tissue, and incitement of the Systemic Inflammatory Response as these will continue until resuscitation and definitive care is instituted[55]. Time to definitive care relates to the time from injury to the time surgery (if required) is started, whether to control hemorrhage, or to control contamination. Intuitively, delay to stop hemorrhage will lead to exsanguination. Delay in controlling contamination increases the risk of septic complications. Both factors may increase morbidity and mortality[56]. To prevent cell death the perfusion of tissues has to be maintained. Inadequate oxygen delivery to the tissues and perfusion, independent of the cause, may it be due to airway obstruction. Ineffective ventilation or hypovolemia is the most common factor associated with a negative outcome.

From this has come the concept of the "Golden Hour"[57], meaning the ideal time that the patient must be delivered from the scene of injury to the site of definitive care.

It was during World War 1that the correlation between time of injury and adequate treatment was first documented[58]. It is now known as the concept of the "Golden Hour" in trauma. The French military noticed that if the patient was treated during the first hour, the mortality was 10%. Mortality increased one percent per hour during the first three hours, increasing exponentially to seventy five percent after ten hours. This data was later used and credited to R Adams Cowley while he was a military surgeon and later while working at University of Maryland Shock Trauma

Centre. "There is a Golden Hour between life and death. If you are critically injured you have less than sixty minutes to survive. You might not die right then; it may be three days or two weeks later - but, something has happened in your body that is irreparable"[59].

Cudnick showed that pre-hospital time does not affect patient outcome.[29] In an article by Lerner and Muscat[60]they could not find scientific proof that this concept really works but common sense indicates that patient might have a better outcome if it is transported promptly to an appropriate institution.

In another study by Newgard et, al.[61]they arrived at the conclusion that the concept of 'Golden Hour ' has no scientific grounds and needs to be investigated further as ambulance crews are sometimes involved in accidents due to this concept. In our setting the delay from scene to hospital is greater than the 60 minutes of the recommended literature and it has a negative impact on patient outcome, also depending on the anatomical localisation of the injury.

2.1.12 Level of Pre-hospital care - The level of care delivered pre-hospital to patients is controversial. In a major study done by the Ontario Pre Hospital Advance Life Support Group, the implementation of the full advanced life-support program did not decrease mortality or morbidity for major trauma patients[62]. The reason given was that more advanced providers of care spent more time on the scene compared with providers with basic training. Endotracheal intubations at scene have not been proven to reduce mortality and morbidity in major trauma patients[63]. The value of fluid resuscitation is also uncertain. One landmark study showed improved survival for not giving fluid resuscitation at the scene and short

(52 minutes) pre-hospital time vs. fluid resuscitation and slightly longer pre-hospital times[50].

2.1.13 Time spent in Emergency Unit

Organisation of Reception – this includes:

Triage – defined as the sorting of patients according to their need for treatment. Patients are triaged on a combination of physiological (Glasgow Coma Scale, systolic blood pressure, respiratory rate), patient characteristics (extremes of age, co-morbid disease) and injury characteristics denoting magnitude of energy transfer (mechanism).

2.1.14 Level of training

The level of training of the doctors in the emergency areas of the public sector varies as the level one trauma unit is also an academic institution and we have doctors in all level of training from interns, medical officers to registrars and consultants. For this reason it is essential that staff is trained in a system that can provide immediate and safe treatment to the patients.

Are the doctors providing initial assessment and resuscitation trained in Advanced Trauma Life Support ® (ATLS®) or not?

The presence of a specialist surgeon appears to be important in the likelihood of a patient's survival.

The impact of the level of training of the receiving doctor is through the ability to triage accurately from a queue of waiting patients, to use a standardised protocol to minimise variability, in this case Advanced Trauma Life Support®, and a resuscitation team led by a senior physician.

Advanced Trauma Life Support® (ATLS) ®

ATLS® is a course presented by the Trauma Society of South Africa under the auspices of the American College of Surgeons Committee with the aim of teaching the following skills: to assess the patient rapidly and accurately; to resuscitate in order of the threat to life; to provide definitive care in the shortest time possible; and to provide optimum care along the way. The level of training of the receiving doctor has an impact in patient outcome, in this case Advanced Trauma Life Support®, should lead to better management, as well as the presence of a rapidly formed resuscitation team led by a senior physician[64,55] There is a paucity of literature showing improved survival using ATLS®-based resuscitation.[31] Organised trauma systems have been shown to reduce the rate of preventable deaths from more than thirty percent to less than three percent[33]. An improvement in survival from injury was shown after the introduction of training using the Advanced Life Trauma Support® (ATLS) ®, Course of the American College of Surgeons, Committee on Trauma.

2.1.15 Trauma Teams

Horizontal organisation of decision-making implies that decisions are made while all decision-makers are present, as opposed to vertical organisation, where junior decisions have to be referred to the next levels of command, until the consultant is asked, and wasting time to critical decision-making. A senior practitioner, preferably a specialist, supervises the junior staff and ensures that protocols are adhered to, procedures are performed to standard, and decisions on definitive care are rapidly made .This horizontal organisation of decision-making shortens the time to life-saving procedures, and may improve survival[64].

