

PhD Submission

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A Trauma System for KwaZulu Natal – Local Development for Local Need

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at the University of KwaZulu-Natal

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Declaration

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Frontispiece

“In life, every man has twin obligations – obligations to his family, to his parents, to his wife and children; and he has an obligation to his people, his community, his country. In a civil and humane society, each man is able to fulfil those obligations according to his own inclinations and abilities.”

Nelson R Mandela

Long Walk to Freedom. Chap 115: 749. Little, Brown and Company, London, 1994

Dedication and notes of thanks

Firstly, to thank the Lord for life, energy and passion in pursuing this project to completion. Thanks also to Tracy and Jonathan for hours sacrificed during the times of reading, writing and data analysis (and to Jennanice for allowing completion of the main papers before her arrival!). Thanks to David Muckart for quiet and continual advice and encouragement, allowing me the leeway to conduct the research and the ever watchful editorial eye in the drafting of the manuscripts. Thanks to the many collaborators, expert advisors and other co-authors on the papers for their input in the study design, advice on content and contributions. Thanks for the quiet, patient, but firm support from my Supervisor Sandie Thomson.

Without all of the willing assistance and patient tolerance this project would not have reached completion. I hope that this project is evidence that I am trying to fulfil both aspects of my obligations to family and society as espoused by the father of our nation.

Tim Hardcastle, January 2013

Additional note: A word of thanks to the three examiners for the time spent reviewing and commenting on the original submission that enabled the final submission to be acceptable for the degree after their excellent suggestions were incorporated.

Tim Hardcastle, November 2013

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PhD Submission Summary

Introduction: The need for Trauma Care in South Africa is without question one of the four major health issues facing the country and indeed the African continent today. First-world developed systems focus on the care of trauma from prevention to rehabilitation, yet in Africa the issue of access to even resuscitation is often the challenge faced by communities in poverty. The philosophical concepts which underpin the main thrust of the thesis are summarised as the introductory chapter. “The 11 P’s of an Afrocentric trauma system for South Africa” and “Guideline for the assessment of trauma centres for South Africa” were the result of this literature review. “Trauma care in South Africa: From humble beginnings to an afrocentric outreach” examines the history of trauma care in South Africa and the current desire to be relevant to the greater African Continent, highlighting the realities of practicing trauma care in this country. Local development is essential with regionally specific injury profiles, especially in a country like South Africa with very high trauma rates when compared to the rest of the world.

Aim: This PhD submission aims to review the practical problems and the ethical issues facing trauma in South Africa. This submission examines the current burden of disease of live-injured patients entering the existing informal system in KwaZulu-Natal, both at a prehospital and in-hospital level of care. This submission also examines the current facilities and transfer processes within the government hospital sector, including specifically the utilization of the Level 1 Trauma Centre at Albert Luthuli Central Hospital. The submission aims to provide a solid provincial dataset on which to design a proposal for a practical system of trauma care across the province, and that may be potentially exportable to the rest of the country, and to Africa.

Methods: This PhD proposal provides the evidence for the achievement of the stated aims through the submission of linked papers published in peer-reviewed medical journals relevant to the field of study covering an overview of the literature, examination of the ethical challenges in trauma facing South Africa, and the need for trauma systems. The current prehospital and hospital disease burden is examined and facility structure and staff skill-sets reviewed. A review of utilisation of and need for a major trauma centre is undertaken. Finally the thesis proposes an appropriate regionalised trauma system, emphasising the need for more

such facilities across the province. The methods were described in the approved protocol and these are presented in the overview chapters.

Results:

The three papers that form the thrust of the scientific contribution of this work were all published in July 2013 in World Journal of Surgery and are as follows:

1. The Prehospital Burden of Disease due to Trauma in KwaZulu-Natal: The Need for Afrocentric Trauma Systems.
2. An Assessment of the Hospital Disease Burden and the Facilities for the In-hospital Care of Trauma in KwaZulu-Natal, South Africa.
3. Utilisation of a Level 1 Trauma Centre in KwaZulu-Natal: Appropriateness of Referral Determines Trauma Patient Access

All three studies received BREC approval (BE011/010).

The essential methodology, findings and conclusions derived from these three papers are outlined here:

Paper 1:

Methods: Using a convenience data set all Emergency Medical Service (EMS) call data for the months of March and September 2010 were reviewed for the three main EMS providers in KZN. Data were extrapolated to annual data and placed in the context of population, ambulance service, and facility. The data were then mapped for area distribution and prehospital workload relative to the entire province. Questionnaire-based assessments of knowledge and deficiencies of the current system were completed by senior officers of the provincial system as part of the analysis of the current system.

Results: The total annual call burden for trauma ranges between 94,840 and 101,420, or around 11.6 trauma calls per thousand of the population per year. Almost 70 % of calls were either for interpersonal intentional violence or vehicular collisions. Only 0.25 % of calls involved aeromedical resources. Some 80 % of patients were considered to be moderately to seriously injured, yet only 41 % of the patients were transported to a suitable level of care immediately, with many going to inappropriate lower level care facilities. Many rural calls are not attended within the time norms accepted nationally. Deficiencies noted by the questionnaire survey are the general lack of a bypass mechanism and the feeling among staff that most EMS bases do not have a bypass option or feel part of a system of care, despite large numbers of staff having been recently trained in triage and major trauma care.

Conclusions: The prehospital trauma burden in KZN is significant and consumes vital resources and gridlocks facilities. A prehospital trauma system that is financially sustainable and meets the needs of the trauma burden is proposed to enable Afrocentric emergency care planning for low and middle income regions.

Paper 2:

Methods: Hospital administrators in KZN were requested to submit trauma caseloads for the months of March and September 2010. Caseloads were reviewed to determine the trauma load for the province per category using two extrapolation methods to determine the predicted range of annual incidence of trauma, intentional versus non-intentional trauma ratios and population-related incidence of trauma. The results were GIS mapped to demonstrate variations across districts. Hospital data were obtained from assessments of structure, process, and personnel undertaken prior to a major sporting event. These were compared to the ideal facilities required for accreditation of trauma care facilities of the Trauma Society of South Africa and other established documents.

Results: Data were obtained from 36 of the 47 public hospitals in KZN that manage acute emergency cases. The predicted annual trauma incidence in KZN ranges from 124,000 to 125,000, or 12.9 per 1,000 population. This would imply a national public hospital trauma load on the order of at least 750,000 cases per year. Most hospitals are required to treat trauma; however, within KZN many hospitals do not have adequate personnel, medical equipment, or structural integrity to be formally accredited as trauma care facilities in terms of existing criteria.

