A RETROSPECTIVE AUDIT OF TRAUMA SURGERY AT A LEVEL 1 TRAUMA CENTRE IN SOUTH AFRICA

By

Dr A H M Sharfuddin Mahmud Chowdhury
MBBS, FCS (SA)
Student Number: CHWSHA001

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Groote Schuur Hospital
University of Cape Town

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Supervisor

Associate Professor Andrew John Nicol
MB ChB (UCT), FCS (SA), PhD (Surgery)
Head of Trauma Centre, Groote Schuur Hospital
University of Cape Town

DECLARATION

I, Dr A H M Sharfuddin Mahmud Chowdhury, hereby declare that the work on which this dissertation is based, is my own original work and neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other University.

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DEDICATION

This work is dedicated to my beloved Parents

Seraj Uddin Ahmed Chowdhury

And

Anowara Begum

For their unfailing inspiration and support to continue my studies

at the University of Cape Town

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ABSTRACT

Background:

Groote Schuur Hospital Trauma Centre (GSHTC) in Cape Town has a role to play in the prevention and mitigation of trauma through the propagation of quality treatment and fulfilling the aim of the World Health Organization (WHO) declaration on emergency care for the injured.

Aim:

An examination of the trauma services at a level-1 Trauma Centre using best care principles as a means of accessing and improving the current trauma system.

Methods:

A retrospective review of patients admitted to the trauma surgical ward (C5) over a 4-month period.

Results:

A total of 300 patients were admitted to trauma surgery ward. The mechanism of trauma was stab wounds in 204 (68%), 73 with GSW's (24.3%), and 23 (7.7%) blunt injuries. Two-hundred and seventy-nine (93%) patients were transported by Emergency Medical Services (EMS). The ISS was >15 in 49%. The median delay for arrival at GSH from scene, Community Health Clinic (CHC), and secondary hospital were 1.5, 5 and 5.8 hours respectively ($p < 0.001$). The delay from injury to theatre was a significant factor in the development of complications. Seventy-two cases (60%) of abdominal trauma were managed non-operatively ($p <0.001$). Of 33 GSW abdomen 24 (72.7%), and of 18 Blunt abdominal trauma only 3 (16.7%) patients required surgery. The median stay was 3 days and 12 days for patients that developed complications ($p<0.001$). Only two patients died (0.7%).

Conclusion:

Penetrating trauma continues to be a major burden on the resources of a Trauma Centre. There were delays in the transport of patients from the smaller hospitals and the direct trauma referral system needs to be strengthened. Non-operative management of abdominal trauma is a very important component of trauma surgical care and is decreasing the operative load on the theatres.

SUMMARY

At Groote Schuur Hospital Trauma Centre (GSHTC) trauma surgical ward care is run by three full time trauma surgeons, one general surgeon and four general surgical registrars. There are 10 high care beds and a 30 bed trauma ward (C5) for admissions. An 8 bed surgical intensive care unit is also available if needed. The trauma surgeons operate on the neck, chest, abdominal trauma, and on all vascular injuries. Trauma is accredited as a sub-speciality by Health Professions Council of South Africa (HPCSA) since 2008.

A total of 300 patients were admitted to trauma surgery ward (C5) during the period of December 2011 to March 2012. Two hundred and seventy seven patients were male with male- female ratio of 12:1. The age range was 14-56 with median of 26. Most of the patients were from Klipfontein 113 (37.7%) followed by Southern 58 (19.3%), Western 48 (16%), Khayelitsha 38 (12.7%), and Mitchell's Plain 33 (11%) sub-districts. 50% patients were injured over the weekend, and 70% during the evening (18h00-06h00). Patients with blunt trauma comprised 23 (7.7%) and penetrating Trauma 277 (92.3%), There were 204 stab wounds (68%) and 73 gunshots (24%). Ninety three percent (279) patients were transported by Emergency Medical Services (EMS) of which majority were by Metro (255, 85%) followed by Healthnet (20, 6.7%) and ER24 (4, 1.3%). Twenty-one patients (7%) arrived at hospital by private transport. The median time response by EMS was 12 min. 28 min., and 40 min. for blunt, gunshot and stabbed patients respectively (p= 0.018). Fifty nine percent (176) patients were referred from Community Health Clinic (CHC) followed by 19% (58) from secondary level hospitals. Twenty two percent (66) patients arrived directly from scene. The median delay for arrival at GSH from scene, via CHC, and secondary hospital were 1.5, 5, and 5.75 hour respectively ($p < 0.001$).

On arrival at GSHTC, 45 (15%), 139 (46.3%), and 116 (38.7%) patients were triaged according to the South African triage score as Red, Orange, and Yellow respectively. Almost half (147, 49%) of the patient's ISS was >15. 121 (59.3%) stab patient's was ISS <15. On the other hand 47 (64.4%) GSW and

17 (73.9%) blunt trauma patient's ISS were 15 or more (p= 0.001). There was significant association of ISS with both the complications (p <0.001) and outcome (p= 0.002).

Of the 102 patients (Stab 69, GSW 33) with penetrating abdominal trauma 45 stabs (65.2%) and 14 gunshots (42.4%) patient underwent CT abdomen (p= 0.02). Eighty three percent (15 out of 18) of the blunt abdominal trauma patients were managed conservatively. Seventy three percent (24 out of 33) GSW and thirty percent (21 out of 69) stabbed abdomen patients required surgery (p <0.001). Overall 60% abdominal trauma patients (72 out of 120) were managed non-operatively (P <0.001).

Of 106 theatre cases 6, 47, 40, and 13 cases were booked as Red, Orange, Yellow and Green and the median delay for operation was 0.8, 2.0, 3.5 and 1.8 hour respectively. Twenty nine percent (31 out of 106, overall 11.67%) patients had post-operative complications and 2 deaths. There was no significant association between operative triage and complications (p= 0.074) or outcome (p= 0.04). The median delay for all operations from booking and from injury was 2.25 and 10.5 hour which did not show significant association with complications (p-value 0.5 and 0.1 respectively). In laparotomy group the median delay from booking, admission and injury are 2.4, 5.0, and 5.8 hour respectively. There was a significant factor in the development of complications with the delay from injury (p=0.02).

The average hospital stay was 5 days, maximum stay 29 days and median stay 3 days. The median hospital stay for blunt, gunshot, and stab wound injury was 6, 4, and 3 days respectively (p= 0.005). The median stay for patients with complications was 12 days and without complications only 3 days (p <0.001). A total of 19 patients were admitted to ICU post-operatively. The median ICU stay was 2 days, range 1 to 16 days. The median stay for GSW patient was 4 days followed by blunt trauma 3 days and stab wounds 2 days (p= 0.4). Out of 300 admitted patients only 2 died for a mortality rate of 0.7%. Two hundred and ninety patients were discharged home and 8 patients were transferred to another facility.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACS	American College of Surgeons
ACSCOT	American College of Surgeons Committee on Trauma
A&E	Accident and Emergency
AIDS	Acquired Immune Deficiency Syndrome
AIS	Abbreviated Injury Score
BoD	Burden of Disease
COHSASA	Council of Health Service Accreditation of South Africa
CQI	Continuous Quality Improvement
CT	Computed Tomography
CTS	Cape Triage Score
CSP	Comprehensive Service Plan
DALY	Deaths and disability adjusted life years
DoH	Department of Health
ED	Emergency Department
EMS	Emergency Medical Service
ENAs	Enrolled Nursing Assistants
ESCCC	Emergency Surgical Case Categorization Chart
eTHR	electronic Trauma Health Record
EUA	Examination under Anaesthesia
FWA	Federal Wide Assurance
GSH	Groote Schuur Hospital
GSHTC	Groote Schuur Hospital Trauma Centre
GSW	Gunshot Wound
HDU	High Dependency Unit
HIS	Health Information System (Clinicom)
HIV	Human Immunodeficiency virus
HREC	Human Research Ethics Committee
ICU	Intensive Care Unit
ICD 10	International statistical Classification of Diseases Version 10
IOM	Institute of Medicine
IQR	Interquartile Range

ISS	Injury Severity Score
KTS	Kampala Trauma Score
MTOS	Major Trauma Outcome Study
NISS	New Injury Severity Score
NOM	Non-Operative Management
NSCOT	National Study of the Costs and Outcomes of Trauma
NTDB	National Trauma Data Bank
NTDS	National Trauma Data Standard
ORIF	Open Reduction Internal Fixation
PDE	Patient Day Equivalent
POS	Probability of Survival
QA	Quality Assurance
RTI	Road Traffic Injury
SA	South Africa
SATG	South African Triage Group
SATS	South African Trauma Scale
TB	Tuberculosis
TC	Trauma Centre
TEWS	Trauma Early Warning Score
TQIP	Trauma Quality Improvement Program
TQM	Total Quality Management
TRISS	Trauma and Injury Severity Score
TSSA	Trauma Society of South Africa
UK	United Kingdom
USA	United States of America
WC	Western Cape
WHO	World Health Organisation
YLL	Years of life lost

LITERATURE REVIEW

INTRODUCTION

Trauma is the leading cause of non-natural deaths worldwide and a major cause of permanent disability. The economically active population group is most affected, thus increasing real costs of injury to society. South Africa is unique in terms of the quantity and severity of trauma seen with trauma being a major burden. Groote Schuur Hospital Trauma Centre (GSH TC) in Cape Town has a role to play in the prevention and mitigation of trauma due to all forms of mechanical injury through the propagation of quality treatment, appropriate surgical intervention and fulfilling the aim of the World Health Organization (WHO) declaration on emergency care for the injured.

The main bodies of the literature relevant to this research include works relating to trauma systems, trauma centres, trauma registries, triage, severity scoring systems, and trauma quality improvement program (TQIP) together with quality and benchmarking systems in trauma centres. A review of this literature fosters an understanding of the resultant decreased mortality occurring in parallel with the development of systems underpinning trauma care in countries where they were implemented.

In addition to examination of this literature, aspects of the burden of disease contributing to the large trauma patient numbers managed in South Africa are reviewed. This inclusion is with a view to promoting an understanding for the requirement of well-functioning trauma centres in South Africa, with particular reference to the situation in the Western Cape, the Cape Town Metropole, and Groote Schuur Hospital Trauma Centre.

BURDEN OF DISEASE

The Burden of Disease (BoD) in a population is an indication of health problems in the community together with the amount of health care provided and the effects of all other aspects that promote or damage health e.g. education, safe water supplies, nutrition, poverty, smoking, and alcohol use.[1] Comprehension of the Burden of Disease (BoD) is essential for planning and

decision-making processes in health departments with appropriate information enabling Government to address and reduce the BoD, rather than just being reactive to pressure on health systems.[2]

South Africa is experiencing a quadruple BoD comprising the HIV/AIDS pandemic, infectious diseases, emerging chronic conditions, and injuries resulting from violence, road traffic related and other trauma.[3] The Western Cape Province is particularly affected and further burdened by the escalating use of substances, especially alcohol and 'tik'.[2] In this province the top three contributors to the overall BoD are ranked as major infectious diseases including HIV/AIDS linked with TB (22% YLL), injury (19.8% YLL) and mental disorder (not quantified).[4] An overview of mortality in Cape Town illustrates a pattern typical of societies that are in transition. Amongst young children mortality is due to infectious diseases, amongst young adults to violence and injuries- and in later life to non-communicable diseases. Gender differences include increased male mortality caused by violence and injuries, with HIV/AIDS accounting for a large percentage of female deaths.[1]

As compared with global averages, mortality rates due to injury in the Western Cape are nearly tenfold greater for males and sevenfold for females[1] with fatalities due to homicide and road traffic injuries in Cape Town still amongst the highest in the world.[5]

Violence is the most important contributor to high rates of injury in the Western Cape. It accounts for 12.9% of premature mortality as compared to 6.9% for road traffic injuries.[3]

The ratio of premature mortality due to violence versus road traffic-related injuries in the Western Cape is greater than in most other provinces, except the Northern Cape and Gauteng with comparable ratios. Violence is the second leading cause of years of life lost (YLL) in the province after HIV/AIDS, accounting for 14.1% of YLL with higher mortality rates than the rest of the country for males (129 per 100,000 versus 115 national average) and females (25 per 100, 000 versus 21 national average).[3]

During a prospective study at the Groote Schuur Hospital Trauma Centre, Donson and Peden (2000) established that most patients injured violently had abused either alcohol and/or drugs prior to the injuries and that more than 60% of patients were intoxicated at the time of presentation.[6] Bourne et al (2007) reconfirmed the linkage between high homicide and traffic related fatalities and alcohol and substance abuse amongst young males in Cape Town.[5]

Road Traffic Injury (RTI) is another globally recognized human made burden that is largely predictable and preventable and can be analysed with implementation of rational counter measures, with speed management as a vital component. More than 85% of deaths due to road crashes occur in low- and middle-income countries, with traffic injuries in South Africa a major and neglected public health challenge requiring participation of all sectors, including Health.[7]

Internationally the contribution of road traffic injuries to the global BoD is expected to increase to 5.1% of deaths and disability adjusted life years (DALYs) lost by 2020. In South Africa the trend in YLL is at 5%, with the Western Cape already ahead of the trend at 6.9% YLL in 2000. High mortality patterns associated with traffic related injuries in Cape Town include male deaths, pedestrian deaths, alcohol use related to driver, pedestrian deaths, and weekend peaks.[7] In a prospective study at the GSH TC, Donson and Peden (2000) confirmed that 52.2% of traffic-related injuries treated during the study period involved pedestrians, 26.1% drivers and 21.7% passengers.[6]

TRAUMA SYSTEMS

Introduction

According to Council of Health Service Accreditation of South Africa (COHSASA), community trauma and emergency services are optimally

delivered when forming part of an integrated trauma and emergency system instead of operating as autonomous and uncoordinated elements.[8]

Gwinnutt *et al* (2001) argue that a trauma system must aim to improve the process of care as well the outcome of the trauma patient. They indicate that this is achieved by establishment of integrated co-ordinated care in the community served. All hospitals must be classified according to level of care, all major trauma cases must be treated at major trauma centres, patient care must commence in the pre-hospital environment, triage protocols must be implemented to ensure that patients are taken to the most appropriate hospitals, patient care must be provided by the most appropriate doctors from resuscitation through to rehabilitation, with co-ordination and control of pre- and in-hospital care.[9]

Blackwell *et al.* (2003) agree that the ultimate objective of a trauma system is to ensure that the most seriously injured patients receive care in correctly designated trauma centres, equipped to deal with their particular injuries.[10] Hoyt and Coimbra (2007) define trauma systems as geographically circumscribed, organized approaches providing integrated care to acutely injured patients. They regard the main goal of a trauma system as the ultimate improvement of health of the community and argue that this is achieved through identification of community risk factors and creation of solutions to decrease injury. According to Hoyt and Coimbra (2007) a trauma system includes a continuum of optimal multidisciplinary care during all phases of the injury, whilst maintaining the ultimate objective to decrease injury related morbidity and mortality and years of life lost (YLL).[11]

Trauma Systems in the United States of America (USA)

Development of modern dedicated trauma systems in the USA is of international significance and has been evolving since the First World War, with the essential characteristics developed by the USA Military during the first seven decades of the 20th century. During World War 2, motorized transport enabled rapid evacuation of the injured, reducing the time between

injury and treatment. Resuscitation, a new concept, added another phase to emergency care and treatment of shock prior to surgery, with new surgical techniques requiring rapid patient prioritization, or triage, terminology gained from the French front lines.[12]

Hoyt and Coimbra (2007) discuss the process of evolution of trauma systems, demonstrating the positive effects realized by some landmark events. First was the acknowledgement of the burden of disease in 1966 though publication of the National Academy of Sciences and the National Research Council white paper "Accidental Death and Disability: The Neglected Disease of Modern Society". Mullins (1999) postulates that this publication "publicly announced trauma care as a political issue".[12]

Another landmark was the establishment of the five components of the Illinois trauma system during the early 1970's. This included the categorization of selected hospitals as trauma centres, instant communication enabled by new technology, new ambulance design for safe transportation, special training of health professionals, and trauma registry information enabling ongoing programmed evaluation of services.[12]
During the late 1970's the American College of Surgeons Committee on Trauma (ACSCOT) developed a system for classification of trauma centres.[12] This ranges from the least sophisticated (levels 4 and 5) to level 1 tertiary trauma centres in major cities with immediate availability of definitive care for critically injured patients, 24-hour trauma care, 24-hour availability of trauma surgeons, admitting at least 1200 cases per annum of whom more than 20% are severely injured, as well as leading trauma research, education, and prevention.[13] Level 1 trauma centres are located in tertiary hospitals and may include the concentrated expertise of specialist facilities e.g. paediatric trauma, burns, spinal cord and hand injury units. ACSCOT subsequently developed "Guidelines for Optimal Hospital Resources for the Care of the Seriously Injured" in 1976.[11]

The California Orange County publicly disclosed the need for improved care for injured patients in the late 1970's, culminating in the formal designation of

different levels of trauma centres and implementation of regional trauma care systems in 1984. In 1980 ACSCOT developed the standardized advance trauma life support course, the American College of Physicians compiled "Guidelines for Trauma Care Systems" in 1987, the Trauma Systems Planning and Development Act was promulgated in 1990 and ACSCOT published "Guidelines for Optimal Care of the Injured Patient" in 2006.[11]

Trauma Systems in South Africa

Although South Africa is one of the few countries in the African continent with an organized statutory system of pre-hospital care, the access of many South Africans limited to basic trauma care due to the constraints of distance and time as in most of the developing world. In addition, migration and urbanization affects South African trauma services.[14]

According to Council for Health Services Accreditation of South Africa (COHSASA) Trauma and emergency services should preferably be delivered as part of a trauma and emergency system with known catalogued capabilities of individual organizations. They argue that provision of an integrated trauma and emergency service requires support from various in-patient and auxiliary services and they question the ability to assess the functioning of a trauma and emergency centre in isolation from the rest of the organization.[8]

In an appraisal of the organisation and management of emergency department services of the Western Cape, Cummins (2004) supports the concept that an integrated emergency care system ranges from the initial health worker through pre-hospital care and medical transport services, the trauma and emergency department, all in-hospital specialities and services, to discharge and rehabilitation services.[15]