Mortality was reduced from 22.8% to 18.7 % just by cutting down the time to initial radiology and ultrasound, increasing the use of computer tomography, reducing time to theatre in case of haemorrhagic shock, and more frequent damage control interventions, especially for orthopaedic patients[65].

During this process, the components of the Primary Survey are allocated to 2 different doctors and 2 nurses, based on a protocol defining actions. Doctor 1 is responsible for assessing airway and breathing, doctor 2 is responsible for assessing and intervening on circulation.

The impact of a lack of senior supervision is a reason for concern – delay in decision-making and action may be leading to a poor outcome, although the literature is divided on this[66]. Some articles state that the consultant does not need to be present at the initial resuscitation, but in those hospitals senior doctors are present. Others say it is essential that the consultant is present at initial decision making[67], while others believe that it does not affect the outcome[68].

As discussed, there are factors other than age, physiological compromise and severity of injury which may affect survival after (penetrating) injury. These include, shock index,[69] resuscitation measured by lactate or base deficit to be added as tools for a more accurate prediction and improvement of patient care[70]. Therefore the reason for this study is to look at extra factors that can contribute to a better patient outcome, to look at the competence of staff at the trauma unit of C.M.J.A.H. and to verify that the international guidelines for survival applies to South Africa.

2.2 Aim and objectives

The aim of this study was to use a retrospective analysis of emergency unit records to investigate why some patients who were predicted to survive, on the basis of their NISS score, died.

2.2.1 Objectives

2.1 To describe the demographic of patients with penetrating injuries presenting to C.M.J.A.H. over a one-year period.

2.2 To compare physiological and injury variables between patients who survived with those that died, according to the NISS with a Ps ≥50.

2.2.1.3 To investigate possible reasons available from mortality and morbidity meetings for those patients who died.

Chapter 3

Materials and methods

3.1 Ethics

This research was approved by the Human Research Ethics Committee (medical) of the Faculty of Health Sciences of the University of the Witwatersrand (protocol approval number clearance certificate number **M0-90627**.

(Appendix.2)

3.2 Study Design

A retrospective, cross-sectional descriptive and comparative study. Data was collected from the unit TraumaBank which is a locally developed data base that automatically calculates New Injury Severity Scores (NISS) and the predictable Probability of Survival based on patient clinical data. The data is collected from forms completed by pre-hospital personnel and patient resuscitation forms in Emergency Department. Data is entered into the computer and analysed by a member of the trauma unit on a regular basis.

Thus this study used a secondary data analysis method. The variables collected from the TraumaBank were the following:

For demographics –

1 Age,

2 Race,

3 Gender.

From pre-hospital data

4 Type of transport

5 Mechanism of injury – Stab/GSW

6 Time from incident to arrival at Trauma Emergency Department

7 Systolic blood pressure

8 Pulse rate

9 Respiratory rate

10 Glasgow Coma Scale.

From Trauma Emergency Department

11 Initial systolic blood pressure

12 Respiratory rate

13 Pulse rate

14 Temperature.

15 Blood gas values - pH, lactate.

16 Fluids administered

17 Consultant present – yes/no

18 ATLS® trained – yes/no

3.2 Study Setting and Population

The Charlotte Maxeke Johannesburg Academic Hospital (C.M.J.A.H.) is a tertiary-quaternary level, teaching hospital in the northern suburbs of Johannesburg, South Africa. The Trauma Unit treats an average of 1 000 adult patients per month, of whom roughly 25% are major injuries requiring resuscitation.

Study Population

Male and female adult patients who presented to the Trauma Unit with penetrating injuries caused by gunshot wounds (GSW) or stabbings. C.M.J.A.H. defined adult patients as 16 years or older. Patients with both single and multiple injuries were included.

3.3 Sampling

Size: The population studied were patients admitted over a one-year period (1 April 2008 to 31 March 2009) and estimated total population was 2480 (N=2480).

Inclusion criteria:

1 - All penetrating injuries, GSW, stab wounds.

2 - Patients sixteen years or older.

3 - NISS Probability of Survival ≥ 50.

4 - Triaged as priority one according to unit protocol.

3.3.3 Exclusion criteria: Patients transferred from other institutions, grossly incomplete records, inability to verify pre-hospital times, vital signs, or time spent at referring facility.

3.4. Data analysis

All data was entered and stored in a Microsoft Excel® (Microsoft Office 2007, Microsoft Corporation) spreadsheet. Data collected was entered in a completely confidential manner. Patients with NISS Ps ≥50% that died and patients with NISS Ps ≥50% that survived were separated and compared.

