

CHAPTER 1

INTRODUCTION

*'And while they were in the field, Cain attacked his brother Abel and killed him. Then the LORD said to Cain, "Where is your brother Abel?" "I don't know", he replied. "Am I my brother's keeper?"'*Genesis 4:8b-9 (one of the earliest known trauma fatalities)

BACKGROUND INFORMATION

Trauma is a global problem and the leading cause of death in the developing world (WHO, 2009). By 2030, the World Health Organization (WHO) projects that the percentage of deaths from non-communicable causes in the developing world will be 70% and trauma mortality will increase by 40% (WHO, 2007b). In December 2010, the United Nations Organization declared this was 'the decade of road safety' in light of the projected mortality in the world. Low and middle-income countries are particularly badly affected by morbidity and mortality caused by non-communicable disease.

Few accurate statistics exist regarding the true extent of trauma in the African Continent; most statistics are projected figures. Large variability between countries exists, particularly regarding those nations suffering conflict and war. What of Zambia? No recent published trauma figures are available; some isolated studies have considered interpersonal violence and long bone fractures at the University Teaching Hospital (UTH) in Lusaka. It is thought that the prevalence of interpersonal violence in Lusaka is 20% (Odimba & Munkonge, 2002). The number of vehicles on the roads has increased exponentially in the last 5 years: this surely has implications regarding road traffic accidents in the capital city. Gun violence is rare in Lusaka and there are no armed conflicts within the country – yet a snap informal survey of the surgical wards at the UTH in 2010 identifies 75% of the in-patients as trauma victims (UTH, unpublished data). Morbidity and mortality at the UTH is discussed on a weekly basis, but specific trauma statistics have not been extracted as yet.

Trauma is a major public health problem worldwide, affecting high- middle- and low-income countries. The disproportionate burden of trauma in the developing world has been highlighted by the 2004 World Health Organization Global Burden of Disease Study: annual global unintentional injury accounts for 61 per 100 000 of the population, with road traffic victims making up the largest number of deaths. The

death rates and disability suffered by low-income countries is appreciably higher: 65 versus 35 per 100 000 and 2 398 versus 774 per 100 000, respectively (Chandran, et al, 2010). Trauma kills more people than malaria each year (Forjuoh, 2010); however, expenditure for tackling this problem remains minimal (Johnston, 2010; Ozgediz & Riviello 2008).

One of the challenges facing low- and middle-income countries (LMIC's) in addressing the burden of trauma is a paucity of data and research conducted in their local regions (Hofman et al, 2005). As such, it is difficult to assign finance, manpower resources, prevention and public health education strategies at a problem that is not quantified. Various authors have called for action in five core areas to address this: improve the collection of data regarding injury; identify the epidemiology of unintentional injury; calculate the cost of trauma; define public understanding of the causes of trauma and appoint policy makers to target prevention and control of trauma (Chandran et al, 2010, Hofman et al, 2005, WHO, 2007a).

The Quality Assurance (QA) movement in the United States of America (USA) drove the development of trauma registries. The QA viewpoint asserts that failures in medical care arise from systems failure rather than individual inefficiencies – an idea derived from Japanese industrial management models that are based on ‘statistical process control ... ultimately leading to quality improvement’ (Nwomeh, et al, 2006). The objective of any QA system is to improve care outcomes. A trauma registry allows for continuous monitoring of patients attending the hospital, the type of injury sustained and the outcome – i.e., a reflection of the care received. Thus, the epidemiology of disease, outcome evaluation and prevention of primary, secondary and tertiary injury can be understood. Information gathered through development of this trauma data will provide guidance on public health education programmes. It will also identify the key elements needed to implement a trauma system appropriate to the hospital concerned. ‘Improvement in trauma care in Africa and other developing parts of the world will ultimately depend on the establishment of functioning trauma care systems, of which a trauma registry is a key infrastructural component’ (Nwomeh, et al, 2006).

Useful tools in the clinical management and prediction of outcome in trauma patients are various trauma scoring systems: one of the earlier tools is the Trauma Injury Severity Score (TRISS); subsequent refinements have been made and the Injury Severity Score (ISS) and Revised Trauma Score (RTS) are the most widely used systems (Boyd et al, 1987; Champion et al, 1989 & 1990). A simplified scoring system was devised for the African setting, the Kampala Trauma Score (KTS – later revised to the KTS II). This score relies on similar parameters and has been validated in Uganda, Kenya, Ethiopia and Malawi (Kobusingye & Lett, 2000; Nwomeh et al, 2006; Samuel et al, 2009).

STATEMENT OF THE PROBLEM

The number of trauma victims presenting to the University Teaching Hospital in Lusaka is not recorded at a central point where the data can be examined and common causes and trends in mechanism identified. Worldwide, such data is collected by an instrument known as a ‘trauma registry’. No formal epidemiological study on trauma has been embarked upon in Zambia: various retrospective reviews have been undertaken, one looking at road traffic accidents and another a pilot study on trauma with emphasis on interpersonal violence (Emenalo et al, 1977, Mtonga & Zavala, 2008); no trauma registry exists as yet at the University Teaching Hospital in Lusaka. The number of victims of fatal trauma is unknown, as there is no focal recording point.

RESEARCH QUESTIONS

- What is the incidence, cause, risk factors, severity of injury, morbidity and mortality of trauma in a university teaching hospital (UTH) in Lusaka, Zambia?
- Does the KTS II perform as a predictor of mortality?

HYPOTHESIS

- The Kampala Trauma Score (KTS II) is a reliable predictor of mortality in trauma patients at UTH.

RESEARCH OBJECTIVES

The aims of this study are:

1. Design and implement a protocol for a trauma registry for the UTH in Lusaka, with a view to create a hospital-based injury surveillance system in Zambia.
2. Identify the epidemiology of trauma in a major centre over 6 months.
3. To establish clinically measurable risk factors for mortality (using the KTS II).

DELINEATION AND LIMITATIONS

This study does not evaluate clinical management directly: diagnosis, some hospital utilisation and limited outcomes are recorded within 30 days hospital stay or discharge or death, whichever comes first. The study has grouped data to facilitate interpretation, for example, age is broken down to 0 – 11 years, 12 – 20 years, 21 – 30 years, 31 – 50 years and above 50 years. As the major referral centre for the country, the University Teaching Hospital was chosen as the sole site of the study as it functions as the trauma centre for Zambia. It has neurosurgery, orthopaedic, urology, ear nose and throat, paediatric and general surgery units available, in addition to a well equipped radiology service where computerised tomography (CT), magnetic resonance imaging (MRI), ultra sound (U/S) and X-rays are available.

ASSUMPTIONS

The study assumes that most patients with trauma will present to the University Teaching Hospital due to the fact it is a referral centre with multi-disciplinary facilities available.

SIGNIFICANCE

The theoretical significance of this study is to derive a template for a trauma registry, starting at the University Teaching Hospital. When refined, other hospitals in the country can be enrolled to create a means of collecting trauma data for the region. Development of a trauma centre, public health education, equipment provision and personnel recruitment and distribution could be supplied to areas of prioritised need.

The ultimate objective of this research study is to establish the foundation for a trauma registry to ‘contribute to processes that improve care. An integrated, concurrent trauma registry provides an ideal information system for a performance improvement process, which is an essential requirement for trauma centers and systems’ (Nwomeh, et al, 2006).

DEFINITION OF TERMS

Data: Crude, isolated, unanalyzed measures that reflect the status or degree of a measured attribute of a component or system (NHTSA, 2006)

DALYs: Disability Adjusted Life Years

The sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability (WHO, 2013)

Epidemiology: the study of how often diseases occur in different groups of people and why. Epidemiological information is used to plan and evaluate strategies to prevent illness and as a guide to the management of patients in whom disease has already developed. Like the clinical findings and pathology, the epidemiology of a disease is an integral part of its basic description (Coggon, et al., 1997)

Injury:the result of an act that damages, harms, or hurts; unintentional or intentional damage to the body resulting from acute exposure to thermal, mechanical, electrical or chemical energy or from the absence of such essentials as heat or oxygen (NHTSA, 2002)

Injury prevention:efforts to forestall or prevent events that might result in injuries (NHTSA, 2002)

Kampala Trauma Score: (KTS II) Modified trauma score derived from other trauma severity scores in a study piloting a trauma registry in Uganda in the 1990’s, revised to KTS II in 2002 (Kobusingye & Lett, 2000; Mutooro et al., 2010)

Major trauma: that subset of injuries that encompasses the patient with or at risk for the most severe or critical types of injury and therefore requires a systems approach in order to save life and limb (NHTSA, 2002)

Mechanism of injury: the source of forces that produce mechanical deformations and physiologic responses that cause an anatomic lesion or functional change in humans (NHTSA, 2002)

Mortality rate: the proportion of deaths to population (NHTSA, 2002)

Quality assurance (QA): all activities that contribute to defining, designing, assessing, monitoring, and improving the quality of healthcare. These activities can be performed as part of the accreditation of facilities, supervision of health workers, or other efforts to improve the performance of health workers and the quality of health services (QAP, 2008)

Quality improvement: a method of evaluating and improving processes of patient care which emphasizes a multidisciplinary approach to problem solving, and focuses not on individuals, but systems of patient care which might be the cause of variations (NHTSA, 2002)

Quality management: a broad term which encompasses both quality assurance and quality improvement, describing a program of evaluating the quality of care using a variety of methodologies and techniques (NHTSA, 2002)

Surgical condition: one that “requires suture, incision, excision, manipulation, or other invasive procedure that usually, but not always, requires local, regional, or general anesthesia”. (This definition includes major obstetric interventions) [Luboga, et al, 2009].

Trauma: a term derived from the Greek for "wound"; it refers to any bodily injury (see injury) [NHTSA, 2002]

Trauma [care] system: an organized approach to treating patients with acute injuries; it provides dedicated (available 24 hours a day) personnel, facilities, and equipment for effective and coordinated trauma care in an appropriate geographical region (NHTSA, 2002)

Trauma registry: A trauma registry is broadly defined as a dedicated data repository for trauma patients (O'Reilly, et al., 2012)

[expanded definition]: 'Trauma registries are databases designed to document the acute phase of hospital care delivered to victims of trauma. Patients are included in the database according to specific inclusion criteria, usually based on a definition using the international classification of diseases (ICD). Trauma registries generally include information on patient demographics, the circumstances surrounding injury, pre-hospital care and transport, emergency department and in-hospital interventions received, anatomic injury description, physiological measurements, complications, outcomes and patient destinations. They also increasingly include information on pre-existing diseases, recognised as an important determinant of outcome, independent of age and injury severity. Trauma registry data are generally coded from the patient file by trained data abstractors using specialised software' (Moore & Clark, 2008)

Vulnerable road user: persons using public transport, pedestrians and cyclists (motorized and bicycles) [Johnston, 2010].

YLDs: Years Lived with Disability (WHO, 2013)

ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
AIS	Abbreviated Injury Scale
ASCOT	A Severity Characteristic of Trauma
BESG	Bellagio Essential Surgery Group
BID	Brought In Dead
BP	Blood Pressure
CGHD	Center for Global Health and Development
CNS	Central Nervous System

CRASH-2	Clinical Randomisation of an Antifibrinolytic in Significant Haemorrhage
CT	Computerised Tomography
CVA	Cerebrovascular Accident
GCS	Glasgow Coma Score
GI	Gastro-Intestinal
HIV	Human Immunodeficiency Virus
IATSIIC	International Association for Trauma and Surgical Intensive Care
ICD	International Classification of Diseases
ISS	Injury Severity Score
QA	Quality Assurance
KTS	Kampala Trauma Score
KTS II	Revised Kampala Trauma Score
LMIC	Low- and Middle-Income Countries
MI	Myocardial Infarction
MoH	Ministry of Health
MRI	Magnetic Resonance Image
MV	Motor Vehicle
MVA	Motor Vehicle Accident
NISS	New Injury Severity Score
PCR	Polymerase Chain Reaction
PNA	Pneumonia
P-value	the probability of obtaining a test number of statistical significance
ROC	Receiver Operating Characteristic
RTS	Revised Trauma Score
RTSA	Road Traffic Safety Agency
SAS 9.3	Statistical Analysis System (version 9.3)
TB	Tuberculosis
TRISS	Trauma Injury Severity Score
UK	United Kingdom
UN	United Nations
UNZAREC	University of Zambia Academic Research Ethics Council
U/S	Ultra-Sound
US(A)	United States (of America)

US\$	United States Dollar
UTH	University Teaching Hospital
VCT	voluntary counselling and testing
VS	versus
WHO	World Health Organisation
ZCAHRD	Zambia Center for Applied Health Research and Development

CHAPTER OVERVIEWS

Chapter 1: Introduction to the study, problem statement and research hypothesis. A short list of defined terms, the significance of the study, assumptions and significance are discussed.

Chapter 2: The Literature review. This chapter covers the scope of the problem of trauma, surgical provision in Africa, improving outcomes in trauma, trauma scoring systems, HIV and trauma and trauma research done in Zambia and sub-Saharan Africa.

Chapter 3: The Method. This chapter deliniates the research design, the methodology which will include the research instrument, the data collected in the context of the population that presented itself and some of the analysis methods. Limitations to the data set are explored, some ethical considerations discussed and a concluding statement.

Chapter 4: Research findings 1: Overview. Age and sex distribution of trauma and the most common causes of injury are presented and discussed.

Chapter 5: Research findings 2: Pre-hospital care and transport. Time of injury and time of presentation to hospital are analysed, as well as the method of transport used to get to UTH.

Chapter 6: Research findings 3: Road traffic trauma. The number of road traffic accidents, the vulnerable road user and safety measures are looked at in this chapter. Hospital utilisation and mortality specific to road traffic victims are also covered.

Chapter 7: Research findings 4: Hospital utilisation. This concerns the hospital resources consumed by trauma patients and a discussion of how services could be improved.

Chapter 8: Research findings 5: The Kampala Trauma Score II. The KTS II is tested for validity in Zambia. The research hypothesis is assessed (the KTS II with regard to mortality), and other variables are considered in relation to their KTS II scores.

Chapter 9: Research findings 6: The ‘brought in dead’ patients. The fraction of trauma patients in those brought deceased to the hospital is reviewed.

Chapter 10: Summary of findings and conclusions to the study. Summary of contribution to trauma research in LMICs. Future research suggestions are made.

Chapter 11: References

Appendix A: Data collection sheets

Appendix B: Study permissions: UNZAREC, MoH

Appendix C: Standard operating procedures for data collection

CHAPTER 2

LITERATURE REVIEW

INTRODUCTION

The problem of trauma is one faced world-wide. Its impact and mortality is higher in the developing world, with the trend set to continue unless urgent action is taken (Peden, 2004). Types of trauma include road traffic accidents, violence, fires, falls, drowning, poisoning, war and self-inflicted injuries (WHO, 2002). The current state of research and surgical services available in Africa is explored, as well as that of Zambia. Various strategies to improve the outcomes in trauma, as well as monitoring of trauma care are reviewed. Possible links between HIV and trauma are looked at. The spectrum of trauma care systems, including pre-hospital care, subsequent management and preventative measures are briefly considered.

THE SCOPE OF THE PROBLEM: TRAUMA

One out of every ten deaths in the world is due to trauma or injury, which equates to approximately 5.1 million deaths in 2010 (Lozano, et al., 2012). Trauma equates to sixteen percent of the worldwide burden of injury (WHO, 2008a). Developing (low and middle income countries – LMICs) have almost double the burden of trauma compared to high income nations (Taira et al, 2009). LMICs bear ninety percent of trauma mortality. The World Health Organisation (WHO) estimates that two of the five million fatalities are preventable with improved trauma care (WHO, 2009). There has been a growing awareness in recent times of the need to address the problem of ‘non-communicable disease’, particularly with regard to LMICs, as much of this category of disease is preventable (Marquez & Farrington, 2012; WHO, 2009).

Leppäniemi (2009), urges a fresh look at prevention and management of global trauma in the light of the ‘environment of trauma’ to deal with key issues. He lists world economy, natural disasters, climate change, armed conflict and global terrorism trends as factors for consideration when preparing for and dealing with injury and the issues that limit best clinical practice to all.

EPIDEMIOLOGY OF TRAUMA

“‘Major trauma’ is a generic term and different regions have different dominating injuries” (Søreide, 2009). Regional variations, such as the availability of firearms, the presence of armed conflict and use and availability of alcohol and drugs, as well as socioeconomic factors will dictate types and mechanisms of injury (Søreide, 2009).

Trauma can be divided into two categories: intentional and unintentional. Sources of unintentional trauma include: road traffic accidents, poisoning, fires, falls, drowning, and exposure to extremes in temperature and pressure, forces of nature and electrical current. Intentional injuries comprise those as a result of war, interpersonal violence and self-harm and were responsible for 1.6 million deaths in 2004. Suicide and interpersonal violence make up a quarter of trauma deaths; road traffic injury provides a further quarter. Interpersonal violence is linked to low income regions in Africa and is the second highest killer of men aged 15 to 44 years. Road traffic injury is the principal cause of trauma mortality worldwide (WHO, 2002; 2009).

As previously stated, more people are killed in road traffic injuries per year compared to malaria, specifically in the age group of 5 to 44 years. Without intervention, road traffic accidents will become the third leading cause of death worldwide by 2030, with 1.3 million deaths in 2010 (Lozano et al., 2012). The economic toll of road fatality is estimated to be over \$500 billion; LMICs suffer the estimated loss of \$65 billion, exceeding financial aid budgets (WHO, 2008a; Naci, et al., 2009). Lessening this financial burden will derive funds for use in development projects (UN Road Safety, 2010). A particular group of road users in low and middle-income countries has been identified as high risk ('vulnerable road users') and include those using public transport, pedestrians and cyclists (motorized and bicycles), which account for at least fifty percent of road user deaths (Johnston, 2010). The aim of the 'decade of road safety' is to reduce the death toll by five million and the number of seriously injured by fifty million worldwide (Commission for global road safety, 2009).

The outcome of trauma comprises both mortality and morbidity: thousands of trauma victims are left with permanent disability. The measure of the fallout is the 'disability-adjusted life year' or DALY, a measure that accounts not only for the years of life lost from premature death but also for the years of life lived with disability (WHO, 2002). Globally, twelve percent of DALY's are thought to be attributable to trauma (Joshi et al., 2004). Males have the highest loss of life as a result of trauma; the age group most affected is ages 15 to 44 (WHO, 2002). Trauma deaths comprise four percent of mortality in the under five age group (WHO, 2007b).

Mitigating factors contribute to the incidence and severity of trauma: one of the most

common is the use and abuse of alcohol and drugs. Drug and alcohol testing of trauma patients is routine in many centers in the United States of America (USA) [Smith, 2000]. Research evidence reveals that 40 to 50% of injured patients have raised blood alcohol levels on admission to Level 1 trauma centers, averaging twice the legal limit of most states (Rivara, et al., 2000). Concerns have been raised regarding the both the usefulness of this information – in most cases this does not change the medical care given to the patient and no treatment for substance dependence is offered – and the medical-legal implications for the patient, such as issues of confidentiality and consent (Warner, et al., 2003; Smith, 2000).

Alcohol appears to play a significant role in trauma in South Africa: 76% of all deaths due to interpersonal violence were alcohol related in 2000; inebriated pedestrians gave rise to 72% of non-paediatric pedestrian mortality (Goosen, et al., 2003). In Cape Town, Durban and Port Elizabeth, a cross-sectional survey of trauma patients (with above fifty percent presenting with violence-related injuries) revealed a range of 36 – 79% positive to alcohol breath-testing (Üddemann, et al., 2004).

HUMAN IMMUNODEFICIENCY VIRUS (HIV) AND TRAUMA

A further relevant condition in the African setting is that of HIV infection: seroprevalence of infection in major trauma patients in Johannesburg was found to be 37% (Bowley, et al, 2002). In Lusaka, Kehoe & Jellis (1994) found HIV prevalence in patients with fractures to be 32%. A more recent study done by Odimba, et al., (2007) demonstrated a prevalence of HIV at 44% in surgical patients at UTH. The reason cited for this high percentage is the demographic of the typical trauma patient seen at UTH, aged 16 – 35 years old, despite official figures that have the population prevalence for HIV in the 15 – 49 age-group at 16% (Republic of Zambia, 2006). Looking at outcomes Goosen, et al., (2003) commented ‘[i]t is accepted that HIV-positive patients suffer more septic complications, have a prolonged stay in all phases of hospital care, but the same rates of survival result for injured patients’. This was found to be the case at the University Teaching Hospital (UTH) in Lusaka (Odimba, et al., 2007). A study on outcomes and prevalence of HIV in trauma patients in the USA reiterated this finding: mortality rates were not different but an increase in pulmonary and infectious complications was present in HIV positive patients (Grossman & Stawicki, 2006).