Western Cape Department of Health Trauma System

Emergency Medicine in the Western Cape Province has been classified as a level 2 general specialist service since 1st April 2008. Emergency Medicine includes the diagnosis and management of acute and urgent aspects of illness and injury. It is envisaged that, at Central Hospitals, relationships with other acute and referral services such as trauma surgery, will be dealt with through local policies. The full extent of the emergency care system in the Western Cape ranges from the initial health worker encountered, through the Emergency Medical Services (EMS) and emergency department to in-hospital specialities, discharge and rehabilitation. EMS relates to emergency ambulance, medical rescue, patient transport and aero-medical services. Emergency centres that form part of the emergency care system are located in and are under the management of 40 hospitals, 58 community health centres and 229 primary care clinics representing different levels of care throughout the province. There are three level 3 (US level 1) hospitals (Groote Schuur Hospital, Red Cross War Memorial Children's Hospital, Tygerberg Hospital) that provide the full range of general and specialist services required for the most complex emergency conditions, 8 level 2 hospitals provide general specialist services and 29 level 1 (US Level 3) hospitals are covered either by part time or full time medical officers.[15]

TRAUMA CENTRES

Introduction

A trauma centre is a hospital equipped and staffed to provide comprehensive emergency medical services to patients suffering traumatic injuries. Gwinnutt et al (2001) argue that a trauma centre on its own does not amount to a trauma system. They defined a trauma centre is a hospital where the medical staff have a commitment to provide 24-hour in house cover by surgeons, anaesthesiologists, and support staff to care for patients.[9]

A Level 1 trauma centre will include 24 hour services as the ultimate referral facility, providing all major specialities and other specialised ancillary clinical services. It provides education and research in its region and could further contain other highly specialized services such as hand and spinal surgery and treatment of burns. A Level 2 trauma centre will provide 24 hour medical staff availability, including 24-hour core general specialist care. The Level 3 trauma centre provides 24-hour services a day, 7 days per week, is situated in a Community Hospital, staffed by General Practitioners, should have facilities for resuscitation and stabilization, has in-patient facilities and can arrange for transfer to a larger facility required for significant problems.[8]

Trauma Centres in the United Kingdom

The world's first trauma centre was the Birmingham Accident Hospital, opened in 1941. This service was extended in 1964 by establishment of the first mobile surgical team in the United Kingdom (UK), with a specialised vehicle, enabling pre-hospital surgical care, mainly to road vehicle and industrial accident victims.[9] Studies of the trauma population in the UK have shown that between 24 and 38 major trauma victims are seen per hospital per annum. It is estimated that, in the UK, a population of 2 million persons would potentially provide 1 major trauma case per day. A trauma centre along USA lines was established at the North Staffordshire Royal Infirmary, working together with 5 district hospitals. Disappointing modest reductions in mortality resulted, as compared with the USA.[9]

Trauma Centres in the United States of America

A large measure of the success in improvement of trauma services in the USA has been ascribed to the establishment of trauma centres as part of the American trauma system. During the late 1970's ACSCOT developed a classification system for classification of trauma centres in the USA.[12] This ranges from the least sophisticated (levels 4 and 5) to level 1 tertiary trauma centres in major cities with the immediate availability of definitive care for critically injured patients, 24 hour trauma care, 24 hour availability of trauma

surgeons, admitting at least 1200 cases per annum of whom more than 20% are severely injured, as well as leading trauma research, education and prevention.[13] Level 1 trauma centres in the USA are located in tertiary hospitals and may include the concentrated expertise of specialist facilities e.g. paediatric trauma, burns, spinal cord and hand injury units.[11]

Trauma Centres in South Africa

According to the Trauma Society of South Africa-TSSA, there are eight medical schools in South Africa, of which five have dedicated trauma services (some have more than one). Current "level 1 equivalent" trauma centres (public and private) are Charlot Maxeke Johannesburg hospital, Chris Hani Baragwanath Hospital Soweto, Groote Schuur Hospital Cape Town, Inkosi Albert Luthuli Central Hospital Durban, Milpark Hospital Johannesburg (Private), Pelonomi Hospital Trauma service Bloemfontein, and Union hospital Johannesburg.[16]

The TSSA is in agreement with international definitions of Trauma Centres considering the extended importance of Level 1 TCs as referral resources for communities in associated regions. For these TCs the TSSA emphasises the 24-hour in-house availability of the following specialist disciplines: Anaesthesiology and Critical Care, General Surgery, Radiology, Emergency Medicine, Internal Medicine, Neurosurgery, Oral and Maxillo-facial surgery, Orthopaedic surgery and Plastic surgery. The Society supports the concept of TCs as leaders in trauma education, system planning, injury prevention and training centres for trauma surgeons and developed a guideline for the assessment of trauma centres in South Africa.[17]

Groote Schuur Hospital Trauma Centre (GSH TC)

The Groote Schuur Hospital Trauma Centre (GSH TC) is compliant with all the requirements of an international (USA) Level 1 trauma centre with sub-specialist surgical and ancillary services on site and immediately available. It serves as a referral resource for designated communities in its referral

regions, offering 24-hour in-house availability of required specialist disciplines: Anaesthesiology and Critical care, Radiology, General Surgery, Emergency Medicine, Internal Medicine, Neurosurgery, Oral and Maxillo-facial Surgery, Orthopaedic Surgery *and* Plastic Surgery. It is a training centre for trauma surgeons and is a leader in trauma research.[17]

At Groote Schuur Hospital Trauma Centre (GSHTC) there are 6 resuscitation beds, 10 stretchers bays and a green area for walk-ins. Trauma surgical ward care is run by three full time trauma surgeons, one general surgeon and four general surgical registrars. There are 10 high care beds and a 30 bed trauma ward (C5) for admissions. An 8 bed surgical intensive care unit is also available if needed. The trauma surgeons operate on the neck, chest, abdominal trauma, and on all vascular injuries.

TRAUMA REGISTRIES

Introduction

The importance of health information systems and the role of mortality statistics towards monitoring of public health, the development of public health policies and the allocation of resources are increasing internationally.[18] This was already recognized by Eastman in 1987 as related to trauma patients, and that it can be achieved by the establishment and maintenance of Trauma Registries as data bases for the collection of trauma data related to trauma patients.[19] Nwomeh et *al.* (2006) highlighted historical evolution of Trauma Registries in conjunction with the Quality Assurance (QA) movement that includes the Continuous Quality Improvement (CQI) and Total Quality Management (TQM) concepts. They examine the goal of trauma care QA programmes as continuous measurable improvement and support the concept of a trauma registry as a timely, accurate and comprehensive data source allowing for continuous monitoring of the process of trauma care.[20] Boffard (2006) confirms that internationally, the maintenance of trauma registries is mandatory for any trauma centre.[21]

In developing countries, trauma registries have generally not been established and where they do exist, they are often basic and incomplete. In Karachi, Kampala and Addis Abba it has been demonstrated that the maintenance of a daily log of trauma admissions by use of the emergency room register or by way of a one page registry form completed by trained staff can act as an effective basic trauma registry. These trauma registries contain data on demographics, injury causation, and treatment outcome.[20]

The maintenance of a trauma registry is considered as critical, together with regular comparison of outcomes as a function of the injury severity scores contained in these registries, where agreed norms are set for comparison with other trauma centres.[19] Similarly, the lack of databases is a meaningful impediment to the effective identification and implementation of changes to existing practices not offering benefit to patients.[13]

Purpose of Trauma Registries

A trauma system has to monitor its performance over time and establish where improvement is required. A system wide trauma registry with compatibility between data collection during different phases of care is a vital component of modern comprehensive trauma care systems requiring continuous reliable data collection and analysis.[11]Combining trauma registries at different service levels allows for unprecedented opportunities for evaluation of patient outcomes and inter-hospital comparisons.[22]

In busy trauma centres and trauma systems, a well-designed trauma registry with validated data serves as the hub for quality control queries. It is a channel to monitor trends in trauma systems and injury and facilitates research. It provides benchmarking data and can be used to integrate financial data and to project resource requirements. Furthermore, it enables reporting of trauma data from institutional to regional and national registries. This data is thus a potent instrument in epidemiology, performance evaluation, trauma centre accreditation, injury control, education resource allocation, and can even support international benchmarking and research.[20]

Edwards *et al.* (2007) assessed the possibility to compare data from trauma services across Europe based on an agreed core dataset. The analysis of results from 14 institutions from 11 countries revealed significant international variations with the potential for the data from this network to support optimal trauma system design across Europe.[23]

Requirements of Trauma Registries

There are many requirements to enable the collection, storage and management of data related to patient demographics, causes, nature and severity of injuries, treatment and patient outcome information as well as data that can be applied for calculation of injury severity and possibility of survival scores. They call for adequate funding, dependable software, data sets tailored to the level of trauma care, well-defined patient populations, effectively trained personnel, defined processes for data collection, reporting and validation, as well as processes for maintaining confidentiality.[20]

Nwomeh *et al.* (2006) promote the case for specialised trauma registry registrars. They describe the certification process in the US, where the registrar is expected to have 2 years data management experience and must have completed specific courses towards registration as a Certified Specialist in Trauma Registry.[20]

In Japan, Masao *et al.* (2005) surveyed 224 Japanese university hospitals related to problems associated with use of their trauma registries and their willingness to participate in the newly established Japan Trauma Data Bank. Of the 84 respondents, 47 had computerized trauma registers. Of these 47 hospitals, only 9 employed specific personnel for data entry. All these hospitals reported major problems with the work burden of data entry and with data quality.[24]

The Canadian Institute for Health Information (2009) promotes three standardized data sets for their National Trauma Registry. These include the

Minimum Data Set containing demographic, diagnostic and procedural information on all injury related acute hospital admissions, The Comprehensive Data Set including data on major trauma related hospital admissions, and the Death Data Set, currently under development, containing data on all injury related deaths. There is a Data Quality Enhancement Programme to ensure integrity of data quality and related information provided to users as well as privacy principles and policies governing data disclosure.[25]

Trauma Registries in South Africa

The Trauma Society of South Africa (TSSA) recognized the quantity and severity of trauma experienced in this country and facilitated the development of Trauma Bank, an electronic trauma registry, the South African National Trauma Registry, as a means of collecting and storing data related to trauma patients seen at South Africa hospitals. This data capturing, processing, storage and retrieval system is developed and maintained by Vertical Apps, a private company, using World Health Organization and other internationally recognized and standardized systems and guidelines. Datasets collected include: patient demographics and incident details, transport and response times, trauma centre admission with clinical information and probability of survival calculations, diagnostic and therapeutic procedures performed, theatre and Intensive Care Unit information and hospital outcome information.[26]

Trauma Bank was developed in SA to suit the requirements of this country and additionally offers such features as the automatic calculation of the internationally accredited Injury Severity Score (ISS), New Injury Severity Score (NISS) and Probability of Survival (POS) scores, together with other scores relevant to patients in Intensive Care Units. The system was successfully piloted in a few hospitals in the private and public sectors in SA and has been implemented in some public and private sector trauma centres, e.g. Charlot Maxeke Johannesburg General Hospital (Public tertiary hospital, Johannesburg) and Christian Barnard Hospital (Private hospital,

Cape Town).[21] More recently the Trauma Bank registry has been augmented as MediBank, to include all emergency patients, including use of the South African Triage Scale in real time and is used in the trauma and emergency centres of a large private health services group in SA.[27]

Western Cape Department of Health Emergency Department data management

According to Cummins (2004) there is no statutory requirement to maintain a hand written Emergency Department (ED) register as opposed to a computerised register. However, where a handwritten record does exist, as specified by the National Archives Act of 1996, it must be retained for 5 years.

Frankish (2003) reports on problems encountered to obtain 31 months of data, April 2000 to October 2002, during an analysis of Trauma and Emergency services in the Western Cape. Neither the Western Cape Department of Health (WC DoH) Provincial nor Regional offices could provide all of the data. It eventually took 6 weeks to obtain and verify data, with some gaps remaining. No historical data related to ambulance services were available.[28]

Cummins (2004) studied 16 emergency service sites in the Western Cape. None of the Western Cape emergency departments (ED's) had access to ED management information software. Some patient information was held on two different electronic patient billing systems," deployed at different sites. This included the DELTA 9 and the Hospital Information Clinicom (HIS Clinicom) patient registration and billing systems. At the time, there were insufficient funds for tertiary hospitals to purchase the HIS ED module. As a result, ED patient attendances were classified as ordinary out-patients or as ward attendances. On the HIS (Clinicom) system, ED, ward and outpatient figures were aggregated, thus causing distortion of the activity data of all three entities and presenting a misleading data base for planning purposes.[15] According to Frankish (2003), besides at the academic hospitals, trauma and medical emergency attendances were not separated. Cummins (2004)

concluded that "Information is simply not available in a form which is useful to hospital managers for operational planning or evaluation purposes".[15]

Cummins (2004) reports the main source of data regarding ED workload and patient throughput to be a handwritten document the accident and emergency register (A&E register). Even though a standard register was prescribed by the province, 6 different registers were in actual use. There was a large variation in data sets recorded at sites using the non-standard registers, as well as between sites using prescribed registers, together with inconsistencies regarding which data items were being recorded. Registers were not held in a central archive and were located in various areas within the various emergency departments. During this study there was difficulty obtaining registers even for the most recent calendar year. They further reports that at most sites variations between attendance data in the A&E registers and data produced by the Information Management division of the Western Cape Department of Health were within 8% of each other. However, at three sites there were significant discrepancies of between 23% and 54% higher, and at one site 35% lower attendances according to provincial figures. Hospital funding in the province is distributed based on the number of patient day equivalents (PDE's), with three ED attendances equalling 1 PDE. This underscores the importance of data accuracy.[15]

Groote Schuur Hospital Trauma Centre data management

The Trauma Centre attendance register in the GSH TC conforms to prescribed minimal requirements for recordkeeping: recording of name, date, mode and time of arrival, treatment administered and information on final patient disposition.[8] In addition, there is the formal electronic HIS (Clinicom) patient registration and billing system.

According to Cummins (2004:12) the GSH A&E registers "were perhaps the most worrying with respect to being archival (sic), as the register is an A2 pad, held together by glue at the top of the page. By the time the pad is finished, some of the early sheets have usually separated from the rest and

probably disappeared".[15]They recommended that HIS casualty and theatre modules should be purchased and implemented as a matter of urgency. A sufficient number of computers should be provided throughout the ED, accessible to all personnel required to make entries. Once this was established, the need for continuation of the handwritten A&E registers should be questioned, together with core data sets required, with revision of the A&E register books. It was additionally recommended that, even before the acquisition of the casualty modules, ICD-10 coding during two phases of the patient journey e.g. presentation and discharge, should be implemented in order to collect data towards understanding of the intensity of the emergency workload.[15]

TRIAGE SYSTEMS

Introduction

The word triage derives from the French word, meaning "to sort" or choose (Gottschalk 2004) and triage was already practiced by the Roman military legions and the chief surgeon of Napoleon Bonaparte for the speedy treatment of battlefield trauma victims.[8] Gottschalk (2004) describes how the French surgeon Baron Jean Larrey prioritised medical care on Napoleon's battlefields by sorting patients according to their possibility of survival to return to the battlefield, rather than by rank[30]. Hoyt and Coimbra (2007) contend that the most important goal of a triage system is to identify patients in need of immediate or prioritized surgical or medical care and that triage involves initial patient evaluation ensuring that more seriously injured patients are transported to facilities capable of appropriate management.[11]

Kampala Trauma Score

In searching for a triage tool that would be suited to a resource restricted environment, MacLeod *et al.* (2007) investigated the Kampala Trauma Score (KTS) developed in the light of the limited resource base of Sub Saharan

Africa. This is a simplified composite of the Revised Trauma Score and the Injury Severity Score, previously validated for ability to predict outcome in Kampala, Uganda during 1996.[31] MacLeod *et al.* (2007) set out to evaluate the ability of the KTS to differentiate injured patients at high risk for poor outcomes from those at low risk. They hypothesised that, even if applied to all injured patients presenting to a health facility, the KTS could be used as a triage tool for health care personnel and would assist with patient referral and treatment, reduce morbidity and mortality and also reduce unnecessary expenditure. The KTS is an instrument designed to differentiate severe from non-severe injuries, but the study was unable to determine a cut-off point to set apart severe versus non-severe patients on an individual basis in a way that would assist health care personnel. Thus, the value of the KTS as a triage tool was found to be limited.[32]

Development of Triage Scoring in South Africa

Gottschalk (2004) postulates that "while an estimated 60,000 South Africans are murdered and die in road traffic accidents each year, at least 2.5 million cases of non-fatal injury require emergency care during the same period". He calls for a triage system that can be applied in a situation where "the number and severity of casualties exceed the medical capacity in that environment", a situation where the triage nurse must be enabled to accurately assess patients in a maximum of 5 minutes.[30]

Wallis *et al.* (2006) describe the colour coded Cape Triage Score (CTS) designed by the Cape Triage Group as a means of prioritising care for use in South Africa. It is appropriate for particular South African personnel resources, large patient numbers and advanced pathology, together with restrictions on training.[33] Whereas, for instance, the Australasian Triage score, together with the Canadian modification there-of are appropriate in those particular settings, those tools are considered as too complex for use by South African Enrolled Nursing Assistants (ENAs), the health care professionals most probable to perform the triage function. Current studies show that applying the CTS equally accurately, South African ENA's are on a

par with doctors and registered nurses. The CTS was launched in 2006 for use in all public hospitals in the Western Cape and is also used nationally throughout the Medi-Clinic private hospital group.[34]

The CTS is a physiological scoring system with the addition of mobility and injury parameters to make provision for trauma patients and time critical medical conditions e.g. ischemic stroke. The CTS is validated for safe roadside use as well as in emergency and trauma units. Allocation of the colour categories is as follows, (i) Red - immediate priority (resuscitation cases), (ii) Orange – very urgent priority (potentially life / limb threatening cases), (iii) Yellow – urgent priority (significant pathology) (iv) Green - delayed priority (minor injuries / illness) and (v) Blue - deceased.[33]
The South African Triage Group (SATG) was established during June 2006, with the aim to establish the CTS as a national tool. The CTS was refined and renamed the South African Triage Scale (SATS).[34] It is recognized by the Council of Health Service Accreditation of South Africa (COHSASA) since 2007 and has been incorporated into Medi-Bank, the South African developed Trauma and Emergency registry.[27]

Application of triage scoring in the GSH Trauma Centre

Wiseman *et al.* (2002) consider the goal of triage systems to enable quick identification of patients most likely to benefit from rapid medical attention. They discuss two different approaches to triage scores including scores based on physiological parameters and others based on injury mechanism and anatomical factors. Physiology based systems are generally preferred above anatomically based scores for detection of currently unstable patients, whilst anatomical and injury mechanism based scores are more suitable to identify trauma patients with the potential for deterioration. Describing the negative effects of potential over and under-triage, they argue that no perfect triage system has yet been devised for specific use with trauma patients. They favour the use of triage systems that include priority triage principles. Priority 1 (P1) equates to the Red patient of colour-coded systems signifying "Emergency" for immediate attention, Priority 2 (P2) equates to Yellow, the

condition is "Urgent" with a delay in care possible for a "limited period of time without significant mortality" (Wiseman et *al.* 2002:1), Priority 3 (P3) equates to Green, indicating "Non- Urgent", Red and Yellow patients are to be addressed first in that order.[35]

Groote Schuur Hospital Trauma Centre (GSH TC) applies the physiology based Cape Triage Score (CTS) in combination with priority triage principles of anatomical and injury mechanism triage systems. CTS is not entirely suited for use as a tool in the trauma environment, with issues of concern also raised by other SA trauma surgeons. As an example, according to the CTS score "haemorrhage - uncontrolled" is classified as Orange indicating that attention to this category of patient can be delayed by 20 minutes. The opinion is that the CTS is a practical tool for immediate use by TC front room junior nursing personnel in order to give them direction, but requires medical back-up in the trauma situation to prevent dangerous under-triage. Certain clinical trauma conditions requiring immediate attention that are not listed on the CTS e.g. O2 saturation of 90% or less, temperature of 33 C or less, penetrating neck and / or torso injuries (chest and abdomen), spinal injury, suspected vascular injury, traumatic amputations, all helicopter transfer arrivals, paediatric patients, and chest pain in the presence of EGG changes. At GSH TC, Orange patients with these clinical manifestations are immediately placed in the Red (P1) category.