All statistical analysis was conducted using STATISTICA® (2008) StatSoft, Inc. (version 8.0.) http:// www.statsoft.com. Descriptive statistics (mean and standard deviation) were used to provide descriptive data. An unpaired t-test Fishers exact test was used to compare numerical and categorical data, respectively, for patients who died to patients who lived. A $p < 0.05$ was considered to be significant for all statistical tests.

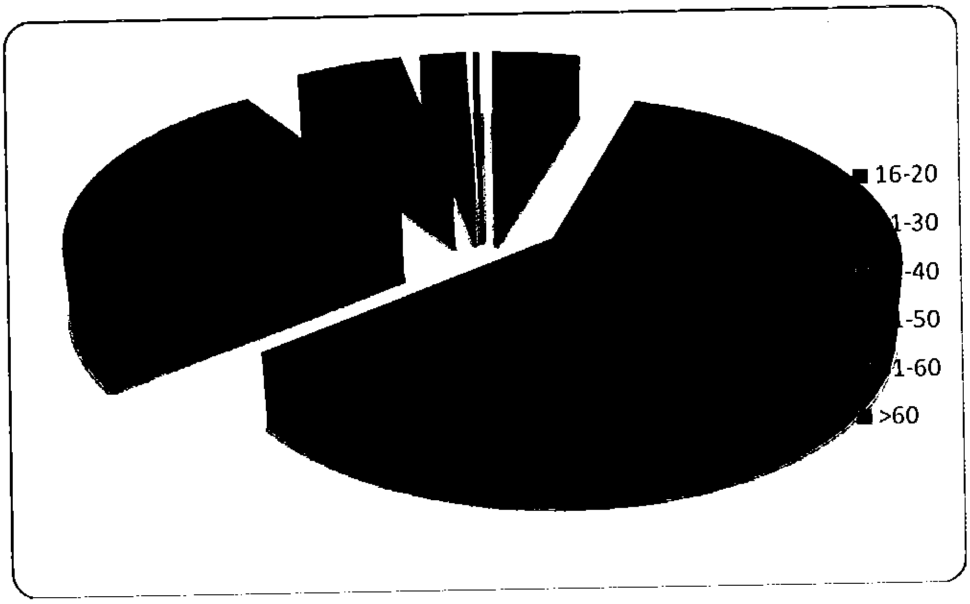
Chapter 4 RESULTS

A total of 1 330 patients was entered in the TraumaBank for the one-year period with penetrating injuries. From this total 725 patients qualified for the inclusion criteria of an NISS Probability of Survival ≥ 50 of which 716 (98.7%) patients survived and 9 died. All subsequent data therefore were collected only from patients with a NISS Probability of Survival ≥ 50.

Demographic Characteristics of the Study Population

Patients that survived (n=716) had a mean (SD) age of 29.5 (8.2.)years. While patients that died (n=9) had a mean age of 32.1 (13.3) years There was no significant difference in age between the two groups (p= 0.16 unpaired t-test).

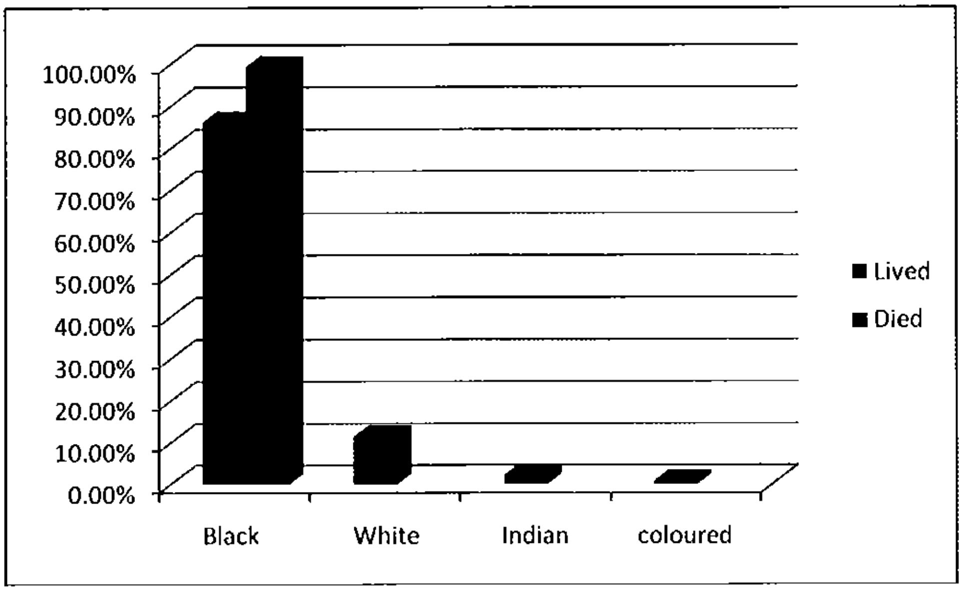
Figure 1- Age distribution (in years) of the total population of patients with NISS P≥50



The majority (97.6%) of patients in the total group were male. In the group that died (88.9%) were male, which was not significantly different from the gender distribution in the total group (p=0.24 Fishers exact test).