There is some evidence that trauma patients do have a higher likelihood of being seropositive for HIV: a study in South Africa demonstrated prevalence in trauma patients to be 27% in survivors and 47% in non-survivors (Grossman & Stawicki, 2006). Figures from the USA reveal that trauma patients are more likely than the general population to be HIV positive (Morrison, et al., 2010). The reasons for this are most likely to be multi-factoral: higher risk-taking behaviour being the most apparent.

HIV testing and the medical, social and economic implications of a positive result, not to mention the stigma of the condition make communities reluctant to come forward for testing. In response to this, the Zambian National Acquired Immune Deficiency Syndrome (AIDS) Council proposed mandatory HIV/AIDS testing for all patients attending any health facility in 2004 (Inter Press Service, 2004). As a result, the Zambian government has proposed VCT (voluntary counselling and testing) be offered at all health facilities, whatever the presenting health problem, '(i.e. routine opt-out testing)' in 2005, a move that has vastly increased the number of tests undertaken (AVERT, 2010).

TRAUMA CARE SYSTEMS

Zong et al., (2011) has defined the trauma care system 'as a set of things working together as parts of a trauma care mechanism'. They include the involvement of government to facilitate successful implementation; clinical aspects such as public education, pre-hospital care, hospital care, rehabilitation and research as a means of auditing, monitoring and improving the system. The notion of approaching an injury victim in an organised, multi-centric way is the trauma care system in action, with evidence of improved outcomes in many countries (Kaczynski & Hilton, 2012). The entire spectrum of care is embodied, including the immediate action taken at the site of injury (basic and advanced care), the journey to the facility with the means of timely and appropriate management of the 'disease', followed by rehabilitation to the highest level of function possible. The 'trauma system care' includes trauma-specific research, training, public education and quality assurance measures (Kaczynski & Hilton, 2012).

In recognition of the problem of trauma, the World Health Organization's (WHO) sixtieth world health assembly urged member states to do the following (WHO, 2007a):

- “(1) assess comprehensively the prehospital and emergency-care context including, where necessary, identifying unmet needs;
- (2) to ensure involvement of ministries of health in, and an intersectoral coordination mechanism for, review and strengthening of the provision of trauma and emergency care; ...
- (4) in settings with a formal, emergency medical-care system, and where appropriate and feasible, to ensure that a monitoring mechanism exists to provide improved pertinent information and assure minimum standards for training, equipment, infrastructure and communication; ...
- (6) to identify a core set of trauma and emergency-care services, and to develop methods for assuring and documenting that such services are provided appropriately to all who need them; ...
- (8) to ensure that appropriate core competencies are part of relevant health curricula and to promote continuing education for providers of trauma and emergency care;
- (9) to ensure that data sources are sufficient to monitor objectively the outcome of efforts to strengthen trauma and emergency-care systems ...”(WHO, 2007a).

The trauma care system in the USA was born in a seminal paper produced by the National Academy of Sciences, entitled *Accidental Death and Disability: The Neglected Disease of Modern Society*, in 1966. The paper set in motion preventative strategies, organised pre-hospital care (basic and advanced), ambulance services, (including helicopter services, based on military experience), emergency departments, trauma research units, a tier-system of trauma units (that interfaced with intensive care facilities), as well as the development of trauma registries, rehabilitation facilities and autopsies of injured victims. The paper also considered medico-legal issues, disaster management plans and urged research into shock and trauma (National Academy of Sciences, 1966).

The Canadian experience, chronicled by Dr Evans (2007), describes a maturation of a trauma system over two decades, evolving from a purely clinical focus to a broader one: ‘trauma care used to be about removing ruptured spleens, it is now squarely

about system building, performance improvement, population-level outcomes-based research, injury prevention and public advocacy.’ Part of the evaluation and monitoring of the system is based on the data found in the National Trauma Registry of Canada. Canada’s largest province, Quebec, formed a trauma government advisory board, advocating a comprehensive plan of prevention of injury and long term disability, including issues such as vehicle speed limit, seatbelt and helmet legislation and optimal trauma care (Evans, 2007).

Tarighi, et al., (2012) in their paper designing a trauma system for Iran, advocated utilising a public health approach: incorporating regional needs assessment, involving agencies of health, engineering, humanities, media and human networks. They stress the need for integrated national leadership (with legal authority) to ensure pooling of resources, designating trauma centres and system development. A similar plea is made by Gore (2012) for a uniform, cohesive approach to deal with the high trauma burden found in India, a developing country with enormously variant levels of injury management and training and given the highest ranking of road fatality in the world.

Nathens, et al., (2004) makes the point that, faced with the enormous complexity and the high levels of ability and knowledge required to provide a successful trauma service, the powers that be base decisions on their personal bias and perceived needs, rather than any available evidence. Furthermore, there is little uniformity in the method of injury data collection within differing zones of the same country, let alone world wide. This had led to trauma systems lacking in verification of their approaches and questionable effectiveness. There is no question of a trauma system improving outcomes (MacKenzie, et al., 2006); but comparing one system with another is difficult, due to the myriad of governmental, organisational and population differences (Nathens, et al., 2004).

Europe describes improvement in trauma statistics (particularly in the Netherlands) attributable to public health measures, with only 25% achievable gains in tertiary care (Lansink & Leenen, 2012). A comparative study of trauma facilities, management and training in Europe, done a decade ago found enormous variability in services on offer, such as the training and speciality of the doctors caring for patients, to dedicated trauma centres, to the provision of helicopter services and the availability of

rehabilitative services. These differences were noted in countries of comparable economic status and similar populations and were found to range from ‘organised ... throughout with specialist training’ to ‘a haphazard and variable service’ (Uranüs & Lennquist, 2002). The trauma service in the UK has evolved from being a frontrunner (an ‘Accident Hospital’ was opened as early as 1942), to emulating the USA in introducing the Advanced Trauma Life Support in 1989 and opening regional trauma centres in the 1990’s (Kaczynski & Hilton, 2012; Nicholl & Turner, 1997). Some of the impetus for reorganisation was lost following the study by Nicholl and Turner (1997), which failed to show a decrease in mortality from the regional trauma care system. However, the National Confidential Enquiry into Patient Outcome and Death in trauma patients (2007) found 60% to have received less than optimal perioperative trauma management, a driver for change in the first decade of the 21st century in the UK (The United Kingdom National Audit Office, 2010). Data collection was problematic in that 60% of National Health Service hospitals that manage seriously injured patients provide statistics to the National Audit and Research Network; thus, 40% of hospitals’ data is unknown (Joseph & Pearce, 2012).

The situation in Africa is one of LMICs bearing 90% of the total global burden of trauma injury (Mock, et al., 2004) and having two percent of the world’s health workforce to deal with it (Ozgediz & Riviello 2008). Hardcastle & Brysiewicz (2012) make the point: ‘The greatest challenge to trauma care in South Africa and Africa is the development of appropriate trauma systems. There is a problem in ... trying to apply ... Developed World systems to Africa, where some entire countries have less specialists than would be needed to staff one Level 1 trauma centre’. They advocate involvement of many stake-holders, including the community, non-governmental organisations, the medical profession and government, urging a patient-centred approach, bearing in mind cost-effectiveness and management of expectations.

The International Association for Trauma and Surgical Intensive Care (IATSIC), in conjunction with WHO, formulated the ‘Essential Trauma Care Project’, aimed at improving the setup of trauma care, regardless of the economic status of the country involved. They provide compelling evidence to motivate for the establishment of coherent trauma systems: ‘panel reviews show an average reduction in medically

preventable deaths of 50% after the implementation of a system for trauma management. Likewise, population-based studies and trauma registry studies show a fairly consistent 15–20% or greater reduction in mortality for better organized systems, compared with either the same systems prior to improvements in organization or to other less organized systems’, (Mock, et al., 2004). Simple grassroots education measures can be effective: in Ghana, training taxi drivers in basic first aid improved pre-hospital care of the injured (Mock, et al., 2002).

Clearly an organised system of trauma management is necessary to improve outcomes of injury victims, requiring the involvement of the community, medical professionals, industry and traffic authorities, non-governmental organisations and government institutions.

EMERGENCY SURGERY IN AFRICA

Notwithstanding the fact that precise figures remain unknown, worldwide surgical conditions represent a probably massive workload, as it is thought two to three billion people (roughly one third to a half of global population) have no means of getting basic surgical care (Taira, et al., 2009). Trauma comprises the majority of the surgical conditions encountered in Africa, followed by obstetric complications (Ozgediz & Riviello, 2008). The Bellagio Essential Surgery Group (BESG), a multidisciplinary team of professionals with the aim of improving surgical services in Sub-Saharan Africa met initially in 2007 and again in 2008. Their consensus statement in 2008 is entitled “The crisis in surgical services in Africa”, a statement which speaks for itself. BESG have made several recommendations, underpinning them with the following statement: ‘The context guiding our recommendations is the lack of even the most basic surgical services in rural areas and small towns throughout Sub-Saharan Africa and our recognition of the broader role of surgery in strengthening health systems and fulfilling a basic human right to health care’ (Luboga et al, 2009). The theme of access to essential surgical services as a basic human right is echoed by Ozgediz and Riviello (2008) in their plea for greater funding and attention to be given to surgical conditions; they make the point that ‘despite a greater burden of disease, surgical conditions (except emergency obstetric care) are ... not included in the Millennium Development Goals’.

Despite 85% of road traffic accidents arising in LMICs and trauma related deaths in these areas 89/100 000 (contrast with 51/100 000 in high-income countries), pre-hospital care, management of the injury victim (including trauma surgery) is mostly unavailable, with inevitably poor outcomes. In a 2002 study, 12% of households in Uganda were found to have a disabled member as a result of trauma. In Ghana, more people died from trauma in urban areas than their rural counterparts; a higher number of disabled persons (as a result of trauma) lived in these areas (Taira, et al., 2009).

Some of the numerous reasons for injury wreaking a particularly destructive path in LMICs include health staff shortages – with two percent of the global health workforce residing in Africa to deal with 25% of the world's burden of disease – shortages of consumables and basic equipment that reduce well-trained staff to provide substandard care which they may find intolerable and ultimately leave as a result (Ozgediz & Riviello, 2008). In Malawi, with a population of 12 million, there was one Malawian general surgeon and one Malawian orthopaedic surgeon in the whole government hospital service in 2005. Of the two fellow trainees of the general surgeon, one left the country and the other was a victim of fatal road trauma (Lavy, 2005). Furthermore, the loss of the 'golden hour' due to poor infrastructure, such as un-paved roads, long distances and reliance on public transport with few emergency response vehicles leads to unfavourable outcomes. There is also lack of provision of both community and hospital-based emergency treatment. Compounding factors include a failure on the part of government to appreciate the effect of trauma on public health and poorly trained health professionals, particularly in the area of specialist trauma care (Hofman et al, 2005). An African professor, in his retirement address, suggested political will to improve standards in health care could be found if government officials (who make and administer policy) were obliged to use them themselves (and not be allowed to jet to a high-income country for medical treatment) [Lavy, 2005].

Whilst it is apparent that rural access to surgical services is lacking, the city-based trauma care may have room for improvement in Sub-Saharan Africa. A study at a university teaching hospital in Ghana found delayed fluid resuscitation, a lower than expected number of intercostal drain insertions and more than half of patients needing surgery were delayed six hours or more (London et al., 2001). The same study

pointed out that the trauma care and quality improvement measures they advocated were low cost, feasible and sustainable. The majority of LMICs do not have a formal system of emergency care and few, if any medical staff have specialized training in the pre- or in-hospital setting. The result of this shortage is significant delay in treatment, compounding poor outcomes. Frequently, conventional global standards of trauma management are ignored, even in large teaching hospitals (Hofman et al., 2005).

Surgical services in Zambia tend to be concentrated in the urban areas. Despite training programmes in postgraduate general, urology, ophthalmology and orthopaedic surgery, there remains a desperate shortage of surgeons in the country, with approximately 44 surgeons to meet the needs of 13 million people; only 6 of these work in rural areas (Bansal, 2012).

IMPROVING OUTCOMES IN TRAUMA

In the 1970's several key areas were identified to improve outcomes in trauma: prevention of trauma; more rapid and skilled transport of injured victims; better early management of primary brain injuries; more effective treatment of late complications of sepsis and multi-organ failure (Baker et al, 1980). According to Joseph and Pearce, (2012), addressing trauma requires a five-pronged approach:

- Improved data collection regarding trauma
- Identify the epidemiology of unintended trauma
- The financial drain caused by trauma
- Community awareness and identification of causes of trauma
- Commitment from government to employ avoidance policies and improve management of injury

Data collection

Compilation of accurate facts and figures (with the appropriate human resources to make rational conclusions) will allow for suitable resource provision. High income countries should be involved in helping LMICs to set up efficient trauma systems (Joseph & Pearce, 2012). Even in countries where trauma registries exist, data is

often only garnered from specialist trauma centres, with ‘nontrauma’ centres submitting no figures (Lansink & Leenen, 2007). If trauma is to be addressed as a national problem, a national data-base is imperative.

Epidemiology of unintended trauma

The type of trauma seen will depend on the demographics of the country under consideration (Lozano, et al., 2012). Increased risk of interpersonal violence include living in Africa or the Americas, access to alcohol and arms and concerted conflict, such as war. War is enabled by accessible firearms, social, political and financial disparity and unjust persecution of the population (WHO, 2009).

Financial considerations

The economic deficits caused by trauma are thought to equal one to two percent of the gross domestic product of the majority of nations when the price tags of productivity and treatment are accounted for (Joseph & Pearce, 2012). Patients with significant head injury and lower limb injuries cost the health system more than other types of injuries (Lanzarotti, et al., 2003). The areas of Africa and South-East Asia suffer more than 50% of the world disease burden and account for 37% of global population: only around two percent of world outlay in health resource is used in these regions (WHO, 2007b).

Community awareness and identification of causes of trauma

The World Health Organization has called for all countries to improve trauma care and prevention by collecting accurate data and implementing trauma care systems to improve outcomes (Johnston, 2010). Data is particularly difficult to garner from LMICs for various reasons: low levels of staffing, poor infrastructure and no budget with which to manage and gather statistics (Hofman et al., 2005). Evaluation of statistics gathered by WHO showed that best practice structures are found in only 29 of the 115 nations providing mortality numbers, embodying 13% of global population (WHO, 2007b).

Government commitment

A comprehensive trauma system requires a body with official authoritative power to implement the system, take responsibility and lead coordination and management

from national, regional and provincial levels (Tarighi et al., 2012). Lack of senior administrative funding and input into trauma care in China, for instance, has been identified as a pressing need to improve outcomes in injured patients in that nation (Zong et al., 2011).

The most frequent type of research looking at improved outcomes in trauma has centered around the effectiveness of trauma systems and dedicated trauma facilities. Evidence abounds regarding the improved mortality and morbidity associated with specialised trauma surgeons (Joseph & Pearce, 2012), and trauma centers – as opposed to non-trauma centers – resulting in a 25% lower mortality (Lansink & Leenen, 2007). There is a 15 to 20% decrease in mortality when a trauma system exists; patients with serious but potentially salvageable injuries are six times more likely to die in countries without an organised trauma system (Mullins & Mann, 1999; Lansink & Leenen, 2007; O’Reilly, et al., 2012). The trauma registry is a vital component of the trauma system, despite limitations in interpretation of the data, as the studies are population based and therefore classified as class III evidence (Lansink & Leenen, 2007). Some authors have called for more sophisticated studies regarding outcomes; looking beyond mortality and quality of life issues, such as the presence of pain, resumption of vocation and/ or studies and the rehabilitation requirements (Mann et al, 1999; Ardolino et al., 2012; Balogh et al., 2012).

The ultimate strategy to avoid poor outcomes in trauma is to prevent it altogether. Strategies include improvements in road safety, such as protecting the vulnerable road user from heavy goods vehicles, cars and motorised cycles by keeping the traffic streams separate; use of basic safety equipment, such as seat belts and helmets and enforcement of speeding laws (Joseph & Pearce, 2012;)

TRAUMA REGISTRIES

Moore & Clark, (2008) define trauma registries as ‘databases designed to document the acute phase of hospital care delivered to victims of trauma’. Information included can encompass patient demographics, conditions in which the injury was sustained (including transport and pre-hospital care), hospital management, severity of physiologic condition (including anatomical injury details), some in-patient data and outcomes (the most common being that of mortality) [Haider, et al., 2012; Moore &

Clark, 2008; Kobusingye & Lett, 2000].

Some limitations of trauma registries include disparities in definitions of inclusive criteria between regions, the lack of 'clean' data-bases and the fact that whilst there is a large body of data, studies conducted using trauma registries are not randomised clinical trials and should therefore be interpreted with a measure of caution (Lefering & Ruchholtz, 2012; Moore & Clark, 2008; Nwomeh et al, 2006). There remains, in the discipline of trauma, a need for quality indicators that are evidence based rather than best practice derived from expert consensus (Willis et al., 2007; Stelfox, et al., 2011).

Trauma registries in Africa are few and far between: it is unrealistic to expect the developing world to be able to implement a system requiring extensive health infrastructure and personnel skilled in data processing techniques. One of the most notable trauma registry projects was undertaken in Uganda in the late 1990's: a hospital-based trauma registry was devised for two hospitals, one an urban tertiary hospital, the other a district level hospital. A minimal data set was devised and a severity score appropriate to a resource-constrained setting validated – termed the Kampala Trauma Score (KTS). The Uganda data set was successfully piloted in Ethiopia and Egypt (Kobusingye & Lett, 2000). In latter years, this trauma registry was successfully extended to five large hospitals in Kampala (Nwomeh et al, 2006), Malawi and Tanzania (Mukhopadhyay, et al., 2009; Chalya, et al., 2012).

A trauma registry audit study undertaken in Ghana at an urban teaching hospital demonstrated that simple, cost-effective measures could be taken to improve care given to injured patients given the base-line data collected (London et al, 2001). A trauma registry study was undertaken at a referral hospital in Lilongwe, Malawi to determine the epidemiology of trauma in Malawi in 2008. One of the reasons cited for conducting the study was 'One of the first steps in addressing injuries in sub-Saharan Africa, including road traffic injuries, is solid data collection' (Samuel et al, 2009). The KTS was also used in this study. One of the recommendations from this study was 'that hospital-based surveillance efforts in low- and middle-income countries include not only prospective data collection in the casualty department (to inform primary and secondary intervention efforts), but also data collection on

hospital care and outcomes of admitted patients’ (Samuel et al, 2009).

TRAUMA SCORING SYSTEMS

The development of trauma scoring was originally aimed at pre-hospital care services to aid correct triaging of patients in the 1970’s (Senkowski & McKenney, 1999). Scoring systems are utilised by clinicians, academics and registries to classify trauma severity and thus influences the type of treatment and centre the patient receives and gives an idea of prognosis (Lefering, 2012). Trauma scoring systems have well documented limitations (Watts, et al.,2012; Moore et al., 2010; Chawda et al., 2004; Demetriades et al., 2001) and despite refinement of existing scores, introduction of new scoring systems (Honarmand & Safavi, 2006) and adjustment of predictions using statistical remodeling (Hannan, et al., 1997; Schluter, 2011b), the well known conventional scoring systems are still used in academic literature (Senkowski & McKenney, 1999; Lefering, 2012). The quality of a score depends on its ability to discriminate, its precision and its calibration (Lefering, 2012).

Summary of Scoring Systems

Table 2.1: Revised Trauma Score (Senkowski and McKenney, 1999)

Coded value	Glasgow Coma Scale	Systolic blood pressure	Respiratory rate
4	13–15	> 89	10–29
3	9–12	76–89	> 29
2	6–8	50–75	6–9
1	4–5	1–49	1–5
0	3		

Table 2.2: Abbreviated Injury Scale (AIS)[Senkowski and McKenney, 1999]

AIS value	Injury severity
0	No injury
1	Minor
2	Moderate
3	Severe (not life threatening)
4	Severe (life threatening, survival probable)

5	Critical (survival uncertain)
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Figure 2.1: Injury Severity Score (ISS)[Yates, 1990]

- (1) Use the AIS90 dictionary to score every injury
- (2) Identify the highest abbreviated injury score in each of the following six areas: head and neck, abdomen and pelvic contents, bony pelvis and limbs, face, chest, and body surface
- (3) Add together the squares of the three highest area scores

The best known scores, the Injury Severity Score (ISS) and the Revised Trauma Score (RTS) were used to devise the ‘TRISS’ method of predicting mortality (Senkowski & McKenney, 1999), which is used by most trauma registries in the US (Lefering, 2012). Further work was done to improve TRISS with the formation of A Severity Characteristic of Trauma (ASCOT) [Senkowski & McKenney, 1999].