INJURY SEVERITY

Introduction

A significant advance culminating in improvement of the survival of injured persons was the developments of objective methods of calculating the severity of a patient's injuries.[36] MacLeod et al. (2007) describe how data in trauma registries is made universally comparable by the routine use of standardised trauma scores, such as the Injury Severity Score (ISS). Injuries have been coded by severity instruments which enable comparison of injury severity, despite injury diversity and can be applied for policy development,

resource allocation, and for quality assurance purposes. It has been hypothesized that injury severity scores can be used as triage tools.[32]

Injury severity scoring in the USA

The categorisation of injury severity is critical to the scientific study of trauma. Despite this, measurement of injury severity by grading the severity of individual injuries only started 50 years ago with development of the Abbreviated Injury Score (AIS). The AIS formed the basis for the Injury Severity Score (ISS) developed in 1974, the most widely used measure for injury severity in trauma patients. The Injury Severity Score (ISS) is a simple numerical method to summarise multiple injuries by anatomical characterization of injuries.[36]Despite the evolution of a multitude of other severity scoring methods, notably the New Injury Severity Score (NISS) and the Trauma and Injury Severity Score (TRISS), the ISS remains the international golden standard for injury severity scoring.[37]

Eastman *et al.* (1987) postulate that the ISS was developed as a method of objectively defining the risk of death as a function of the extent of the injury, with an agreed risk threshold. They indicate that injury severity scores are critical to the definition of major trauma patients, the numerical score used for the prediction of probabilities of death and the calculation of preventable deaths.[19]

Pohlman *et al.* (2007) point out the most fundamental application of trauma scoring as the ability to predict trauma outcome. They indicate that other more recent applications are related to end-of-life decision making, together with resource allocation. They argue that, because injury severity is so difficult to quantify, outcome prediction will never be perfect, the reason for the emergence of multiple scoring systems.[36]

Nathens et al (2004) analyse of preventable death rates have successfully been used to assess the effectiveness of trauma systems and for comparative purposes. Reliable data are thus required to provide rational

bases for system configuration and to facilitate comparisons of outcomes between different trauma centres.[13]

TRAUMA QUALITY IMPROVEMENT PROGRAM (TQIP)

The Trauma Quality Improvement Program (TQIP) was initiated in 2008 by the American College of Surgeons Committee on Trauma (ACSCOT). Its aim was to provide risk-adjusted data for the purpose of reducing variability in adult trauma outcomes and offering best practice guidelines to improve trauma care. TQIP makes use of national data to allow hospitals to objectively evaluate their trauma centres' performance relative to other hospitals. TQIP's administrative costs are less than those of other programs, making it an accessible tool for assessing performance and enhancing quality of trauma care.

Morbidity and mortality rates are variable across United States trauma centres. Institutional variations can be attributed to differences in patient population and quality of care at each institution.[38]To address these discrepancies, John Fildes created an ad hoc work group to create and implement an outcomes-based, validated, risk-adjusted trauma quality improvement system. The goal was to utilize existing trauma infrastructures to measure and continually improve the quality of trauma care. This was done by accessing each hospital's registry database using the National Trauma Data Standard (NTDS) from the National Trauma Data Bank (NTDB), resulting in the creation of the Trauma Quality Improvement Program (TQIP) by the American College of Surgeons (ACS).[38]

A reference document published by the ACS Committee on Trauma in 1979 created a framework for the trauma centre verification review process with a systems approach to trauma care.[39] The Major Trauma Outcome Study (MTOS) of 1982–1989 subsequently established the national standards for trauma care. The MTOS database also facilitated the creation of a methodology to estimate an individual trauma patient's survival probability, also known as the Trauma Injury Severity Score (TRISS).[38] Other studies, such as the 2006 National Study of the Costs and Outcomes of Trauma

(NSCOT), aimed to identify differences in expenditures and outcomes at various hospitals.[40]

TQIP is designed to give each hospital an objective measure of its trauma centre's performance compared to that of other trauma centres. It is meant as a self-reflective tool to be used in determining how to improve outcomes and decrease costs by understanding the reasons for variability and identifying best practices. Results are not intended to be used for marketing purposes or bestowing competitive advantages.[38] TQIP reports allow hospitals to focus on outcomes and workflows, including care coordination, in-hospital processes, and resource allocation.[41]

TQIP's external benchmarking utilizes NTDB data collection and NTDS with specific enhancements. Deliverables comprise risk adjusted hospital comparisons in the form of one annual benchmark report as well as two separate annual reports related to a topic of interest and the TQIP online analysis tool. Education and training are delivered via the annual meeting, online training, and monthly educational experiences for abstractors, and monthly open forum calls for registry staff. Data are submitted quarterly and quality is monitored through a data validation site visit, a TQIP validator, and data quality reporting. Feedback to participating trauma centres about their relative performance encourages the sharing of practices during the annual meeting with emphasis on high performers and web conferences.[39]

As of 2014, over 200 Level I or Level II trauma centres are participating in TQIP, which is facilitating the identification of high performers. Enrolment is done on a rolling basis that allows hospitals to join at any time. Additionally, a paediatric TQIP pilot with thirty-eight participating centres is currently underway and external data validation has been implemented.[42]

BENCHMARKING AND QUALITY

International

Mock *et al.* (2004) consider their "Guidelines for Essential Trauma Care" as attainable in almost any setting worldwide. These guidelines were designed with a view to ensuring a worldwide minimum level of trauma care and include specifications for human and other resources. The ultimate objective of these guidelines is to promote an infrastructure that will decrease the number of trauma-related preventable deaths.[43]

During February 2006 ACSCOT conducted an Emergency Department Performance Measures and Benchmarking Summit, culminating in the publishing of their Consensus Statement. Welch (2006) postulates that there are convincing reasons why emergency practitioners should make use of standardised language and terminology and why they should implement performance measures and benchmarking practices. This includes the development of quality improvement data as core measures and flow standards that should ultimately support regulated accreditation. The Consensus Statement is a comprehensive document containing wide-ranging time, process and space definitions and performance measures. It is championed by ACSCOT and has been widely disseminated.[44]

South Africa

The South Africa National Department of Health has developed "Regulations Governing Emergency Centre in South Africa" for attachment to the National Health Act no 61 of 2003.[45] These regulations contain extensive prescriptions related to all aspects of the trauma system, trauma centre criteria, registration and licensing, and offences and penalties with provision for expanded trauma registry data for major emergency centres.[45]

The Council for Health Services Accreditation of South Africa (COHSASA) has devised a document, "Emergency Centre Standards". The post pilot version, November 2007, is endorsed by the Emergency Medicine Society of

South Africa (EMSSA) and Trauma Society of South Africa (TSSA). The comprehensive document includes suggested standards for all aspects of emergency services including: management, leadership and administration, clinical functions and support services.[8]

SUMMARY

Available literature on trauma care is extensive and covers all aspects of development, management and clinical care of trauma patients in different environments across the world. For the purposes of this research, this review is focused on works relating to trauma systems, trauma centres, trauma registries, triage, severity scoring systems and trauma quality improvement program.

A review of literature regarding the burden of disease for trauma in South Africa, the Western Cape and Cape Town provides insight into the injury load, mechanisms of injury and injury patterns in these areas.

Finally a review is included of the development of landmark documents related to more recent attempts to formalise quality and benchmarking issues in trauma care: internationally, and in South Africa.

AIM OF THE STUDY

The aim of the study is to examine the trauma care service at a level 1 trauma centre, Groote Schuur Hospital, Cape Town, using best care principles as a means of accessing and improving the current trauma system in Cape Town.

METHODS

INTRODUCTION

This descriptive study is based on the retrospective analysis of data related to patients admitted to Groote Schuur Hospital trauma ward during the period of 01 December 2011 to 31 March 2012.

AUTHORISATION

Authorisation to conduct research in the Trauma Centre as part of Groote Schuur Hospital was obtained from Dr Bhavna Patel, Chief Executive Officer of Groote Schuur Hospital.

ETHICS APPROVAL

Ethics approval to conduct this study was obtained from Human Research Ethics Committee, Faculty of Health Sciences University of Cape Town.
Reference numbers of this approval are:
Human Research Ethics Committee (HREC) reference: 440/2013

ETHICS ISSUES RELATED TO PATIENT IDENTIFICATION

Patient identity by way of names, surnames and hospitals numbers is contained in the source documents. During this study, patient folders were reviewed and data was transcribed onto Microsoft Excel spreadsheets. All data reported is anonymous. All source documents containing individual patient identification is kept in the strictest confidence by the primary researcher.

STUDY DESIGN

A descriptive, non-interventional, observational study method was used in this study, with the intention to develop a body of knowledge to increase information about characteristics within *a* particular field. Examination of the epidemiological variables of time, place and person were incorporated.

A descriptive study method was chosen as study design, with a view to providing service providers and planners with information that will assist them to design services and allocate resources efficiently.[46]

SELECTION OF STUDY SAMPLE

The sample included consecutive patients admitted to ward C5, under the care of the trauma surgeons during the period of 01 December 2011 to 31 March 2012 and were entered into the C5 Trauma ward attendance register.

INCLUSION CRITERIA

- all acute admission to C5 Trauma ward
- sustained penetrating or blunt chest, abdomen, neck and peripheral vascular trauma
- age above 13 years

EXCLUSION CRITERIA

- Burns, isolated head, orthopaedic, hand and Maxillo-facial trauma as these patients are managed by the respective specialities.

- Elective admission such as for closure of colostomy, skin graft etc. as we are looking at only acutely admitted patients.

SAMPLE SIZE

A total of 300 patients in the C5 trauma ward attendance register for the period of 4-months (01 Dec 2011 to 31 March 2012) have been included in this study.

DATA SOURCE

Trauma wards C5 GSH TC admission register and the hospital folders.

MEASUREMENTS

- Demographics details: Gender, age
- geographical area of injury
- Injury: mechanism, day, date and time
- Transport: mode, name of Emergency Medical Services, time of contact, time of arrival, time spent at scene, time arrival at GSH
- Referral hospital
- Time since injury on arrival at GSH
- Triage Category- Red, Orange, Yellow, Green
- Severity of injuries classified by Revised Trauma (RTS) Score, Injury Severity Score (ISS) and TRISS
- Investigations
- Diagnosis
- Indication for Surgery
- Type of Surgery
- Operative Triage- Red, Orange, Yellow, Green
- Time from arrival to Surgery
- Reasons for delay to theatre
- Complications
- ICU stay
- Total hospital time
- Outcomes- Discharge or Death.

EMERGENCY SURGICAL CASE TRIAGE

At Groote Schuur Hospital the emergency surgical case categorization chart (ESCCC) is based on similar principles to the Cape Triaging Score (CTS). It has identical colour coded categories (but with different emphasis and definitions) which define different levels of surgical acuity and gravity and suggests timing and urgency for operative intervention. The surgical team admitting a patient is responsible for the initial categorization of the case.

According to the priority of the cases the emergency cases are booked as Red, Orange, Yellow and Green for operation. Red cases are immediate priority (resuscitation cases), Orange cases are very urgent priority- potentially life/limb threatening pathology should be done within 2 hours, Yellow cases are urgent priority- significant pathology should be done within 6 hours and Green cases are delayed priority – minor injury/illness should be done within 24 hours. Green cases become yellow after 24 hours. Yellow cases become orange after 6 hours. Booked cases are assessed on an ongoing basis and re-categorized as required (The detail chart is at Appendix- page 92).

SURGICAL COMPLICATIONS

The Clavien-Dindo classification of surgical complications was initiated in 1992 updated in 2004 by Dindo et al. and is based on the type of therapy needed to correct a complication. The classification has been used in many centres as a tool for quality assessment in audits and everyday practice, and it is increasingly used in the surgical literature. It allows complications to be graded and thereby allows comparisons of morbidity across institutions.[47, 48] In our study we graded post-operative complication according to the updated Clavien-Dindo classification of surgical complications (The detail table is at Appendix- page 93).

STATISTICAL ANALYSIS

Categorical variables assessed using frequency tables. Associations between categorical variables determined vs. contingency tables and chi-squared tests of association

Numerical variables assessed with summary statistics (mean, standard deviation etc.). Associations between numerical and categorical variables determined using non-parametric tests: Mann-Whitney in instances where the categorical variable has two categories and Kruskal-Wallis otherwise.

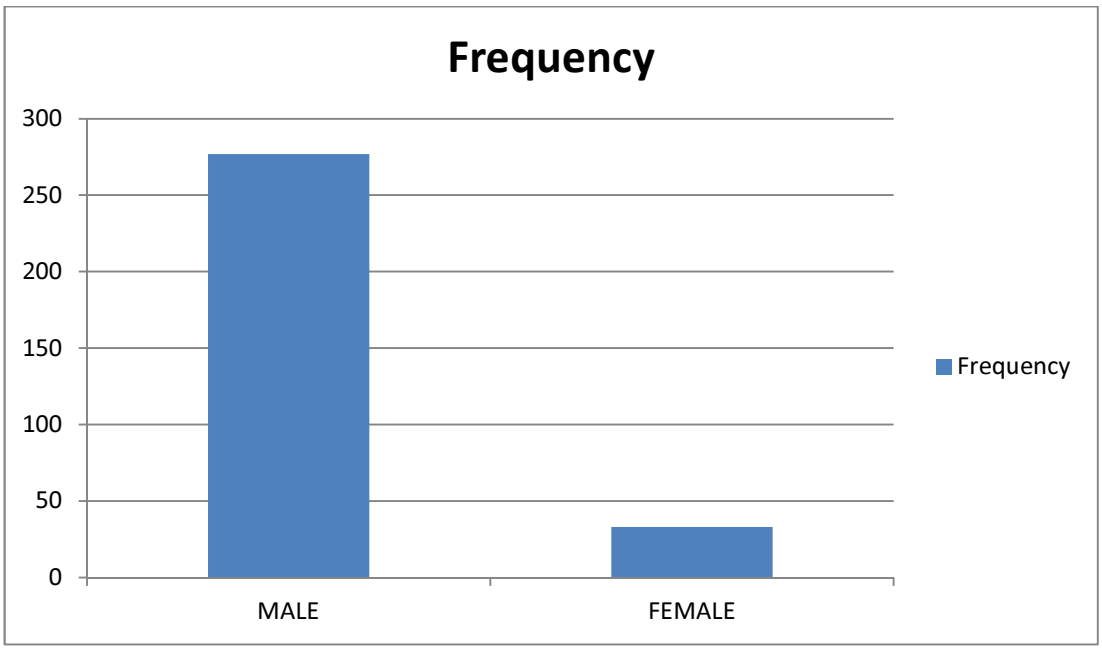
Statistical analysis was done by Miss. Katya Mauff, Statistical Consultant, at the Department of Statistical Sciences, University of Cape Town

RESULTS

There were a total of 300 trauma patients admitted to ward C5 during this time. There was a predominance of males of 277 (92.3%) than females of 23 (7.7%) with significantly higher Male to female ratio of 12:1.

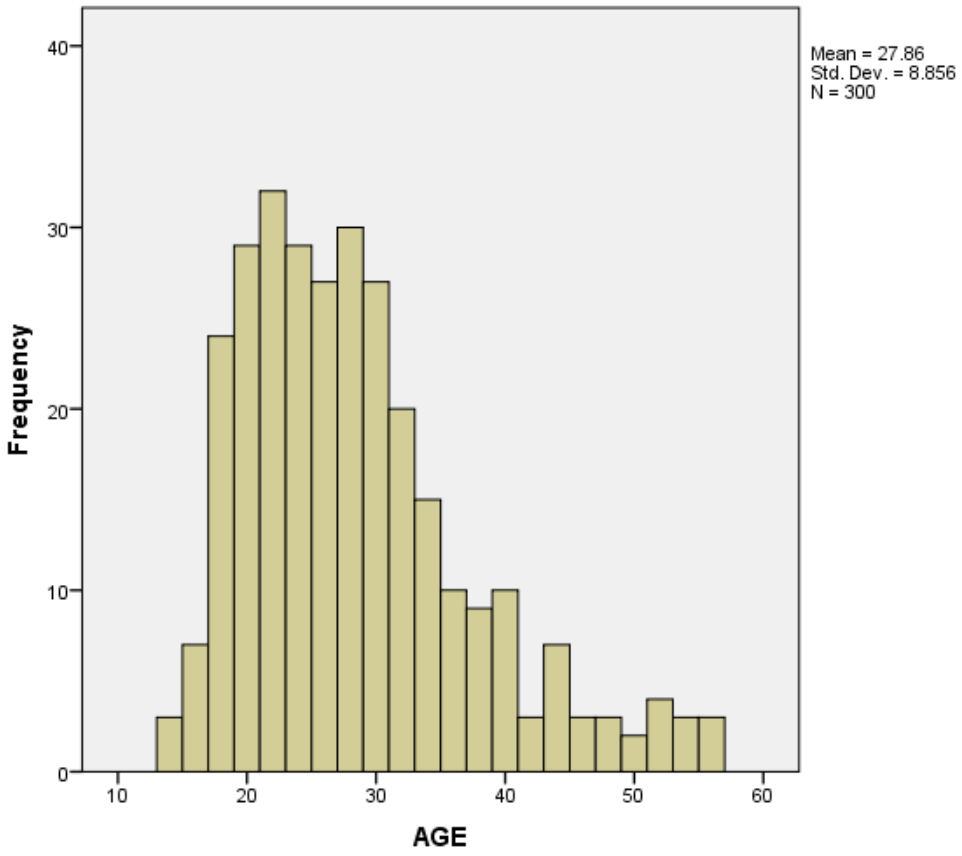
Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	23	7.7	7.7	7.7
Male	277	92.3	92.3	100.0
Total	300	100.0	100.0	

Table 1: showing Gender distribution



Bar Chart 1: showing frequency of Male and Female admissions

The minimum age of patient was 14years and maximum age 56 years with mean age of 28 years. The median age is 26 years with Interquartile Range (IQR) of 21-32.