The majority of patients in the total group, as well as the two separate groups, were black. Due to the high proportion of black patients no analysis was done of any variables between racial groups.

Figure 2 Race distribution patients that survived and died



Training and Supervision

A consultant was present in the resuscitation area for 55.5%of patients that survived and was present in 75%of patients that died (P value 0.311 Fishers exact test not significant).The medical staff trained in ATLS® 84.1% with patients that survived and 83.5% with patients that died (P value 0.063 Fishers exact test not significant).

The table 4.1 below compares the vital signs and blood gases between those who survived and those who lived.

Patients who died had a statistically significant decreased BP (p<0.0001) and an increase in the pulse rate (p <0.0001), compared to those who survived. Those that died also had a lower Glasgow Coma Scale (p<0.0001) compared to those who survived. The Shock index was relevant as the score was higher in the patients who died (p<0.0016). Lactate was also significantly higher in the patients who died (p<0.0001). This was supported by a significantly lower Ph in the patients who died (p<0.0001)

Table 4.1: Vital signs and blood gas results obtained in Trauma Emergency Department in patients with penetrating injuries with NISS Probability of survival>50 between those who survived and those who died.

.	Survived n=716		Died n=9		P value
	Mean	(SD)	Mean	(SD)	
Shock index	0.73	(0.23)	1.19	(0.42)	<0.0016
BP Systolic (mmHg)	123.0	(21.3)	93.0	(13.4)	<0.0001
Pulse Rate (bpm)	86.3	(19.1)	104.7	(29.4)	<0.0001
G.C.S	14.6	(1.4)	14.1	(1.7)	<0.0001
Respiratory Rate(Breaths per minute)	21.5	(6.5)	20.1	(4.3)	0.284
Ph	7.4	(0.1)	7.3	(0.3)	<0.0001
Lactate (mmol/l)	3.8	(2.5)	5.6	(7.0)	<0.0001
Base excess	0.9	(7.1)	2.3	(13.7)	0.0005
Temperature °C	37.5	(14.4)	36.0	(1.8)	0.73

G.C.S.=

Glasgow Coma Scale

shock index=HR/SBP

(Unpaired t-test comparing patients who survived with those who died)

The fluids in the trauma unit are administered according to the unit protocol that is based on international guidelines mainly for crystalloid administration. This is the reason why there is not a significant difference between those who died and those who survived. Patients who died had a statically significant increase in use of colloids, blood and FFP ($p<0.0001$) compared to those who survived (table 4.2)

Table 4 .2 Fluids administered in Emergency Department as per protocol guidelines for patients who survived and died with NISS Probability of survival>50. (Unpaired t-test to compare patients who lived with those who died)

	Survived n=716		Died n=9		P value
	Mean	(SD)	Mean	(SD)	
Colloid (mls)	123.1	(298.6)	611.1	(485.9)	<0.0001
Crystalloid(litres)	1.5	(0.7)	1.5	(1)	0.43
Blood (units)	0.05	(0.04)	1.5	(1.94)	<0.0001

(P=1.0 Fishers exact test) the most common mechanism of injury was stabbing

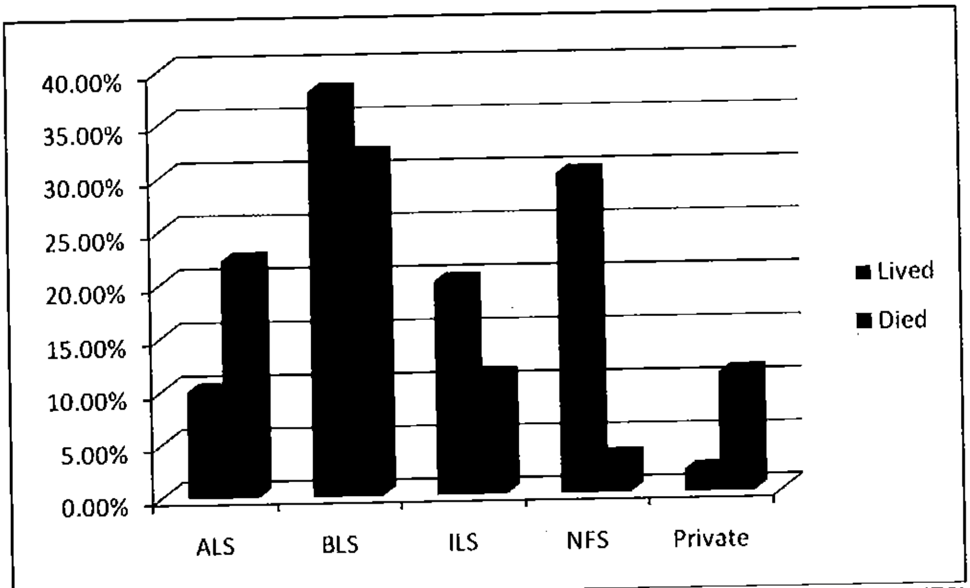
Figure 3 Comparison of mechanism of injury between those that survived and those that died