As mentioned above, the Kampala Trauma Score (KTS) was developed in Uganda in 1996 as an appropriate score for low resource settings (Kobusingye & Lett, 2000). Further study demonstrated favourable performance when compared with RTS, ISS and TRISS (MacLeod et al, 2003 & 2007). The KTS was found to be comparable with the Revised Trauma Score (RTS), the Triage Revised Trauma Scores (tRTS) and Glasgow Coma Score (CGS) in a study looking at predicting mortality in an accident and emergency ward in a teaching hospital in Nigeria (Oluwadiya, et al., 2010). The KTS has since been updated to the KTS II in 2002 – the criteria remained essentially the same but the number score allocation changed. This has been validated with the New Injury Severity Score (NISS) [Mutooro et al., 2010].

Table 2.3: The KTS I & II (Kobusingye & Lett, 2000 & Mutooro et al., 2010)

		KTS I	KTS II
A	Age (in years)		
	5 – 55	2	1
	< 5 or > 55	1	0
B	Systolic Blood Pressure on admission		
	> 89 mmHg	4	2
	89 – 50 mmHg	3	1
	Equal or below 49 mmHg	2	0
	Undetectable	1	
C	Respiratory rate on admission		
	10 – 29/min	3	2
	30+	2	1
	< 9/min	1	0
D	Neurological status		
	Alert	4	3
	Responds to verbal stimuli	3	2
	Responds to painful stimuli	2	1
	Unresponsive	1	0
E	Number of serious injuries:		
	Nil	3	2
	Single	2	1
	Multiple	1	0

A + B + C + D + E = KTS Score

KTS I: Maximum score: 16; minimum score 5.

KTS II: Maximum score: 10; minimum score 0.

Lower scores correlate with worse outcomes.

TRAUMA RESEARCH IN ZAMBIA AND SUB-SAHARAN AFRICA

The BEG recommends ‘a research agenda to build the evidence to inform policy-makers’ (Luboga, et al., 2009) and suggest .. “quantification of:

- Burden of surgical disease, particularly at the country level.
- Need for, access to, and outcomes of surgical care; and of disparities in these indicators between socioeconomic groups and populations living in urban and rural areas.
- Iatrogenic expenditure related to surgical care. Since the economic consequences of having a major operation may be substantial, health financing strategies that minimize this economic burden need to be developed.
- Availability and use of surgery-related resources such as human resources, equipment, and supplies.
- Coverage, quality, and effectiveness of interventions to strengthen the delivery of essential surgical services”.

Finding research data pertinent to Africa is a challenge: Hofman, et al., (2005) suggest one reason for this is that ‘clinicians who might otherwise participate in research efforts are overwhelmed by the burden of infectious diseases and struggle to provide high-quality care in facilities lacking basic equipment and supplies. They have neither the time nor the training that would enable them to effectively participate in research’. Most papers regarding trauma in Africa mention ‘sketchy data’ and suggest estimates rather than precise figures but Hofman, et al., (2005) makes the point that governing bodies and stakeholders in health will not be able to acknowledge trauma as a significant public health issue unless facts and figures are available. A key factor in the lack of research is available funding. In 2007/8, of the US\$300 million spent on donor-supported health projects in Uganda, only 2 out of 111 partially supported regional hospital services. ‘US\$85/Disability-Adjusted Life Years (DALY) is spent on HIV research compared to only US\$0.50/DALY for injury research’ (Ozgediz & Riviello, 2008; Lavy, 2005).

Whilst it is doubtful that figures from South Africa (credited as one of the most violent peace-time countries in the world) could be applied to the rest of Africa, more data is available from this country. Figures in 1996 suggest 23% of male and 10% of

female mortality was due to external violence. A one-month survey in 1999 regarding non-fatal injuries presenting to casualty revealed that 55% were due to violence, 29% were accidents and 16% due to road traffic accidents (Goosen et al., 2003). Regarding penetrating injuries, a multidisciplinary approach, aggressive resuscitation and early operative exploration are keys to survival (Bowley et al., 2002). Perhaps more surprisingly, in one of the few African countries with organized pre-hospital trauma services, a 3.7-fold increase in mortality following penetrating injury was found in ambulance transported patients as opposed to privately transported victims (Dickson et al., 2007).

Little research in trauma has been undertaken in Zambia: a pivotal incident, a train crash in Kalomo, raised the issue of trauma and disaster response in the country in the 1990's (Odimba, 1996). Professor Odimba did a retrospective descriptive comparative study on trauma presenting to UTH, a hospital in Mauritania and one in the Democratic Republic of Congo over a twenty-year time period (1986-2006). It found the highest contributing cause of trauma was road traffic accidents, followed by assault. It took patients an average of five days to get to hospital (Odimba, 2007). UTH contributed to a recent study done on the effects of tranexamic acid in trauma patients (CRASH-2, 2010). A study done in the 1970's regarding road traffic accidents suggested that there were higher fatalities per car on the road compared to Europe and higher fatalities per injured person compared to neighbouring countries (Emenalo et al., 1977). Official figures show an almost three-fold increase in the number of vehicles on the road in Zambia from 2004 to 2008; the number of fatalities per 10 000 vehicles stands at 45 for 2008. This indicates a reduction of approximately 44% since 2004 (RTSA, 2009) but nevertheless remains unacceptably high – fatality per 10 000 vehicles in the USA was around 1.7 in 2006 (Lagarde, 2007).

A pilot study done 30 years after Emenalo et al., compared injuries presenting to major hospitals in five different African countries and found approximately 49% were due to road traffic accidents, a further 49% due to interpersonal violence and around two percent as a result of self-harm. Zambia was included in the study, featuring UTH in Lusaka. Out of the five countries surveyed (Democratic Republic of Congo, Nigeria, Kenya, Uganda and Zambia), Zambia was recorded as having the highest

number of casualties, accounting for almost half the figures gained for the study. The high rate of casualties recorded may be due to data collection errors (admitted by the investigators to be highly likely) or Zambia may, in fact, suffer a high trauma rate. A further study is needed to verify or refute these previous findings. Furthermore, the focus of the study was looking at interpersonal violence and road traffic injuries and little in-patient data was collected (Mtonga & Zavala, 2008). A study done in 1998 at UTH reviewed alcohol abuse in road traffic accident victims over a one-month period: blood alcohol levels were measured from 100 victims (of a total of 345). The study found that 58% of the victims tested positive for alcohol levels of above 80mg/dL (Mulundika, 1999).

A descriptive cross sectional study of violent injury in Zambia undertaken approximately ten years ago by Professor Odimba and Professor Munkonge (2002) found an annual prevalence of 13% for the country, with over 20% prevalence for Lusaka alone. Unpublished data from UTH reviewing mortality in the Department of Surgery for the first three quarters of 2009 shows 39% of surgery patients having perished was as a result of trauma. Further disaggregation of this data indicates a 44% mortality resulting from burns, 39% from road traffic accidents and 17% from injury (including accidents, interpersonal violence and self-harm) [UTH, 2009].

LITERATURE REVIEW CONCLUSION

It is clear that trauma is a significant burden in the developing world and Zambia is no exception (Zavala et al., 2008). Whilst courses in the delivery of trauma care are run on an annual basis at UTH and open to health professionals nation-wide, there is no scheme in place to measure the effectiveness of such training. No system exists to measure the exact number of patients presenting with trauma, the cause of such trauma and mitigating factors such as alcohol abuse or HIV prevalence. No structure is in place to assess care given to trauma patients specifically (all surgical patients are included in monthly audits but this does not identify precise aspects of presentation, exact mode of injury, time to theatre etc). There are no baseline figures to plan provision of trauma services (staffing levels, disposable equipment and bed numbers) or to appreciate improvement or decline in management of trauma patients. There is no widely available, organised pre-hospital care service, including trained paramedics and an emergency number to call for such an appropriately equipped ambulance or

rescue service within Zambia. Without accurate data, public awareness, education and national health planning on the prevention of injury is difficult.

With this background and the call from various bodies to strengthen research endeavour in Africa (Luboga et al., 2009; WHO, 2007a; Hofman et al., 2005), it is clear that a trauma registry at UTH is needed. The trauma registry developed during the proposed project will provide baseline statistics with which to assess the types of trauma, causes and groups affected in Zambia. Quality of care and areas of improvement will be identified through the trauma data collected and public health and awareness programmes may be focused on specific areas of concern.

Regarding the collection of trauma data, Zavala et al., (2008) faced challenges gathering information in five African countries that are common to many other developing countries, the main one being low staffing levels in emergency departments. Kobusingye & Lett made a similar observation in 2000: "In sub-Saharan Africa, most hospitals are understaffed and even basic record keeping is given a low priority ... Data collection done by individuals with clinical responsibility should not be burdensome". The situation is unlikely to improve with the recent global economic downturn and the constant challenge of keeping health care costs low. These factors have to be taken into account when designing a trauma surveillance data sheet: it should be straightforward, take minutes to complete and it would be useful if a simple trauma score were included. The KTS II, piloted in Kampala, is a possible assessment tool that could be utilised (Kobusingye & Lett, 2000). The best outcome envisaged for this study is that a trauma data sheet and registry (database) could be a standard permanent fixture at UTH in order to allow ongoing audit and thus continuing improvement in provision and quality of trauma care.

CHAPTER 3

METHOD

INTRODUCTION

The study purpose was to develop a frame-work for a hospital-based trauma registry that would establish the epidemiology of injury at a major centre in Zambia. The study method, therefore, was designed to identify the incidence, cause, risk factors, severity of injury and morbidity of trauma in a university teaching hospital in Lusaka,Zambia. The data set included means of transport to the hospital; a limited spectrum of hospital utilisation; alcohol use; mortality of trauma patients and the KTS II score for all captured patients.

Overview of chapter

Research design; its advantages and disadvantages. Methodology, including research instrument used, with its design, the three sections of the data collection tool, the purpose, reliability and validity of the tool. The data collector training and equipment are discussed, as well as the data management team responsibilities. The handling of the data sheets is detailed and the strengths and weaknesses (including any potential biases) of the data are mentioned. A brief mention of the statistical analysis of the data is made. Limitations of the study are stated. The ethical considerations regarding the study population are discussed and the chapter concluded.

RESEARCH DESIGN

Two research questions were proposed: the first, to discover the incidence, cause, risk factors, severity of injury, morbidity and mortality of trauma in a university teaching hospital (UTH) in Lusaka, Zambia. To answer this, a prospective observational cross-sectional study was undertaken, using a specifically designed data collection tool. The population recruited was all first presentation trauma patients attending UTH casualty in Lusaka over a six-month period. The second question centered around a contextual trauma scoring system, the Kampala Trauma Score (II): does the KTS II perform as a predictor of mortality? To facilitate answering this question, the KTS II was calculated for each patient. A limited follow-up of 30 days was instituted for all admitted patients. Previous studies have instituted a 14-day follow-up period (Kobusingye & Lett, 2000; MacLeod et al., 2003 & 2007; Mutooro et al., 2010).

Advantages of Study Design (Levin, 2006)

- Relatively inexpensive
- Able to be undertaken in a six to eight month time frame
- Convenience sampling: all patients presenting with trauma to UTH (for the first time) were recruited during the study period
- Prospective data collection: data collected in real time with the specific objective in mind
- A wide range of demographic data and outcomes were assessed
- Trauma aetiology assessed
- Constructive for public health planning
- Helpful for proving or disproving hypothesis

Weaknesses/ limitations: (Moore & Clark, 2008; Levin, 2006)

- Population-based study, not as strong as a randomised control trial (type III evidence when used in comparative studies)
- May not be applicable to entire country
- Some of the Lusaka trauma population not counted (patients who shunned government hospitals: consulting traditional healers and/ or the private sector)
- Study done during the summer rainy season: may have missed some of the trauma population, particularly burns injuries that are more prolific in the winter months.

METHODOLOGY

Research Instruments

Design

Factors considered during data set design: valid and reliable parameters that would not prove too difficult or time-consuming to collect (Nwomeh, et al., 2006). No codes were assigned to the data set as the data was collected using pen and pre-printed sheets as opposed to a computerised input system within the health facility (the data sheets were later scanned into a data reading computer program). This research undertaking followed the Ugandan registry study, using the International Classification of Disease (ICD) codes as a guide, with some diagnoses simplified and minimised to keep the data collection simple and straightforward (Kobusingye & Lett,

2000). In common with trauma registries of high income countries, the data set included demographic details, mechanism of injury, physiological measurement, radiology undertaken, hospital resource use and patient disposition (Nwomeh, et al., 2006). This data set also included some information on patients that were dead on arrival to hospital.

The data collection tool was divided into three sections: (1) the trauma data sheet which captured the patient demographics, the scene of injury, the means of getting to hospital, anatomic area of injury and a KTS score; (2) a hospital utilisation sheet which was applied to admitted patients and documented their final diagnosis, a limited data set of the hospital services consumed and final disposition (within 30 days) and (3) a 'brought in dead' sheet, a simple snapshot of patients deceased on arrival to hospital: the percentage of those who perished as a result of trauma from the total was captured in this data set.

The trauma data sheet

Much of the trauma data sheet was based on the original data sheet designed for the seminal trauma registry study done in Uganda (Kobusingye & Lett, 2000). The WHO 'decade of road safety' (Johnston, 2010) influenced the data collection surrounding road traffic accidents: this section was expanded to include child restraints, seat belt use and the motor vehicle involved; the patient role in traffic was included and number of fatalities on scene. In keeping with the Ugandan design, the KTS was an integral part of this data sheet. This sheet also documented if the patient was admitted or not.

Hospital Utilisation

In keeping with other trauma registries (Haider, et al., 2012) outcomes and facilities used in the hospital were accounted for in this form. This included if the patient attended theatre (operating room), received a blood transfusion, underwent radiological testing, developed septic complications and if he or she was tested for HIV infection. The disposition of the patient was recorded: if they were discharged, still in hospital, left against medical advice or died. The initial and final diagnoses were recorded.

Brought in Dead

This data set included an expanded section on trauma (particularly road traffic detail), demographic detail and a section for non-trauma death.

Purpose

A specific but simplified data set was collected to form the basis of a future trauma registry for Zambia. The KTS II data set was assembled in order to validate the KTS II in Zambia.

Reliability and Validity

Similar instruments have been utilised in the US since the early 1970's with the UK, Canada, Europe and Israel following suit in the 1980's and 1990's, and have been influential in improving trauma standards of care and outcomes (Moore & Clark, 2008). Various countries in Africa (Uganda, Ethiopia, Egypt, Malawi, Kenya, Nigeria and South Africa) have instituted several attempts to institute trauma registries with comparable data tools, but face many obstacles, including staffing and funding issues to maintain them (Kobusingye & Lett, 2000; Nwomeh, et al., 2006; Samuel, et al., 2009; Hardcastle & Brysiewicz, 2012). Follow-up studies where such instruments have been instituted have demonstrated an improvement in mortality (Demyttenaere, et al., 2009).

Data Collector Training

Data collectors were recruited from UTH nursing staff (primarily from the casualty department) who volunteered for the study. The positions were advertised by word of mouth and posters and a small payment was made for each shift. The volunteers who signed up for the study attended a mandatory training session of 6 contact hours. Completion certificates were issued and only persons in possession of these were able to collect data on behalf of the study. Two training sessions were held over the course of the study period to recruit sufficient data collectors. A data manager was appointed to ensure the entire 24-hour period of the study was covered, in a shift system, with the data collectors 'booking' shifts in advance. A back-up staff member would be contactable, should the original person be indisposed.

The data training consisted of a presentation about the research, its goals and purpose. A training session on the ethical implications of being part of the research study was given by an individual not involved in the particular study (with a 'completion of ethics training' certificate given to all participants). The data sheets were presented and a line by line instruction on a standardised approach to data completion was given. Each participant was given an information pack containing standard operating procedures for the study and a job description for each shift. Details were given on how to store completed data sheets to ensure patient confidentiality and security of data.

Data Collectors Equipment

The data collector team were supplied with pens, data sheets, stickers to earmark patient charts (for the 30-day follow-up), stapler and automated blood pressure machine for taking vital signs (for the KTS scoring) and an alcohol breathalyzer device (with disposable mouth-pieces). They were also supplied with a research uniform when on shift: this ensured a professional appearance whilst making it clear they were not regular casualty staff. Permission was granted for secure storage boxes to be installed in the casualty area to store the data sheets: these were clearly labeled as to which sheets should be stored in which box. The box was designed as a type of 'post box' with a slot to place the data sheet and a padlock secured the box closed. The lock combination, known only to the data management team, was used to open the box to collect the data sheets.

Data Management Team

The data management team were recruited from nursing and medical student populations. The data manager was responsible for the data collectors' rota and assisted the principal researcher in ensuring there were sufficient forms, that the data forms were correctly labeled with the research numbers and individual sheets correctly attached and that the electronic devices (BP machine, breathalyzer) had working batteries. The medical students were responsible for following up the admitted patients and collecting data for the 30-day follow-up window. The team ensured that the completed data forms were collected from their secure storage boxes and distributed to the correct sites thereafter. In the latter stages of the study, some

ward clerks were recruited to help track down follow-up patients' notes in order to complete the hospital utilisation sheets.

Data Management Meetings

The data management team meetings consisted of the principal researcher, the co-supervisor, the management team from the hospital and the data management team volunteering from the Center for Global Health and Development (CGHD), Zambia Center for Applied Health Research and Development (ZCAHRD) and a volunteer from Mercy Flyers. These volunteer data managers took responsibility for scanning the data forms, 'cleaning' the data and initial statistical analysis. The meetings were held on a weekly basis for the duration of the study to ensure that problems and difficulties were addressed and that the data collection was proceeding smoothly.

Data

Data Cover Page

All patients recruited into the trauma study had a 'cover page' completed, which recorded the date and time, the patients' name, hospital number and research number. The purpose of this frontsheet was to be able to trace the patient and file at a later date, should further research be conducted on this cohort of patients. With these sensitive identifying details, these sheets were treated with special caution. They were detached from the rest of the data sheets and stored in their own clearly labeled secure box in casualty. These forms were collected by the principal researcher and stored at a secure site at the Mercy Flyers office, a separate site to the rest of the data sheets.

Data Sheet Management

The trauma data sheets were collected by the principal researcher or another member of the data management team and deposited at the ZCAHRD premises, where they were scanned into a computer (Teleform, version 8) and then stored in a secure filing cabinet. The data management team cross-checked any queries produced by the computer program (i.e., if the computer was unable to read a box that had been too lightly checked) and manually in-putted misread data to ensure that the data set was as complete as possible. Some data had to be physically entered, as demographic details such as village or suburb were hand-written on the form; there were also a few

areas where a written note could be entered if the option on the form did not match the patient's circumstance.

The hospital utilisation forms were deposited in the secure box once completed, as were the 'brought in dead' sheets. These were scanned and securely stored and the data cleaned in the same way as the trauma data sheets.

Data strengths

A minimal sample size was calculated to ensure data validity, which was found to be 246 (see calculation in figure 1 below). The total number of patients collected was 3425. This has ensured a sufficient sample from which to draw conclusions. The data was entered and cross-checked by a team separate to the collection team, which helped to maintain objectivity. No breaches of confidentiality were known to have been made. There were no complaints or concerns raised by third parties to the study.

Data weakness

As with any research study, the data set is not perfect. There were occasional lapses in completing some of the data sets (such as the KTS). There was a random loss of data in the in-patient cohort of the study despite adequate systems in place to follow these patients (many individuals did not surrender their in-patient file to the hospital system and took it home with them). There is no easily accessible comparable data set in with which to compare the findings of the study in Zambia.

Figure 3.1: Minimal Sample Size Calculation

$n = \frac{t^2 \times p(1-p)}{m^2}$	n = required sample size
	t = confidence level at 95%
	p = estimated prevalence
	m = margin of error at 5%
$n = \frac{1.96^2 \times 0.2(1-0.2)}{0.05^2}$	
$n = 245.86$	

(Prevalence estimated from study undertaken by Odimba & Munkonge, 2002).