Conclusions: There is a significant trauma load that consumes vital emergency center resources. Most hospitals will need extensive upgrading to provide appropriate care for trauma. An inclusive trauma system needs to be formalized and funded, especially in light of the planned National Health Insurance for South Africa.

Paper 3:

Methods: An audit was performed of the referral proformas used in the unit to record admission decisions and of the computerised trauma database. The audit examined referral source (scene vs. interhospital), regional distribution, and final decision regarding admission of the injured patients. The study was approved by the UKZN Ethics Committee (BE207/09 and 011/010).

Results: Of the 1,212 external consults, 540 were accepted for admission while the rest were not accepted for various reasons. These included 206 cases where no bed was available, 233 did not meet admission criteria (minor injury or futile situation), and 115 were for subspecialty management of a single-system injury. Finally, 115 were initially refused pending stabilisation for transfer at a regional facility. Twenty-six percent of the cases were referrals from the scene, with an acceptance rate of 96 %. Most patients (59 %) were from the local eThekweni region.

Conclusion: Major multiorgan system trauma remains a significant public health burden in KwaZulu-Natal. A Level 1 Trauma Service is used appropriately in most circumstances. However, the additional need for more hospital facilities that provide such services across the whole province to enable effective geographical coverage for those trauma patients requiring such specialised trauma care is essential.

After evaluation of the submitted papers a summative chapter is provided as to how they provide a framework to design a Trauma System relevant to KZN, South Africa and potentially Africa.

Overall Conclusions: In the developed world trauma systems have been shown to substantially reduce mortality and morbidity after major and moderate trauma. Few such systems and centres of excellence exist within the developing world scenario. The solutions offered by such systems may not be entirely relevant to the African scenario. A trauma system relevant to KwaZulu-Natal, South Africa and the African continent is essential to reduce the huge mortality burden in low to middle income regions, where trauma is a major source of reduced life-years. The results of the studies presented here are valuable in providing insight to the needs and potential solutions to the challenges faced in our environment. A plea is therefore made for pilot implementation at provincial level. This will involve further research into the feasibility of introduction and how such an introduction could be audited and refined for broader adoption in South Africa and the African continent.

Chapter 1 – Background and protocol development

Trauma centre and system development: An opening summary

Global trauma perspective

Trauma is a disease process that is intimately related to man's interaction with other people and his/her environment. Trauma is the leading cause of non-natural death, a major cause of permanent disability and leaves the economically active population group most affected, thus increasing the real costs of injury to society. [1]

Globally, injuries constitute a major cause of mortality with around 10 deaths every minute due to violence and injury across the world. That implies almost 6 million trauma deaths and many millions of persons seeking treatment for non-fatal injury worldwide. Ninety percent of these injuries are in the so-called developing world, which comprises the low and middle income countries (LMIC). [2]

South African Burden of Disease

South Africa is included in the list of LMIC countries and the injury burden is heavily influenced by two major underlying factors: motor vehicle collisions and interpersonal violence. South Africa has limited accurate statistics on the burden of injury, with most studies examining the fatality-cohort. However in 2007, Norman and colleagues highlighted the fact that in this country interpersonal violence was at seven times the global average and motor vehicle related injuries double that of the global average. They highlighted additionally that prevention strategies would assist in curbing this unhealthy trend. In work from the same group at the Medical Research Council it transpired that in 1999 the estimated trauma disease burden was approximately 40/1000 persons in the population.[3,4,5]

International trends in trauma care

Over the preceding five to six decades great advances have been made in the treatment of trauma with the establishment, firstly in Birmingham in the United Kingdom in 1941 [6,7] and later, more visibly, in the United States of America, in 1966 at Cook County Hospital of so-called "trauma centers" – comprehensive centers of excellence where each and every speciality and sub-speciality of medical provider and allied health professional was present to provide initial assessment, quality resuscitation and definitive care and most importantly to

speed the recovery of the patient with appropriate rehabilitation facilities. This has been demonstrated to positively impact on overall outcome. [8,9]

South African Trauma Centres

South Africa followed this trend with formal establishment of major trauma services at Johannesburg (Charlotte Maxeke [1962] and Baragwanath Hospitals) [7], Groote Schuur [1982], Tygerberg Hospital [1987] and Pelenomi Hospitals and at Milpark in the private sector. In KZN, as recommended by Muckart in 1991 [1], the same is true of Inkosi Albert Luthuli Central Hospital, where the facilities were among the most modern in the country when the unit opened in 2007. Trauma remains a large component of the emergency surgical and orthopaedic workload at most public hospitals, even where formal trauma services do not exist. [10]

The concept of Trauma Systems

Progressing from this developed the concept of a trauma system, where the services and facilities outside the major trauma centers were included to provide optimal care and referral of the appropriate patient to the appropriate higher level of care facility. The system concept includes the integration of the pre-hospital fire and medical rescue services (EMS) into the matrix as well as the development of sufficient inter-facility and inter-service communications systems so that the right patient gets to the right level of care within a defined optimal period of time. [8,9]

Developments toward Trauma systems in Africa and South Africa

In Africa, in general, and more specifically in South Africa, some important steps have been taken with regard to setting criteria for the development of emergency and trauma systems [11-21]. The World Health Organisation (WHO) has taken the initiative to try and formalize standards for middle and low-income countries wishing to establish trauma and pre-hospital systems, and these recommendations were developed with the input of a number of South African trauma experts. [22,23,24] By establishing criteria for individual hospitals and accreditation of the individual hospitals the potential system can then be established by determining appropriate referral pathways, audit pathways, bypass or step-down facilities and feedback-loops for quality improvement.

The Trauma Society of South Africa has created a set of standards against which hospitals can be assessed to determine if they meet criteria for certain levels of trauma care provision [25] that have been revised recently and peer-reviewed prior to publication [26]. In the introduction to the revised version a concerted effort was made to highlight that it is less about “centers” and more about a “system of care” in providing optimal injury care.

Other South African developments

The EMS in South Africa has evolved into a highly trained profession with independent practice rights and a self-regulating professional board [27]. The Emergency Medicine Society, Trauma Society and the Council of Health Service Accreditation of South Africa (COHSASA) have developed a set of standards, guidelines and norms for the staffing and equipment of Emergency Centres in both the public and private domains. [28] These trends have been complimented by the parallel advances in the creation of appropriate postgraduate qualifications. Trauma surgery has recently become a separate sub-specialist discipline in Surgery [29] and Emergency Medicine was recently established as a specialty in its own right [30]. This will hopefully lead to improved overall care of not just the trauma victim but all those presenting with all medical emergencies. Those in rural areas often have limited access to experienced and enthusiastic caregivers while in the urban areas overworked experienced trauma providers burn out due to the workload and lack of modern facilities and equipment to deal with the volume of trauma. [31] A national priority arose to meet the international standards of trauma care in light of the emergency medical services requirements for the FIFA 2010 Soccer World Cup. [32]

This is a summary of the key concepts that are further explored in depth in the Literature Overview.