The NISS probability of survival was significantly lower on those that died (79.2)(18.2)compared to those that survived (97.5)(12) (p<0.0001 impaired t-test) as per table 4.4 below. The actual NISS Ps in patients who died, were still above 50 but still lower than the patients who survived

Table 4.3 Comparison of the NISS probability of survival from those who died and those who survived

	Survived n=716 Mean	(SD)	Died n=9 Mean	(SD)	P value
NISS Ps	97.5	(12)	79.2	(18.2)	<.0001

Figure 4 A comparison of methods of transport between patients that survived and those that died



Advanced Life Support (ALS), Intermediate Life Support (ILS), Not Further Specified (NFS)
Basic Life Support (BLS)

The prevalent method of transport was BLS, ,the method of transport had no impact between those that survived and those that died

(p= 0.667 Fishers test exact and therefore not significant).

Results from Mortality and Morbidity Meetings (M & M)

Post Mortem Results discussion

From the post mortem results and mortality and morbidity meeting the following results were given for the patient who died:

1 – Stab wound level T6 massive haemopneumothorax right. Unit extremely busy, help not called in. Angiography embolisation done, should have gone to theatre

sooner (went after 8 hours) hypovolemic shock. Significant breach of protocol. Potentially preventable, unacceptable, internal factors. This mortality was due to a prolonged stay in the emergency room

2 – Gun shot wound epigastrium heart subendocardial bleed, penetrating injury right upper arm. Bled out. Significant physiological derangement, Potential preventable, acceptable.

3- Gunshot wound injury abdomen patient with small bowel laceration grade 3, pancreas laceration grade 4inferior cava laceration (major), transverse colon grade 2, diaphragm laceration grade 2, liver laceration grade 2 Tembisa hospital and Baragwanath hospital allegedly closed. Patient arrived at 163 Trauma Emergency Department five hours later from Alexandra Clinic. In reality these institutions were not closed at that time. (Patients from Alexandra clinic are not considered to be inter-hospital transfers, but primary response due to lack of resources at the clinic). This mortality was due to an excessive pre-hospital time

4-Gunshot wound groin right laceration femoral artery, subendocardial bleed. Anaesthetist not available (early hours of morning). Patient arrived at theatre 2 hours later. This mortality was due to delay to theatre, definitive care.

5 – Stab neck zone 1 right, haemopneumothorax right, laceration subclavian vein Three intercostal drains inserted, IC Drain bottles filled. There was a clear-cut indication for ER (emergency room) thoracotomy. There was a delay to theatre

6 – Gunshot wound thoraco- abdominal injury, left haemo pneumothorax, laceration abdominal aorta fractured lumbar vertebra 3. 60 minutes to arrive at hospital, 60 minutes to theatre with a systolic blood pressure of 58mmHg. Intraoperative delay to control bleeding, patient exsanguinated on theatre table.

7 – Gunshot wound abdomen Jejunum and colon laceration grade 2 Patient arrived by private car, no consultant present, unexplained intra operative bleed. Inadequate control of bleed delay to start transfusion. Pre-operative Phaemoglobin 14g/dl. Post-operative haemoglobin 5g/d.

For patients 8 and 9 no post mortem results were available therefore the discussion was not recorded on the trauma bank database.

Chapter 5

Discussion

It appears that there are no studies in the literature looking into the causes of mortality in patients with a NISS probability of survival of ≥50.In this study the NISS probability of survival in patients who died was significantly lower than those who survived. Overall these patients were significantly more likely to have circulatory collapse, be unresponsive, a low pH and received more fluids.

Blood pressure on its own is a poor indicator of severe circulatory dysfunction[71]. The production of catecholamine and neuronal mechanism in response to trauma, may maintain the blood pressure even in the presence of a decreased flow; this can only be sustained for a short period of time in a young population.

A relatively normal blood pressure measurement gives the staff a false sense of security and this can compromise the initial triage.[72] The optimal definition of hypotension was systolic blood pressure of 100 mm Hg for patients 20 to 49 years, 120 mm Hg for patients 50 to 69 years, and 140 mm Hg for patients 70 years and older. The optimal systolic blood pressure for improved mortality in hemorrhagic shock increases significantly with increasing age. Elderly trauma patients without major head injuries should be considered hypotensive for systolic blood pressure less than 140 mm Hg.[44] The patient might be a transient responder to hypovolemic shock and the intravenous fluid given by the ambulance crew might just be enough for them to arrive with a systolic blood pressure of 90 or above. This is one reason why it is so important to listen to an ambulance crew handover as it is crucial to find out about the systolic pressure on the scene as it I gives us a great insight on initial triage[73] .