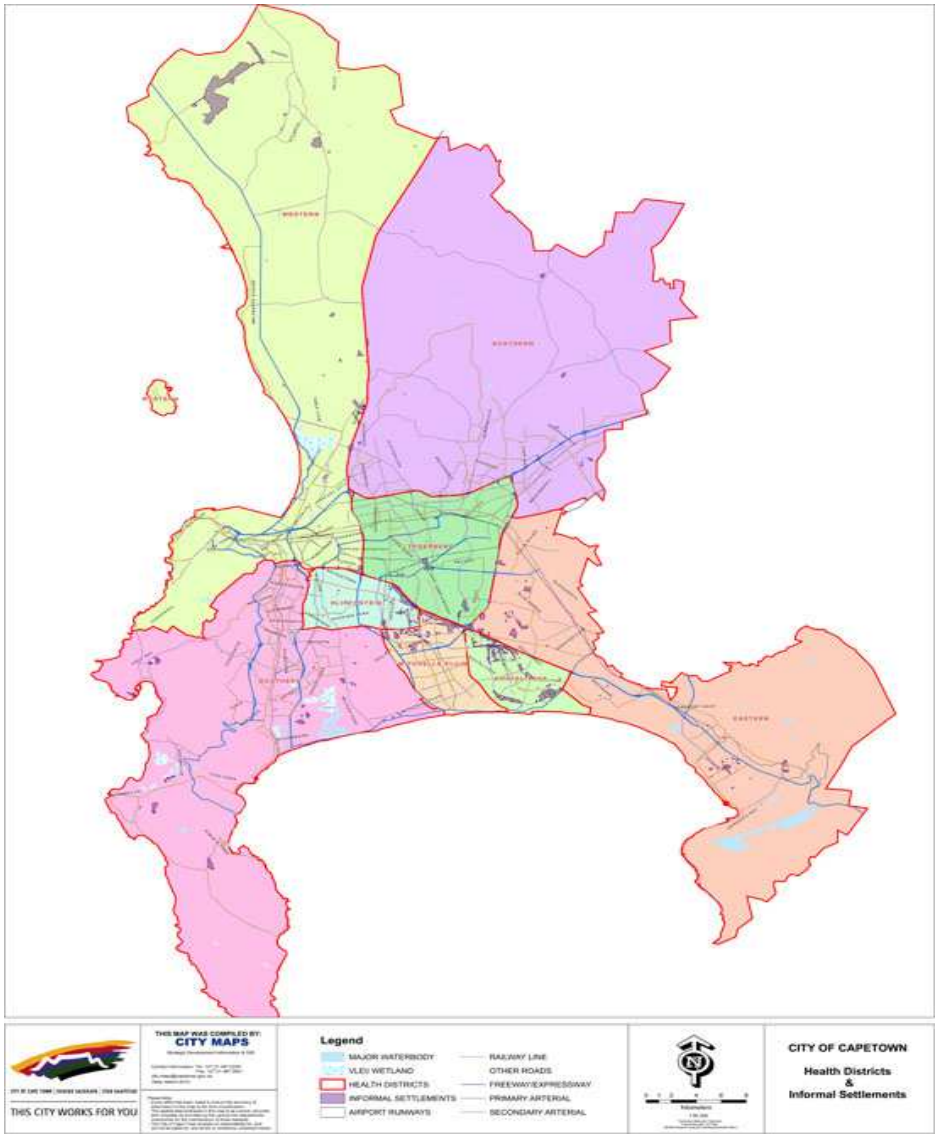
Bar Chart 2: Age distribution

GEOGRAPHICAL AREA OF INJURY

Most patients were admitted to Trauma ward following an injury from Klipfontein 113 (37.7%) followed by Southern 58 (19.3%), Western 48 (16%), Khayelitsha 38 (12.7%) and Mitchell's Plain 33 (11%) sub-districts.

Health Sub-Districts	Frequency	Percent
Klipfontein	113	37.7
Southern	58	19.3
Western	48	16
Khayelitsha	38	12.7
Mitchell's Plain	33	11
From outside the drainage area	10	3.3

Table 2: Geographical area of Injury



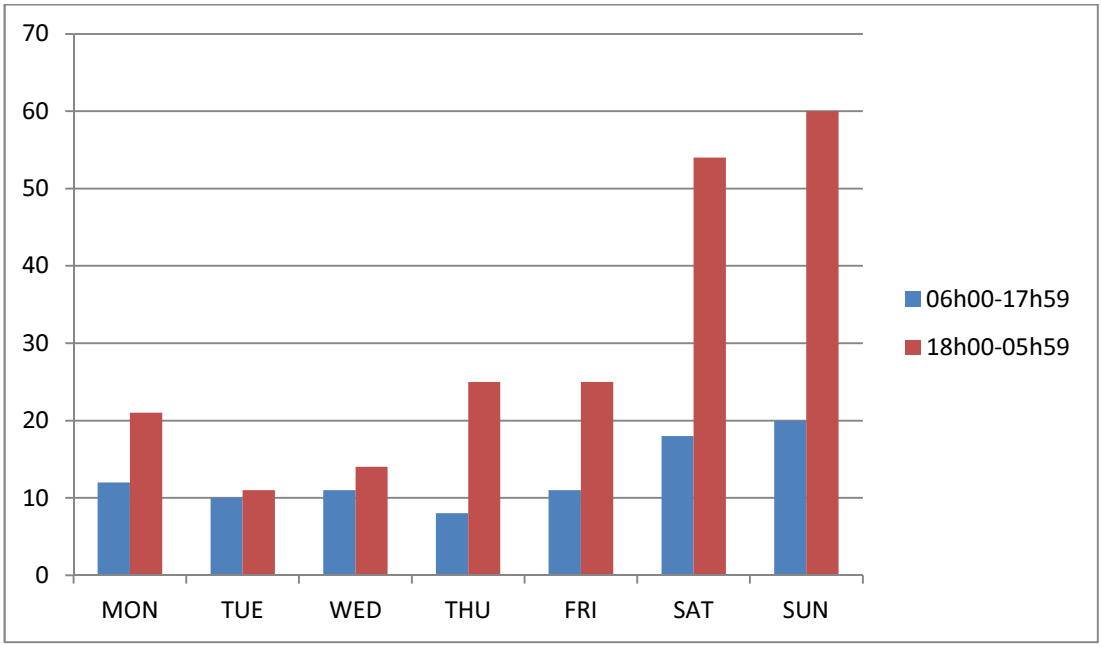
Map: Cape Town city Health Sub-Districts

TIME AND DAY OF INJURY

Out of all admitted patients a total of 210 (70%) patients were injured during the evening time (18h00-05h59) and 90 (30%) were injured during the day time (06h00-17h59). The majority of the injuries occurred during over the weekend. On Saturday and Sunday greater than half (152, 50.7%) of injuries took place.

Day	Time of Day		Total
	06h00-17h59	18h00-05h59	
MON	12	21	33
TUE	10	11	21
WED	11	14	25
THU	8	25	33
FRI	11	25	36
SAT	18	54	72
SUN	20	60	80
Total	90 (30%)	210 (70%)	300

Table 3: Day and Time of Injury



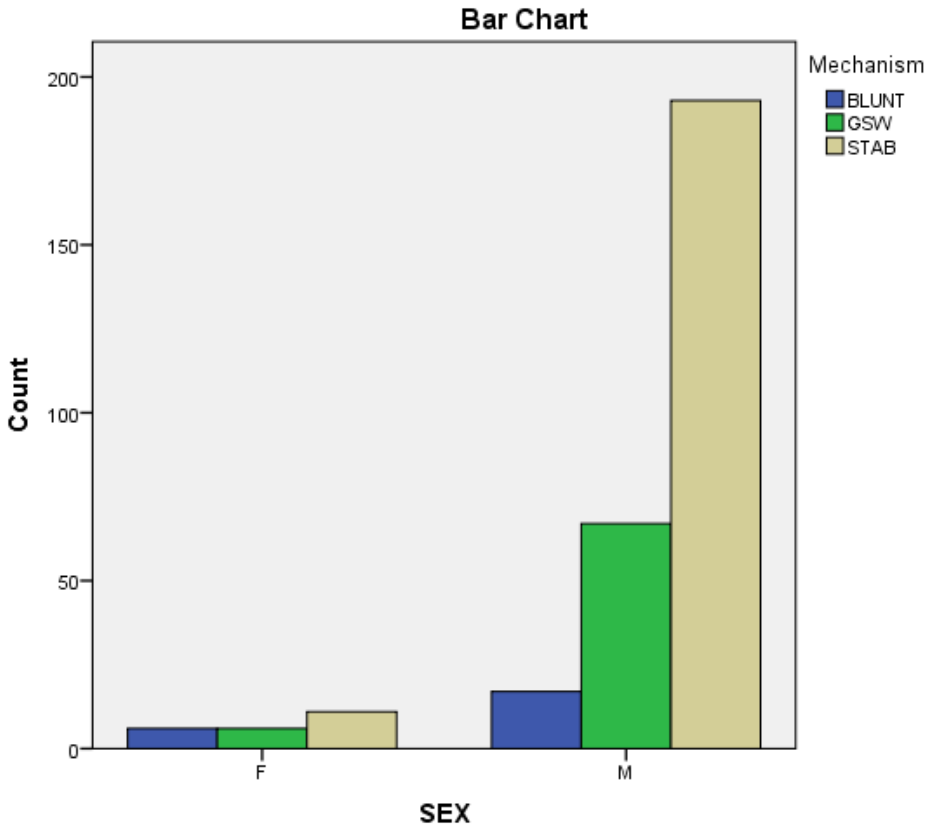
Bar chart 3: showing the relationship between the time and the day of injury.

MECHANISM OF INJURY

Two hundred and seventy-seven patients (92.3%) were admitted following penetrating (Stab and Gunshot) trauma. Stab wounds comprised 204 (68%) and Gunshot wounds (GSW) 73 (24.3%). The number of admissions due to blunt trauma was 23 (7.7%). Male patients were more frequently injured in all types of injury than female (p= 0.002).

SEX	Mechanism of injury			Total
	BLUNT	GSW	STAB	
Female	6 (2%)	6 (2%)	11 (3.7%)	23 (7.7%)
Male	17 (5.7%)	67 (22.3%)	193 (64.3%)	277 (92.3%)
Total	23 (7.7%)	73 (24.3%)	204 (68%)	300

Table 4: Mechanisms of injury by sex



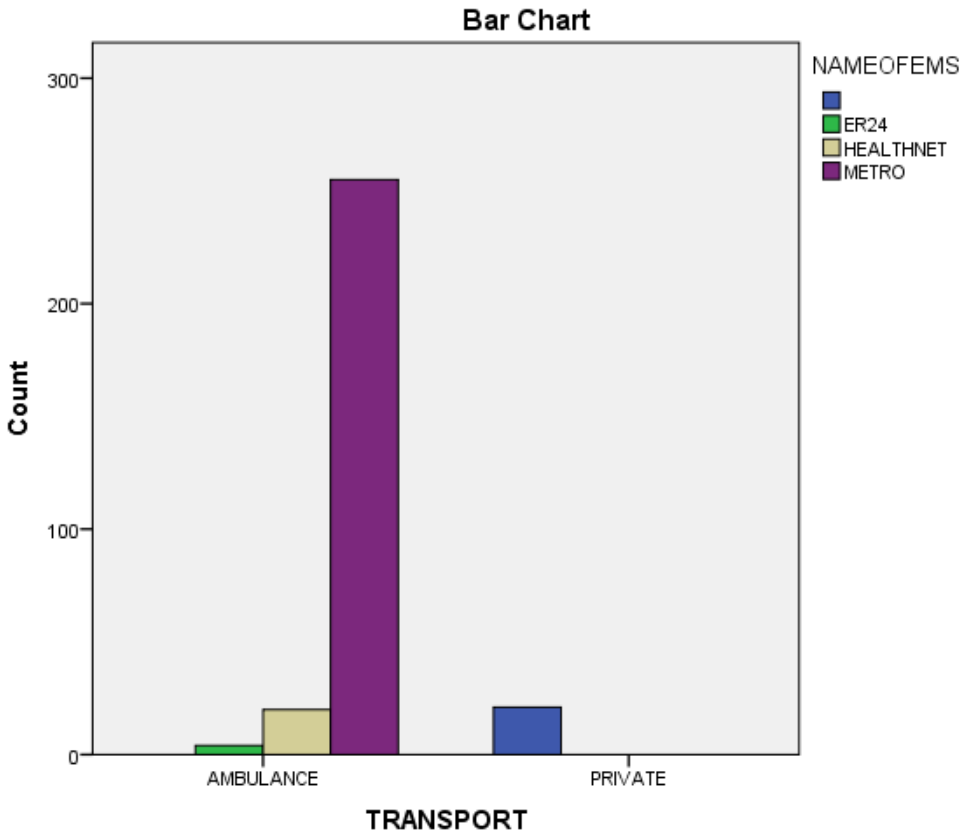
Bar chart 4: Different Mechanisms of injury according to sex.

MODE OF TRANSPORT

Two-hundred and seventy-nine patients (93%) were transported by emergency medical services. With respect to different ambulance services, Metro tranported the majority patients with 255 (85%), followed by Healthnet 20 (6.7%), and ER24 4 (1.3%). Twenty-one (7%) patients arrived at hospital by private vehicle.

TRANSPORT	NAME OF EMS				Total
		ER24	HEALTHNET	METRO	
AMBULANCE	0	4 (1.3%)	20 (6.7%)	255 (85%)	279 (93%)
PRIVATE	21	0	0	0	21 (7%)
Total	21	4	20	255	300

Table 5: Mode of Transport



Bar chart 5: Modes of transport

RESPONSE OF AMBULANCE SERVICES

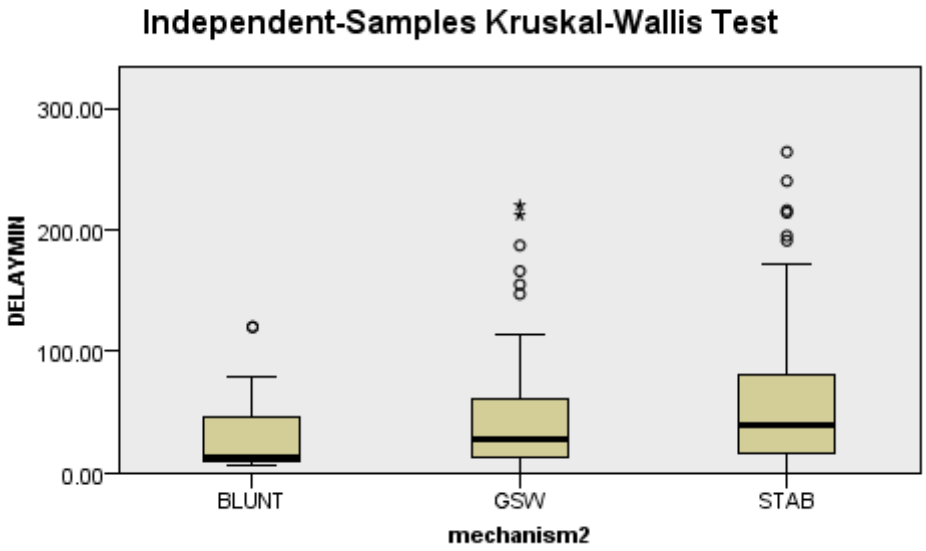
Time delay in response of the ambulance services since contacted by categories of mechanisms

The median time taken by the ambulance service to attend to the patient from time of dispatch following an injury was 12 minutes, 28 minutes and 40 minutes for blunt, gunshot and stabbed patients respectively. Stab wounds

had the longest waiting time for ambulance (40 minutes, Interquartile Range 16 to 80 minutes) followed by GSW (28 minutes, Interquartile Range 13 to 61 minutes) and Blunt trauma (12 minutes, Interquartile Range 10 to 46 minutes). The median delay was significantly different between mechanisms (p= 0.018).

		mechanism2								
		Total N	Valid N	Minimum	Maximum	Mean	Standard Deviation	Median	Percentile 25	Percentile 75
DELAYMIN	BLUNT	23	21	6	120	33	37	12	10	46
	GSW	73	69	0	220	48	51	28	13	61
	STAB	204	189	0	264	57	52	40	16	80

Table 6: Response time in minutes by the ambulance services



Referral

Of the 300 patients admitted, 176 (58.7%) were referred from Community Health Clinic (CHC), followed by secondary level hospitals of 58 (19.3%) patients. Sixty-six patients (22%) arrived directly from scene without any referral.