Literature Overview

Historical context.

Trauma has been called a malignant epidemic [1] and the “neglected disease” of the modern era [18]. This is due to the common occurrence, yet relatively scant attention paid to the study and treatment thereof in mainstream medical curricula prior to the National Academy of Sciences report of 1966 [33]. This was the first report to highlight the challenges of trauma,

which increased public awareness and led to the establishment of a federal agenda for trauma system development in the USA.

The treatment of trauma has traditionally been the treatment of war wounds. [34] From the experiences of the First and Second World wars the British and US trained surgeons returning to civilian practice began to implement the strategies that had decreased mortality and morbidity in the field to the civilian sector. The result was the development of the Birmingham Accident Hospital in 1941 with a mobile medical unit and the first true Trauma Team in the civilian environment. [7] In America, surgeons in San Francisco and Chicago provided dedicated trauma care in the emergency room to the injured and the first Trauma Centres were established in 1966, soon to be followed by the now-famous R Adams Cowley Shock-Trauma Centre in Baltimore in 1969. [8] This has progressed through establishment of national policies and funding strategies with the establishment of classification systems for Trauma Centers in the USA and processes for the accreditation and monitoring the quality of care provided in the dedicated centers.

In South Africa the first Accident and Injury unit was established at the Johannesburg Hospital by Wilkinson in 1962 after his visit to Birmingham in 1960 [7] and was supported by the Medical school of the Witwatersrand. Indeed this means that a trauma center in South Africa actually preceded the centers in the USA by some years. Groote Schuur [1982], Tygerberg Hospital [1987] and Pelenomi Hospitals and at Milpark in the private sector. Lately the unit at Inkosi Albert Luthuli Central Hospital was established in 2007.

Trauma system development

Trauma systems developed as a need was identified for better care of the injured. A system is defined as: A set of things working together as parts of a mechanism or an interconnecting network [34]. In the context of trauma this refers to a complex interaction of Prehospital care, Emergency Center care and Definitive care. There is also a growing emphasis on the inclusion of rehabilitation services as part of this system. A trauma system is thus defined as an organized approach to acutely injured patients within a defined geographical area providing full and optimal care integrated with the EMS system. [35]

Initially the trauma system consisted only of “centers of excellence” in a sea of indifference, however it was soon noted that inclusion of the entire spectrum of care-givers led to better

outcomes and so was born the surgeon-led trauma systems typical of many First World, developed, high income countries of today [34]. This, too, has led to the newer philosophies of care for the severely injured, including the philosophy of “damage control” surgery [36,37,38], the development of specialized trauma ICU facilities and early rehabilitation interventions to decrease not only mortality, but also morbidity and to optimize the return to functional activity of the productive age-group who constitute the majority of trauma patients. [35]

The Developed World scenario

Depending on where one finds oneself in the Developed World, there may be excellent or developing systems [8], however, in the developed world the focus has shifted toward researching methods to improve outcome, focussing on the need for trauma prevention. The developed world is marked by adequate resources and a lesser trauma burden compared to the developing world [8]. The access to advanced diagnostic services and expensive medications and therapeutic devices leads to a reduction in mortality, which is not appreciated in the developing world.

The major characteristic of developed world systems is that there is a comprehensive package of care delivered to the injured person. [35] This will include clinical care, resource management, training, facilities, rehabilitation, communication systems, medical clinical governance, public participation and trauma prevention. Also care may include services for transfer and retrieval, system regulation and performance assessment and finally also regional regulation and standard generation.

In the developed world there is most often rapid access to emergency ambulance services with highly trained pre-hospital providers, even in less developed systems, with access to aeromedical support and transfer to well equipped major teaching hospitals in most urban and suburban areas. The less developed systems are generally found in rural regions where the population density does not justify or afford the expenses of locally based advanced care. However, even in these systems some care is presented and standards are generated that must be achieved. This has particularly been examined in the rural USA and Australia, where decentralized specialist services and retrieval systems exist to get the patient to appropriate care after initial generalist care. [39,40]

The individual levels of care at individual hospitals within the system may provide for differences based on admission severity, such that some hospitals will initially see and treat all injuries, the so-called “inclusive” care component, transferring those with a certain grade of severity out to more selective so-called “exclusive” units either within that same hospital, or to other regional referral centers. These inclusive trauma care systems incorporate every health care facility within a community providing a continuum of services to all acutely injured persons, with level of care matched to the clinical need of the patient.

The American College of Surgeons Committee on trauma have established criteria for the benchmarking of the level of care at individual trauma centers, defining both the level of the center itself and the requirements for the involvement of sub-specialities in the care of particular special injuries. They also specify regulations for performance improvement, regulation, research and major incidents with mass casualties. [41] These criteria will be reviewed in more depth in a following section.

The challenges facing the Developing World

Brazil

Brazil in South America is an example of a system in transition. [42] General surgeons caring for trauma have often only 2 years of post-medical school surgical training if working in rural and under-resourced areas, while in the cities the specialist is respected while the generalist is looked down upon, thus discouraging practitioners from general surgical practice, including trauma. Additionally Emergency Medicine is not a recognized speciality, yet the emergency centers are overcrowded and the work there is poorly remunerated. As with emergency care, there is a lack of access to critical care beds, with a situation not dissimilar to that in South Africa, with a primary care focus in daily medical care. What is envisioned is the recognition of an Acute Care Surgical speciality with trauma, emergency surgery and critical care as a separate speciality that will be adequately remunerated, offering patients a surgeon with no less than 4 years of residency training irrespective of location in the country.

Some progress in reducing the injury burden in Brazil has occurred with the introduction of prevention strategies and a prehospital trauma system. This resulted in a 6/100000 reduction

in mortality, from 35/100000 to around 29/100000 over 5 years. They have subsequently shown that the two groups poorly addressed were pedestrian injuries and motorcyclists.[43]

Asia and the East

Thailand and India represent low-to-middle income countries in the ASEAN (Association of Southeast Asian Nations) region and have similar issues, namely large areas of rural populations, poorly developed infrastructure and fairly high proportions of trauma, with Thailand listing trauma as the second leading cause of unnatural death [44], while in India transport-related trauma alone is said to be second only to cardiac disease as a cause of morbidity and mortality, with trauma as the ninth overall cause of death [45,46].