Those who died had a lower blood pressure; the heart rate was higher, as expected, due to compensatory mechanism. When calculating the shock index (SI) (calculated as heart rate/systolic BP; normal range, 0.5-0.7), Rady found that with apparently stable vital signs, an abnormal elevation of the SI to > 0.9 shock index is a good indicator of patient hemodynamic instability.[74] In the group of our patients that died shock index was 1.19 significantly higher than the indicator level.

There was no compensatory increase in respiratory rate due to vasomotor and respiratory centres depression due to hypovolemia and shown by the low GCS. This may indicate brainstem malfunction.

There were significant differences in pH, lactate, and even GCS between those patients who lived and those who died, due to change in sensorium from bleeding and consequent poor perfusion. Low blood pressure causes a reduction in perfusion to tissues and an increase in lactate production by cells due to anaerobic metabolism. Serum lactate increases and metabolic acidosis can ensue. Hyperlactataemia is defined as a plasma lactate concentration over 2.0 mmol/L and is directly related to an increase in mortality and patients' morbidity as they are at risk of developing multiple organ failure.[43] An increase in acidity produces depression of consciousness evaluated by lower Glasgow Coma Scale.

Those who died had more colloids, blood and FFP. As per massive transfusion protocol. Massive transfusion is defined as the replacement of the patient's total blood volume in less than 24 hours or the administration of more than half the patient's estimated volume per hour. Massive transfusions are not innocuous to the patient It should be aimed at a balance between oxygen delivery and oxygen consumption extraction rate (ER) of 25%. The most appropriate indicator is reflected by mixed venous partial pressure of oxygen PvO_2 6KPa (45 mmHg). If PvO_2 gets to a critical level around 3KPa,(23 mmmHg) then transfusion needs to be started. The transfusion should be based on patient hemodynamic stability. Dilutional thrombocytopenia and disseminated intravascular coagulation (DIC), hypocalcaemia, hyperkalemia and acid –base disturbances are all complications of massive transfusions .[75]These values were significantly different between the two groups, as expected. If the patient presents with hypovolemia, more fluid is required to resuscitate the patient. The only fluid that was not significantly different was crystalloids as, per protocol; doctors are only allowed to infuse 2000 mls as per international resuscitation guidelines [42, 43.]

Those who died there was an inability to realise the patient was in a hypovolemic state according to Shock Index (SI).There were delays in arriving at hospital, delays in getting to theatre, delays in making the right decisions. There was a delay from surgical registrars in realising the severity of patient conditions. Calculating the shock index would have alerted them to patient severity of injuries[76].

There was no difference in the staff training, mechanism of injury, and means of transport to emergency unit. The staff at trauma unit C.M.J.A.H. is well trained. An average of 84% is ATLS® trained which gives good continuity in the delivery of care. The training of medical staff was similar in both groups, although the presence of a consultant was more representative in the group that died, probably due to the severity of patient injuries. The ATLS® course aims to provide a safe method for the management of severe trauma and set standards of resuscitation for the trauma victim[77]

As far as method of transport was concerned there was no significant difference between the two groups. The most common method of transport was BLS (Basic Life Support).[78] This type of ambulance personnel has minimal training and no equipment. Bls crew have less qualification than the ATLS® staff in the emergency department so any time spent with them has a negative impact in patient outcome so even though no difference between the two groups the excessive time spent with BLS trained staff may have a negative impact on those in the group that died

In Lyon a new score system – Mechanism, G C S,Age, Arterial blood pressure (MGAP)[79] for pre-hospital triage was devised. They take into consideration GCS, systolic arterial blood pressure and age. They defined three risk groups: low (23-29 points), intermediate (18-22 points), and high risk (<18 points), with a mortality was 2.8%, 15%, and 48%, respectively. In this study they concluded that the MGAP score could accurately predict in-hospital death in trauma patients.

In Japan they did a variation of MGAP scoring system (GAP) by eliminating the mechanism of injury because, as a criticism to MGAP, they comment that they had given a higher score to penetrating injuries than blunt and not all penetrating injuries are more severe than blunt injuries. GAP scores are the GCS score (from three to fifteen points), patient age (< 60 years, three points) and SBP (> 20 mmHg, six points; 60 to 120 mmHg, four points).

Perhaps the trauma unit should look at GAP[80] score (Glasgow Coma Scale, Age, Arterial blood pressure) as an adjuvant to the pre-hospital score.

The unit resuscitates an average of fifty patients per week, the bulk being over weekend nights. It is important that the patients are triaged according to their injuries and adequately handed over on arrival.

In South Africa the adopted method of triage is the South African Triage Score (SATS). This triage system takes into consideration the physiologic derangement of the patient and discriminators such as mechanism of injury, symptom complexes, discriminators and senior healthcare personnel's opinion.