CHC (176)		HOSPITAL (58)		From Scene (66)	
Gugulethu	46	GF Jooste	27	Ambulance	45
Mitchell's Plain	41	New Somerset	12	Private	21
Khayelitsha	35	Victoria	09		
Hanover Park	35	Vredenberg	04		
Vanguard	11	Worcester	01		
Retreat	04	Wesfleur	01		
Woodstock	01	Private	04		
Heideveld	01				
Kewtown	01				
Robertson	01				

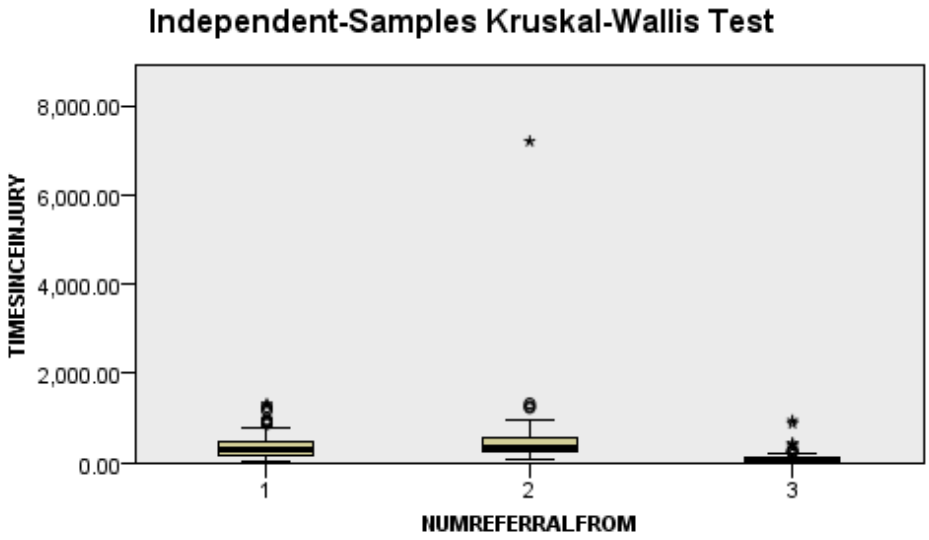
Table 7: Patients referral hospital

TIME DELAY (MIN.) OF ARRIVAL AT GSH TRAUMA CENTRE SINCE INJURY

The median time delay of arriving patients after injury directly from scene was the shortest (90 minutes or 1.5 hours, Interquartile Range 60 to 120 minutes), followed by referred from Community Health Clinic (300 minutes or 5 hours, Interquartile Range 180 to 450 minutes) and secondary level hospital (345 minutes or 5.75 hours, Interquartile Range 240 to 570 minutes).

REFERRAL	TIME DELAY (MIN.) OF ARRIVAL AT GSH TRAUMA CENTRE SINCE INJURY							
	Valid N	Minimum	Maximum	Mean	Standard Deviation	Median	Percentile 25	Percentile 75
1.CHC	176	30	1304	362	250	300	180	450
2.Hospital	58	93	7200	575	936	345	240	570
3.From Scene	66	10	945	134	166	90	60	120

Table 8: Delay of arrival from different hospital



(1=Community Health Clinic, CHC, 2= Secondary level Hospital, 3= From Scene)

There is significant difference between time of arrival at GSH Trauma centre since injury via Community Health Clinic, secondary level hospital or directly from scene ($p < 0.001$).

ADMISSION TRIAGE

On arrival to GSH trauma centre patients were triaged according to the adult triage score calculator. The majority of the patients (139, 46.3%) admitted to trauma ward were orange on presentation, followed by yellow (116, 38.7%), and Red (45, 15%). No green patients were admitted to trauma ward either for observation or for operation.

TRIAGECATEGORY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ORANGE	139	46.3	46.3	46.3
	RED	45	15.0	15.0	61.3
	YELLOW	116	38.7	38.7	100.0
	Total	300	100.0	100.0	

Table 9: Admission Triage

ISS (mild/moderate/severe)

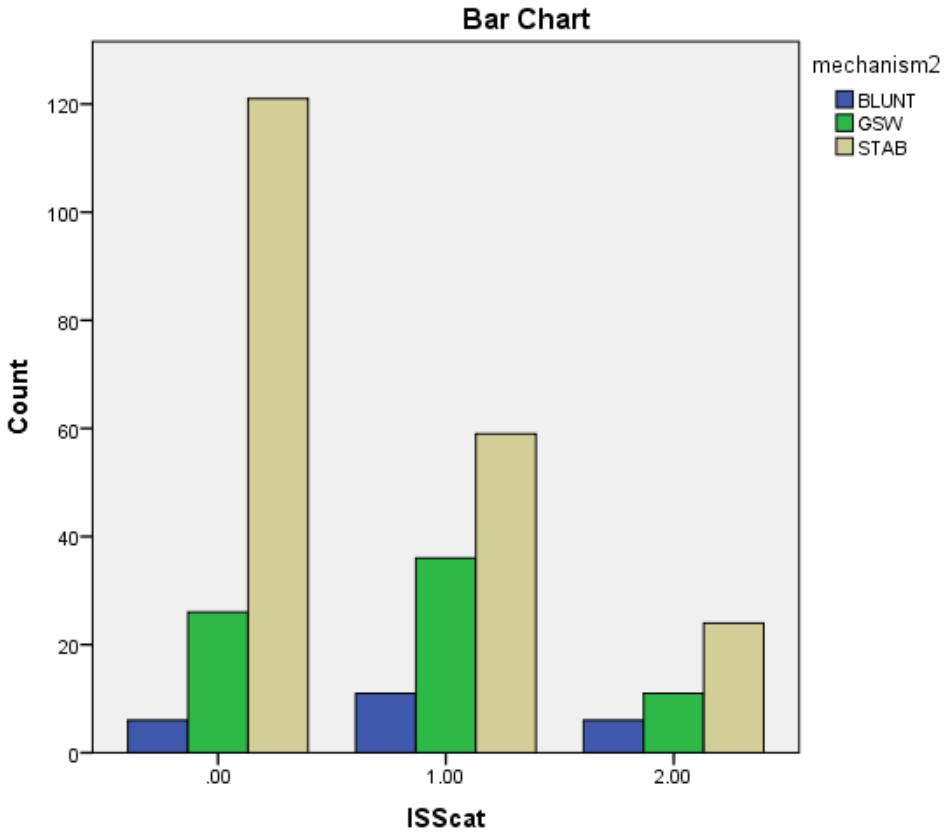
Among all admitted patients just less than half of the patients (147, 49%) injury severity score (ISS) was greater than 15. One-hundred and fifty three (53%) patients were mildly injured (ISS <15).

ISS (mild/moderate/severe) by mechanism

The stabbed (121, 59.3%) patient's ISS tended to be less than 15. On the other hand gunshot (47, 64.4%) and blunt trauma (17, 73.9%) patient's had an ISS of 15 or more.

ISS		MECHANISM			Total
		BLUNT	GSW	STAB	
	<15 .00	6	26	121	153
	15-25 1.00	11	36	59	106
	>25 2.00	6	11	24	41
Total		23	73	204	300

Table 10: ISS frequency by mechanism



Bar Chart 6: ISS by Mechanism

There was significant association between injury severity score (ISS) and different mechanisms (p= 0.001).

Complications (Types and Clavien-Dindo Grading)

Thirty one patients (29%) developed different types of post-operative complications as listed below. Organ failure (18, 58%) remained major post-operative complication.

Clavien-Dindo Grading	Type and Number of Post-operative Complications	Type and Number of Complications patients without Surgery
I	Wound Sepsis (5) Ileus (1)	
II	Pneumonia (1)	
III a	Loculated haemothorax (1)	Loculated Haemothorax (1) Chylothorax (1)
III b	Empyema chest (3)	Empyema chest (1)
IV a	Acute Kidney Injury (6), Respiratory Failure (9)	AKI (1)
IV b	Multi-organ Dysfunction (3)	
V	Death (2)	
Total	31	4

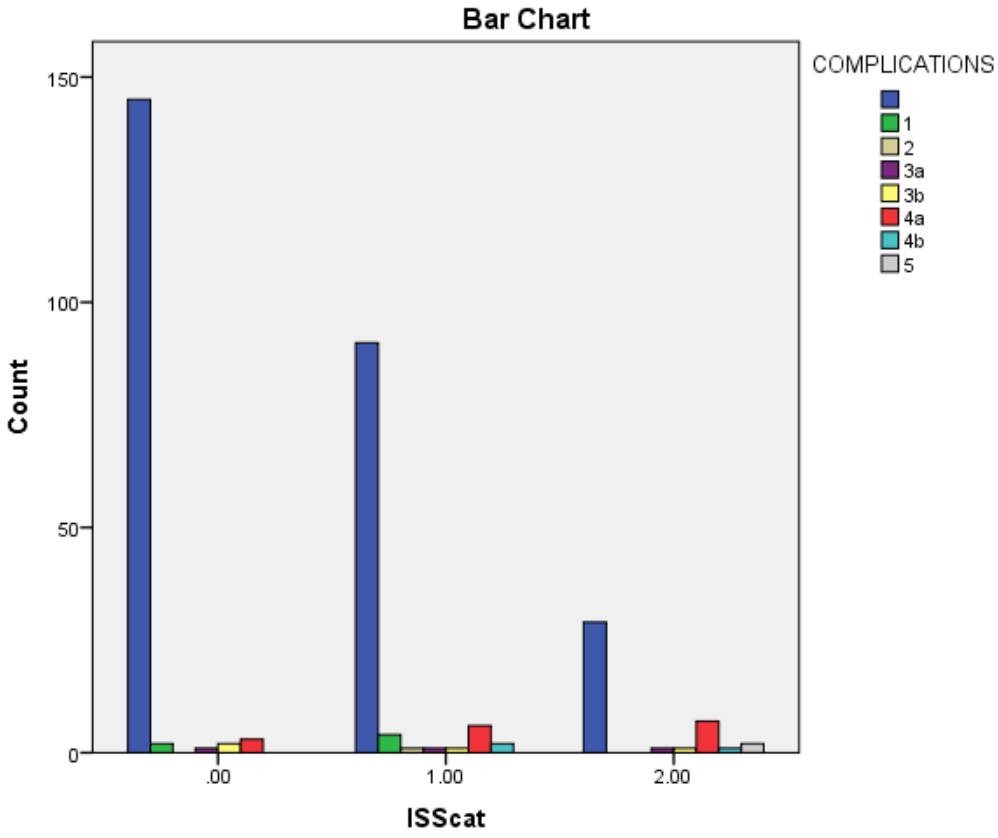
Table 11: Types of complications according to Clavien-Dindo classification

ISS (mild/moderate/severe) by complications

Out of 300 patients, 35 patients developed complications. Complications were grouped according to Clavien-Dindo classification of surgical complications and tested against Injury severity score.

ISS		COMPLICATIONS								Total
		No	1	2	3a	3b	4a	4b	5	
<15	0	145	2	0	1	2	3	0	0	153
15-25	1	91	4	1	1	1	6	2	0	106
>25	2	29	0	0	1	1	7	1	2	41
Total		265	6	1	3	4	16	3	2	300

Table 12: ISS vs Complications according to Clavien-Dindo classification



Bar Chart 7: ISS vs Complications according to Clavien-Dindo classification

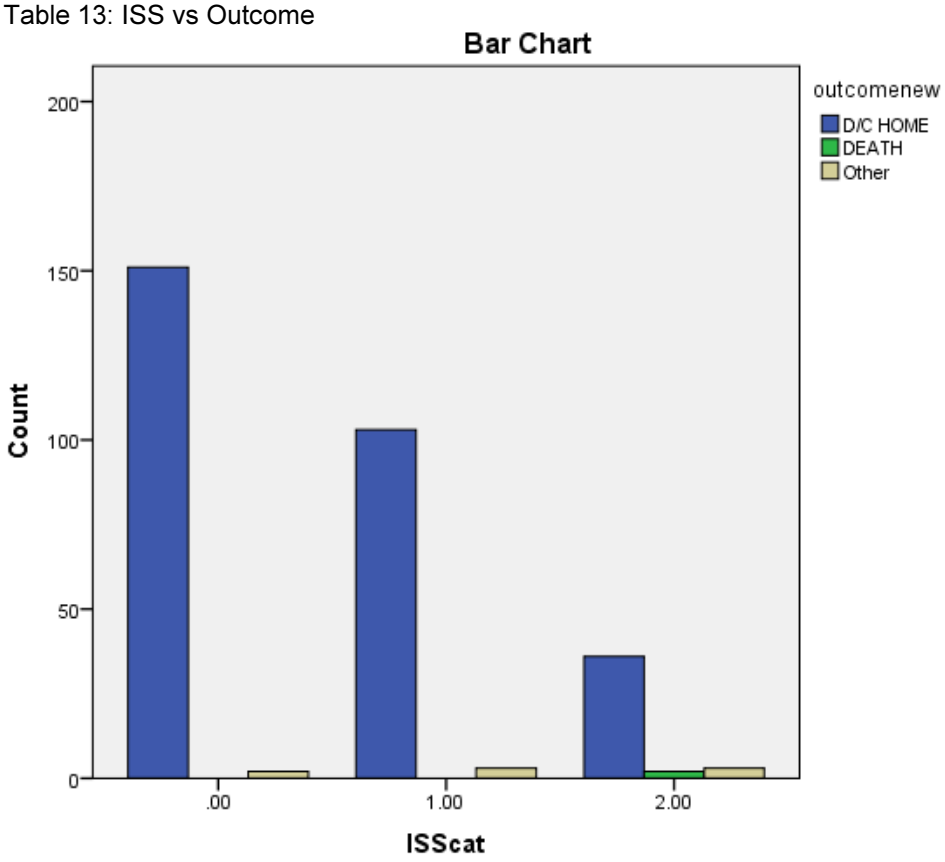
There was significant association with ISS and complications. The more severe the injury is the more complications ($p < 0.001$).

ISS (mild/moderate/severe) by outcome

Only 2 patient died whose Injury Severity Score (ISS) was >25.

ISS		OUTCOME			Total
		D/C HOME	DEATH	To Other facility	
	<15 .00	151	0	2	153
	15-25 1.00	103	0	3	106
	>25 2.00	36	2	3	41
Total		290	2	8	300

Table 13: ISS vs Outcome



Bar Chart 8: ISS vs Outcome

The association between different categories of ISS and outcome are found to be significant (p= 0.002).

INVESTIGATIONS UNDERTAKEN

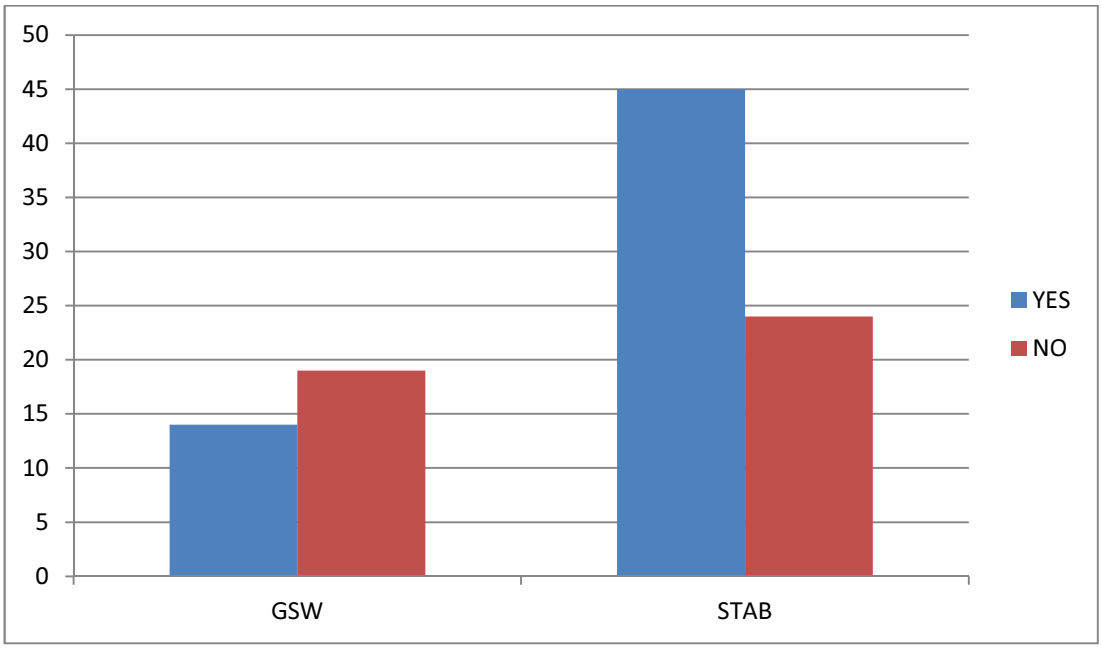
CT ABDOMEN BY MECHANISM

Out of 102 patients with penetrating abdominal trauma (GSW 33, Stab 69), a total 59 (57.8%) underwent CT scan of the abdomen. Sixty five percent (65.2%) of the stabbed patients (45 out of 69) and 42.4% GSW patients (14 out of 33) went for CT abdomen.

MECHANISM	CT ABDOMEN		TOTAL
	YES	NO	
GSW	14	19	33
STAB	45	24	69
TOTAL	59	43	102

Table 14: CT abdomen by mechanism

The CT scans of the abdomen by mechanisms were found to be statistically significant (p= 0.02).



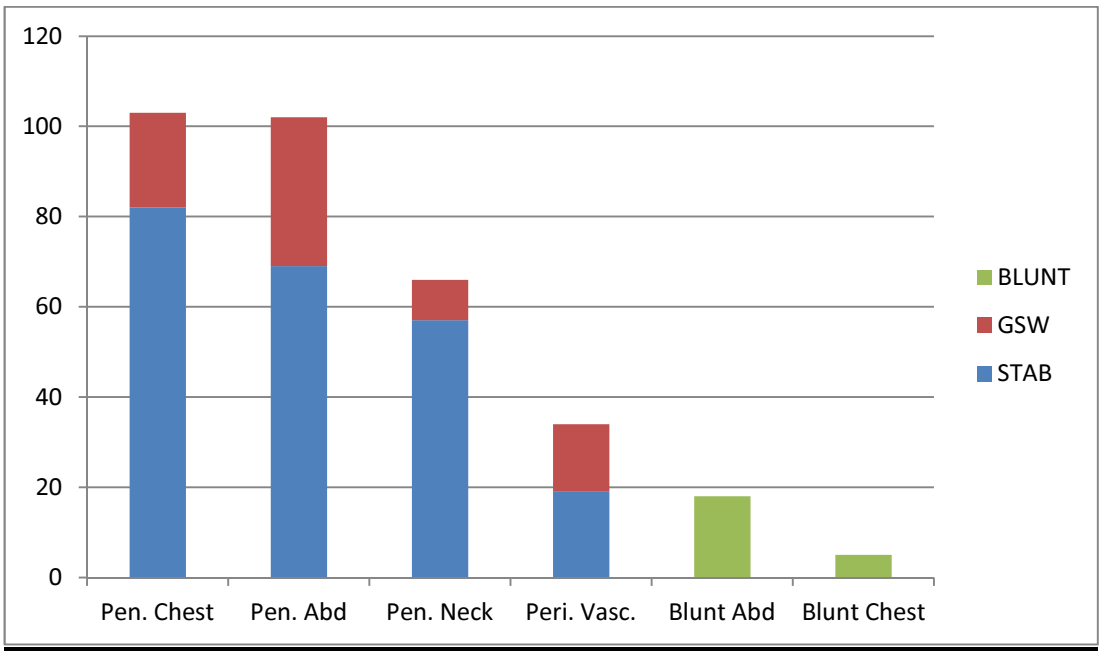
Bar chart 9: Frequency of CT abdomen By Mechanism of Injury

DIAGNOSIS- ACCORDING TO THE ANATOMICAL REGION AND MECHANISMS

Table-15 divides the patients on the basis of anatomical region and mechanism (GSW, Stab, and Blunt).