The system, or lack thereof in these countries is remarkable. While 25% of emergency department visits in Thailand were trauma related [44], there exists no formal training for ambulance staff and ambulance services are under-resourced. Hospital care is similar to the British model with consultants and residents in large hospitals and a shortage of cover after hours, more notably in the rural areas, where there are no trainees. This situation has been successfully addressed since 1984 with the establishment of a pre-hospital system. Additionally, they have improved the composition of the in-house trauma teams, communication within the hospital and across the referral region, leading to decreased trauma mortality. They have established a trauma registry, to monitor disease burden and outcome, initially in 5 hospitals and this has expanded to 22 hospitals at present. [23,24]

In India the mortality of major trauma (Injury Severity Score >16) was six times that of the developed world. [46] The situation in India is compounded by the fact that there ambulance services are practically non-existent, there are no national guidelines for training or care [45] and those public hospitals were overburdened, while the private sector was under no obligation to provide trauma care. However, through the introduction of the WHO-EsTC criteria [23] some progress has been made over the past few years in improving the situation as outlined below. [46]

Improvements include the initiation of a National Trauma Management Course through the IATSIC group and the National Board of Examinations has begun to certify courses in trauma care. Prehospital care is in its infancy and only available in selected provinces, where most ambulances still serve only a transport role with no paramedical care offered to the

patient. No norms exist to govern the hospital care either, with reasonable care on offer at most teaching hospitals, where care is free of charge. Most hospitals do not have trauma teams. Leadership is divided between different specialities, with often poorly trained “casualty officers” the only physicians able to offer any form of resuscitative care. Interfacility transfer and rehabilitation services are sadly lacking. [46]

Africa

In Africa most attempts at developing a trauma system are hampered by lack of resources and established emergency medical services, both at prehospital and in-hospital level.

Additionally the governments of many sub-Saharan African countries face greater challenges from other treatable diseases and from soaring HIV rates than deaths from trauma, particularly in countries where there is no plague of civil war or faction fighting on a regular basis.[47] Quality research from African countries is therefore scanty, at best, often undertaken by external organizations. Some success has been achieved notably in, Ghana and Nigeria. They have undertaken studies and implemented programs to improve the plight of the injured in their countries and have shown improved outcomes with even simple system changes as summarised here. [48,49] In Ghana [48] simple low-cost achievable and sustainable improvements in care were shown to potentially decrease trauma morbidity and mortality, including provision of simple equipment to under stocked district hospitals, with basic training provided to generalists staffing these facilities. Including their Fire Service in the planning assisted in bringing down the road death toll in that country. They established an injury surveillance system and working groups for prehospital and in-hospital care. This will be tested over the next few years to determine if true decreases in morbidity and mortality occur.

Nigeria [49] has an astonishing rate of 75% of all emergency room deaths being due to trauma and yet, like many African countries, the facilities and staffing of hospitals and clinics outside the limited number of larger teaching hospitals is inadequate and skills are sporadic. Despite the establishment of a Federal Road safety commission in 1988, which included the transport and care of injuries as part of its mandate, limited pre-hospital care was offered to accident victims. By simple education of commercial drivers in basic First Aid, a follow-up study at about 1 year showed that 61% had used their new-found knowledge in treating trauma victims. It is emphasized in the report from Nigeria that monetary status is the major

determinant of the speed and quality of trauma system development. It is additionally complicated by the well-described “brain-drain” from low to higher income countries.

This reflects only on two countries, however across the continent Africa has a large segment of young people and children in the continent’s population, yet the result of these inadequate system issues has led to Africa holding the highest unintentional injury rates in the world – 53 per 100000. [50] Most of these injuries are traffic related.

South Africa

South Africa has been a leader in medical science and medical education in Africa, yet holds the distinction for having the highest homicide rates of any country not at war, outside of central America. [37]. South Africa also has the challenge of differently structured trauma services across the various provinces, mainly based on the American model, often not taking the unique challenges of scarce resources, limited advanced prehospital care and obstacles in the process of referral and transfer of severely injured patients. The dichotomy of public versus private medicine and the subsequent expectations of the population are also impacting on the image of trauma care and the apparent differences in outcome in these two different environments. [51,52] Violence against women is commonplace and this is worsened by the impact of alcohol abuse as a precursor to interpersonal violence, particularly in a traditionally patriarchal society. Drunk pedestrians accessing major highways where vehicles travel at high speed have lead to high pedestrian collision mortality. Funding redirected to primary care, where often facilities are inadequate for management of surgical pathology, further impact on the dysfunction of the system as it currently exists.

For the most part South Africa is an example of a system without coordination. Emergency medical services (EMS), while often well trained at the Advanced Life Support level, are largely staffed by Basic Life Support providers and these persons have limited skills and motivation. The EMS in the public sector work largely independently of the hospital-based trauma care services, mostly without medical oversight, while most smaller hospitals are poorly equipped to deal with major trauma and the process of referral is often cumbersome and leads to delays. Hospital overloading as a result of the lack of communication and adequate facilities for patient dispersal lead to errors of judgment and an increased risk of medico-legal consequences for the Department of Health (DOH). [51,52] Aeromedical

services exist as an advanced life support resource in major centers but are often provided at great cost to the public health sector.

Additionally an inadequate number of nursing staff trained in intensive care and trauma, together with a short supply of tertiary beds leads to rationing in the allocation of resources, [53] something frowned upon in the Constitution of the Republic of South Africa, where according to the Bill of Rights emergency care is a constitutional obligation. [54] This, despite the established career paths available to providers at all levels, from basic to advanced prehospital care; post-registration training in trauma and intensive care for nurses and the potential for cross registration. For doctors there exist post-graduate short courses, diplomas (Dip PEC) and specialist training in Surgery and Emergency Medicine, with the addition recently of sub-speciality training in Trauma surgery, which includes a year of intensive care.