The definers of the South African Triage Score felt the need to have more physiological parameters thus introducing the Medical Early Warning Score (MEWS), that uses physiological parameters ,such as systolic blood pressure, heart rate, temperature, respiratory rate, and AVPU. AVPU is a scale used to assess level of consciousness A -Alert able to answer questions; V- verbal responds to verbal stimulus ;P -pain responds to painful stimulus U unresponsive level of consciousness This early warning system was not working well for the trauma patient because the trauma patient is usually a healthy patient and the patient was under triaged so MEWS (Modified Early Warning Systems) was modified to Triage Early Warning Score (TEWS)[81]

The comments above reflect a consensus of a panel comprised of the senior members of the unit - 5 trauma surgeons/fellows and the head of the trauma emergency unit. At the time of mortality and morbidity meetings patients are analysed in full detail and all parameters taken into consideration. The options for the verdict given in most cases, is either, no protocol violation, not preventable and acceptable. We understood the care of the patients who died to be acceptable, because there was no overt protocol violation. In many studies from trauma outcomes it was found that TRISS scores had a common ground amongst different institutions for predictive values but this method analyzes sensitivity, positive predictive value (PPV) Negative predicted value (NPV), false positive false negative and misclassification rate .The misclassification rate equals the sum of false negatives and false positive values as a percentage. These values should be adjusted by W-statistics .The W statistic stands for the difference of the number of patients that actually survived and those that TRISS method had predicted to survive in percentage[82] ; however this study shows that we need to look more deeply into the decision criteria.

Limitations of this study

The low number of patients that died with an NISS Ps≥50 is a statistical limitation. It is on the other hand a good reflection on how the unit resuscitates its patients and how well trained the staff is to cope with the patient load. The results compare with first-world centres, although we practice in a third-world environment.

With higher numbers of patients in the group that died, other variables may also have been found to be significantly different between the two groups.

Chapter 6

Conclusions

In this study the researcher have shown that the overall mortality rate for the patients with NISS probability of survival equal or higher than 50% was low, but these mortalities occurred in patients who were expected to survive. The mortalities occurred despite the fact that the staff of the trauma unit are well trained to perform their duties. According to the results one could conclude that unit protocol was generally followed. There were a low number of unexpected deaths, yet the small numbers may have made statistical conclusions difficult to accept without some limitations.

This study highlighted the fact that scoring systems do not always reflect the accurate physiologic derangement of the "stable" patient and that it is advisable for an additional tool to be used to evaluate the patient. That greater cognizance is taken of the predicted value of shock index, base deficit, lactate, and that decision makers to act immediately on readily available information to avoid unnecessary mortality.

This study highlights the need for extra adjuvant to the scoring triage system. The patient is triaged by ambulance service personnel, sometimes incorrectly, then triage in the unit is performed mainly by junior doctors and nursing staff because after hours and on weekends the work load increases substantially and, although they follow the physiologic parameters, they do not have the insight to appreciate the severity of injury and sometimes the patient is not prioritised according to appropriate scores.

It is normally assumed that patients with NISS≥ 50 with circulatory collapse as per shock index will live, but accordingly to our data they are likely to die. The response should be to triage these patients both pre- hospital and in the emergency unit and start immediate resuscitation. Surgeons should interpret data available within five minutes of arrival in a new light, and act upon it.

At the time of mortality and morbidity meetings we understood the care of the patients who died to be acceptable, as there was no protocol violation. However this study suggests that protocols needed to be revised. Perhaps the Shock Index should be part of the protocol as it is an easy calculation with possibly great advantage to triage patients and it may improve their outcome.

Future studies

If the problem occurs before the patient reaches hospital, as our study suggests due to delay to get to definitive care, perhaps more information about the state of patient circulation should be gathered at this level.[83]

In a study done pre-hospital in Helsinki,[84] Finland, using blood gas analysis and outcomes in trauma resuscitation there was an improvement in outcome. Although the study was not designed with triage in mind, but was about fluid resuscitation, I think it will be a good idea to use it with triage patients. It will give us accurate details at a cellular level about the physiologic derangement of the patient and not just an empiric outlook based on pulse and blood pressure

A prospective study adding blood gases on arrival at the reception area, as an alerting mechanism for the trauma Emergency Department staff, could be done as an adjunct to triage. While blood gases are usually done on priority one patients may be they also should be done on patients that might be a priority two.

A larger study, prospective or retrospective, over a longer period of time such as five years would analyse the trend of the 50% percentile as it applies to South Africa, as in this limited study it suggests that the cut off should be raised.

Chapter 7

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Appendix 1-

Trauma Bank

ICU Data

A self-contained module for ICU admissions which calculates the **predicted death rates** according to the following scoring systems: **SAPS II, KES, APACHE II** as well as calculating the **SOFA** score, which can be done daily. Other daily info regarding ventilation, inotropes, TPN, cultures and comments can be recorded.

Performance Review

This module tracks any performance review issues, for example deaths or breaches of protocol. A memo field records comments and post mortem findings.