Analysis

Trauma Registry Analysis

The computer program used for data analysis was SAS 9.3. Cross tabulations were produced of the nominal variables with numbers and percentages calculated to depict:

- the basic overview of the data
- top four injury causes for each age group
- falls by injury setting
- hospital utilisation by demographic data and cause of injury
- child restraint in traffic accidents
- patients brought in dead
- alcohol use and type of trauma suffered
- hospital utilisation associated with type of trauma

Cross tabulations were produced to describe the most common mechanisms of injury (by gender and age); and most common modes of transport to the hospital and time taken to get there.

KTS II Analysis

A Microsoft excel sheet was created to analyse the KTS II scores, using descriptive statistics to calculate the mean score, the standard deviation and the corresponding p values. Receiver-Operating Characteristic (ROC) curves have been calculated for the KTS II, with sensitivity, specificity, positive predictive value and negative predictive values included regarding the KTS II and:

- mortality
- hospital admission
- surgery performed
- blood transfusion given

LIMITATIONS

Patients excluded from the study

Trauma registries in many developed countries include that of acute poisoning (NTDB, 2009). Patients presenting with acute poisoning are often admitted to the medicine department at UTH: as the focus of this study centers on admissions to the

surgical department, these patients were excluded from the study. Victims of sexual violence are usually referred directly to the obstetrics and gynaecology department and were therefore also excluded from the study.

Possible omissions to the study

The study was biased toward the 'walking wounded': due to the layout of the casualty area, it is suspected that occasionally, seriously injured (polytrauma) patients were admitted to UTH without being captured within the trauma data set. To explain, study data collectors were stationed in casualty, collecting data on patients with minor injuries, whilst the critically injured patient would undergo resuscitation in a 'resus room' (separate from casualty) and then be transferred straight to theatre or intensive care. This group is not well represented in the data set as a whole (and are not reflected in the loss rate in the hospital utilisation cohort). Although breathalyzer testing was done, it relied on verbal consent of the patient and it was not done if there were many patients waiting to be included in the study. The 'brought in dead' data may contain some omissions as the casualty work was prioritised over this data.

ETHICAL CONSIDERATIONS

Permission to undertake the study was requested from the University Teaching Hospital, Lusaka (via the Graduate Forum platform administered by the University of Zambia) and the Ministry of Health (Ref: MH101/17/6). These permissions were granted. Approval was sought from the Biomedical Research Ethics Committee. The Research Ethics Committee was petitioned to forego individual written consent forms for this study for the following reasons:

- patient care was not affected directly by the study
- it was an observational study with no interventional arm
- information regarding individual patients was anonymised. During data collection, a unique identifier (study number) was assigned to each record and the patient name was not included within the database
- trauma epidemiology studies undertaken in Uganda, Ethiopia, Egypt, Malawi and the United States of America did not obtain informed written consent from patients (Kobusingye & Lett, 2000; Samuel et al., 2009; Champion et al.,

1990)

- the research project was intended to build a frame-work for deriving a long-term quality improvement tool to improve trauma care within the hospital and to identify targets for public health interventions
- the standard opt-out permission for HIV testing (Republic of Zambia, 2005) was undertaken.

Permission for the study to proceed was granted, together with a waiver of written consent forms (Ref: IRB00001131 of IOR G0000774).

Permission from the Research Ethics Committee was sought (and granted) for the duration of the study to perform alcohol breathalyzer testing on all trauma patients presenting to casualty who gave the data collector verbal permission to do so. When alcohol testing was done previously on trauma patients in UTH, verbal informed consent was gained for blood alcohol testing on volunteers (Mulundika, 2009). Whilst not done routinely in Zambia, it is standard procedure to test alcohol levels in trauma patients without consent in other parts of the world (Rivara et al., 2000, Warner et al., 2003).

Consideration was given to the fact that minors were included in the study: again, data regarding individual patients was anonymised and medical care unaffected; alcohol testing was not performed on minors but HIV testing was offered to in-patients.

The data sheets were handled in a manner to optimise confidentiality and security of data. No identification of specific individuals is possible in the final presentation of the data.

CONCLUSION

This was a descriptive cross-sectional study: as there was no intervention, an informed written consent waiver was petitioned for (and granted) and no randomisation was required. Training specific to the data collection tool was given to ensure uniform data collection. No advanced research knowledge and skills were required to complete the data collection, and a dedicated data collector team was

recruited. The data set was collated from previous studies (Kobusingye & Lett, 2000; Nwomeh, et al., 2006) with some region-specific criteria added. Data security and confidentiality was maintained. The KTS II is a previously validated scoring system appropriate to the research setting, which may be found to be beneficial. This study provides data recognised by the Ministry of Health as being relevant and important for decision making in health policy in Zambia (see Appendix B).

CHAPTER 4
Research Findings 1:
OVERVIEW

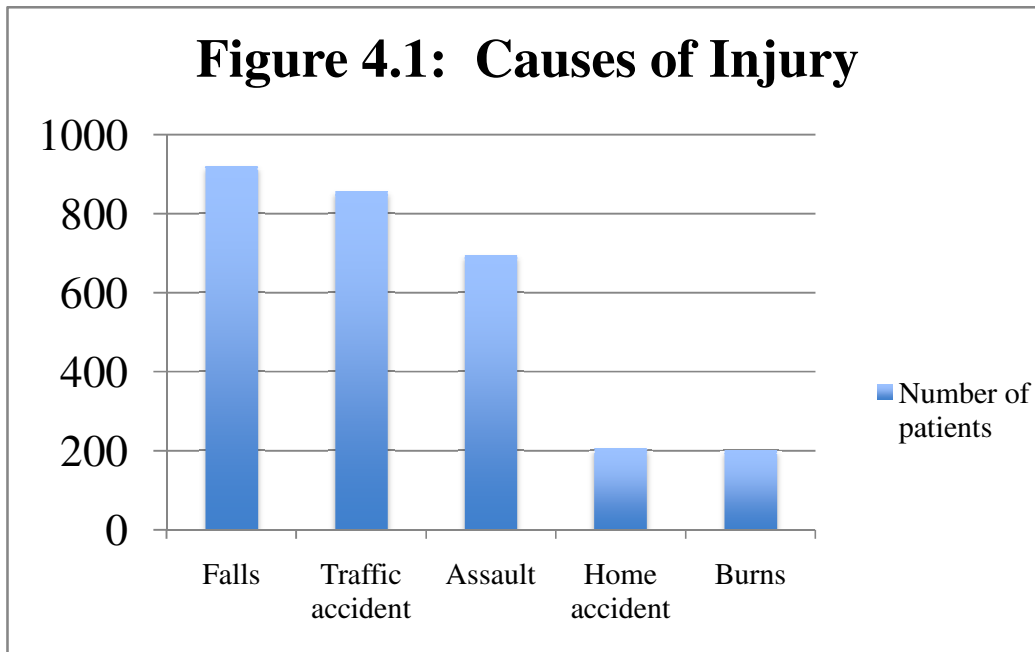
INTRODUCTION

The study results cover a wide range of potentially useful data as a protocol for a trauma registry. This chapter is broken down into an overview covering sex and age of the trauma population, the most common causes of injury and how different trauma affects the various age groups. A short analysis and subconclusions of this data set is made.

OVERVIEW OF RESULTS

As stated in the previous chapter, 3425 patients were captured in the study. 2453 patients were male (71.6%) and 963 were female (28.1%) [0.3% missing data]. These findings are in keeping with the Ugandan registry study, where 71.3% were male and 27.7% female (in a population of > 5000) [Kobusingye & Lett, 2000]. A study in Malawi found 75.7% to be male (Samuel, et al., 2009), whilst in rural Kenya, the male trauma population numbered 77% (Otieno, et al., 2004). 82.2% (2816) patients were injured in the Lusaka area. The principal causes of injury (see chart 4.1) in the data set were falls (26.8%), followed by road traffic accidents (25.5%) and then assault (20.3%). The rest of the causes of injuries fell across a wide spectrum: industrial accidents, animal bite, blunt injury and gunshot to name some. These results are different to similar work: most other trauma studies in Africa record road traffic accidents as the most common cause of injury with incidences ranging from 52 – 43% (Otieno, et al., 2004; Samuel, et al., 2009; Demyttenaere, et al., 2009). A rural health centre in Kenya found blunt force injury (36.6%) to be the most common (Odero, et al., 2007), whilst in South Africa external violence accounted for around 54.9% of trauma admissions (Goosen, et al., 2003).

Figure 4.1: Causes of Injury presenting to Casualty at the University Teaching Hospital



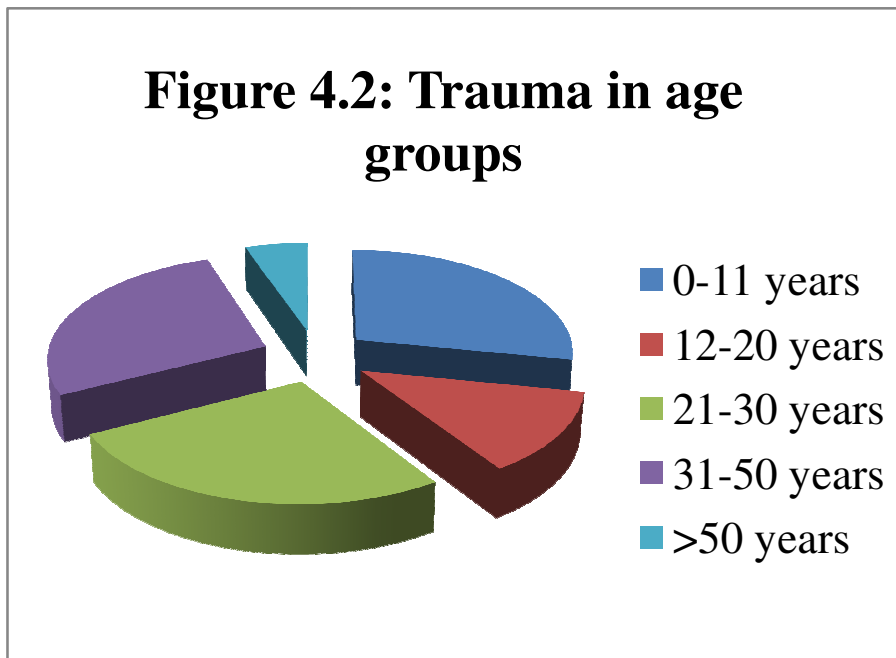
The highest recorded mechanism of injury were falls, so a closer look at the available data was warranted. The most common setting of sustaining a fall (70%) was at home for all age groups. Almost half the falls (49.7%) were sustained by children (0 – 11 years old). This is in keeping with figures from the USA, where unintentional falls are the highest cause of non-fatal injury in the population under 14 years old (Gill & Kelly, 2014). The remaining falls were sustained by the rest of the population (ages 12 - >50).

Unintentional injury comprised 2843 (84.5%); there were 98 (2.9%) reports of self-inflicted injuries and 425 assaults (12.6%). The intentional injury was slightly higher than the two percent figure from the injury pilot study undertaken in Lusaka in 2007 (Mtonga & Zavala, 2008). Self-inflicted harm was found to be 1% in a small study in rural Kenya (Otieno, et al., 2004) and almost a quarter (24.4%) of trauma cases in the sentinel Ugandan study (Kobusingye & Lett, 2000). Cases of self-harm appear to be higher in South Africa where mortality from suicide is recorded to be 7% (Goosen, et al., 2003).

TRAUMA RELATED TO AGE GROUP

Looking at trauma across age categories (see chart 4.2), the 0 – 11 year age group had the highest incidence of trauma (26.5%); the next highest group were the 31 – 50 year olds (25.8%), closely followed by the 21 – 30 year olds (25.1%). In contrast, the age distribution in Malawi found 34.5% of trauma victims in the 21 – 30 year old age group, followed by the 31 – 50 year old group making up 25.1% of their trauma victims, whilst children aged 0 – 10 years made up 18.2% of their trauma numbers (Samuel, et al., 2009).

Figure 4.2: Trauma within various age groups



The top four causes of trauma for each age group are summarised in Table 4.1. Falls, assault and traffic accidents feature heavily.

Table 4.1: Top Four Causes of Trauma in Each Age Category

AGE CATEGORY	TYPE OF TRAUMA	FREQUENCY	% of group
0-11	Fall	457	51.3%
	Burns	150	16.8%
	Home accident	88	9.9%
	Pedestrian vs motor vehicle	87	9.8%
12-20	Fall	120	29.9%
	Assault	81	20.2%
	Pedestrian vs motor vehicle	79	19.7%
	Motor vehicle accident (vehicle vs vehicle)	35	9%
21-30	Assault	276	32.6%
	Pedestrian vs motor vehicle	131	15.5%
	Motor vehicle accident (vehicle vs vehicle)	121	14.3%
	Fall	105	12.4%
31-50	Assault	257	30%
	Fall	140	16.3%
	Motor vehicle accident (vehicle vs vehicle)	137	16%
	Pedestrian vs motor vehicle	116	13.5%
>50	Fall	51	31.1%
	Pedestrian vs motor vehicle	31	18.9%
	Assault	21	12.8%
	Motor vehicle accident (vehicle vs vehicle)	19	11.6%

vs = versus

ALCOHOL RELATED TRAUMA

Alcohol held the strongest links to cases of assault – 33.4% (232 persons out of a total of 694), followed by 23.2% of patients with a cut or stab wound (23 patients out of 99), 19% of the few with gunshot wounds (4 out of 21 patients) and 18.3% of the road traffic accident victims (156 out of 855), but in the pedestrian versus motor vehicle group, 21.4% had a positive alcohol history. These findings are in keeping with similar studies done in the African continent, where alcohol use was associated with 51.3% of assault victims in one study (Odero, et al., 2007) and in South Africa, 36 –

79% of trauma patients were positive to alcohol breath-testing (Üddemann et al., 2004).

ANALYSIS OF FINDINGS

The number of patients recruited to the study is sufficient to be able to draw conclusions about trauma patients presenting to UTH. The male / female ratios of trauma victims were comparable with other studies done in similar settings, showing a predominance of young male patients. 70% of all causes of trauma fell into three top categories: falls, road traffic accidents and assaults; the remaining 30% of injuries were spread across a wide spectrum.

Self-harm does not account for high numbers of injury in the Lusaka setting, consistent with findings in other African countries such as Kenya, whereas numbers appear to be higher in Uganda and South Africa (Otieno, et al., 2004; Kobusingye & Lett, 2000; Goosen, et al., 2003).

It is unclear as to why falls should predominate in this trauma study: the high number of children featured may account for this. These findings are at variance to Professor Odimba's retrospective study of trauma at UTH (he did include comparable regions such as Mauritania and the Democratic Republic of Congo) which, in the two decades spanning 1986 to 2006 produced the finding of road traffic accidents being the most common cause of injury, followed by assault (Odimba, 2007). Risk factors for falls in children include living in LMICs, where the child has greater probability of being exposed to overcrowding, hazardous environments (such as poorly defined play areas) and inadequate supervision (WHO, 2008 b). The study took place during 'mango season', which could account for some of the high number of falls among children.

Five major categories of falls are defined in the elderly adult population, which include environment, medications, medical conditions, poor nutrition and lack of exercise (Masud & Morris, 2001). Environment could be a factor in the high fall numbers in that the study was undertaken during the rainy season and therefore there was a higher risk of falling on slippery wet surfaces both at home and elsewhere (such as the roadside). Zambia does not have the strict home maintenance laws of the developed world (such as not allowing people to fit electrical wiring etc. unless a

certified electrician): much home maintenance is done by the home owner or tenant with no formal training. This can create an environment where people are more apt to fall from roofs, ladders and the like whilst tending to electrical faults, water tanks and other maintenance problems. Medical conditions predisposing to falls in Zambia usually relate to poorly managed epilepsy; few adults take regular medications (despite hypertension being reasonably common). Poor nutrition and lack of exercise are not obvious causes of falls in Zambia. As the predominance of falls was an unexpected finding, specific questions regarding circumstances of these were not included in the trauma study instrument. Alcohol played a significant role in assault and stab wound patients and in injured pedestrians.

SUBCONCLUSIONS

- Inferences about trauma at a University Teaching Hospital in Lusaka can be drawn
- Young adult males and children under the age of 11 years old are at greatest risk of trauma in Lusaka
- Self-harm, whilst it does exist, is not a significant trauma load in the capital city
- There is a high risk of injury due to falls sustained in the home for both children and adults
- Road traffic injury is significant in Lusaka
- Levels of assault are high in Lusaka
- Alcohol enhances the risk of injury, particularly in the young adult male population, aged 21 – 50 years old

CHAPTER 5
Research Findings 2:
TRANSPORT TO
HOSPITAL

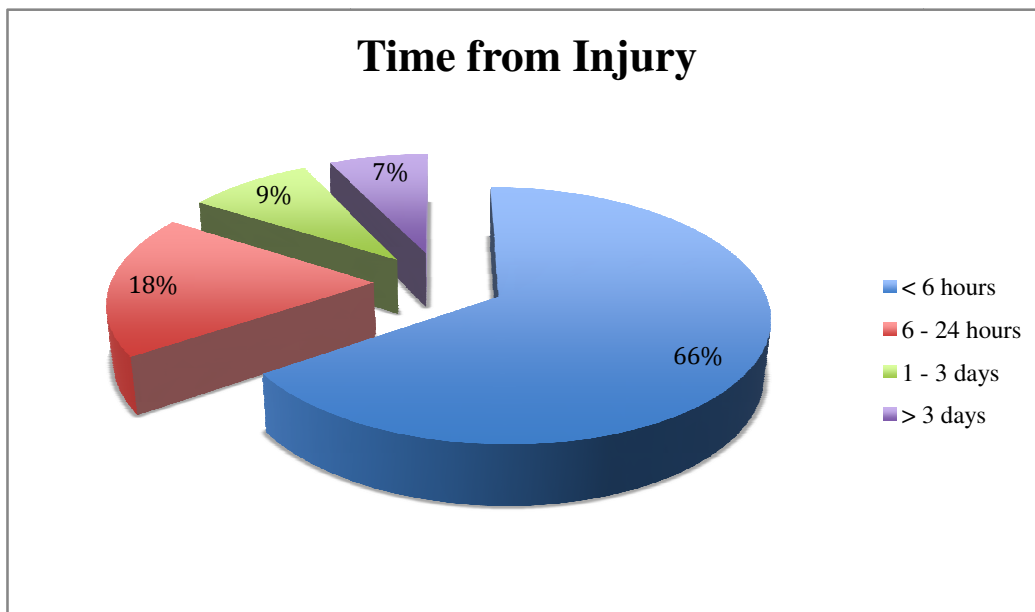
INTRODUCTION

Literature supports prompt intervention in cases of trauma (Sasser, et al., 2005) with improvement of survival giving rise to road and helicopter ambulance services and the like in the US to get patients to hospital without delay (Nathens, et al., 2004). The Lusaka data set contains time from injury to UTH and how the patient made their way to hospital to get baseline figures on transport times.

TIME FROM INJURY TO ARRIVAL IN HOSPITAL

It was established that 82.2% of injuries occurred within the Lusaka district. 13.9% of this data was found to be missing and 1.6% of trauma occurred in outlying districts, such as Chongwe, Kafue and Luangwa. The majority of injuries were sustained at home (44.5%). Only 22.8% of patients presented to the hospital within an hour of injury. Approximately two thirds of the total number of patients arrived in under 6 hours of injury (See Figure 5.1).

Figure 5.1: Time from Injury to Arrival in Hospital



METHOD OF TRANSPORT TO UTH

The options in the data collection sheet of transport to hospital were listed as private ambulance; private car; public ambulance; public transport; walked / carried / bicycle (non-motorised transport as one option) and 'other'. 1.9% of patients were listed as

having come under ‘other’ (see Table 5.1). On interviewing the data collectors, this

Method of transport to UTH	Number	Median time (hrs)	% usually	
			<=1hr	<= 1 hr

selected when the police brought a patient to hospital.

The public ambulance times are somewhat skewed, as some of these patients were brought from other health centres or outlying hospitals and there was a large range of times from injury to being brought to UTH. As a result of this, median times are recorded rather than the full range. The public ambulance median times (10.9 hours) are comparable with a trauma study undertaken in rural Kenya, where the median delay before presentation was 9 hours (Otieno et al., 2004). A review of trauma cases at UTH and comparable regions (Democratic Republic of Congo, Mauritania), from 1986-2006, undertaken by Professor Odimba found an average delay of five days between time of injury and presentation to hospital (Odimba, 2007).