Diagnosis	Number
1. Penetrating Chest	103 (STAB 82, GSW 21)
2. Penetrating Abdomen	102 (STAB 69, GSW 33)
3. Penetrating Neck	66 (STAB 57, GSW 9)
4. Peripheral Vascular	34 (STAB 19,GSW 15)
5. Blunt Abdomen	18
6. Blunt Chest	5
Total	328

Table 15: Diagnosis by anatomical region and mechanism



Bar Chart 10: showing injury to different anatomical area of body and mechanism.

OPERATIONS

The majority (192, 64%) of the admitted patients were managed non-operatively. One hundred and eight patients of the 300 had required surgery (including interventional radiology). Some patients required combination of procedures such as laparotomy and thoracotomy or vascular and nerve repair at the same time. Relook operations were excluded here. Table-15 below shows different types of operations performed.

Types	Frequency
Laparotomies (excluding Relooks)	48
Subxiphoid Pericardial Windows	13
Vascular Repair	27
Thoracotomies	4
Sternotomy	1
Nerve Repair	3
Video Assisted Thoracoscopy (VATS)	2
Laparoscopy	1
Interventional radiology	2
Others- Debridement, Removal of Foley's catheter, Skin Graft, Fasciotomies, minor etc.	13

Table 16: Types of Operations

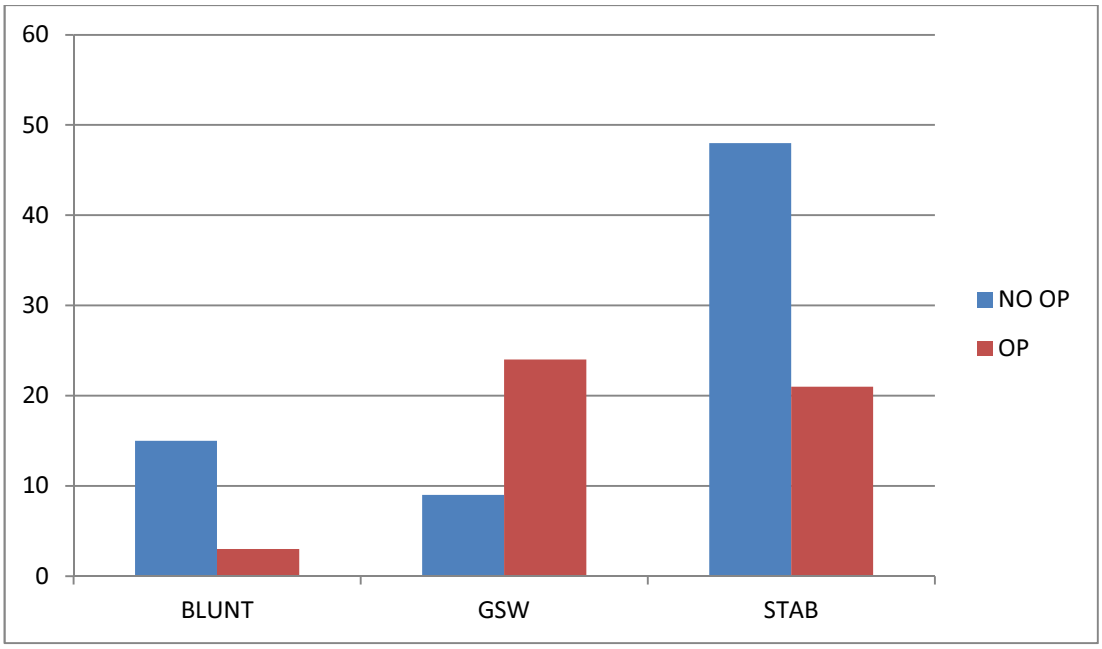
ABDOMINAL TRAUMA MANAGEMENT OPERATIVE VS NON OPERATIVE BY MECHANISM

Eighty three percent (83.3%) of the blunt abdominal trauma patients were managed conservatively. Only 16.7% (3 out of 18) patients required operation. On the other hand 72.7% gunshot abdomen patients (24 out of 33) and 30.4% stabbed patients (21 out of 69) required surgery. Overall 60%

abdominal trauma patients (72 out of 120) were managed non-operatively and 40% (48 out of 120) required laparotomies.

MECHANISM	OPERATION	NO OPERATION	TOTAL
BLUNT	3 (16.7%)	15 (83.3%)	18
GSW	24 (72.7%)	9 (27.3%)	33
STAB	21 (30.4%)	48 (69.6%)	69
TOTAL	48 (40%)	72 (60%)	120

Table 17: Abdominal Trauma- Operative vs Non-operative



Bar chart 11: showing management of abdominal trauma by mechanism

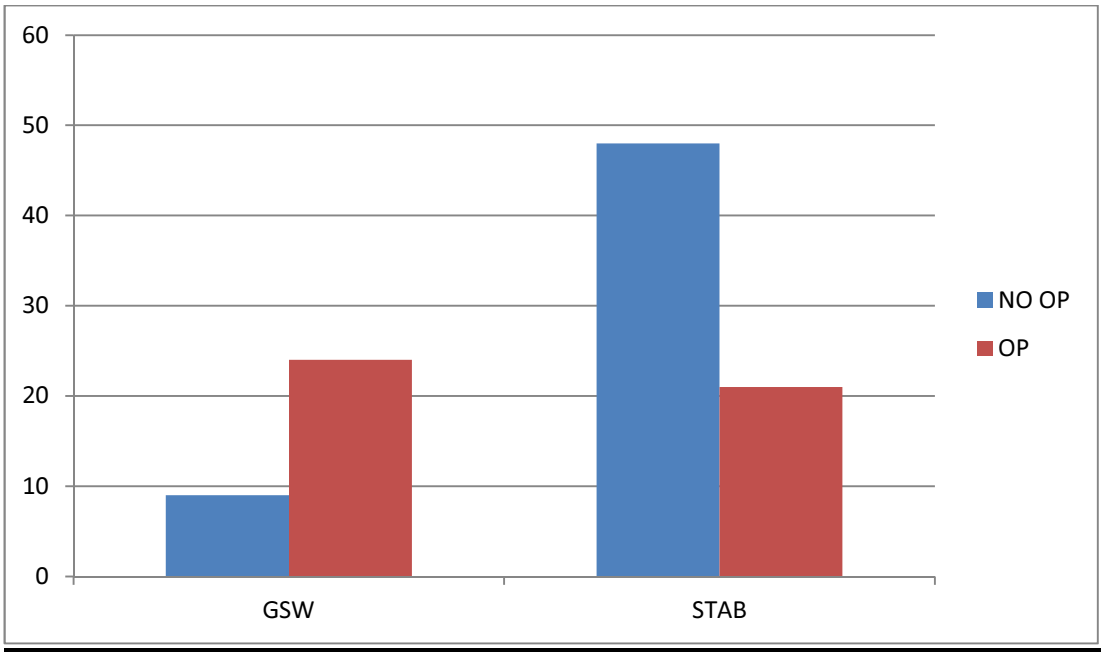
The association between the management of the abdominal trauma patients by mechanisms of injury were found to be statistically significant ($p < 0.001$).

PENETRATING ABDOMINAL TRAUMA: OPERATIVE VS NON-OPERATIVE BY MECHANISM

Among all penetrating abdominal trauma majority (72.7%) of Gunshot abdomen patients (24 out of 33) required surgery and most (69.6%) of the stab abdomen patients (48 out of 69) were managed non-operatively.

MECHANISM	OPERATION	NO OPERATION	TOTAL
GSW	24 (72.7%)	9 (27.3%)	33
STAB	21 (30.4%)	48 (69.6%)	69
TOTAL	45 (44.1%)	57 (55.9%)	102

Table 18: Penetrating Abdominal Trauma- Operative vs Non-operative



Bar Chart 12: showing management of penetrating abdominal trauma by Mechanism.

The association between the management of penetrating abdominal trauma by mechanisms were found to be statistically significant ($p < 0.001$).

OPERATIVE TRIAGE

According to the priority of the cases the emergency cases were booked as Red, Orange, Yellow and Green for operation. Red cases were immediate priority (resuscitation cases), Orange cases were very urgent priority- potentially life/limb threatening pathology should be done within 2 hours, Yellow cases were urgent priority- significant pathology should be done within 6 hours and Green cases were delayed priority – minor injury/illness should be done within 24 hours.

COLOR CODE	Delay (Minutes) from Booking to operation							
	Patient No.	Mean Delay (min)	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
RED	6	48	17	25	70	48	35	60
ORANGE	47	131	87	10	390	120	53	185
YELLOW	40	228	148	35	720	213	113	300
GREEN	13	162	124	15	390	110	65	265

Table 19: Operative Triage vs Delay

Of 106 booked cases Red, Orange, Yellow and Green cases were 6, 47, 40 and 13 consecutively. The median delay for Green, Yellow and Orange cases were within expected time but the Red cases took unexpectedly longer time (median 48 min, Range 25 min. to 70 min.).

REASONS FOR DELAY IN GETTING TO THEATRE

Table-19 below shows the reason for delay in getting to theatre according to booking colour code. Out of six red patients only one patient died due to delay in transfer (GSW- Chest unstable had front room thoracotomy and took 55 minutes to get to theatre after booking). Three red cases were delayed due to no theatre being available at that time.

CAUSE	RED	ORANGE	YELLOW	GREEN	Total
No Theatre	3	22	8	1	34 (32.1%)
Ongoing Case (booked case is scheduled next)		4	3	1	8 (7.5%)
Priority of Other Case		16	26	10	52 (49.1%)
Delay in Transfer (Resus. Theatre not ready etc.)	3	5	3	1	12 (11.3%)
Total	6	47	40	13	106

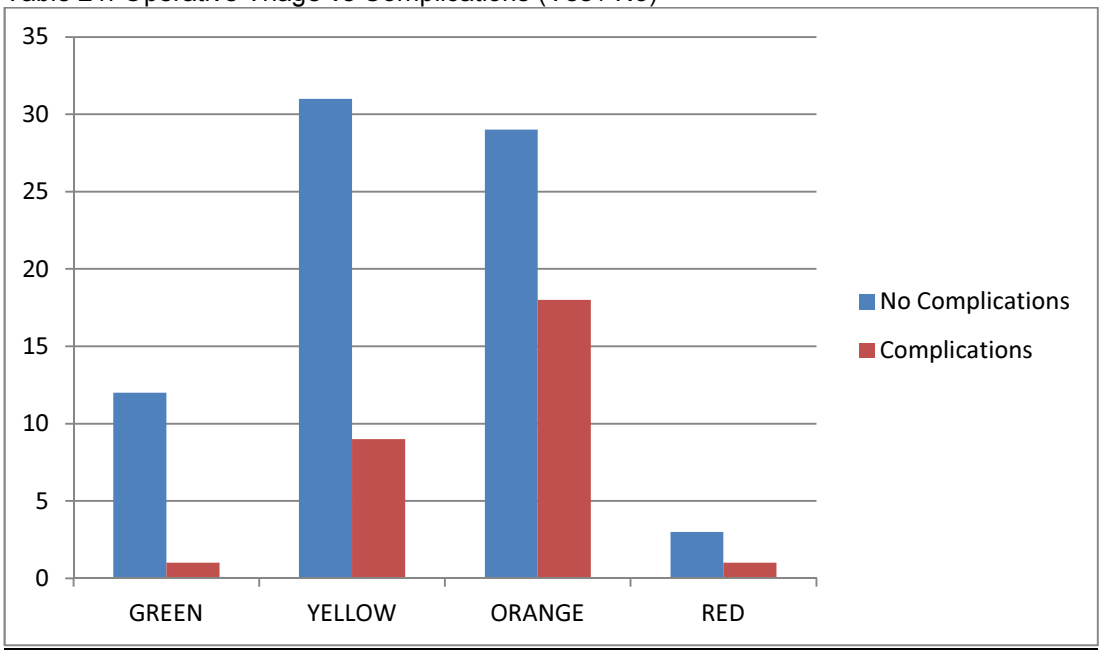
Table 20: Operative triage vs Reasons for delay

OPERATIVE TRIAGE VS COMPLICATIONS

Of the 106 operative cases, 31 had complications. Among the booked Green, Yellow, Orange and Red cases 1, 9, 18 and 3 cases had post-operative complication respectively.

COLOR CODE	NO COMPLICATIONS	COMPLICATIONS	TOTAL
GREEN	12	1	13
YELLOW	31	9	40
ORANGE	29	18	47
RED	3	3	6
TOTAL	75	31	106

Table 21: Operative Triage vs Complications (Yes / No)



Bar chart 13: showing relations between operative triage and post-operative complications

There was no statistically significant association between operative triage and post-operative complications (P= 0.074).

OPERATIVE TRIAGE VS OUTCOME

There were only two post-operative deaths. Data was analysed against the operative triage colour.

	Discharge home or other facility	Death	Total
Green	13	0	13
Yellow	39	1	40
Orange	47	0	47
Red	5	1	6
Total	104	2	106

Table 22: Operative Triage vs Outcome

There was no statistically highly significant association between operative triage and outcome (p=0.04).

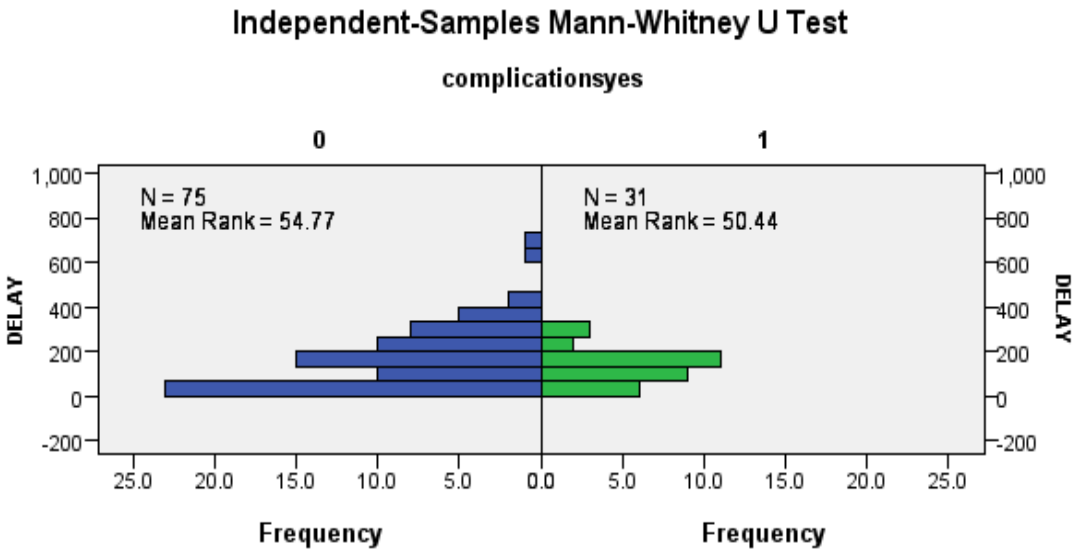
OPERATIVE DELAYS VS COMPLICATIONS:

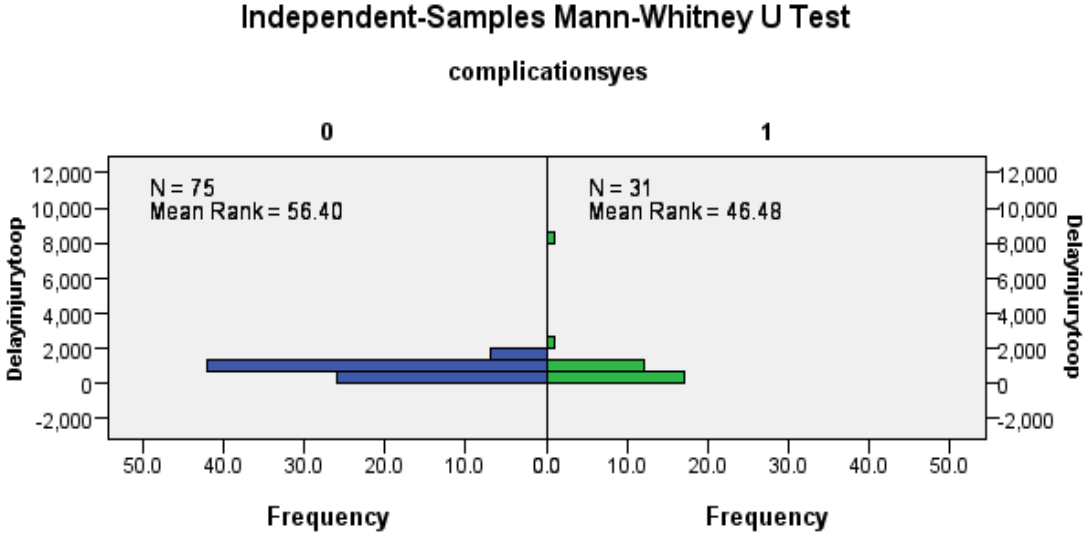
The median delay for all operations from booking and from injury was 135 minutes (2.25 hour) and 630 minutes (10.5 hour) respectively. The Interquartile range was 90-185 and 305-970 for booking to operation and from injury to operation group.

DELAY		COMPLICATIONS (YES VS. NO)							
		Valid N	Mean	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
FROM BOOKING	0	75	178	141	10	720	165	60	265
	1	31	140	75	25	325	135	90	185
INJURY TO OP	0	75	829	391	125	1995	840	540	1130
	1	31	949	1481	130	8515	630	305	970

Table 23: Operative delay vs Complications

TIME DELAYS FOR OPERATION BY COMPLICATION (YES VS NO) NON- PARAMETRIC TESTS





Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of DELAY is the same across categories of complicationsyes.	Independent-Samples Mann-Whitney U Test	.509	Retain the null hypothesis.
2	The distribution of Delayinjurytoo is the same across categories of complicationsyes.	Independent-Samples Mann-Whitney U Test	.131	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

The distribution of delay across categories of complications for both delay from injury or delay from booking the operation did not show statistically significant association (p-values for booking to operation group and injury to operation group 0.509 and 0.131 respectively).