Hospital Outcome

This section records the hospital discharge date, calculates the **days spent in hospital** and **ICU**, provides a summary of the number of ventilated, inotrope, dialysis days and gives an indication of the patient's condition on discharge. A field is provided for the total amount billed.

REPORTING FUNCTIONS:

The most important part of a computerised database system is what it can produce in terms of **REPORTS**. MediBank is a very powerful tool when it comes to OUTPUT. The following list contains some of the numerous reports already built into the program:

- A comprehensive Individual Patient Report
- Incident, Diagnosis, Procedure & Complication Reports (providing a list, or allowing for a search on a specific incident, diagnosis, etc.)
- Death Report (listing patients dying within a selected date range)
- Summary Reports (e.g. average blunt and penetrating ISS scores; actual versus predicted death rates, etc for a specified time period).
- Performance Review reports listing issues discussed.
- Various graph reports.

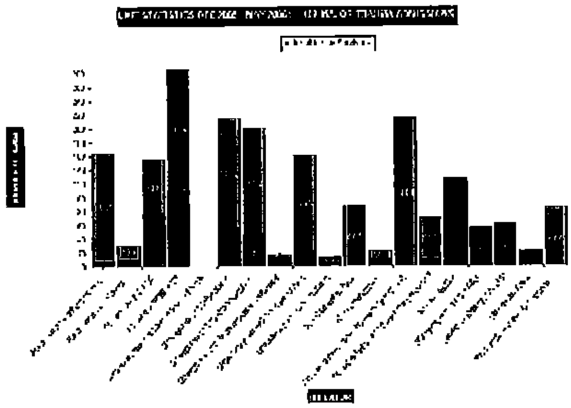
Customised reports can be written on any of the data points entered into the program. Data fields (including actual diagnosis) can be exported to Excel for further analysis and generation of graphs.

MediBank

written and maintained by Vertical Apps, backed by Trauma Society

This Patient Registry was developed as an internal management tool to manage information and improve the care of Emergencies in South Africa. The program allows the practitioner and manager alike to keep a finger on the pulse of patient management within the practice or institution.

MediBank is a locally developed program tailored to meet our needs with regards to the capturing, storing and retrieval of vital information.



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Trauma Society of South Africa

TraumaBank: The South African National Trauma Registry

A Trauma Registry is simply a means of collecting and storing data relating to the type and management of trauma patients being seen in an institution. Internationally Trauma Registries are common practice, and would be considered mandatory for any Trauma Centre (or any practice requiring accurate and accessible records). "out there" there is a great deal of resistance to the impact that trauma has on all aspects of our lives. The most effective research and political lobbying tool created is accurate data.

South Africa is unique in terms of the quantity and severity of trauma seen. It is high time that we were able to analyse, present and compare our data in a scientific manner.

TraumaBank is a locally developed program designed to meet our needs. It is unique in that the software automatically calculates both the Injury Severity Score (ISS) and New Injury Severity Score (NISS) and predicted PROBABILITY OF SURVIVAL based on both these scores, at the stage when the first vitals were taken on the scene as well as on arrival in the Emergency Unit. It also incorporates an ICU module which can be used to score any ICU admission using the SAPSII, KES, APACHE II and SOFA scoring systems. The importance of being able to measure and benchmark the patient's progress against multiple international scoring systems with such ease is an invaluable quality assurance tool.

The concept of being able to build up National statistics and trends based on information (which can be sent anonymously from participating centres) is an exciting one. This will facilitate injury surveillance, and allow for evidence-based decision making on a National level by TSSA with regards to policy making, planning and development of injury prevention and control strategies, as well as being able to lobby on the political stage, with hard data backup for the first time.

TraumaBank has been extensively tested at the Johannesburg Hospital (over 3400 patients logged during the past 18 months) as well as Milpark, Union, J F Jooste and Union (Swartklip).

With the imminent grading and verification of the delivery of Trauma Care at Trauma and Emergency Departments and Hospitals, the grading will depend to a significant extent on the ability to collect credible data on the patients treated. No Centre wishing to register as a site for research including drug trials would be considered without a working database of its patients.

Upon installation an agreement will be signed guaranteeing that your data will never be viewed or shared with any party whatsoever without your express written approval. As mentioned previously downloads to the TSSA National Database will be done anonymously.

Please contact us should you require further information, or wish to become part of this exciting project.

Best wishes,

Ken Boffard
President: Trauma Society of South Africa

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Appendix 2: Human Research Ethics Committee Clearance

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

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Helena MR Alves

CLEARANCE CERTIFICATE	**M090627**
PROJECT	Factors Influencing Mortality in Major Trauma in the Trauma Unit of Charlotte Maxeke Johannesburg Academic Hospital
INVESTIGATORS	Dr Helena MR Alves.
DEPARTMENT	Department of Family Medicine
DATE CONSIDERED	09.06.26
DECISION OF THE COMMITTEE*	Approved unconditionally

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

DATE 09.06.26 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written "informed consent" attached where applicable
cc: Supervisor : Prof Goosen

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...