Goosen and Veller highlight in their review in 2008 the need for total patient care, commencing at the Emergency Centre, through the course of the hospital care to a point where rehabilitation can be undertaken, the latter sorely lacking in many public health care services of this country. [52]

So why have we termed this process “an *Afrocentric* approach”. Afrocentrism is a philosophy or “world-view” that seeks to ensure that novel thought regarding developments in Africa come from within Africa reflect African culture and yet incorporate the best basis from established processes in the European, American and Asian spheres. This is without losing sight of the unique cultural and religious atmosphere of Africa, so-called “ubuntu”. Afrocentricity asks what natural responses would occur in the relationships, attitudes toward the environment, kinship patterns, preferences for colours, type of religion, and historical referent points for African people if there had not been any intervention of colonialism or enslavement? The Afrocentric method is a form of cultural criticism that examines etymological uses of words and terms in order to know the source of an author’s location. This allows one to intersect ideas with actions on the basis of what is creative and transformative at the political and economic levels. [55] The Afrocentric objective is African development. This latter aspect is what this researcher intends applying to the concepts of Trauma Systems.

In summary, the lack of an Afrocentric, resource-based, coordinated trauma system is profoundly obvious – there remains “centers of excellence” amid the flood of indifference, while the injured are often still quietly dying for lack of basic resources and a minimal skill level. With the FIFA2010 soccer World Cup in the recent past, which stimulated much debate on optimal care of the injured within the country, the time is right to design a system that will work, which is sustainable, and which will benefit the entire population of the country.

Current standards and criteria:

Currently there exist a number of sets of guidelines, standards and sets of criteria for the assessment, equipping and monitoring of the treatment of the injured. Each of these will be briefly reviewed with the intention of producing a concept document of what the ideal trauma system should entail in the South African context. Many of these documents are based on experience in well resourced countries, which may not be entirely relevant to South Africa.

International Documents & standards

American College of Surgeons (ACS) criteria [41]:

The ACS has, since 1993, produced a document called “Resources for Optimal Care of the injured patient”, which was revised in 1998 and again in 2006. Outlined in the document are the human resource, capital equipment and system issues for patient care and quality assurance in the care of the injured. The challenge in utilization of the document in its present format is that the writing is directed toward the American health care system, where medico-legal issues and restrictive practice policies dictate the level of care and the type of care provider.

Some useful aspects of this document that are relevant to the planning of trauma care are the emphasis placed on systems rather than trauma centres, with a move toward inclusive systems with an exclusive component; the need for that system to coordinate care across all levels of care to optimize referral and transfer; the need for trauma teams to receive and manage the patients and finally, the need for a “Trauma Service” separate from other emergency surgical services to oversee the entire hospital course of the injured patient.

From the perspective of the current study the document establishes the steps in organizing a trauma system:

- A needs assessment of the burden of disease
- Public support (“buy-in”) of the reasons for needing a trauma system
- A resource analysis in terms of human and capital resources
- A set of standard definitions by which the facilities in a region may be classified as to the level of care capable to be offered, ensuring that adequate facilities are available, but not over-providing services thus diluting the value of experience provided by adequate numbers.
- The specific additional requirements for the management of injured children
- Integration of the entire chain of survival into the system plan from the prehospital phase to the rehabilitation phase, with medical oversight of the prehospital phase identified as an imperative
- Obtain legal authority from the governing bodies to implement a system and ensure inclusiveness of all role players
- Identify a lead agency (most often the centre with the highest level of care)
- Establish a trauma registry for system evaluation, quality assurance, peer review and performance improvement, which captures standard data, irrespective of where the patient is treated.
- The need for education and outreach by the lead agency

The document highlights the challenges of rural trauma care and certain specific requirements for audit of such rural environments are potentially applicable to the current research

The section on performance improvement deserves additional comment: the need for problem recognition through data collection (trauma registry), collation and analysis (audit); system review assessments, leading to modification of treatment of the injured to improve care and instruction across the system to ensure continuity of care at a best-evidence level (published results).

- There is a need for administrative and legislative support
- The lead clinician of the lead agency should be able to set standards for the care of the patient
- Process and outcome measures must be monitored
- Reviews should be well structured and multidisciplinary in nature

- Corrective actions may take numerous forms including setting written guidelines, ongoing trauma education, supplementing resources and even disciplinary action if required
- The need for inclusion of prevention strategies is also an integral part of system evaluation as the strategies are incomplete if the efficacy thereof is untested

Where the document is less helpful is in terms of the criteria for training, credentialing and staffing of hospitals, since the health system training and the categories of health providers differs significantly from South Africa. The one aspect of these sections that is useful, is the requirement for ongoing learning and research for lead units and specialists within the system.

British Documents:

Two large practice reviews have been undertaken in the United Kingdom. [56,57] Both identified numerous discrepancies to reference standards and propose certain recommendations for the care of the severely injured patients and the steps to achieve a system relevant to the UK. In 2000 the Royal college of Surgeons and the British Orthopaedic Association published the Better Care for the Severely Injured report. While much of this document is relevant to the UK scenario, some aspects pertinent to the South African situation are relevant. In “Part 1” of the report the inadequate staffing and under provision of adequate facilities for trauma care is highlighted in the light of the high mortality due to trauma in the UK. Deficiencies in staff training were also highlighted.

The need for enhanced ambulance staff training, better pre-hospital and in-hospital communication and the regionalization of trauma care were promoted. At the time of this report the majority of severely injured were taken to the “nearest” hospital, rather than a designated appropriate level of care, much like the situation currently in KZN. While there were many hospitals in the UK, only 5 had the full range of required services to treat major trauma.

The most relevant aspect of the “Better Care” report is found in Part 3, which sets recommended standards of care for the initial assessment and systematic management of the severely injured. These are attainable standards, worthy of consideration for the resource challenged and the resource rich environment. Some important aspects include:

- Ambulance service oversight and pre-communication
- Hospitals receiving major trauma must have an appropriately trained surgeon (Medical Officers in the case of District Hospitals) capable of emergency surgical intervention
- The care of the trauma patient should be supervised by a “Trauma Team” who will remain with the patient until referred or sorted out
- Access to emergency surgical facilities should be attainable within 60 minutes
- Transfer should be arranged rapidly and with due regard for the potential for deterioration in the transfer period
- Patients remain the responsibility of the referring hospital until arrival at the receiving hospital when patients are transferred
- The need for the provision of adequate numbers of high and intensive care beds relevant to the size of the trauma population
- The need for integrated rehabilitation care of the recovering patient is essential

In 2007 the National Confidential Enquiry into Patient Outcome and Death report on trauma care in the UK, entitled “Trauma – Who cares?”, was published as a sequel to an assessment of the impact of the “Better Care” recommendations on the practice of trauma care in the United Kingdom. Again much of this document is irrelevant to the daily care of trauma patients in an African environment, but the report again highlighted some general principles to consider when a trauma system is under development. The following practical points are relevant to trauma system planning:

- A hospital designation system must be implemented
- Emergency Medical Services must be integrated into the clinical governance system with hospitals
- More prehospital doctor involvement is required
- Liberal access to whole-body CT-scans is required for major injury victims, especially where no urgent intervention is required, however unstable patients should not go to the CT-scanner
- Regionalized facilities should enable prompt CT-scans of the head for the head injured patient – then the Cervical spine should be automatically imaged as well
- Special facilities and staff experienced in paediatric trauma should be established with additional training for the staff provided

- All hospitals receiving major trauma should have at least 4 resuscitation bays
- Rapid access to primary survey in the prehospital environment and full assessment in hospital is essential. Analgesia should be rapidly provided
- Ambulance protocols should divert ambulances to an appropriately equipped and staffed facility when major trauma is identified and should allow for bypass of inadequately equipped hospitals
- Good clinical note and team composition notes should be retained
- An audit system applicable to the entire UK with standardized formats and data proformas should be established

Currently suggested international minimum standards for the under resourced environment

The World Health Organization (WHO) carries on its shoulders the responsibility for leadership and guidance on matters of universal importance in health. It is within this mandate that the WHO has developed two sets of guidelines for trauma care – one for prehospital care and the other for the in-hospital care of the injured. These documents [23,24] are focused on the lower and middle income countries of the developing world and therefore some of their recommendations are less than what would be considered ideal for the South African situation, where the system of health care is somewhat more mature and expectations are, therefore higher. What is needed (and will hopefully result from this research), is a middle-ground between these criteria and the criteria of the American College of Surgeons that are costly to achieve. What is particularly relevant to the discussion at hand is the equipment lists for minimum standards of care and the levels of training recommended by the organizations who assisted in drafting these formidable documents, namely IATSIIC (the International Association for Trauma Surgery and Intensive Care).

WHO Prehospital criteria [24]

This document is the result of multi-staged consensus meetings and discussion by a multi-national and worldwide expert panel. The premise of the prehospital guidelines is that continuity of care from public bystander to professional care provider can improve trauma outcome. This is mooted by means of differing standards depending on the extent to which a structured EMS system exists in a particular country. From the South African perspective, we currently have a system that conforms to the highest proposed levels indicated in the

document, however, with little local and regional coordination, particularly with reference to the response to call and the setting (and meeting) of standards. Considering that there is little evidence to support Advanced Life Support in the prehospital field, particularly at the expense of good basic life support, this may need to be a focus point to be examined in our scenario. It is essential that whatever system is applied to a particular region, that it be clinically efficient and cost-effective.

The document further outlines the key elements in setting up an efficient system, namely:

- Lead agency: Designate a lead agency to govern the system. This agency's responsibilities should include legislative development, regulatory oversight, organization of the system and financing.
- Support: Ensure there is regional and local support and involvement that includes members of the local community. This should include Disaster planning
- Local administration: Develop local administration and oversight, taking into account the local context and resources.
- Medical direction: Ensure that a medical director is providing the essential coordination of care, training and education, and quality improvement initiatives. Standards and protocols will have little effect without good medical direction
- Political support: Develop political and legislative support. These are essential for ensuring the operational and financial viability of the system.

The document also outlines the training level of the prehospital providers, the equipment and layout suggested for Ambulances, which most Ambulances services in South Africa already strive towards. The rescue, communication and command structures, and coherency of service provision often do not meet the requirements suggested both in training of personnel and public-private cooperation in South Africa. The lists of skills, knowledge, equipment and consumables are listed as essential, desired, possibly required or irrelevant for any given criterion – the list considered to be applicable to South Africa is that most, if not all items should be considered essential, except for certain “irrelevant items”, (to use the WHO term) specifically where the skill or use of equipment is outside the existing Basic or Advanced Life Support, or facility scope of practice. Specifically “irrelevant items” included items that would in normal circumstances not be expected to be found at a given level of care, even when the full spectrum of resources is present, for example CT-scanners, mechanical

ventilators, or advanced invasive monitoring would be “irrelevant” in a community clinic or GP environment, even in the developed world scenario.

An important emphasis in the document is that whatever system is implemented it should be available to all, irrespective of ability to pay for the service rendered.

A major element, which is addressed, is good data capture and retrieval – an EMS registry of calls and patient data are required, which may contain certain minimum datasets to enable audit. This will enable the assessment of timely response, initial care and appropriate end-destination to be determined. This also enables optimal vehicular distribution and station allocation. The document highlights the need for prehospital bypass of basic care centers (e.g. District Hospital) for the more severely injured. To enable this to occur optimally appropriate triage systems and decisions are required.

Medical direction by a suitably experienced medical supervisor is important for quality assurance, which may include radio monitoring, call observation, report review, outcome studies, debriefing and continuing education, the latter being highly deficient in the South African environment, despite a requirement for 15 - 30 hours of annual CPD for all EMS providers. [36] This level of professionalism is an important aspect of ethical and responsible patient care in the prehospital environment. Finally, this document complimented the Essential Trauma Care Document [23] aimed at setting similar standards for the in-hospital setting in resource-challenged countries.

Essential Trauma Care [23] (EsTC Project):

The focus of this document is the equipment, human and capital resources required for the provision of intra-facility trauma care in an inexpensive manner, yet with the ability to preserve life. The project is based on the premise that improved organization of trauma care services can be a cost-effective way of improving care of the injured worldwide. While the direct aspects of trauma system options and development are not specifically addressed, the document is useful for setting a baseline to which each and every low-to-middle income country can strive as part of the development of a trauma system. Of particular relevance is the intimate involvement of a number of prominent South African clinicians in the drafting of this document. The planning of systems for trauma management implies several integrated functions, including political jurisdictions designating which hospitals are to fill the roles of

trauma centres at varying levels of complexity, ranging from large urban trauma centres to small rural hospitals and clinics. It also implies the integrated planning with emergency medical services, pre-hospital triage (to determine which patients should go to which types of designated facilities), transfer criteria and transfer arrangements between hospitals.

The document espouses the philosophy of saving life, preventing deterioration and promotion of recovery as the three major goals of trauma care, each of these then further classified into specific medical interventions to achieve the goals.