TIME DELAYS IN MINUTES FOR LAPAROTOMY

The median delay for surgery from booking, admission and injury were 145 minutes (2.4 hour), 302 (5.03 hour) and 348 minutes (5.8 hour) with maximum time delay 620 minutes (10.3 hour), 1330 minutes (22.2 hour) and 1995 minutes (33.25 hour) respectively.

Delay	Total N	Mean	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
From Booking	48	160	117	10	620	145	60	235
From admission	48	398	299	65	1330	302	192	509
From Injury	48	677	389	125	1995	623	348	875

Table 24: Delay (minutes) for Laparotomy

The table-23 above is showing the time delay in minutes for laparotomy from injury, from admission to trauma centre and from booking the case in theatre for operations.

DID THE TIME DELAYS FOR LAPAROTOMY INCREASE THE COMPLICATION RATE?

The median delay for laparotomy with post-operative complications from booking the case, from admission, and from injury was 140 min. (range 50-285 min.), 170 min. (range 90-895 min.), and 305 min. (range 130-970 min.) respectively.

COMPLICATIONS		DELAY							
		Valid N	Mean	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
FROM BOOKING	NO 0	33	162	133	10	620	150	60	250
	YES 1	15	154	73	50	285	140	100	195
ADMISSION TO SURGERY	NO 0	33	443.12	325.77	65	1330	335	210	541
	YES 1	15	299.4	207.5	90	895	250	170	415
DELAY INJURY TO OP	NO 0	33	765	411	125	1995	735	480	1005
	YES 1	15	483	251	130	970	505	305	615

Table 25: Delay for laparotomy vs complications

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.
1	The distribution of DELAY is the same across categories of complicationsyes.	Independent-Samples Mann-Whitney U Test	.593
2	The distribution of admissiontosurg is the same across categories of complicationsyes.	Independent-Samples Mann-Whitney U Test	.122
3	The distribution of Delayinjurytoop is the same across categories of complicationsyes.	Independent-Samples Mann-Whitney U Test	.018

Although delay for laparotomy from booking and from admission did not show any significant difference for increasing complications but there was a significant factor in the development of complications with the delay from injury (p=0.02).

HOSPITAL STAY

The average hospital stay was 5 days, maximum stay 29 days and median stay 3 days with range from 0 to 29 days.

	Total Patient	Mean	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
HOSPITALSTAY	300	5	5	0	29	3	2	6

Table 26: Hospital Stay (day)

HOSPITAL STAY BY MECHANISM

The median hospital stay for Blunt, Gunshot and stab injury was 6, 4 and 3 days with range of 1-29, 0-22 and 1-26 days respectively.

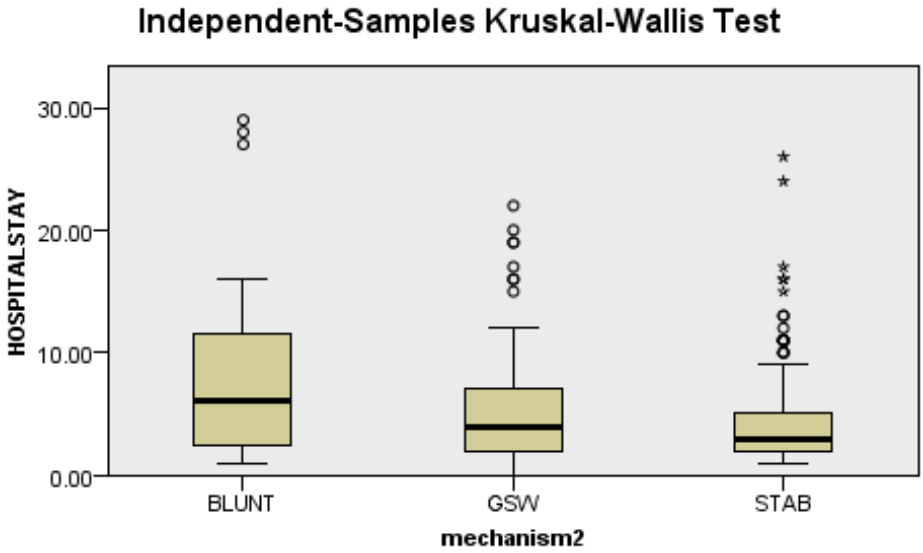
MECHANISM	HOSPITAL STAY							
	Total Patient	Mean	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
BLUNT	23	9	9	1	29	6	2	12
GSW	73	6	5	0	22	4	2	7
STAB	204	4	4	1	26	3	2	5

Table 27: Hospital stays vs Mechanism

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of HOSPITALSTAY is the same across categories of mechanism2.	Independent-Samples Kruskal-Wallis Test	.005	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



The blunt trauma patients stayed longer than GSW and stabbed patients. The distribution of hospital stay across the categories of mechanisms was found to be statistically significant (p= 0.005).

HOSPITAL STAY BY OPERATIVE VS NON OPERATIVE

The median stay for patients with surgery was 4 days and without Surgery 2 days. The ranges for hospital stay with or without Surgery were 0-29 and 1-28 days respectively.

HOSPITAL STAY	TOTAL N	MEAN	STD. DEV.	MIN.	MAX.	MEDIAN	PERCENTILE 25	PERCENTILE 75
SURGERY								
NO	192	3	4	1	28	2	2	4
YES	108	8	6	0	29	6	4	11

Table 28: Hospital stays by Operative vs Non-operative

The distribution of hospital stays across the categories of operative patient was found to be statistically significant (p <0.001).

HOSPITAL STAY BY COMPLICATIONS

The median stay for patients with complications was 12 days and without complications only 3 days. The Interquartile range for hospital stay with or without complications are 8-17 and 2-5 days respectively.

		COMPLICATIONS (YES VS. NO)								
		Total N	Valid N	Mean	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
HOSPITALSTAY	0	265	265	4	3	1	27	3	2	5
	1	35	35	13	7	0	29	12	8	17

Table 29: Hospital stays by Complications.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of HOSPITALSTAY is the same across categories of complicationsyes.	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

The distribution of hospital stays across the categories of complications was found to be statistically significant (p <0.001)

ICU STAY

Out of 106 who underwent surgery 19 patients admitted to ICU post operatively. The median ICU stay was 2 days, range 1 to 16 days.

	Total N	Valid N	Mean	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
ICU STAY	106	19	4	4	1	16	2	1	6

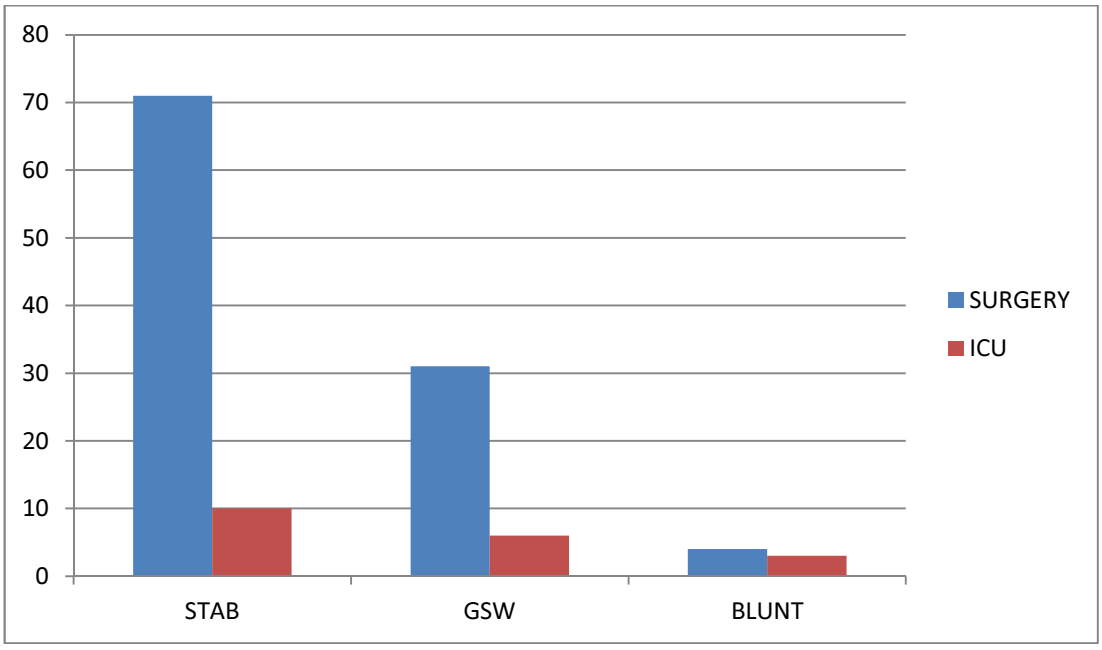
Table 30: Total ICU stay

ICU STAY BY MECHANISM

Out of 19 ICU patients stab wounds, GSW and blunt Trauma patients' were 3, 6 and 10 respectively. The median stay for GSW patients were 4 days followed by blunt trauma 3 days and stabs 2 days.

		MECHANISM							
		ICU Patient	Mean	Std. Dev.	Min.	Max.	Median	Percentile 25	Percentile 75
ICUSTAY	BLUNT	3	4	4	1	8	3	1	8
	GSW	6	6	5	2	16	4	2	7
	STAB	10	3	3	1	10	2	1	3

Table 31: Total ICU stay by mechanism

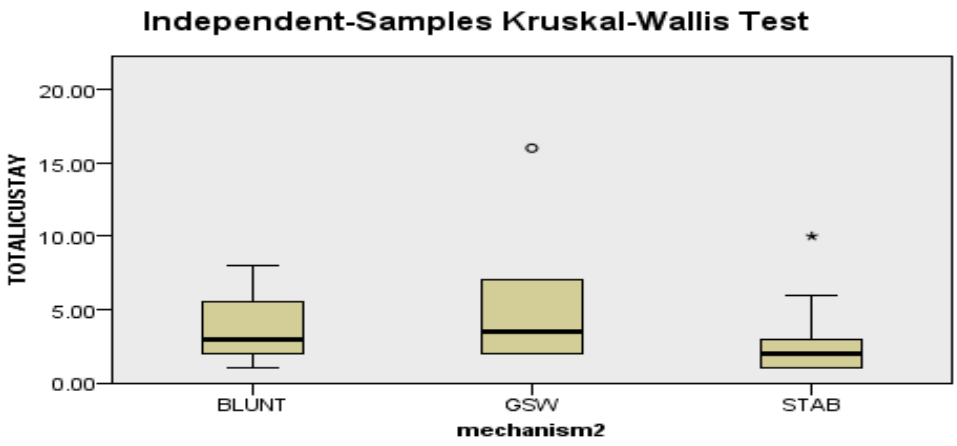


Bar chart 14: showing frequency of Post-operative ICU stay by Mechanism

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of TOTALICUSTAY is the same across categories of mechanism2.	Independent-Samples Kruskal-Wallis Test	.426	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



The distribution of total ICU stay by mechanism of injury was not found to be statistically significant (p= 0.4).

OUTCOME:

Out of 300 admitted patients only 2 (0.67%) demised. 290 patients were discharged home. Four patients were transferred to another ward for further management, 3 patients were down staged to secondary level hospital, and 1 patient transferred to Rehabilitation centre.

DISCUSSION

Donson and Paden (2000) reported a prevalence of 75% males and 25% females for both their studies at GSH TC in 1999 and 2000. Frankish (2003 and 2004) did not specifically examine gender data during his study. [28,29] Cummins (2004) did not specifically examine GSH TC data for gender but reports a "preponderance of male over female attenders at emergency department" attributed to the higher proportion of males than females as victims of assault or traffic incidents.[15]Groenewald et al (2007) report the gender ratio for homicide in Cape Town (2001 to 2004) as 7.5 male deaths for every female death.[49]The Medical Research Council (1990), in their National Trauma Research Programme, Cape Metropolitan Study, reported a typical gender distribution a 2:1 male preponderance and added that this ratio was also recorded by other national and international researchers.[50] In the current study there was clear preponderance of male versus female patients with a male-female ratio of 12:1.

During the Cape Metropolitan Trauma Study, the MRC (1990) reported a higher frequency of injuries amongst the 15 to 29 year age group[50], adding that this corresponded with findings in other national and International literature. Donson and Paden (2000)[6] during their surveillance of substance abuse and trauma at the GSH TC reported a mean age of 31.5±13.2 years of selected patients see during an idealised week, with the largest proportion in the 13 to 24 age group.[6] Groenewald et al (2007) during a comparison of homicide related mortality in Cape Town (2001 to 2004) indicated a peak in the 15 to 24 year age group, tapering off with age and increasing again after 65 years.[49] The study showed the median age for all admitted patient was 26 with Interquartile Range (IQR) of 21 to 32 which are mirrored by the recent study. Clearly, in order to make meaningful comparisons, standardised age series must be used, with a caution against too large age ranges. There is much scope for further studying of multiple trends related to the age of patients reporting to the GSH TC, especially associated with different mechanisms of injury and the design of upstream preventive interventions.

Comprehensive service plan (CSP) sub-districts represent the substructure of the Cape Metropole for the Provincial Government of the Western Cape Department of Health. Theoretically only the Klipfontein, Southern, Western, Mitchell's Plain and part of Khayelitsha (Site B) form part of the formal drainage area of the GSH TC. However, there are explanations for the admission of 3.33% of patients from outside the formal drainage areas. Ambulance diversions are regularly called for when any of the Cape Metropole hospitals are functioning beyond full capacity, together with 7% (21 out of 300) of patients who made their own way to the trauma centre. The study showed the geographical area of injury, in descending order: Klipfontein 113 (37.67%), Southern 58 (19.33%), Western 48 (16%), Khayelitsha 38 (12.67%) and Mitchell's Plain 38 (11%) which is pretty similar to that described by Donson and Peden (2000).[6]

Cummins (2004) indicates that individual emergency department workloads differ according to social and economic circumstances of their drainage areas. Despite staff protests about workload unpredictability, patterns of expected patient flow according to time of the month, day of the week and time of the day can be demonstrated over time. Furthermore, routine data collection enables detection of seasonal trends required by managers for rational resource scheduling.[15] Donson and Peden (2000) demonstrated that more than half the patients presenting at the GSH TC during their 1999 and 2000 studies had sustained their injuries from Friday evenings to Monday mornings. Both their studies revealed distinct peaks between 16h00 and 19h59.[6] Cummins (2004) also demonstrated weekend peaks at the GSH TC during June 2002.[15] Examination of the current data confirmed weekend and evening peaks- Saturday and Sunday 50.7% of patients admitted (152 out of 300) and 210 patients injured after 6 pm.

Meyers and Naledi (2007) add their voices to concerns about Cape Town trends in mortality related to homicide and road traffic incidents still being amongst the highest in the world, with predominance amongst male youth, linked to alcohol and substance abuse.[4] Matzopoulos et al (2007a) describe

the rising contribution of road traffic related injuries to the international burden of injury, expected to be 5.1% of DALYS lost by 2020, YYL already reached 6.9%.[7] They comment about the burden of traffic injuries in Cape Town and highlight distinctive mortality patterns as high percentages of male (78%) and pedestrian deaths (>60%), high alcohol relatedness to driver deaths (>50%) and pedestrian deaths (>60%) with distinct weekend peaks in the mornings and early afternoons amongst adults and school going children.[29] They also concur that the effects of violence are not only confined to physical injuries, but may extend to behavioural and emotional problems, such as post-traumatic stress disorder that, in turn, may fuel continuation of cycles of violence, extending into psycho-social outcomes.

This study showed 277 (92.3%) and 23 (7.7%) patients were admitted to trauma ward following penetrating and blunt trauma respectively. Among all penetrating trauma patients Gunshots were 73 (24.3%) and stab wounds were 204 (68%). Males were predominant in all mechanisms of injury (p= 0.002).

One of the most well-known principles in trauma is ‘‘golden hour’’, which specifies that patients outcome are improved when the patient is transported to a designated trauma centre within an hour of injury. Nearly all emergency medical services (EMS) providers can remember their first exposure to the concept of the “golden hour” with the idea that trauma patients have significantly better survival rates if they reach surgery within 60 minutes of their injury. The “golden hour” summarized by the 3R rule of Dr Donald Trunkey, an academic trauma surgeon, “Getting the right patient to the right place at the right time.” But the concept of golden hour is still questionable in most of countries.[51]The study showed 93% patients were transported by Emergency Medical Services (EMS) especially by Metro service (85%) with longest response time for blunt trauma 2 hour, for GSW 3.67 hour and 4.4 hour for stabbed patients (p= 0.018), as a result the median delay for arrival at GSH TC from Community Health Clinic (CHC) and secondary hospital were considerably longer (5 hour and 5.75 hour respectively) (p <0.001).

Among anatomical severity scores, the Injury Severity Score (ISS), created by Baker et al. in 1974 has been considered for over 20 years to be the gold standard to classify trauma victims, both blunt and penetrating. The ISS is based upon the Abbreviated Injury Scale (AIS). ISS is obtained by summing the square value of the 3 highest AIS scores, identifying severity of patients and enabling stratification of them. A poly-trauma is defined as an ISS > 15. The greater the score value, the greater the severity of patient, and, consequently greater mortality. The current study showed significant association ISS >15 (49% patients) with both the complications ($p < 0.001$) and outcome ($p = 0.002$).

The ISS does have significant limitations, most notably, the ISS does neither account for multiple injuries to a single body region nor for differences in severity across body regions. For instance, an AIS 5 injury is given equal weight in the ISS calculation, despite the fact that an abdomen AIS 5 injury is associated with a significantly higher probability of survival than an AIS 5 head injury. In 1997, authors of ISS changed this indicator because there was a flaw identified in its calculation, which considered a single lesion per body lesion, underestimating the severity of patients. In patients with multiple lesions located in the same body region, ISS considers only the most severe, ignoring the second most severe lesion that many times, is in the same body segment of the first. To correct these limitations the New Injury Severity Score (NISS) was created considering the three most severe lesions in the calculation, regardless of the body region.[52]This change from ISS to NISS aimed at increasing predictive value of the index and simplifying its calculation. The predictive value of NISS vs. ISS has been assessed with regard to several outcomes, including survival, rate of hospital stay, admission to ICU, sepsis, multiple organ dysfunction syndrome, nosocomial infection, postoperative complications, post trauma complications, results/functional skill, transference to other hospitals and situation at discharge (whether or not resources and/or specific medical care were needed after hospital discharge), and it has generally been found that NISS outperforms or is equivalent to ISS in predicting these outcomes.[52]

High rate of operative complications caused paradigm shift from operative to non-operative management (NOM) in hemodynamically stable blunt abdominal trauma patients.[53,54] NOM can be safely practiced in a Trauma Care Centre which has Trauma Surgeons, newer imaging modalities, High Dependency Unit (HDU), ICU and other supporting services.[55] Repeated clinical examination supplemented with modern imaging and laboratory investigations play a key role in reaching therapeutic decisions, thus preventing unnecessary laparotomies. Recently published a 10 years review (1071 patients with blunt abdominal injuries) by Raza et al. reported Non operative management of blunt abdominal injuries were highly successful in 90% of the patient.[56] The current study showed 83.3% (15 out of 18) of blunt abdominal patients were managed conservatively.