The most common form of transport to the hospital was by private car (53.4%), followed by public transport (37.7%), then public ambulance (5.6%), non-motorised transport (1.9%), followed by ‘other’ (mostly police transport) [1%] with private ambulance the least utilised service at 0.3%. The majority of patients transported in less than an hour were brought by private car but when the percentage of people brought to UTH within the hour for each mode of transport is calculated, the ‘other’ (police) fared the most efficient (see table 5.1). These results are comparable with a study done by Samuel, et al., (2009) in Malawi, where 43.8% arrived via private vehicle, 15.4% were brought by ambulance, 12.4% by public transport, 15.9% brought by non-motorised transport and 7.8% by the police. 48% of those brought by private vehicle in Malawi arrived within an hour of injury, whereas 45% transported by the police were brought in within an hour of injury . Fastest response times – arrival within an hour of trauma in Malawi (53% of the patients brought this way) was an added category of transport, ‘the company car’ (Samuel, et al., 2009).

Private ambulance	10	1.71	3	30	<i>Table 5.1: Most Common Modes of Transport and Transport</i>
Private car	1743	2	515	29.6	
Public ambulance	184	10.9	20	10.9	
Public transport	1231	5.7	183	14.9	
Walked/carried/bicycle	63	5.5	10	15.9	
Other	33	2.7	14	42.4	
All	3264	3	745	22.8	

Time

ANALYSIS

Most patients are resident locally with less than two percent known to be referred from outlying districts. The home appeared to be the most prominent site of injury for both adults and children.

Less than 75% of patients presented to UTH within an hour of injury: this could reflect the bias toward the ‘walking wounded’. When the Kampala injury scores are

accounted for (see chapter 8), the scores are more reflective of serious injury in the patients who presented in under 6 hours. All the patients who died presented within 6 hours of injury. Insufficient information exists to determine as to why approximately 20% of patients (not counting those transferred from outlying districts by ambulance) took more than six hours to get to hospital. From the KTS II scores, it is possible that, suffering minor injury, they either went elsewhere first or initially assumed their injuries were not serious enough to warrant hospital care.

The long transport times by public ambulance are representative of the distance the patient travelled to get to UTH. Thus, in this cohort of patients it is assumed that these patients were treated by a health care team within a reasonable amount of time after injury (minutes to hours) and did not have to wait for the time recorded for medical treatment. However, vast distances in Zambia lead to unacceptably long transport times for patients from outlying districts. Less than 6% of patients are brought to hospital by ambulance: thus 94% of trauma patients came by other means, reflecting the lack of 'emergency' ambulances ('transfer' ambulances are available). A functioning rapid emergency service reduces preventable deaths and may reduce the severity of injuries sustained (Zong, et al., 2011).

Proportionally, the police brought patients into hospital quickest: they may be able to do this because of a designated vehicle fitted with a siren and clear labeling that is able to get through the traffic efficiently.

SUBCONCLUSIONS

- UTH serves the mostly the local district population
- Home safety is a priority for focused public health intervention (preventational measures)
- Long distances from outlying districts to definitive care at UTH make road transport an unattractive option for transporting injured patients: alternatives should be explored
- A 'trauma ambulance' emergency care service may play a role in reducing time of injury to definitive care times

CHAPTER 6
Research Findings 3:
ROAD TRAFFIC
TRAUMA

INTRODUCTION

As stated in the overview, road traffic accidents featured in the ‘big three’ top causes of trauma in Lusaka. It was the commonest cause of injury in a retrospective review of trauma cases presenting to UTH between 1986 and 2006 (Odimba, 2007). These findings are in keeping with the findings of other Low and Middle Income countries’ (LMICs) studies looking at the number and distribution of road traffic accident victims (Demyttenaere, et al., 2009; Samuel, et al., 2009; Chalya, et al., 2012). The details of the problem of road trauma are detailed in this chapter.

ROAD TRAUMA STATISTICS

25.5% of injuries in the study cohort were caused by road traffic incidents. They featured in the top four causes of trauma for every age group (see table 6.1).

The median age of injury was 27 years. The male / female ratios were similar to the overall trauma population, with 71.5% male patients and 28.3% female. The median age for pedestrians struck by a vehicle was 24 years, with the motor vehicle population median age being 30 years old. This compares with findings in Tanzania where the median age of traffic victims was found to be 26 years old (Chalya, et al., 2012). A population based study in Nigeria found the mean age to be 29.4 years old (Labinjo, et al., 2010), the same as that in the Tanzanian study, whilst the mean age in Lusaka was 31.4 years.

Table 6.1: Age Group Related to Traffic Injury

AGE CATEGORY	CAUSE OF TRAUMA	FREQUENCY	% (of age group)
0 – 11 years	Pedestrian vs motor vehicle	87	9.8%
12 – 20 years	Pedestrian vs motor vehicle	79	19.7%
	Motor vehicle accident (vehicle vs vehicle)	35	9%
21 – 30 years	Pedestrian vs motor vehicle	131	15.5%
	Motor vehicle accident (vehicle vs vehicle)	121	14.3%
31 – 50 years	Motor vehicle accident (vehicle vs vehicle)	137	16%
	Pedestrian vs motor vehicle	116	13.5%
> 50 years	Pedestrian vs motor vehicle	31	18.9%
	Motor vehicle accident (vehicle vs vehicle)	19	11.6%
All			% of group
	Pedestrian vs motor vehicle	477	54.4%
	Motor vehicle accident (vehicle vs vehicle)	360	41%
	Motor vehicle accident, unknown type	18	2.1%
	Traffic Accident, not applicable (bicyclists,etc)	22	2.5%

THE VULNERABLE ROAD USER

In this study, 54.4% of road traffic trauma was sustained by pedestrians. 84.9% were ‘non’drivers – passengers and pedestrians. These figures compare with a road traffic trauma study done in Tanzania, where 55.4% of victims were pedestrians and 27.2% were passengers (as compared with Lusaka’s 30.5%) [Chalya, et al., 2012]. Looking at minority injuries, 33 (3.8%) patients were bicyclists and 16 (1.8%) were motorcyclists. The motorcycle injury numbers are comparable to those found in Malawi, where Samuel, et al., (2009) had 1.6% motorcycle injured patients compared

to Tanzania (3.5%), Ghana (4%) and Nigeria (36.2%) [Samuel, et al., 2009]. There is weak evidence that more pedestrians were admitted after 18h00 as compared to other road traffic victims, but when trying to corroborate this with recorded injury time (comparing pedestrians with other injured road users), the difference was not significant – 31.7% for pedestrians and 27.5% for other road users (possibly due to an inadequate sample size to make this association). It was thus not possible to draw any firm conclusion regarding pedestrians and the time of day that injury took place.

MOTOR VEHICLE VERSUS MOTOR VEHICLE

41% of traffic victims were in the motor vehicle versus motor vehicle category (see table 6.1), of which 20.6% were drivers – comparable to Tanzania, where 17.2% were drivers (Chalya, et al., 2012).

PASSENGER RESTRAINTS

Assessing the figures available, 75.8% of road traffic victims were not restrained in the vehicle (no safety belt or child seat if under 12 years old), i.e., 24.2% of victims used some type of restraint. This is only marginally better than the Tanzanian study numbers of 13.5% seat belt use (Chalya, et al., 2012). Numbers were limited to draw sufficient details regarding child restraint records in the Lusaka, but the figures show that the majority of children were not restrained in motor vehicles. The mean ages of restrained children – seatbelt and child seat was 4 years and 4.9 years respectively. The mean age of non-restrained children was 6.9 years old.

HOSPITAL UTILISATION

A little under half (49.1%) of RTA victims were admitted. Considering the in-patient data available (203 patients), the most common injury sustained (49.8%) was fracture – major and minor, with the highest percentage (28.6%) suffering major (long bone or compound) fractures, followed by lacerations (22.2%), then head injury (including minor head injury and traumatic brain injury) [17.7%]. These findings are comparable with injuries suffered by patients from Tanzania, 62.5% of which suffered open wounds (including crush injury, traumatic amputation as well as lacerations and contusions) as the most common form of injury; 26.3% had fractures and they had a higher head injury burden with minor head injuries comprising approximately 19.7% and major head injuries (requiring neurosurgery) were 16.8% (Chalya, et al., 2012).

X-rays were performed on most patients (89.2%), and 11.3% underwent CT scanning. Surgical procedures were carried out on 48.3% of the in-patients and 8.9% received blood products. Chalya, et al., (2012) undertook surgical procedures on 80.3% of their traffic trauma patient study group, with the most common procedure being wound debridement, followed by fracture management.

MORTALITY

From the available admitted data (203 patients), 12 patients died (5.9%), a better rate than that in the Tanzanian study of 17.5% (Chalya, et al., 2012); however, a rural Kenya trauma study revealed a more favourable death rate of 4.8% amongst road traffic victims (Otieno, et al., 2004). A Ugandan registry recorded that 61% of their mortalities (they had a 2.7% death rate for all trauma patients) were from road traffic victims (Demyttenaere, et al., 2009), whereas the Lusaka cohort had a overall mortality rate of 4.1% for all trauma patients, 36.4% of whom were road traffic victims. This compares well with the mortality rate of road traffic victims in the unpublished UTH surgical audit data of the first three quarters of 2009 (39%) [UTH, 2009].

ANALYSIS

Road traffic injury is significant in Zambia and affects primarily young men in their late 20's, an economically active group with a high likelihood of dependents. Male characteristics of risk-taking behaviour (consuming alcohol, speeding and not using a seat belt) may contribute to this injury toll. The vulnerable road user is at particular risk in Zambia, with over half of injured persons on the road pedestrian victims. This suggests low traffic awareness – pedestrians not using crossings and pavements provided and poor separation of these road users from the motorised user.

Children at various developmental stages are unable to appreciate danger and make adequate risk assessments of their environment: they should not be expected to simply avoid stepping in front of vehicles. They should be protected and adult road users made aware that children are unpredictable and unable to judge speed and distance in the same way adults are able to.

Low seat belt use puts a patient at higher risk for more severe injury (Chalya, et al., 2012). There appears to be an urgent need for public education regarding the use of restraints, particularly regarding children. The current law in Zambia states that persons over the age of 10 years are responsible for wearing their seat belts and the driver is responsible for his own seat belt use and those of children under the age of 10 years. This is unenforceable and steps are in place to change this, as the police are highly unlikely to prosecute a child of 11 years old for not wearing her seat belt. The confusion may be responsible for a poor uptake of seat belt use, despite the law demanding that all should be restrained within a standard vehicle.

The fractures, soft tissue injuries and head injuries are comparable with other studies (Chalya, et al., 2012) and represent a significant problem for Zambian society, especially when outcomes of lower limb fractures and head injured patients are accounted for. There is good evidence that patients with significant bony injury suffer long-term poor quality of life and considerable disability (Balogh, et al., 2012). Brain-injured patients require long term rehabilitation and support with poor functioning in society post injury (Rosenfeld, et al., 2012).

Mortality in road traffic victims is often especially heart-breaking as these are young productive members of society and leave dependents with blighted lives – not only having bereavement to deal with; they are often left in financial crisis as well. To add to this tragedy is the fact that many of these deaths are preventable.

SUBCONCLUSIONS

- Public health education aimed at young men regarding behaviour as road users for both drivers and pedestrians is urgently needed
- Public education regarding the use of pedestrian walkways and pavements is required to prevent further loss of life and ability
- Protection of school children by situating schools away from main roads and having traffic calming systems or managed crossings outside schools
- Children should not be playing near the road, particularly busy streets
- Education regarding alcohol use and walking home in the road or driving whilst under the influence of alcohol: avoid leaving for home inebriated and

wear reflective gear if on the road in the dark. Much has been achieved in high-income countries with raising public awareness of drink-driving and a change of attitude has evolved: drink-driving is considered socially unacceptable and arrangements are routinely made by a group 'on a night out' to either have a 'designated driver' or a taxi arranged after alcohol consumption

- Use of bicycle lights and reflectors to avoid collisions, especially at night
- A straightforward policy on seat belt use and its enforcement after public education

CHAPTER 7
Research Findings 4:
HOSPITAL
UTILISATION

INTRODUCTION

The hospital utilisation explores the resources used by the trauma patients: the intention is to estimate the level of services required, both from a staffing and equipment level. The type of injury the patient presents with has a bearing on the type of services required. The trauma patients that did not sustain injuries resulting from road traffic accidents are considered here. The causes of injury include falls, assault, home accidents, industrial accidents, blunt injury, burns, animal bites, gunshot and stab wounds. Trauma with the cause not recorded account for two point one percent of the data.

HOSPITAL UTILISATION AND ADMISSION TYPE

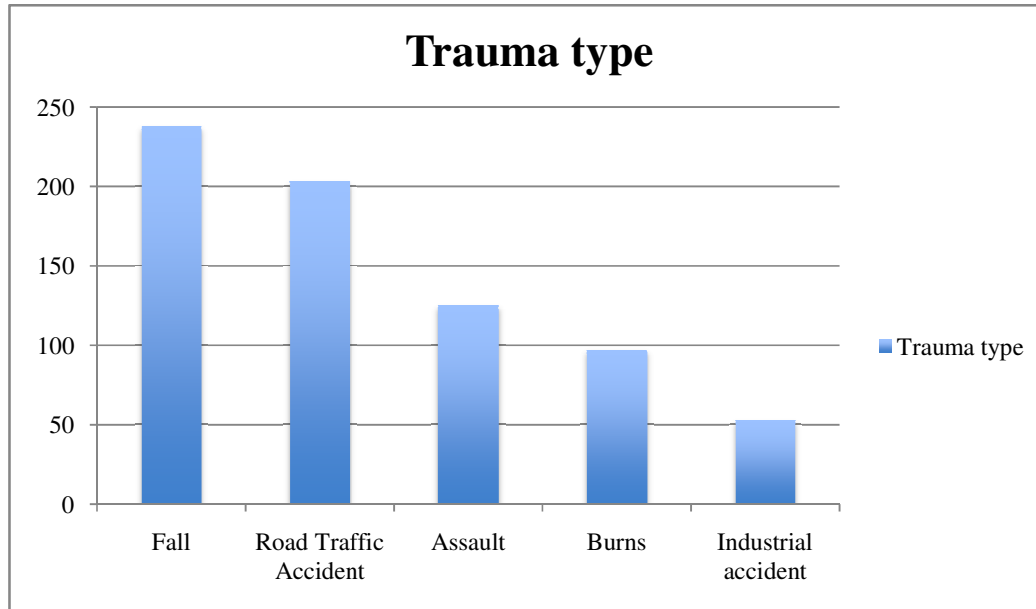
The number of patients admitted was 1769 (52%) of studied trauma victims (2% unknown admission status). The number of completed hospital utilisation forms captured was 863 (49% of those known to have been admitted), of which 613 were non-traffic related trauma. Patients admitted to the 'intake' wards constituted 57% (under 24-hour admissions); 40% were admitted to the main surgical wards or the intensive care unit (24-hour or longer admissions). This is higher than a study done at a referral hospital in Malawi, where the admission rate was 26.8% (Samuel, et al., 2009), but comparable to Uganda, where the admission rate was 41.6% (Demyttenaere, et al., 2009).

A trauma study in rural Kenya found the most common cause of injury to be road traffic accidents (52%), followed by falls, assault and burns (Otieno, et al., 2004). Other studies in the African region recount blunt trauma, with pedestrian accidents at 24%, road traffic accidents (motor vehicle) accounting for 23%, with burns at 8% and penetrating injury (includes gunshot and stabbing injury) at 6%. Further data records being 'struck by an object' (36.6%), assault (34.4%), falls (11.6%), burns (6.2%) and road traffic accidents (4.7%); [London, et al., 2001; Odero, et al., 2007]. The top five categories for admission in Lusaka are listed in figure 7.1, and comprise falls, road traffic accidents, assault, burns and industrial accidents.

The longest hospital stays were incurred by the burns patients; 93% of the captured patients were discharged within 30 days; two percent remained in hospital and one percent left against medical advice. A Malawi study with a 14-day follow-up

demonstrated 85% being discharged and 12% remaining in hospital (Demyttenaere, et al., 2009).

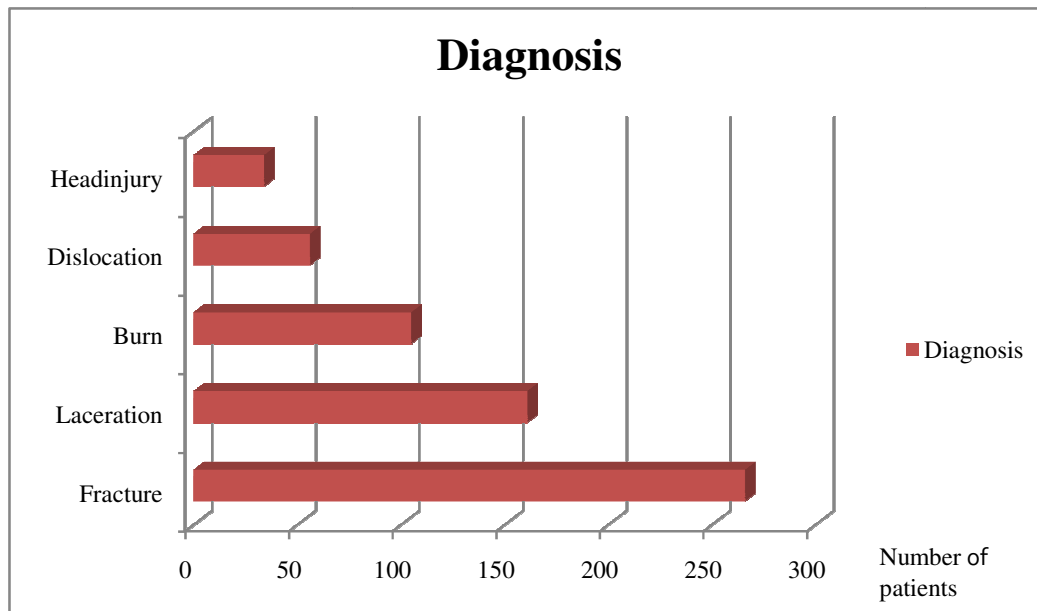
Figure 7.1: Admissions Related to Trauma Type (top five)



PRIMARY DIAGNOSIS

The most common primary diagnosis was a fracture – 259 patients (42.3%) in available data set (23% minor, 20.4% major), followed by a laceration – 153 patients (25%), followed by burns (17.6%). The burns patient numbers in Lusaka are double or more than figures collected in comparable settings: a trauma study (undertaken in the summer months) in rural Kenya was 6.5% and 6.2% (Otieno, et al., 2004; Odero, et al., 2007), Uganda (data collected over a year) 6% (Demyttenaere, et al., 2009), Ghana 8% (data collected over a year period) and in Malawi (a six-month study, including early cold season) it was 5.6% (Samuel, et al., 2009). The five most common diagnoses are summarised in chart 7.2. The study undertaken in rural Kenya had a high number of severely head-injured patients (12.5%), whilst the numbers in Malawi were 7.5% (Otieno, et al., 2004; Samuel, et al., 2009), compared to the Lusaka cohort of 5.6%.

Figure 7.2: Top Five Primary Diagnosis



RADIOLOGY

Given the high number of patients sustaining bony injury (fractures and dislocations), it is not surprising that 73.5% of patients underwent an x-ray. The only patient group x-rayed at a rate of $\leq 65\%$ were the burns patients. Five point three percent of patients underwent CT (Computerised Tomography) or ultra-sound scanning, the same percentage of patients that sustained a head injury (minor head injury and traumatic brain injury combined). Ultra-sound scanning is only available within working hours at the University Teaching Hospital in Lusaka, whereas x-rays and CT scans are available out of hours.

HIV TESTING

HIV testing was carried out on 46.2% of patients. Of these with known status, 30 patients were positive (7.7%), whilst 361 were negative (92.3%). This uptake of the 'opt out testing' policy in UTH is low, and the HIV prevalence rate is low, particularly compared to previous studies done in the surgery department at UTH showing rates of infection to be 32 – 44% of admitted patients (Kehoe & Jellis, 1994; Odimba, et al., 2007).

BLOOD PRODUCTS

A blood transfusion was given to five percent of the admitted patients. This is in contrast to rural Kenya (Otieno, et al., 2004), where the transfusion rate was 7.5% (a study with a higher percentage of critically injured patients); in Ghana approximately a decade ago, three point six of patients were transfused in a similar study setting with comparable numbers of patients (London, et al., 2001). The highest number of transfusions were given to the assaulted patients (including stab victims), followed by burn patients and fall victims.