Of relevance to the South African current health system, the requirements for GP-staffed, specialist staffed and tertiary care facilities have specific bearing and these will be of assistance in deriving locally applicable matrix type spreadsheets against which the current situation can be analysed and recommendations presented for improvement. A number of the items listed as “desirable” in the lists are clearly “essential” in the context of the better overall South African resources, while the relevance of the items under the “non-doctor” clinics should be irrelevant as these clinics should not be treating anything beyond minor injuries, which is not the focus of the trauma system. The details of the specific matrices and the specific items will not be detailed further at this point. Suffice to mention that the current lack of rehabilitation resources in the KZN province stands in glaring contrast to the WHO document where a full set of requirements for rehabilitation are outlined in chapter. Quality assurance and clinical governance issues are also outlined briefly in the text.

Current South African standards

The Trauma Society of South Africa is the professional body representing all persons who have an interest in trauma care. In 1992, the society, under its president Prof DJJ Muckart, compiled a local modification of the “verification” criteria used by the American College of Surgeons for the verification of local facilities as trauma treatment centres of various levels. This document was originally known as the TSSA Trauma Centre Standards for South Africa [9] and has subsequently been extensively revised and published as a peer reviewed Consensus Guideline [26] (see Chapter 4) highlighting the need for systems rather than just centres, with the focus on what is relevant to local practice by experts in the field. Hospitals are then deemed to be either primary health care centre, community, urban or major trauma centres if they complied with the criteria set. Only academic centres can become “Level 1” centres and large regional hospitals will mostly be “Level 2”. The updated version also

addressed the issues around establishment of trauma systems as being superior to simply trauma centres.

These criteria also complied with the South African Society of Anaesthesia/Critical Care Society of Southern Africa [59] recommendations for intensive care, for levels of care where intensive care was deemed appropriate. The disadvantage of these standards is that they focus solely on trauma and thus exclude other emergencies and they follow closely the American system, which is in many ways different to the way medical practice is administered in South Africa. However, with the 2010 World cup planning and the establishment of Emergency Medicine as a separate specialty [30], these same standards have been adopted by the National Health Department 2010 working group as the standard for the assessment of public hospitals nationally for all emergencies (personal communication LA Wallis, previously Emergency Medicine Society of SA president). This document is often read in conjunction with the Council Of Health Service Accreditation of South Africa (COHSASA) standards for Emergency Care published in final draft format in 2007 [28].

The COHSASA standards [28] cover additional aspects not covered in the TSSA document, many of these relating to the overall hospital standards in addition to the actual emergency centre requirements, such as the managerial and governance aspects and the support services. This document to, which this researcher contributed, as a member of the compilation team, has a distinct bias toward the private sector in the manner in which the standards are formulated. This is of concern in relation to the management aspects of the document. This is derived from the fact that the COHSASA group currently inspects and verifies extensively in the private sector.

Derived from the COHSASA standards is the current draft document from the National Health Department for the equipment and staffing norms for South African Emergency Centres to which this researcher contributed extensively during the recent past. These three documents should provide the basis or any comparative study assessing the current provincial system to a “gold” standard and for determining whether any changes to the existing system are warranted.

The community, urban and major hospitals will similarly be required to participate in ongoing improvement of care (audit and clinical governance) programs and application of the Batho Pele principles [60] to the treatment of the injured.

Current trauma service provision in KZN

Currently the management of trauma and other emergencies is provided at both state and private facilities where the level of expertise and the available resources vary widely.

EMS is provided through a structured tiered system with Basic & Intermediate Life Support ambulances (ESV) and Advanced Life Support (ALS) Rapid response units (RRU) with Critical Care Assistants and National Diplomates or Bachalauriettes. However, there is currently limited coordination of resources and limited ability for redirection and bypass as the vehicles in public service are often hospital based and in many areas there is extremely limited availability of ALS cover to supervise care of the critically injured in transit. [61] Numerically the rural services are short of trained staff and vehicles and this may also lead to reluctance to do hospital bypass to larger, better equipped units.

Hospital care is fragmented with state hospitals providing general practitioner and some specialist level service without the direct support of a surgeon-led trauma service in most areas. There appears to be a fixed referral system, which is satisfactory for the moderately injured patient, but likely to lead to delay to appropriate care in the severely injured patient, particularly the patient in need of an ICU bed.

Neurosurgical care for the province is exclusively located at IALCH with advice dispatched via interpretation of remote site CT-scanning. This enables prevention of unnecessary transfer of patients for whom surgery is unnecessary, but may delay care to many potentially salvageable surgical lesions. Vascular injury care was previously also only provided at IALCH and delays in transfer to definitive care have the potential to delayed revascularization and jeopardize limb salvage, however a single vascular surgeon has recently joined the Pietermaritzburg team.

The rate limiting step in most of the care pathways is the time taken for transfer to higher care facilities and this is a combination factors including patients being taken initially to inadequately staffed and equipped facilities and severity of injury being underestimated, to major delays due to the inadequate numbers of Emergency Service Vehicle (Ambulance) and Rapid Response (Paramedic) Unit with suitable numbers of ALS practitioners. Thus, patients are not getting an equitable treatment care plan.

Ngwelezana, Grey's/Edendale (PMB) and Albert Luthuli are notable exceptions to this norm, each having registered trauma sub-specialists on the surgical staff, but these facilities are overstretched and of limited capacity with both Ngwelezana and Grey's/Edendale providing the trauma care as a part of the overall surgical emergency service as there is no separate Trauma Service as such, although this has now become formalised at Greys/Edendale since 2011. Both these hospitals (Ngwelezana and PMB) currently have the only units in the entire province with Emergency Centre's led by registered Emergency Physicians. Most hospitals have a combined casualty with, family physician non specialist personnel with minimal formal training in emergency care and busy non-emergency workloads.

The trauma caseloads consume significant resources and energy with little reward and with a limited hope of real rehabilitation potential as there is no dedicated rehabilitation facility in this province where patients with spinal injuries or brain injuries can be housed for long-term post-acute rehabilitation. The facilities currently in existence in the Durban Functional Region, based at Mahatma Ghandi and Clairwood hospitals are under resourced and can only cater for selected patients.