Although there is no debate that patients with peritonitis or hemodynamic instability should undergo urgent laparotomy after penetrating injury to the abdomen, it is also clear that certain stable patients without peritonitis may be managed without operation. The practice of deciding which patients may not need surgery after penetrating abdominal wounds has been termed selective management. This practice has been readily accepted during the past few decades with regard to abdominal stab wounds; however, controversy persists regarding gunshot wounds. The current study showed 69.6% (48 out of 69) stabbed abdomen and 27.3% (9 out of 33) GSW abdomen patients were managed conservatively ($p < 0.001$).

Scheduling emergency cases among elective surgeries often results in prolonged waits for emergency surgery and delays or cancellation of elective cases. A dedicated OR for emergency cases improve quality of care by decreasing cancellations and overruns in elective rooms and increasing the proportion of patients who accessed care within the targeted time.[57] There are 24-hour emergency OR at Groote Schuur Hospital. There is also a dedicated trauma theatre from Monday to Thursday 8 am to 5 pm. Friday, after hours and weekends emergency trauma cases are done at emergency OR. Early operative control of haemorrhage is vital and any delay before

surgery may adversely affect outcome.[58]With this view at GSH the Emergency Surgical Case Categorization Chart (ESCCC) is in practice to triage the emergency surgical cases.

The study showed Yellow and Orange cases were operated within the expected time but the Red cases took unexpectedly longer time (median 48 min, minimum 25 min. to maximum 70 min.) to get to theatre since booking. Out of six red patients only one patient died in delay in transfer group (GSW-Chest unstable had front room thoracotomy and took 55 minutes to get to theatre after booking). Three red cases were delayed due to no theatre at that time but outcome wise all patients were discharged home and only one patient had post-operative complication. The median delay for laparotomy from injury with post-operative complications was 5.08 hours (range 2.17 hour to 16.17 hour), which found to be significant in the development of complications (p=0.02).

To facilitate faster access, improved pre-hospital care, and more seamless patient care throughout the continuum of care, the Emergency Medical Services (EMS) and first responders should be more integrated within the health care system. Transport vehicles (air and ground) should be strategically placed rather than facility based and should be used appropriately to facilitate timely access and response, especially in areas that are least accessible.[59]

CONCLUSION

Penetrating trauma continues to be a major burden on the resources of a Trauma Centre. There were significant delays in the transport of patients from the referral hospitals which was responsible for the development of complications. The transport of the patients from the smaller hospitals and the direct trauma referral system needs to be strengthened. Non-operative management of abdominal trauma is a very important component of trauma surgical care and is decreasing the operative load on the theatres.

The Injury Severity Score (ISS) does neither account for multiple injuries to a single body region nor for differences in severity across body regions. Considering the limitations in the risk adjustment in South African trauma centres the change from ISS to NISS is necessary in predicting outcomes.[52]

This type of rigorous data collection and analysis can be sustained by an ongoing electronic Trauma Health Record (eTHR). To this, an electronic Trauma Health Record (eTHR) has been developed and currently being implemented and used at our trauma centre since March 2014. This technology is enabling trauma clinicians to use low-cost, familiar devices to guide care, and to seamlessly gather pertinent trauma data with minimal or no disturbance of workflow and with little additional training. The collected data then can be wirelessly and securely uploaded to an electronic trauma registry for use by both injury prevention and trauma quality improvement programs.[60]

On the surface of this analysis, it seems like the volume, complexity and outcomes of trauma at GSH compare favourably with the world's best trauma centres. There is potentially a role for our trauma centre and other centres in South Africa, to participate in the global quality improvement program such as United Kingdom trauma audit and research network and American College of Surgeons Committee on Trauma's (ACSCOT) Trauma Quality Improvement Program (TQIP). Furthermore, local African benchmarking, risk adjustment, and quality improvement programs could also be developed to suit the local contexts.

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APPENDIX

UNIVERSITY OF CAPE TOWN

Department of Surgery

Departmental Research Committee
Professor Anwar Suleman Mall
J-45 Room Old Main Building, Groote Schuur Hospital,
Observatory 7925, South Africa
Tel (021) 406 6168/6232/6227 Fax (021) 448 6461
Email: Anwar.Mall@uct.ac.za

25th April 2013

Dr S Chowdhury
Department of Surgery
Division of General Surgery
Groote Schuur Hospital
University of Cape Town

Dear Dr Chowdhury

RE: PROJECT 2013/039

PROJECT TITLE: **A retrospective audit of Trauma Surgery at a Level 1Trauma Centre in South Africa**

The above proposal was reviewed by the Department of Surgery Research Committee and I am pleased to inform you that the committee approved the study.

Please use the above project number in all future correspondence.

Yours sincerely

PROFESSOR ANWAR S MALL
CHAIRMAN: RESEARCH COMMITTEE

Western Cape Government
Health

GROOTE SCHUUR HOSPITAL

Enquiries: Dr Bhavna Patel
E-mail : *Bhavna.Patel@westerncape.gov.za*

To: Dr A Chowdhury
c/o A/Prof Nicol
General Surgery
Trauma Centre
NGSH

E-mail: dr_smahmud@yahoo.com

Dear Dr Chowdhury,

RESEARCH PROJECT: A RETROSPECTIVE AUDIT OF TRAUMA SURGERY AT A LEVEL 1 TRAUMA CENTRE IN SOUTH AFRICA

Your recent letter to the hospital refers.

You are hereby granted permission to proceed with your research.

Please note the following:

a) Your research may not interfere with normal patient care
b) Hospital staff may not be asked to assist with the research.
c) No hospital consumables and stationary may be used.
d) **No patient folders may be removed from the premises or be inaccessible.**
e) Please introduce yourself to the person in charge of an area before commencing.
f) Please discuss the study with the Head of Surgery and Trauma before commencing.
g) Please provide the research assistant/field worker with a copy of this letter as verification of approval.
h) Confidentiality must be maintained at all times.
i) Your research may not commence until we have received your ethical clearance letter.

I would like to wish you every success with the project.

Yours sincerely

DR BHAVNA PATEL
CHIEF EXECUTIVE OFFICER
Date: 05 November 2013

G45 Management Suite, Old Main Building,
Observatory 7925

Tel: +27 21 404 3178/9 fax: +27 21 404 3121

Private Bag X,
Observatory, 7935

www.capegateway.go.v.za

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E52-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6338 • **Facsimile** [021] 406 6411
Email: shuretta.thomas@uct.ac.za
Website: www.health.uct.ac.za/research/humanethics/forms

29 November 2013

HREC REF: 440/2013

Dr A Chowdhury
c/o A/Prof A Nicol
General Surgery
Trauma Centre

Dear Dr Chowdhury

PROJECT TITLE: A RETROSPECTIVE AUDIT OF TRAUMA SURGERY AT A LEVEL 1 TRAUMA CENTRE IN SOUTH AFRICA

Thank you for your letter to the Faculty of Health Sciences Human Research Ethics Committee dated 26th November 2013.

It is a pleasure to inform you that the HREC has formally approved the above-mentioned study.

Approval is granted for one year until the 30th November 2014

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period. (Forms can be found on our website: www.health.uct.ac.za/research/humanethics/forms)

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC reference no in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN ETHICS
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.
The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

Subject:	Chowdhury : Confirmation of Approval of Study Proposal
From:	Jackie Cogill (jackie.cogill@uct.ac.za)
To:	dr_smahmud@yahoo.com;
Cc:	NCLAND004@myuct.ac.za; andrew.nicol@uct.ac.za; dianne.pryce@uct.ac.za; lorraine.mcdonald@uct.ac.za;
Date:	Wednesday, January 29, 2014 11:20 AM

Dear Dr Chowdhury

Candidature Approval (CHWSHA001)

Degree	MMed in Surgery
Title	A retrospective audit of trauma surgery at a level 1 trauma centre in South Africa
Department	Surgery
Supervisor	A/Prof A Nicol
Ethics Approval	440/2013

I am pleased to advise that the Chair of the Dissertations/Doctoral & Masters Committee has approved your candidature for the above degree on behalf of the Committee. Formal approval was obtained by publication in the Dean's Circular, PG-Med January 2014.

Yours sincerely

Jackie Cogill

Audit of Trauma surgery at GSH

Observer…… Date……

Patient Sticker

Name & Folder No……..

Age…… Sex: M / F

Time & Date of Injury ……

Mechanism of Injury : MVA- Driver / Passenger / Pedestrian / Motor Cyclist
Blunt Assault / Penetrating- Stab / GSW

Geographical Area of Injury……

Time of Emergency Service contacted……

Name of Emergency Service: Metro/ ER 24/ Net care / other……

Time of arrival at scene……..

Time Spent at scene (minutes): ……

Type of Transport: Ambulance / Private Vehicle/ Helicopter / other……

Referral from: CHC- Khayalitsha / Gugulethu / M'Plain / Hanover Park / other.....
Hospital- GFJ / NSH / VHW / other……..…

Time of arrival at GSH: ……..

Presenting Vitals:

P	BP	GCS	RR	T
HB	PH	Lactate	BE	

Triage Category: Yellow / Orange / Red

Injury Score: Head Neck 1 2 3 4 5 6 Face 1 2 3 4 5 6 Chest& Diaphragm 1 2 3 4 5 6
Abdomen 1 2 3 4 5 6 Extremity 1 2 3 4 5 6 External 1 2 3 4 5 6
(1- Minor, 2- Moderate, 3- Serious, 4- Severe, 5- Critical, 6- Maximal)

Score AIS…….. ISS…… NISS……

RTS…… TRISS……..

Investigations:

Diagnosis:

Surgery:

Indication for Surgery……..

Time of Booking for surgery……

Colour Code: Red / Orange / Yellow / Green

Time of Surgery……...

Reasons for Delay: Priority of cases / No theatre / No anaesthetist / No Nursing staff / No surgeon available/other

Type of Surgery:

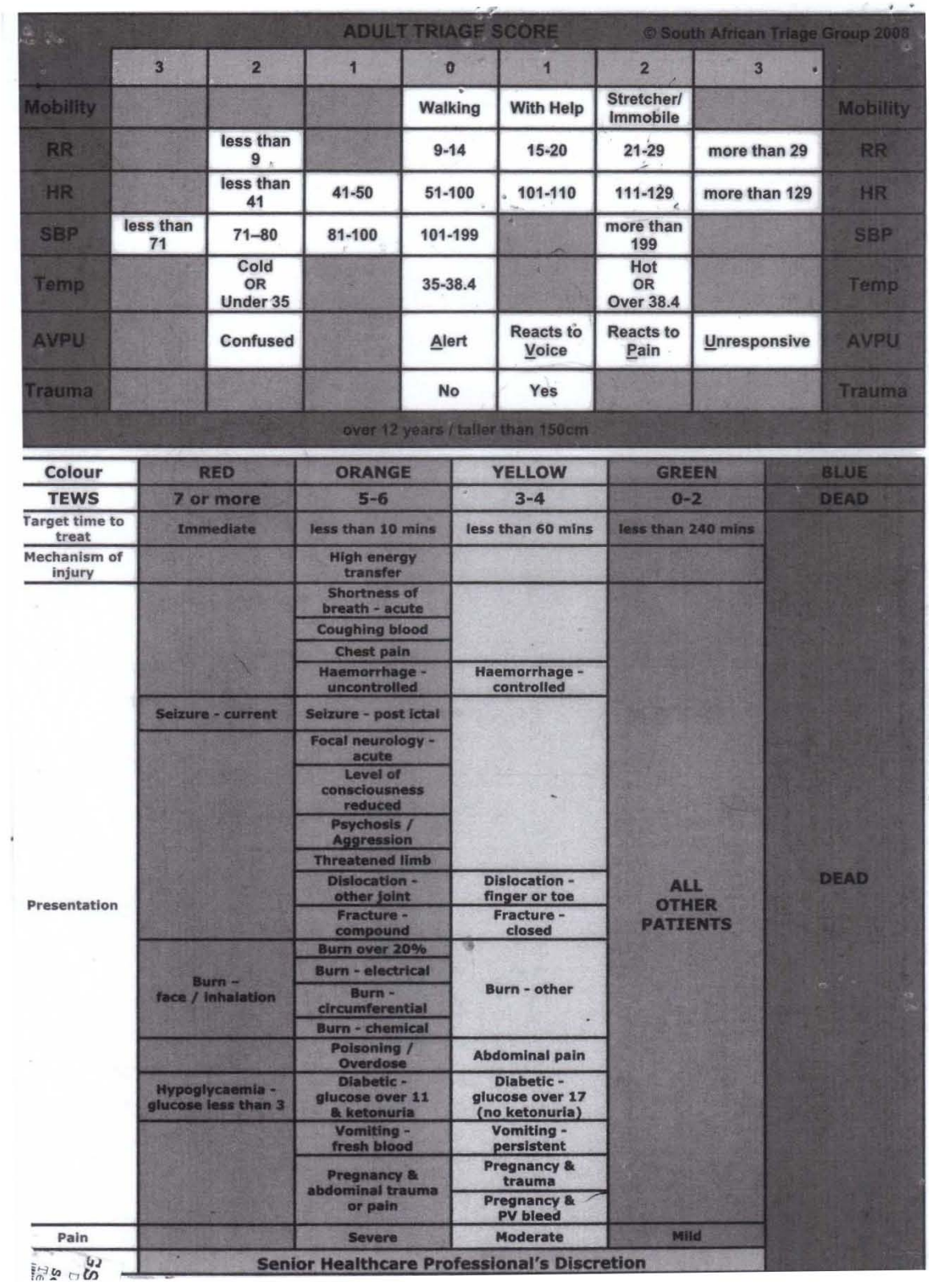
Operative Findings:

Complications: SIRS / Septic Shock / DIC / Resp Failure / AKI / Wound Infection / MOF / others .

Total ICU stay……... Ventilation (Days)……..

Total Hospital Stay: ……..

Outcome: Death / Discharge



ADULT TRIAGE SCORE © South African Triage Group 2008

	3	2	1	0	1	2	3	
Mobility				Walking	With Help	Stretcher/ Immobile		Mobility
RR		less than 9		9-14	15-20	21-29	more than 29	RR
HR		less than 41	41-50	51-100	101-110	111-129	more than 129	HR
SBP	less than 71	71–80	81-100	101-199		more than 199		SBP
Temp		Cold OR Under 35		35-38.4		Hot OR Over 38.4		Temp
AVPU		Confused		Alert	Reacts to Voice	Reacts to Pain	Unresponsive	AVPU
Trauma				No	Yes			Trauma

over 12 years / taller than 150cm

Colour	RED	ORANGE	YELLOW	GREEN	BLUE
TEWS	7 or more	5-6	3-4	0-2	DEAD
Target time to treat	Immediate	less than 10 mins	less than 60 mins	less than 240 mins	
Mechanism of injury		High energy transfer			
Presentation		Shortness of breath - acute		ALL OTHER PATIENTS	DEAD
		Coughing blood			
		Chest pain			
		Haemorrhage - uncontrolled	Haemorrhage - controlled		
	Seizure - current	Seizure - post ictal			
		Focal neurology - acute			
		Level of consciousness reduced			
		Psychosis / Aggression			
		Threatened limb			
		Dislocation - other joint	Dislocation - finger or toe		
		Fracture - compound	Fracture - closed		
	Burn – face / inhalation	Burn over 20%	Burn - other		
		Burn - electrical			
		Burn - circumferential			
		Burn - chemical			
		Poisoning / Overdose	Abdominal pain		
	Hypoglycaemia - glucose less than 3	Diabetic - glucose over 11 & ketonuria	Diabetic - glucose over 17 (no ketonuria)		
		Vomiting - fresh blood	Vomiting - persistent		
		Pregnancy & abdominal trauma or pain	Pregnancy & trauma		
			Pregnancy & PV bleed		
Pain		Severe	Moderate	Mild	
	Senior Healthcare Professional's Discretion				

Emergency surgical case categorization chart

Icon	Case Category	Parameters
Red	Immediate	Immediate life-saving operation, resuscitation simultaneous with surgical treatment e.g. resuscitative laparotomy, ruptured aortic aneurysm, threatened airway, cord prolapse, foetal bradycardia
Orange	Expedited	Operation as soon as possible after resuscitation (within 1 to2 hours) - e.g. ruptured ectopic pregnancy, leaking aortic aneurysm, cranial decompression, positive DPL in multiple trauma, threatened limb, emergent foetal concern
Yellow	Urgent	Operation within 6 hours of booking e.g. compound fractures, appendicitis, incarcerated hernia/intestinal obstruction, EUA for non-accidental injuries
Green	Emergent	Operation not immediately life or limb saving but to be done within 24 hours of booking e.g. ORIF of simple fractures, bleeding haemorrhoids, I&D abscess
Blue	Scheduled	Semi-urgent cases, to be done within 72 hours. Operation during in-hours on next available slate if possible

Clavien-Dindo Classification of Surgical Complications

Grade	Definition
Grade I	Any deviation from the normal course without the need for pharmacological treatment or surgical, endoscopic and radiologic interventions Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics, electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications Blood transfusions and total parenteral nutrition are also included
Grade III	Requiring surgical, endoscopic or radiological intervention
III a	Intervention not under general anesthesia
III b	Intervention under general anesthesia
Grade IV	Life-threatening complication (including CNS complications)* requiring IC/ICU management
IV a	Single organ dysfunction (including dialysis)
IV b	Multiorgan dysfunction
Grade V	Death of a patient

*Brain hemorrhage, ischemic stroke, subarrachnoidal bleeding, but excluding transient ischemic attacks.
CNS, central nervous system; IC, intermediate care; ICU, intensive care unit.