SURGICAL PROCEDURES, CHEST TUBE INSERTION

In the cohort of the captured patients, 59.5% underwent a surgical procedure. These included fracture and dislocation management, such as manipulation under anaesthesia and application of a backslab, debridement of open fractures and Steinmann pin insertion (skeletal traction). The next most common procedure was management of lacerations with debridement and suturing. This falls in line with management given in a study done in rural Kenya (Otieno, et al., 2004) and Ghana (London, et al., 2001). Chest drains were inserted into six patients – approximately one point six percent of all surgical procedures undertaken and accounting for approximately one percent chest tube insertion rate for the captured patients. This is in contrast to rural Kenya, which had a chest tube insertion rate of 8.5% (Otieno, et al., 2004), but more favourable than rates in Ghana, where 0.6% of patients underwent chest tube insertion (London, et al., 2001). In the in-patient data available, 12 patients had a positive laparotomy (1.5% of all surgical procedures) following trauma: 8 had a solid organ injury and 4 sustained a bowel injury.

MORTALITY

Twenty-one patients in this data set died, giving a mortality rate of 3.4%. The overall rate of mortality, with RTA victims included was 4.1%. This compares with fatality rates in rural Kenya of 3.5% (Otieno, et al., 2004) and slightly higher than a Ugandan cohort, which had a 2.7% mortality (at 14 days rather than 30 days) [Demyttenaere, et al., 2009]. An earlier data set in Ghana found a mortality rate of 9.4% (London, et al., 2001). The highest number of fatalities in Lusaka occurred in the burns patients (42.9%), followed by road traffic victims (36.5%), assaulted patients (23.8%) and then patients who fell (14.3%). This correlates with the unpublished surgical data of

2009, where burns mortality was calculated at 44%. The Uganda data set had the highest mortality amongst RTA patients (see chapter 7), followed by 15% in their burns population. 7% of their mortality was from falls (Demyttenaere, et al., 2009). One patient in the entire Lusaka trauma data set died within 24 hours of arrival to hospital: all the other deaths occurred after 24 hours (within 30 days) – this includes the road traffic accident patients.

ANALYSIS

The hospital utilisation is an indicator of the severity of injury and morbidity likely to be suffered by the trauma patient. The patients lost to follow-up occurred in a random manner (no systemic errors were identified): the data is thus considered analysable, with comparable numbers to other trauma studies done (Otieno, et al., 2004; Mukhopadhyay, et al., 2009).

When the trauma type is related to most common diagnosis and hospital admission, it is clear that falls and road traffic accidents cause a large load of bony injury with the subsequent management strategies to be in place that this type of trauma demands. In UTH, the surgical admission wards are run by general surgery teams that have one or two orthopaedic trainees attending for an average of 6 – 8 hours during the 24-hour ‘call’; these trainees are expected to put in an eight-hour day before and after their call day (one day of the week, with 2 week-end days per month). The consultant(s) on duty are general surgeons. There are no dedicated orthopaedic theatres available for these emergencies: they fit into the general surgery patient emergency theatre lists. Due to staffing and sterility concerns, no emergency orthopaedic implants are attempted in the emergency theatres: femur fractures are managed using Steinmann pins (skeletal traction), and open fractures, after debridement and washout are as often as not, immobilised with a plaster of paris backslab. At any given time, the number of orthopaedic trainees number half the number of general surgery trainees.

Radiology services bear a high workload with the high orthopaedic injury rate: not only do they take the initial x-rays but also take ‘check’ x-rays post management, as the emergency theatre does not have fluroscopy to confirm fracture reduction post manipulation in the emergency theatre. The x-ray facilities are not digital: thus, there

is a high manual workload involved in producing the physical films with cassettes and development chemicals required for the process.

Debridement and suturing comprise a substantial occupation of the on-call team during any given call duty: it is not unknown to run short of specific sutures occasionally. Large lacerations are managed in theatres, due to facilities of a clean space, adequate light and sufficient sterile packs.

One of the most worrying findings of the study has been the number and mortality suffered by burns patients, most of whom are children (median age 3 years). There is no dedicated burn unit at UTH: burn patients are managed in the general wards, in side wards. There are no dedicated facilities for their admission: they are admitted to the 'intake' ward, together with all other surgical patients. The initial cleaning of the wound is done in the intake ward under opiate analgesia. The nurses on the general surgery wards are expected to take care of the burn wounds, together with their other duties in wards holding upwards of 30 patients and 2 – 4 nurses on duty per shift.

The use of blood products in UTH is comparable with other centres in the Sub-Saharan region: whole blood is available after hours. The blood bank services have comparable testing mechanisms with high income countries for HIV and hepatitis B and C etc. (PCR system). Platelets and fresh plasma can only be requested by special arrangement during working hours. It should be noted that the source of 90% of donated blood in Zambia is from senior school scholars: thus, during long vacations (December), the hospital regularly runs short of blood. This study included this period, which implies that some patients may have not received a blood transfusion but were clinically eligible for one. There is also a significant minority of Zambians who would choose to decline a transfusion on religious grounds.

The HIV testing and prevalence was found to be lower than expected in this patient cohort: one of the reasons could be the high number of children included in the study. The group of patients least likely to be tested is the paediatric population, as these patients tend to be tested on clinical suspicion rather than following the 'opt out policy' that focuses on the adult population. Many patients who are concerned they

may be HIV-positive due to their high risk lifestyles may choose to refuse testing, unable to face up to the possibility of having their worst fears confirmed.

Chest tube insertions are relatively low in Zambia (one percent): trauma registries in high income countries have rates of around 6% (London, et al., 2001). The preponderance of limb (long bone) injuries may account for this, but vigilance is needed to avoid missing patients eligible for chest tube insertion

The comparatively higher mortality rates in assault victims are likely to be related to the high prevalence of head injury suffered by this cohort, both traumatic brain injury and closed (minor) head injury. The next highest group of traumatic brain injury and closed head injury are the fall victims, in keeping with the mortality rate.

SUBCONCLUSIONS

- High incidence of orthopaedic injury necessitates a greater provision of orthopaedic services to be made available, including:
 - Staffing – senior consultant or senior registrar leadership for the management of orthopaedic injury, particularly regarding operative management
 - A dedicated orthopaedic team on call in parallel to the general surgery team, where both teams are able to assist each other should one team have a higher workload at any given time
 - Dedicated 24-hour emergency orthopaedic theatres where environmental and equipment sterility can be assured and appropriate apparatus (such as fluoroscopy) is available. Specialist theatre staff should be an essential aspect of these operating rooms
 - Suitable disposables, such as implants to be made available at cost to those who are able to afford them and at highly subsidised rates to those unable to raise the actual fee
 - A recruitment drive for specialist trainees and appropriate increase in available orthopaedic posts at UTH

- Digital x-rays may save costs in the long term, after initial purchase and installment costs are accounted for, as they do not require disposables such as film and chemicals on an ongoing basis
- HIV testing uptake should be higher as per government policy
- Blood product availability is an ongoing issue: a wider donor pool may alleviate some of the shortages currently experienced
- A dedicated area with appropriate lighting and equipment for suturing in casualty may enable patients to be sutured and allowed home sooner than preparing them for theatre, involving trolleys, porters and theatre staff
- There is clearly an urgent need for action regarding burns patients:
 - Focused public education regarding protecting young children from scalding and flame burns
 - A dedicated burns unit with appropriate nursing, physiotherapy and nutritionist staff
 - A long-term plan to attract plastic surgery trainees and consultants to manage these patients
 - Availability of topical antibiotics and equipment for early graft management
- Aggressive management of head-injured patients to prevent secondary brain injury: early ventilation and intensive care management and use of newer therapies, such as statins to improve outcomes(Rosenfeld, et al., 2012).

CHAPTER 8
Research Findings 5:
THE KAMPALA
TRAUMA SCORE II

INTRODUCTION

It is difficult to quantify the severity of injury (which will determine the resources required to treat the patient and dictate the probability of survival) without a trauma scoring system. Most scoring systems are derived by a computer when the appropriate data is entered into a specific program. The Kampala Trauma Score (KTS), devised in Uganda in the 1990's has been validated in several African countries (as previously discussed) and later had the scoring (but not the criteria) revised, so it is referred to as the 'KTS II'. The beauty of such a score is that it can be calculated immediately (on a piece of paper). The Kampala Trauma Score has not been validated in Zambia prior to this research project and it is the portion of the study with an hypothesis to prove. The hypothesis states the KTS II is a reliable predictor of mortality. The study expanded on this hypothesis by looking at the KTS II related to several other variables, such as admission, the fate of road traffic accident victims and hospital utilisation.

The KTS II score was calculated for 2733 patients: some of the children's data was omitted due to a delay in getting a paediatric blood pressure cuff at the commencement of the study, so the full score was not calculated; subsequent paediatric patients were scored when the equipment was made available, approximately 3 weeks after the study commenced. KTS II scores are classified as mild injury: **9 – 10**; moderate injury **7 – 8**; and severe injury ≤ 6 . From the available in-patient data, 48.2% of the *admitted* victims suffered mild injury, 41.4% suffered moderate injury and 8.7% severe injury. A study in Uganda classified injury using the KTS II and found mildly injured patients to constitute 82%, the moderately injured to be 14% and the severely injured to be 4% (Demyttenaere, et al., 2009). The mean KTS II score for all presenting patients was 8.3; the median score was 9.0, consistent with the Ugandan study which had a mean KTS II score of 9.1 (Demyttenaere, et al., 2009).

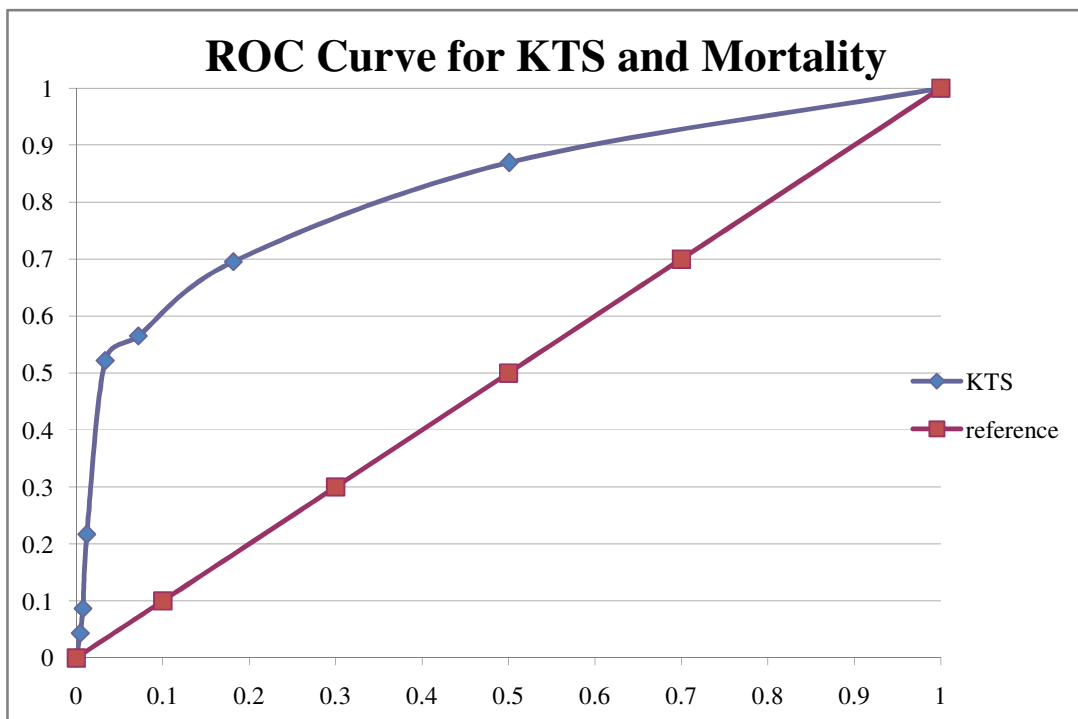
THE KTS II AND MORTALITY

The mean KTS II for surviving patients was 8.25 (standard deviation 1.19) and for deceased patients a mean value of 6 (P value < 0.0001). The accuracy of the KTS II in predicting mortality was confirmed by calculating the area under receiver operating

characteristic (ROC) curves with the mortality as the state variable and the KTS II as the test variable – see chart 8.1. The area under the curve was calculated to be 0.81533.

The closer the area under the curve is to the best score of 1.0, the less is the likelihood of the finding being owed to chance (worst score is 0.5) [Senkowski & McKenney, 1999]. These scores are comparable to studies done comparing the KTS to other scoring systems, where the KTS scored 0.836 for 2-week mortality prediction (MacLeod, et al., 2003) and KTS II 0.8711 for the same period (Mutooro, et al., 2010). Both these studies used the Ugandan trauma registry, birthplace of the Kampala Trauma Score (KTS I & II).

Figure 8.1: ROC Curve for the KTS II & Mortality



The KTS II scores for the deceased are summarised in table 8.1. This data concerns the available in-patient (hospital utilisation with complete KTS II) information. The number of patients scoring a $KTS II \leq 6$ and dying in this data set was 13; the number of patients surviving scores ≤ 6 was 47. As expected, 608 patients with KTS II scores

of 7 and above survived; however, 10 patients in this moderate to mild injury category died (43% of the total deceased with KTS II data).

Table 8.1: KTS II Scores and Number of Fatalities

Kampala Trauma Score II (0-10)	Fatalities	
	No	Yes
	N	N
2	3	1
3	2	1
4	3	3
5	14	7
6	25	1
7	72	3
8	209	4
9	282	3
10	45	0

N = Number of patients

THE KTS II AND TIME OF PRESENTATION

The KTS II was calculated for patients arriving within 6 hours of injury: the findings are summarised in table 8.2.

Table 8.2: KTS II For Patients Arriving Within 6 Hours of Injury

	Number	Mean KTS II	Std Deviation	P Value
Patient Admitted				
Yes	1191	7.97	1.36	< 0.0001
No	1036	8.58	1.12	
Surgery Performed				
Yes	235	7.5	1.52	
No	327	8.3	1.08	< 0.0001
Received Blood Transfusion				
Yes	35	7.49	1.44	0.02
No	526	8.02	1.31	
Status at 30 days				
Died	24	6.08	1.77	< 0.0001
Discharged	552	8.05	1.26	
Left against medical advice	7	7.57	1.81	
Still in Hospital	6	8.5	0.54	
Vital status				
Dead	24	6.08	1.77	< 0.0001
Alive	565	8.04	1.27	

The KTS II for patients presenting later (those presenting 24 hours after injury) were less significant for interventions such as surgery and leaving against medical advice.

THE KTS II: ADMISSION AND HOSPITAL UTILISATION

The admitted patients (1399 with KTS II scores available) scored a mean KTS II of 8.2 (standard deviation of 1.29), whilst those treated and sent home the same day (1334) scored a mean KTS II of 8.7 (standard deviation 1.1), P value < 0.0001. Thus, patients with a mild to moderate injury were sent home and those with moderate to

serious injury were admitted, some only for the day (sent home from the admission ward the following day). This is comparable to figures from Uganda, where 65% of the captured trauma registry patients were treated and sent home the same day with mild injury scores (Macleod, et al., 2007). Looking at the in-patient status at 30 days, those still in hospital had a mean KTS II score of 8.3, those who were discharged scored a mean KTS II of 8.3 and the deceased (as previously mentioned) scored a KTS II of 6. Patients who left hospital against medical advice had marginally higher KTS II scores of 8.7. There was no statistical difference between KTS II scores of briefly admitted patients (admission wards) and those admitted in the main wards for more than 24 hours. ROC curves for these types of admissions had an area under the curve of 0.61478.

Patients admitted, receiving a blood transfusion and undergoing a surgical procedure all had lower KTS II scores than trauma victims who were seen and treated (not admitted), those who were discharged and the ones who survived their injuries. The KTS II was not a good predictor of length of hospital stay, a finding similar to a study in Uganda that found the KTS II a poor predictor of long stay in hospital (Mutooro, et al., 2010). Despite the significant difference between those receiving surgery and those who were not operated on (for all patients, as well as those included in table 8.2 above), the area under the ROC curve was calculated at 0.40697, suggesting poor sensitivity and specificity for the KTS II as a predictor of patients needing surgery. ROC curves for blood transfusion were calculated to be mildly significant at 0.63826 for the area under the curve.

THE KTS II AND RTA PATIENT

Mean KTS II scores were calculated for road traffic victims according to their role in traffic. The KTS II mean scores were marginally different from each other, but did not reflect the severity of injury in the groups: pedestrians scored marginally lower than bicyclists and drivers. Findings are summarised in table 8.3.

Table 8.3: KTS II and the Road Traffic Accident

Patient Role in RTA	Number of patients	Mean KTS II	Standard deviation	P value
Bicyclist	33	8.82	1.21	0.0077
Driver	74	8.66	0.95	
Motorcyclist	16	8.56	0.73	
Passenger	248	8.44	1.23	
Pedestrian	381	8.24	1.3	

ANALYSIS

The research hypothesis: ‘The KTS II is a reliable predictor of mortality in trauma patients at UTH’ has been proven by more than one statistical method, looking at mean and median scores, standard deviation and P values. The ROC curves are further evidence of the reliability of the KTS II score, with similar values to studies undertaken in Uganda (MacLeod, et al., 2003; Mutooro, et al., 2010). Patients scoring 6 or less are at significant risk of death. The KTS II is a simple and effective score that is able to be done at the bedside in minutes, requiring minimal effort and training (Demyttenaere, et al., 2009). Predictors of poor outcome is useful in low resource settings where there may be limits to the type of care that can be offered to the patient, with finite resources per patient. The scoring system may be able to alert junior medical staff or nurses of the need for early senior input and these patients may be prioritised for resources such as blood. More patients with a KTS II score of 6 or less survived in our data set, which is an encouragement to manage these patients aggressively.

Patients with KTS II scores in the mild to moderate category who died are considered potentially salvageable patients, translating to 10 preventable deaths at UTH in this data set. The early Ugandan KTS study suggested 7 preventable deaths in their cohort (Kobusingye & Lett, 2000). Patients requiring further hospital resources, such as admission, surgery and blood products do have lower scores than those not requiring such interventions, but these differences were not statistically significant.

Patients still in hospital and patients discharged at 30 days both had KTS II scores of 8.3: with the high number of patients suffering from long bone fractures treated with skeletal traction, the patients most likely to still be in hospital are patients with femur fractures in skeletal traction for approximately 40 days. These patients are, for the most part, stable, with single non-life threatening bony injury and expected KTS II scores of 7 – 9.

Although not significant, the gradual decline in KTS II scores, depending on the patient's role in traffic does reflect the poorer outcomes experienced by pedestrians as compared to other road users.

SUBCONCLUSIONS

- The KTS II has been validated as a reliable predictor of mortality in Lusaka, Zambia
- The KTS II is able to be calculated with minimal equipment and training and should be used to triage severely injured patients to ensure senior input into their care
- A trauma registry with the KTS II embedded will be a reliable record of the number of trauma victims seen in UTH with an indicator of injury severity
- Having a record of injury severity will allow hospitals in Zambia to plan and allocate appropriate resources to specific areas of need
- Injury severity scores can be compared with outcomes (such as mortality) to monitor efficacy of care

CHAPTER 9
Research Findings 6:
‘BROUGHT IN DEAD’

INTRODUCTION

The ‘brought in dead’ (BID) arm of the study is the third aspect of the data collection. Patients found deceased are brought to a specific area of the hospital, where there is a police post. The police make an initial enquiry into the circumstances of the death to confirm if there is any cause for suspicion. Patients who die within hours of arriving in casualty are occasionally counted as BID, which is why they were included in the study. During the study however, one patient died within 24 hours in casualty and was not included in the BID numbers. The purpose of the BID data was to have a snapshot of all the patients ‘brought in dead’ to the hospital, and out of these, to find out how many perished as a result of trauma.

‘BROUGHT IN DEAD’ CAUSES OF DEATH

A total of 1307 patients were included in this data set. Causes of non-trauma death are summarised in table 9.1.

Table 9.1: Non-Trauma Related Deaths

Non-trauma Deaths	Number	%
Heart Attack/MI	18	1.6
Hypertension/BP-Related	46	4.1
Stroke/CVA	26	2.3
Meningitis/CNS	20	1.8
Diarrhea/GI Related Illness	142	12.7
Malaria	155	13.8
TB	252	22.5
Pneumonia (PNA)	54	4.8
HIV-Related Illness	23	2.1
GI Bleeding	2	0.2
Liver Failure/Problems	10	0.9
Sepsis	27	2.4
Poisoning	23	2.1
Sudden Death	91	8.1
Natural Death/Old Age	43	3.8
Other	129	11.5
Unknown	59	5.3

Ninety-two point two percent of the BID victims were non-trauma, 5.6% trauma related and 2.2% were unknown. The highest number of fatalities were ascribed to tuberculosis (TB), followed by malaria and diarrhoeal disease. As none of these victims were followed up, it is not known if any of the given causes of death were confirmed by post mortem. The highest number of fatalities were in the > 50 years age group (31.9%), followed by the 31-50 year olds (17%), with the 0 – 11 year old age group at 16.8%. Fourteen point three percent did not have an age category recorded. Eighty-five victims did not have their medical condition recorded. Only 3.8% had a ‘natural death’ (such as old age) recorded.

‘BROUGHT IN DEAD’ TRAUMA VICTIMS

The BID trauma victims are summarised in table 2. There were a total of 73 trauma victims in the data set (5.6%). Over half of the trauma deceased resulted from road traffic accidents (53.5%), with the majority of these pedestrians struck by vehicles.

Table 9.2: Trauma Deaths

Trauma Deaths	Number	%
Assault	4	5.5
Burns	3	4.1
Gunshot	2	2.7
Industrial accident	3	4.1
MVA (MV vs MV)	10	13.7
Pedestrian vs MV	21	28.8
MVA (unknown type)	8	11.0
Other	3	4.1
Type of trauma not recorded	19	26.0

MVA = Motor Vehicle Accident

MV = Motor Vehicle

vs = versus

ANALYSIS

A significant number of patients were brought to the hospital deceased, with a trauma mortality rate of 5.6%. This suggests that trauma is not causing a huge problem of mortality in Lusaka, Zambia; however, it would appear that much of this is preventable, especially when taking into account the road traffic injury numbers. As the total number of patients admitted to the hospital was not recorded, it is not possible to draw many conclusions from this data set.

SUBCONCLUSIONS

- Education regarding road safety should be prioritised in Zambia, with emphasis on pedestrians
- The majority of deaths recorded in Lusaka are not trauma related

CHAPTER 10

CONCLUSION

INTRODUCTION

The objectives of discovering incidence, cause, severity and mortality of trauma has been achieved in this study. The hypothesis has been successfully tested to be reliable, regarding the use of the Kampala Trauma Score (KTS) II in Lusaka, Zambia.

SUMMARY OF FINDINGS

Trauma occurs in high figures in Lusaka: the study recruited sufficient numbers of patients to draw meaningful conclusions. There is a high incidence of injury in children and amongst the male youth population. Most injuries are non-intentional. The vast majority of trauma patients attending the University Teaching Hospital (UTH) are from the greater Lusaka area. Less than 25% of injured patients arrive within an hour of the trauma incident. Road traffic trauma comprises a quarter of injured patients presenting to UTH, with the highest number of victims (more than half) from the vulnerable road user population.

The most common injury sustained is that of bony trauma, followed by lacerations and burns. The most common cause of trauma for admitted patients is a fall, followed by road traffic accidents, assault and then burns. The burn patients numbers are higher than the surrounding regions of comparable African countries, despite the fact the study took place during the summer season. The death rates of the burns patients are also higher than the comparable countries (Otieno, et al., 2004; Odero, et al., 2007; Demyttenaere, et al., 2009; Samuel, et al., 2009). There is a low uptake (less than 50%) of in-hospital HIV testing. The majority of patients 'brought in dead' to the hospital are not trauma related.

The KTS II has been validated in UTH and is a reliable predictor of mortality. The KTS II was also able to differentiate between patients needing admission and those seen and discharged from casualty. The KTS II was not an a predictor of length of hospital stay, nor did it differentiate patients requiring a surgical procedure and those treated conservatively.

CONCLUSIONS

The group with the greatest trauma problem in the study (26.5%) are children under the age of 12 years: this may reflect the predominance of youth in the population, but

as minors, they are surely worthy of greater protection. The top cause of trauma was found to be falls: as an unexpected finding, there was unfortunately insufficient detail gathered as to the circumstances and mechanism of these falls. The registry was devised with other African studies taken into account, with an emphasis on simplicity and clarity, bearing in mind the data was gathered in a 'minimum data set' (on paper) rather than a comprehensive, extensive (computerised) format. Thus, details such as height of fall, surface of impact (concrete or dirt) and associated activity such as sport, play area, etc. were not gathered. Approximately half the falls (49.7%) were sustained by the children, representing a little over a quarter of the total trauma population, with the remaining falls sustained by the residual three quarters of the trauma population set. The suggestions put forward by the WHO (2008b) for the prevention of falls in children may not be entirely relevant to Zambia: they suggest redesigning play areas and furniture such as bunk beds and cribs and the instillation of window bars in houses (particularly above one storey) and, most constructively, engendering a culture of safety within a community. WHO (2008b) states there is insufficient evidence regarding one-off education efforts, covering wells and ditches and enforcing building codes. It would appear that a combination of safety awareness and better child supervision may be the answer to the problem of child trauma. Improved socio-economic conditions are also known to lessen trauma suffered by children (Grossman, 2000).

Young adult males are a high-risk group sustaining an excessive amount of trauma in Lusaka; the risk to the male youth population is raised in the presence of alcohol intoxication.

It is notable that UTH serves primarily the local greater Lusaka population, despite being a referral centre. The long delay periods between injury and presentation to UTH are thus disappointing, with only two percent of patients from outside Lusaka (with expected delay in presentation) but over 75% of patients present an hour or more after trauma. Traffic congestion in Lusaka, whilst not at levels experienced in Dar es Salaam, Kampala or Nairobi has worsened in recent years as cars have become more available; this is perhaps the reason for the 'other' (police) transport times being more efficient. If time between injury and arrival to hospital is prolonged, it makes sense to provide an emergency trauma transport care service. Advanced pre-hospital

care is favoured in Europe (particularly France) and moved away from in the United States of America (as a result of comparing outcomes in trauma registry studies): it is to be assessed within context before being accepted or discarded (Nathens, et al., 2004). In countries such as Australia, where distances are vast, it is a necessary service, whereas short distances and the availability of helicopter services may obviate the need for the service. Zambia will have to assess the merits of providing advanced immediate roadside care versus basic care with fast efficient transport; either way, the evidence for improved outcomes when receiving definitive trauma management within the first hour of injury has been proven (Nathens, et al., 2004).

There appears to be a lack of common public knowledge regarding the preventability of road traffic accidents and the prevention of the severity of injury that can be sustained. Simple, cost-effective education of road users regarding the use of safety measures such as helmets has reaped rewards in Vietnam, where the uptake of helmet use increased from 30% to above 90%, with head-injuries dropping by 16% and the risk of dying falling by 18% (Joseph & Pearce, 2012). Such measures could be adopted in Lusaka, particularly regarding the use of seat belts, reflective gear in the dark and the use of lights (bicycle, vehicle headlights and streetlights).

Much needs to be done to educate pedestrians. Uptake on walkways that bypass busy roads is low: it is not uncommon to witness pedestrians threading their way through busy traffic with a skywalk overhead! Traffic calming measures and urban planning all need to play a role in the protection of children; some of these actions have been taken in Lusaka on the back of local tragedy. Public education regarding the lack of ability of children to assess risk, appreciate danger and form a distance judgment should be prioritised. Urban planning measures providing safe areas for children to play will also prevent children from playing in the road. Road traffic safety requires a multi-agency response of public media (newspaper, radio and television), traffic agencies (including law enforcement), educational institutions, the alcohol industry and medical professionals to concert their efforts to bring down the death toll on Zambia's roads (Schatz, 2008).

The Global Road Safety Commission released a document entitled *World report on road traffic injury prevention*, in which they laid out national activities that should be

undertaken in order to meet realistic and achievable road safety targets. These are the ‘five pillars of road safety’ (see table 10.1) [UN/WHO, 2010].

Table 10.1: International Co-ordination/Strengthening Global Architecture for Road Safety[UN/WHO, 2010]

Pillar 1	Pillar 2	Pillar 3	Pillar 4	Pillar 5
Road safety management	Infrastructure	Safe vehicles	Road user behaviour	Post crash care

A great deal could be achieved regarding the UTH trauma set up in response to the research findings. The Lusaka trauma population is similar to the world wide trend of the majority of patients presenting with injury requiring at least one orthopaedic procedure (Balogh, et al., 2012). There is clearly a need to prioritise services to deal with orthopaedic injury. The orthopaedic injury numbers demands a response from the orthopaedic surgery team that has to include infrastructure (such as theatres, surgical and imaging equipment) to increased staffing levels (senior and junior doctors, nursing staff and physiotherapists) to meet the huge need. Currently there are probably half the resources in place to deal with the bony injury work load, which requires general surgeons to shoulder the burden. With studies showing quality of life outcomes for those with lower limb bony injury in high income countries being akin to a spinal cord injury, (one year or more after the trauma) [Balogh, et al., 2012], it is doubtful that Lusaka’s orthopaedic trauma victims enjoy better outcomes; efforts should be made to improve recoveries in every way possible, and having expert training and involvement of a specialist team from acute injury to rehabilitation is in a better position to achieve this.

Minor modifications in current service provision at the hospital could improve the flow of trauma patients, such as dedicated areas in casualty where, with adequate light

and equipment, much of the suturing could be done to help release patients earlier after treatment. The HIV counseling services could be encouraged to target more surgical patients to improve the uptake of retroviral disease counseling and testing, as per government aims (AVERT, 2010). Blood availability will probably always be an issue, but more could be done regarding advertising for volunteers to come forward, particularly in times of predicted shortage.

Burns patients, the majority of which are toddler-age children are a particular concern: with incidence levels double those of comparable countries, urgent action is needed. There is no dedicated burns unit in UTH and no special services set aside for these patients. The first need is to decrease the number of victims: public education, using all means of media and perhaps involving antenatal clinic visits may help to alert families as to how to protect their young children from suffering this type of trauma. Facilities at UTH, such as designated areas with specific allocated staff equipped with the means to take care of the burns wounds are needed as a secondary measure. There is also a need for educating the public as to the advantages of early grafting: a local research study uncovered resistance to 'early' grafting (within the first two weeks), which has proven better long-term outcomes (Maimbo, 2012). Optimal management requires nutritionists, physiotherapists, occupational therapists and the equipment needed to graft the burns.

Head injured patients have poorer outcomes in our study: improved management strategies include the prevention of secondary brain injury with the acute provision of oxygen by facemask (not always available in the admission wards) and ventilation for patients with low Glasgow Coma Scores. Acute CT scanning is available, but there are some infrastructure difficulties (particularly with critically unwell patients) as the CT scanner is physically some distance from the casualty area and portable oxygen is usually not available. Further recruitment, improvement of facilities and equipment and incentives are needed to encourage post graduate training in neurosurgery: the workload is exceptionally high for the current team at UTH.

The research hypothesis stated 'The Kampala Trauma Score (KTS II) is a reliable predictor of mortality in trauma patients at UTH'. This statement has been validated in UTH, using descriptive statistics and ROC curves to show that patients with lower

KTS II scores have a statistically significant increased risk of dying from their injury (P value < 0.0001; auc 0.8153). Thus, the KTS II is a useful tool to identify the severity of injury and those patients more likely to need admission. As there are no systems in place to 'triage' unwell patients at UTH (no early warning scores), the KTS II could be used to differentiate those patients who may benefit from early senior input and aggressive management. The score takes minutes to complete, using routinely captured vital signs and basic information (such as age of the patient); it would be possible to embed this score into the initial patient notes as a form of triage.

SUMMARY OF CONTRIBUTIONS

No previous 'trauma registry' has been described in Zambia before this study. This research project has contributed to a knowledge base of the epidemiology of trauma seen in Lusaka, Zambia, the most common forms of injury and the focus needed for public education. Much of the types of trauma, the admission rates and mortality is comparable to work done in other African countries (Kobusingye & Lett, 2000; London et al., 2001; Otieno, et al., 2004; Odera, et al., 2007; Samuel, et al., 2009; Demyttenaere, et al., 2009) with higher rates of falls and burns and injury to children than comparable studies.

The surprise finding of 'falls' causing the greatest trauma to the patients presenting at UTH is a surprise finding and one that needs further investigation. This finding may represent the high numbers of children in the data set, as they were disproportionately represented.

There is a paucity of functioning trauma registries in low and middle income countries (LMICs) [O'Reilly, et al., 2013]. This study has added to the body of literature towards establishing trauma registries appropriate to the LMIC setting.

SUGGESTIONS FOR FURTHER RESEARCH

Further research is needed to address the high number of falls in Lusaka: there is little indication of what the primary causes are – uneven paving, poorly lit streets or gardens with surrounding ditches for the unsuspecting to fall into. Further details regarding the circumstances and mechanisms of falls (such as height of fall, type of surface fallen onto) are needed. Another issue is the high number of burns patients in

this cohort. It would be useful to study causes and circumstances of burns to plan more effective prevention strategies.

Further studies with the data set could be undertaken in other medical centres in Zambia, such as district hospitals and district health clinics to compare incidence and types of trauma sustained in other areas.

Further studies on the longer term outcomes of trauma, in terms of disability, rehabilitation and quality of life are also needed. This manner of study could also guide the type of orthopaedic interventions made available to trauma patients with the most cost effective and appropriate established by evidence in this LMIC setting.

FINAL WORD

This study set out to produce a baseline for a trauma registry in Zambia at the University Teaching Hospital in Lusaka. It has achieved this aim. Gruen & Fitzgerald (2012) have put forward the idea of an international research agenda for trauma, involving both military and civilian practice to agree on achievable global research priorities and devise a road map for such research that can be cost effective and executed to enhance the recovery and rehabilitation of trauma patients. LMICs, such as Zambia, with their significant trauma burden should be part of the world trauma research initiatives so that cost effective, appropriate management strategies can be instituted to alleviate the suffering and death sustained by this group of patients. 'The time has come for injured people to benefit from research-based advances on a scale similar to that which has transformed other domains of health-care' (Gruen & Fitzgerald, 2012).

CHAPTER 11

REFERENCES

- Ardolino A., G. Sleat, K. Willett
Outcome measurements in major trauma—Results of a consensus meeting
Injury, Int. J. Care Injured 43 (2012) 1662–1666
- AVERT- Averting HIV and AIDS World-wide. 'HIV and AIDS in Zambia'
[Online].
Available at: <http://www.avert.org/aids-zambia.htm> [Accessed 19 June 2010].
- Balogh, Z.J., M.K. Reumann, R.L. Gruen, P. Mayer-Kuckuk, M.A. Schuetz, I.A. Harris, B.J. Gabbe, M. Bhandari
Advances and future directions for management of trauma patients with musculoskeletal injuries
Lancet 2012; 380: 1109–19
- Bansal, S., 2012.
Zambia's healthcare system in need of an MOT as road accidents increase
guardian.co.uk, Friday 14 September 2012 07.00 BST [Online]. Available at:
<http://oas.guardian.co.uk/5c/www.guardian.co.uk/global-development/2012/sep/14/zambia-healthcare-system-road-accidents/oas.html/508218662> [Accessed 23 March 2013]
- Baker, C.C., L. Oppenheimer, B. Stephens, F.R. Lewis, D.D. Trunkey, 1980.
Epidemiology of trauma deaths.
The American Journal of Surgery, 140(1), pp.144-150.
- Boyd CR, Tolson MA, Copes WS.
Evaluating trauma care: the TRISS method. Trauma Score and the Injury Severity Score.
J Trauma 1987;27(4):370–8.
- Bowley, D.M.G., E. Degiannis, J. Goosen, and K.D. Boffard, 2002.
Penetrating vascular trauma in Johannesburg, South Africa.
Surgical Clinics of North America, 82(1), pp.221-235.
- Chalya, P.L., J.B. Mabula, R.M. Dass, N. Mbelenge, I.H. Ngayomela, A.B. Chandikand J.M. Gilyoma
Injury characteristics and outcome of road traffic crash victims at Bugando Medical Centre in Northwestern Tanzania [Online]. Available at:
<http://www.traumamanagement.org/content/6/1/1> [Accessed 17 February 2013]
Journal of Trauma Management & Outcomes 2012, 6:1
- Champion HR, Sacco WJ, Copes WS, et al.
A revision of the trauma score.
J Trauma 1989;29:623–629.

- Champion HR, Copes WS, Sacco WJ, et al.
The Major Trauma Outcome Study: establishing national norms for trauma care.
J Trauma 1990;30(11):1356—65.
- Chandran A., A.A. Hyder and C. Peek-Asa., 2010
The Global Burden of Unintentional Injuries and an Agenda for Progress.
Epidemiologic Reviews 2010. Published by Oxford University Press on behalf of the Johns Hopkins Bloomberg School of Public Health.
- Chawda, M.N., F. Hildebrand, H.C. Pape, P.V. Giannoudis
Predicting outcome after multiple trauma: which scoring system?
Injury, Int. J. Care Injured (2004) 35, 347—358
- Coggon, D., G. Rose and D.J.P. Barker, 1997
Epidemiology for the uninitiated, 4th ed. 1997. BMJ. [Online]. Available at:
<http://www.bmj.com/about-bmj/resources-readers/publications/epidemiology-uninitiated> [Accessed 23 March 2010]
- Commission for global road safety, 2009.
Executive Summary: Make roads safe. A decade of action for road safety.
[Online]. Available at:
http://www.makeroadssafe.org/publications/Documents/decade_of_action_exec_summary_EN.pdf [Accessed 15 October 2012].
- Committee on Trauma and Committee on Shock: Division of Medical Sciences, National Academy of Sciences.
Accidental Death and Disability: The Neglected Disease of Modern Society. Washington DC: National Academy of Sciences, September 1966
- Crash-2 trial collaborators, 2010.
Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial.
The Lancet, 10.1016.60835-5
- Demetriades, D., L. Chan, G.V. Velmans, J. Sava, C. Preston, G. Gruzinski, T.V. Berne, 2001
TRISS Methodology: An Inappropriate Tool for Comparing Outcomes Between Trauma Centers
J Am Coll Surg 2001;193:250—254
- Sebastian V. Demyttenaere, S.V., C. Nansamba, A. Nganwa, M. Mutto, R. Lett, T. Razek
Injury in Kampala, Uganda: 6 years later
Can J Surg, Vol. 52, No. 5, October 2009; E146-150

- Dickson, E., Van Niekerk, D., Robertson, S., Goosen, J., Plani F., Boffard, K., 2007.
Ambulance transport is associated with a higher mortality than private transport following major penetrating trauma in a semi-urban environment. *Critical Care*, 11(Suppl 2), p.442.
- Dutton, R.P., L.G. Stansbury, S. Leone, E. Kramer, J.R. Hess, and T. M. Scalea, 2010.
Trauma Mortality in Mature Trauma Systems: Are We Doing Better? An Analysis of Trauma Mortality Patterns, 1997–2008. *The Journal of TRAUMA® Injury, Infection, and Critical Care* • Volume 69, Number 3, September 2010 pp 620-626
- Emenalo, S., Puustelli, M., Ciampi, A., & Joshi, H.P., 1977. Analysis of road traffic accidents data in Zambia. *Accident Analysis & Prevention*, 9(2), pp81-91.
- Evans, D.C., 2007.
From trauma care to injury control: a people's history of the evolution of trauma systems in Canada
Can J Surg, Vol. 50, No. 5, October 2007, pp. 364-369
- Fitzgerald, M.C., A.B. Bystrzycki, N.C. Farrow, P.A. Cameron, T. Kossmann, M.E. Sugrue, & C.F. Mackenzie, 2006.
Trauma reception and resuscitation.
ANZ J. Surg. 2006; 76: 725–728
- Forjuoh, S.N., 2010.
Supporting the UN Decade of Action for Road Safety 2011–2020
International Journal of Injury Control and Safety Promotion, 17:4, 213-214 [Online]. Available at:
<http://dx.doi.org/10.1080/17457300.2010.535246>[Accessed 10 September, 2012]
- Gill, A. C., N. R. Kelly. Editors: J. E. Drutz, M. M. Torchia. 2014.
UpToDate: Prevention of Falls in Children [Online]. Available at:
<http://www.uptodate.com/contents/prevention-of-falls-in-children>
[Accessed 14 March, 2014]
- Goosen, J., D.M. Bowley, E. Degiannis, F. Plani, 2003.
Trauma care systems in South Africa.
Injury, Int. J. Care Injured, 34, pp.704–708
- Gore, M., 2012.
Training in Trauma Care
Indian J Surg (March–April 2012) 74(2):128–130

- Grossman, D.C., 2000.
 The History of Injury Control and the Epidemiology of Child and Adolescent Injuries.
The Future of Children UNINTENTIONAL INJURIES IN CHILDHOOD
 10(1): 23-52 [Online]. Available at: <http://www.futureofchildren.org>
 [Accessed 14 March 2014]
- Grossman, M.D., & S.P. Stawicki, 2006.
 The impact of human immunodeficiency virus (HIV) on outcome and practice in trauma: Past, present and future.
Injury, Int. J. Care injured, 37, pp.1117-1124.
- Gruen, R.L., M.C Fitzgerald
 Towards a maturation of trauma research
Lancet, Vol 380 September 22, 2012, pp.1033-1034
- Haider A.H., et al., 2012.
 Influence of the National Trauma Data Bank on the Study of Trauma Outcomes: Is It Time to Set Research Best Practices to Further Enhance Its Impact?
J Am Coll Surg 2012;214:756–768.
- Hannan, E.L. , L.S. Farrel and C.G. Cayten
 Predicting survival of victims of motor vehicle crashes in New York State
Injury Vol. 28, No. 9-10, pp. 607-615, 1997
- Hardcastle, T.C., and P. Brysiewicz, 2012.
 Trauma care in South Africa: From humble beginnings to an afrocentric outreach
International Emergency Nursing (2012) [Online]. Available at:
<http://dx.doi.org/10.1016/j.ienj.2012.05.002>[Accessed 2 February 2013]
- Hofman, K., A. Primack, G. Keusch, S. Hrynkow, 2005.
 Addressing the Growing Burden of Trauma and Injury in Low- and Middle-Income Countries.
Am J Public Health. 95(13), pp.13-17.
- Honarmand, A., M. Safavi
 The new injury severity score: A more accurate predictor of need ventilator and time ventilated in trauma patients than the injury severity score
Indian J Crit Care Med Oct-Dec 2006 Vol 10 Issue 4
- IPS-Inter Press Service. Geloo, Z., 2004.
 'Health – Zambia: In a quagmire over AIDS testing' [Online]. Available at: <http://www.ips.org/institutional/> [Accessed 19 June 2010].

- Johnston, B.D., 2010.
Road traffic injury prevention.
Injury Prevention, 16(1), p.1.
- Joseph, A., A. Pearce, A., 2012.
Editorial: The future of trauma care
Injury, Int. J. Care Injured 43 (2012) 539–541
- Joshiyura M., C. Mock, J. Goosen, M. Peden, 2004.
Essential Trauma Care: strengthening trauma systems round the world
Injury, Int. J. Care Injured (2004) 35, 841-845
- Kaczynski, J., J. Hilton, 2012.
Trauma care services in the United Kingdom: past, present and future
The Journal of Perioperative Practice; Aug 2012; 22, 8; ProQuest
Hospital Collection pg. 266
- Kehoe, N.J. & J.E. Jellis, 1994.
The incidence of the human immunodeficiency virus in injured patients in
Lusaka.
Injury, 25, pp.375-378.
- Kobusingye, O.C., R.R. Lett, 2000.
Hospital-Based trauma registries in Uganda.
The Journal of Trauma: Injury, Infection and Critical Care, 48(3), pp.498-
502.
- Lagarde, E., 2007.
Road Traffic Injury Is an Escalating Burden in Africa and Deserves
Proportionate Research Efforts.
PLoS Med, 4(6): 170 [Online]. Available at:
<http://www.plosmedicine.org/article/info:doi/10.1371/journal.pmed.0040170>[Accessed 20 June 2010].
- Lansink K.W.W. and L.P.H. Leenen, 1999.
Do designated trauma systems improve outcome?
Current Opinion in Critical Care 2007, 13:686–690
- Lansink, K.W.W. and L.P.H. Leenen, 2012.
History, development and future of trauma care for multiple injured
patients in the Netherlands
Eur J Trauma Emerg Surg 2012
- Lanzarotti, S., C.S. Cook, J.M. Porter, D.G. Judkins, M.D. Williams, 2003.
The cost of trauma.
The American Surgeon; Sep 2003; 69, 9; ProQuest Hospital Collection pg.
766

- Lavy, C., 2005.
 Open letter to Tony Blair on publication of the report of the Commission for Africa
BMJ 2005;331;46-47
- Lefering, R., 2013
 Trauma scoring systems
Trauma Volume 18 _ Number 6 _ December 2012 [Online]. Available at:
www.co-criticalcare.com [Accessed 2 Feb 2013]
- Lefering R., S. Ruchholtz
 Trauma registries in Europe
Eur J Trauma Emerg Surg (2012) 38:1–2
- Leppäniemi, A.K., 2009.
 Update on global trends in trauma.
Trauma 2009; **11**: 37–47
- Levin, K.A., 2006
 Study design III: Cross-sectional studies
Evidence-Based Dentistry (2006) 7, 24–25.
- London, J.A., C. N. Mock, R.E. Quansah, F.A. Abantanga, G.J. Jurkovich, (2001).
 Priorities for Improving Hospital-Based Trauma Care in an African City.
The Journal of Trauma: Injury, Infection, and Critical Care, 51(4), pp.747-753.
- Lozano R., et al., 2012.
 Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010
Lancet 2012; 380: 2095–128
- Luboga S, S.B. Macfarlane, J. von Schreeb, M.E. Kruk, M.N. Cherian, et al., 2009
 Increasing Access to Surgical Services in Sub-Saharan Africa: Priorities for National and International Agencies Recommended by the Bellagio Essential Surgery Group.
PLoS Med 6(12), pp.100-1020.
- MacKenzie E. J., et al., 2006.
 A National Evaluation of the Effect of Trauma-Center Care on Mortality
N Engl J Med 354:4 January 26, 2006. [Online]. Available at:
www.nejm.org [Accessed 24 April 2012]
- Macleod, J.B.A., O. Kobusingye, C. Frost, R. Lett, 2007
 Kampala Trauma Score (KTS): Is it a New Triage Tool?
East and Central African Journal of Surgery Volume 12 Number 1 - April 2007 pp 74-82

- MacLeod, J.B.A, O. Kobusingye, C. Frost, R. Lett, F. Kirya, C. Shulman, 2003
A Comparison of the Kampala Trauma Score (KTS) with the Revised Trauma Score (RTS), Injury Severity Score (ISS) and the TRISS Method in a Ugandan Trauma Registry. Is Equal Performance Achieved with Fewer Resources?
European Journal of Trauma 2003 No. 6 pp 392-398
- Maimbo, M., 2012.
Early versus late grafting in burns patients at a teaching hospital in Lusaka
Masters of Medicine (Surgery) Dissertation, School of Medicine, University of Zambia, Lusaka.
- Mann N.C., R.J. Mullins, E.J. MacKenzie, G.J. Jurkovich, C.N. Mock, 1999
Systematic review of published evidence regarding trauma system effectiveness.
J Trauma. 1999 Sep;47(3 Suppl):S25-33.
- Marquez, P., and J.Farrington, 2012.
Africa's next burden. Non-infectious disease.
BMJ, **345**, pp.24-27
- Masud, T., R. O. Morris, 2001.
Epidemiology of Falls.
Age and Ageing, **30-S4**: 3-7
- Mock, C.N., M. Tiska, M. Adu-Ampofo, G. Boakye, 2002.
Improvements in prehospital trauma care in an African country with no formal emergency medical services.
The Journal of Trauma: Injury, Infection, and Critical Care: 2002 Volume 53 - Issue 1 - pp 90-97
- Mock C., J.D. Lormand J. Goosen, M. Joshipura, M. Peden, 2004.
Guidelines for essential trauma care.
Geneva, World Health Organization, 2004
- Moore L., D.E. Clark
The value of trauma registries Injury
Int. J. Care Injured (2008) 39, 686—695
- Moore, L., A. Lavoie, A.F. Turgeon, B. Abdous, N. Le Sage, M. E'mond, M. Liberman, E. Bergeron, 2010
Improving Trauma Mortality Prediction Modeling for Blunt Trauma
J Trauma. 2010;68: 698–705
- Morrison, C.A., M.M. Wyatt, M.M. Carrick, 2010.
Effects of human immunodeficiency virus on trauma outcomes: a review of the national trauma database.
Surgical infections, 11(1), pp.41-47.

- Mtonga, R.E., Zavala, D.E., 2008.
Implementing a Hospital Based Injury Surveillance System in Zambia - A Preliminary Report. [Poster presentation].
Medicine, conflict and survival, supplement.
- Mukhopadhyay, B., R. Boniface and T. Razek
Trauma in Tanzania: researching injury in a low-resource setting
McGill Journal of Medicine 2009 12(2): 27-33
- Mullins R.J., N.C. Mann
Population-based research assessing the effectiveness of trauma systems.
J Trauma. 1999 Sep;47(3 Suppl):S59-66.
- Mulundika, J.I.M., 1999.
Characteristics of road traffic accident victims with special reference to alcohol intoxication in the University Hospital.
Masters of Medicine (Surgery) Dissertation, School of Medicine,
University of Zambia, Lusaka.
- Mutooro S.M, E. Mutakooha, P. Kyamanywa
A Comparison of Kampala Trauma Score II with the New Injury Severity Score in Mbarara University Teaching Hospital in Uganda.
East and Central African Journal of Surgery Volume 15 Number 1.
March/April 2010. Pp 62-71
- Naci, H., Chisholm, D., and Baker, T.D., 2009.
Distribution of road traffic deaths by road user group: a global comparison
Injury Prevention 2009;15:55-59.
- Nathens, A.B., F.P. Brunet, R.V. Maier, 2004.
Development of trauma systems and effect on outcomes after Injury
Lancet 2004; 363: 1794-801
- National audit office. Report by the comptroller and auditor general. HC 213
Session 2009-2010.
Major trauma care in England. [Online]. Available at:
http://www.nao.org.uk/publications/0910/major_trauma_care.aspx
[Accessed 24 April 2012]
- National Highway Traffic Safety Administration (NHTSA), 2002.
Trauma System Agenda for the Future. [Online] Washington, DC
Available at:
<http://www.nhtsa.dot.gov/people/injury/ems/emstraumasystem03/vision.htm>
[Accessed 28 February 2010].
- National Highway Traffic Safety Administration (NHTSA), 2006.
Appendix A - Glossary of Terms - NHTSA [Online]. Available at:
www.nhtsa.gov/people/injury/ems/pandemicinfluenza/PDFs/AppA
[Accessed 23 March 2010]

- New International Version, 1984.
The Holy Bible. Grand Rapids, Michigan: Zondervan
- Nicholl, J., J. Turner, 1997.
 Effectiveness of a regional trauma system in reducing mortality from major trauma: before and after study
BMJ 1997;315:1349
- Nwomeh, B.C., W. Lowell, R. Kable, K. Haley and E.A. Ameh, 2006.
 History and development of trauma registry: lessons from developed to developing countries.
World Journal of Emergency Surgery, (1)32, pp.1749-7922.
- Odero, W., S. Polsky, D. Urbane, R. Carel and W.M. Tierney
 Characteristics of injuries presenting to a rural health centre in western Kenya
East African Medical Journal vol 84 no 8 August 2007, pp.367-373.
- Odimba, E.B.F.K., 1996
 The Kalomo Train Disaster: Medical Lessons Learnt
Journal of Medicine and Health Sciences, 1996; 2: 17-9.
- Odimba, E.B.F.K., 2007
 Aspects particuliers des traumatismes dans les pays peu nantis d'Afrique. Un vécu chirurgical de 20 ans (Specific aspects of trauma in African developing countries. A 20-year Surgical Experience)
e-mémoires de l'Académie Nationale de Chirurgie, 2007, 6 (2) : 44-56
- Odimba, E.B.F.K., Y. Mulla, G. Desai, K. Bowa, L. Chikoya, 2007.
 The compliance of surgical patients to routine diagnostic counselling, testing and care about HIV infection at the University Teaching Hospital (UTH), Lusaka.
 In: UNZA (University of Zambia), *First International Multi-discipline Conference on recent advances in research*. Lusaka, Zambia. Directorate of research and graduate studies, UNZA, Lusaka.
- Odimba, E.B.F.K., L. Munkonge, 2002.
 Epidemiological characteristics of injury and violence in Zambia and its prevention.
 In: UNZA (University of Zambia), *First International Multi-discipline Conference on recent advances in research*. Lusaka, Zambia. Directorate of research and graduate studies, University of Zambia, Lusaka.
- Oluwadiya, K.S, S.O Popoola, L.M Oginni
 The performances of the Glasgow Coma Scale, the Revised Trauma Score, the Triage Revised Trauma Scores and the Kampala Trauma Score in predicting mortality in the accident and emergency ward of a teaching hospital in Nigeria
Inj Prev 2010 16: A 193

- O'Reilly, G.M., P.A Cameron, M. Joshipura
Global trauma registry mapping: A scoping review
Injury, Int. J. Care Injured 43 2012 1148–1153
- Otieno, T., J.C. Woodfield, P. Bird, A.G. Hill
Trauma in rural Kenya
Injury, Int. J. Care Injured 2004 35, 1228—1233
- Ozgediz D. and R. Riviello, 2008
The “Other” Neglected Diseases in Global Public Health: Surgical
Conditions in Sub-Saharan Africa.
PLoS Med 5(6): e121. doi:10.1371/journal.pmed.0050121
- Peden M., R. Scurfield, D. Sleet, et al., eds.
World report on road traffic injury prevention.
Geneva: World Health Organization, 2004
- The Quality Assurance Project (QAP), 2008.
U.S. Agency for International Development (USAID). [Online].
Available at: <http://www.qaproject.org/>[Accessed 12 July 2010].
- Republic of Zambia, National HIV/AIDS Council, 2006.
National HIV and AIDS strategic framework 2006-2010.
- Rivara, F.P., S. Tollefson, E. Tesh, and L.M. Gentilello, 2000.
Screening Trauma Patients for Alcohol Problems: Are Insurance
Companies Barriers?
The Journal of Trauma: Injury, Infection, and Critical Care, 48(1),
pp.115-118.
- Road Transport and Safety Agency (RTSA), Republic of Zambia, 2009.
Annual Report for 2008, pp.1-48.
- Rosenfeld, J.V., A.I. Maas, P. Bragge, M.C Morganti-Kossmann, G.T Manley,
R.L Gruen, 2012.
Early management of severe traumatic brain injury
Lancet Vol 380 September 22, 2012, pp.1088-1098
- Samuel, J.C., A. Akinkuotu, A. Villaveces, A.G. Charles C.N. Lee, I.F. Hoffman,
W.C. Miller, P. Baloyi, M. Hoffman, L.B. Brown, A.P. Muyco, 2009.
Epidemiology of Injuries at a Tertiary Care Center in Malawi
World J Surg 2009 33:1836–1841
- Sasser S., M. Varghese, A. Kellermann, J.D. Lormand, 2005.
Prehospital trauma care systems.
Geneva, World Health Organization, 2005

- Schatz, J., 2008
 On the road in Zambia
The Lancet Vol 372 August 9, 2008 [Online]. Available at:
www.thelancet.com[Accessed 15 October 2012]
- Schluter, P.J., 2011 a
 Trauma and Injury Severity Score (TRISS): Is it time for variable re-categorisations and re-characterisations?
Injury, Int. J. Care Injured 42 (2011) 83–89
- Schluter, P.J., 2011 b
 The Trauma and Injury Severity Score (TRISS) revised
Injury, Int. J. Care Injured 42 (2011) 90–96
- Senkowski, C.K., M.G. McKenney, 1999
 Trauma Scoring Systems: A Review
J Am Coll Surg Vol. 189, No. 5, November 1999 pp 491-503
- Smith, R.S., 2000.
 Routine Drug Screening in Trauma Patients.
South Med J. 2000;93(4). [Online]. Available at:
<http://www.medscape.com/viewarticle/410530> [Accessed 23 June 2010].
- Søreide, K., 2009.
 Epidemiology of major trauma.
British Journal of Surgery 2009; **96**: 697–698
- Stelfox, H.T., S.E. Straus, A. Nathens, B. Bobranska-Artiuch, 2011.
 Evidence for quality indicators to evaluate adult trauma care: A systematic review
Crit Care Med 2011; 39:846–859
- Taira, B.R., K.A.K. McQueen, and F.M. Burkle, Jr, 2009.
 Burden of Surgical Disease: Does the Literature Reflect the Scope of the International Crisis?
World Journal of Surgery, 33(5), pp.893-898.
- Tarighi, P., Tabibi, S.J., Motevalian, S.A., Tofighi, S., Maleki, M.R., Delgoshaei, B., Panahi, F., Masoomi, G.R., 2012.
 Designing a Model for Trauma System Management Using Public Health Approach: The Case of Iran
Acta Medica Iranica, Vol. 50, No. 1 2012
- Üddemann, A.P.I., C. Parry, H. Donson, A. Sukhai, 2004.
 Alcohol use and trauma in Cape Town, Durban and Port Elizabeth, South Africa: 1999-2001
International Journal of Injury Control and Safety Promotion, 11(4), pp.265-267

- United Nations Road Safety Collaboration, 2010.
Draft plan for the decade of action for road safety 2011-2020.
[Online]. Geneva. World Health Organization. Available at:
<http://www.who.int/roadsafety/en/> [Accessed 2 March 2010].
- University Teaching Hospital (UTH), 2009.
Activities analysis by department. Report of the year 2009. University
Teaching Hospital, Lusaka, Zambia.
- Uranüs, S., S. Lennquist, 2002.
Trauma management and education in Europe: a survey of twelve
geographically and socioeconomically diverse European countries
Eur J Surg 2002; 168: 730-735
- Warner, E.A., R.M. Walker, P.D. Friedmann, 2003.
Should Informed Consent Be Required for Laboratory Testing for Drugs of
Abuse in Medical Settings?
The American Journal of Medicine, 115 , pp.54-58
- Watts H.F, Y. Kerem, E.B. Kulstad, 2012.
Evaluation of the revised trauma and injury severity scores in elderly
trauma patients
Journal of Emergencies, Trauma, and Shock 5:2 pp 131-134. Apr - Jun
2012
- Willis, C.D., B.J. Gabbe, P.A. Cameron, 2007.
Measuring quality in trauma care
Injury, Int. J. Care Injured (2007) 38, 527—537
- World Health Organization, 2002.
*THE INJURY CHART BOOK: A graphical overview of the global burden
of injuries*. [Online]. Geneva. World Health Organization.
Available at:
www.who.int/entity/...injury...injury/chartb/en/index.htm [Accessed 28
February 2010]
- World Health Organization, 2007 a.
Sixtieth World Health Assembly. Health systems: emergency-care
systems. [Online]. Geneva. World Health Organization.
Available at: [www.who.int/gb/ebwha/pdf_files/WHA60/A60_R22-
en.pdf](http://www.who.int/gb/ebwha/pdf_files/WHA60/A60_R22-en.pdf) [Accessed 26 February 2010]
- World Health Organization, 2007 b.
Ten statistical highlights in global public health. [Online]. Available at:
www.who.int/whosis/whostat2007_10highlights.pdf [Accessed 6 July
2010].

- World Health Organization, 2008a.
The global burden of disease: 2004 update. [Online]. Geneva. World Health Organization. Available at:
www.who.int/healthinfo/global_burden_disease/2004_report_update/en/index.html [Accessed 19 October 2012]
- World Health Organization, 2008b.
World report on child injury prevention Edited by M. Peden, et al. [Online]. Geneva. World Health Organization. Available at:
http://www.who.int/violence_injury_prevention/child/injury/world_report/Falls_english.pdf [Accessed 14 March 2014]
- World Health Organization, 2009.
Global Forum on Trauma Care. [Online]. Rio de Janeiro, Brazil. Available at:
www.who.int/.../traumacare/global_forum_meeting_report.pdf [Accessed 26 February 2010].
- World Health Organization, 2013.
 Key policy documents: Humanitarian Health Action. Definitions: emergencies Glossary of Humanitarian Terms - ReliefWeb. [Online]. Available at:
<http://www.who.int/hac/about/definitions/en/> [Accessed 23 March 2013]
- Yates, D.W.
 Scoring systems for trauma
BMJ Vol 301 10 November 1990 pp 1090-1094
- Zavala, D.E., S.J.I.A. Bokongo, I.P. Senoga, R.E. Mtonga, A.Z. Mohammed, W.O. Anjango, P. Olupot-Olupot, 2008.
 Implementing a hospital-based injury surveillance system in Africa: lessons learned.
Medicine, conflict and survival, 24(4), pp.260-272.
- Zong Z, N. Li, T. Cheng, X. Ran, Y. Shen, Y. Zhao, Q. Guo, L. Zhang
 Current state and future perspectives of trauma care system in mainland China
Injury, Int. J. Care Injured 42 (2011) 874–878