A Review of the known Trauma Burden – A summary

Trauma is a significant disease burden to the DOH-KZN. In the city of eThekweni alone every year over 70000 motor collisions are reported [62], with an ever increasing incidence of severe injury, despite a decrease in overall fatalities. In 2008 alone there were over 530 fatal injuries, 4300 serious injuries, and a progressively increasing minor/moderate injury rate with an increase of over 2000 per year. Many of these injuries are to pedestrians, which is also different to the experience of the developed world, where occupants are more commonly injured.[63]

The waiting time for medico-legal post-mortem (mostly due to traumatic injury) at the Durban Forensic Mortuary is up to one week. The unnatural mortality rate in South Africa for traffic trauma is over 3 times the global average. [64]

The trauma service at the IALCH Trauma Unit has admitted over 1400 major trauma patients (Injury severity score >16 – at least two major organ system injuries) since March of 2007 when the unit was commissioned. The average hospital stay and cost of care for these severely injured patients is extensive due to the need for intensive care. Despite the severity of injury, the survival rates in this dedicated trauma service show a lower than average mortality, despite the long hospital stay. This implies that a systematized care impacts positively on outcome. [63]

In a recent set of studies from the Injury and Violence Lead Program of the Medical Research Council [65-67], Matzopoulos and colleagues point to violence and road trauma as the dominant causes of injury identified in the Western Cape Burden of Disease project. They also highlight the influence of drugs and alcohol identified as a co-factor in the presence and severity of injury – highlighting that studies where Durban was a contributing centre found up to 46% of murder suspects were positive for drugs or alcohol. [66] Young adults, males and substance abuse are also implicated in fatal motor collisions. [67]

Regarding the overall burden of trauma in KZN, the literature reveals the following statistics: In 1995 Muckart and colleagues pointed out that the spectrum of penetrating truncal trauma seen at the King Edward Hospital (KEH) had shown a shift from stabs to gunshot wounds with the latter increasing by 800% [68]

Using extrapolation calculations the burden of abdominal trauma at the same hospital (KEH) over a 7 year period for all general surgical units averaged 375 patients per year based on the experience of one surgical unit [69]. If this is extrapolated to the total number of hospitals with surgical services this increases to over 1000 patients per year, just for the eThekweni region (DFR). One should realize that this does not include the Pietermaritzburg region (Area 2) or the Ngwelezane Region (Area 3), where similar numbers could be reasonably expected, given similar population numbers. These extrapolated values are corroborated by a more recent study at one of the other regional hospital units, where 78 abdominal gunshot wounds were treated in one surgical unit over 6 months. [70]

Similar extrapolation of the incidence of head injury can be determined - with only around 16% of head injuries being transferred to the neurosurgical service, resulting in 84% of head injuries being admitted by general surgical services. This constituted 265 patients in one surgical unit over a one year period. With the 5 surgical units at KEH this would extrapolate to around 1300 head injuries annually at KEH and almost 2000 within the DFR. [71] A newly released report places South Africa second in the continent, and over both the global and regional road death rates with pedestrian and cyclist deaths high on the list, compared to elsewhere in the world. This also suggests the need for better trauma care and systematised regional facility-based care. [72]

While most of the studies referred to here relate to adults, one study from 1998 emphasized that injuries due to gunshots in children under the age of 12 affected an average of 20 children per year, most of these being under the age of 7 years. There had been a continual escalation each year over the preceding period from 1983 – 1994. [73] There were minimal data on paediatric trauma to undertake further extrapolations from historical data and this one study is mentioned for completeness. Previous studies by this researcher (for his M.Med degree at University of Stellenbosch) [74] demonstrated that around 36% of the trauma burden in the Cape Town area were children under the age of 13 years. It is highly likely that the spectrum of paediatric injury is fairly similar in KwaZulu-Natal.

In conclusion, since the burden of trauma is of this magnitude, it is essential that a system of care is developed to optimize the time to therapy and correct intervention at the appropriate level of care. This system must span the entire spectrum from pre-hospital to district, regional and central hospital level of care.

A summary of the literature overview

The key elements of this literature overview are summarised in the three opinion papers presented in chapters 2-4. These can be summarised under the following headings, which have formed the framework of the research question:

1. Historical context
2. Trauma System development
3. The Developed World scenario

4. Challenges facing the Developing World
5. Current international, regional and local standards of care and criteria for optimal service provision
6. An overview of the current service provision for trauma in KZN
7. The currently known trauma burden

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Chapter 2 – Peer reviewed opinion piece after literature appraisal

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FORUM

ISSUES IN MEDICINE

The 11 P's of an Afrocentric trauma system for South Africa – time for action!

Timothy Hardcastle

A trauma system involves the interaction of prehospital care, emergency centre care and definitive care (including prevention and rehabilitation services), providing an organised approach to acutely injured patients within a defined geographical area, from primary care to advanced care. Trauma is, after infectious disease, the second leading cause of death and disability in Africa (Table 1), and must therefore feature on the national health agendas of all African countries.^{1,4} The requirements for developing cost-efficient, patient-centred trauma systems relevant to South Africa are outlined below (each item commencing with a P, and hence the title).

violence and road traffic collisions, and treatment and rehabilitation (hospital services and transfer protocols).⁵

Political will requires more than tacit acceptance, but also funding and human resources, particularly as it may take up to 10 years before the effects of a well-designed trauma system are demonstrable.¹⁰

Public pressure

In the USA and the UK, the drive to establish trauma systems initially came from sustained public pressure. The latter is essential for government to improve care and establish systems of care based on best-practice. It is time for South Africans to bring the government to account, particularly in view of its commitment to the guidelines of the World Health Organization's Decade of Action for Road Safety 2011 - 2020.¹¹

Participation from multiple sectors

Establishing a trauma system is not simply a health service task; it involves many roleplayers who must 'own' the project from the start, including the departments of Health, Finance, Transport, Police and Local Government.⁴ In addition, the early integration of various NGOs (e.g. Automobile Association) and professional bodies (e.g. Trauma Society of South Africa, Association of Surgeons, Emergency Medicine Society) is essential to maximise service provider integration into an inclusive system.^{2,3}

Professional compliance

Professional compliance implies that clinicians and other professionals must practise medical care based upon best-practice. This ensures referral of the right patient to the correct level of care, within a reasonable timeframe, to optimise outcome without primarily considering the patient's ability to pay. Such a goal also requires practitioners to remain current by continuing professional development, skill development and awareness of local policies regarding the system in their place of practice. They should not attempt to provide treatment beyond their own, or their facility's, capability. Such training would include courses such as Advanced Trauma Life Support, Definitive Surgical Trauma Care, College of Emergency Medicine Diploma in Primary Emergency Care, and the part-time MSc or MPhil (Emergency Medicine). Courses for pre-hospital and nursing personnel will also enhance the care of trauma patients. Formalisation of advanced training in emergency medicine and the sub-specialty of trauma surgery should develop adequate human resources for the current burden of disease.^{12,13}

Provincial restructuring

Current referral patterns in South Africa largely deal with non-acute pathology and chronic care; trauma patients have different needs that differ from those of non-surgical emergencies, owing to the need for surgical care, which may be restricted to higher-level facilities.¹⁴

While most regional hospitals can manage surgical emergencies, many district hospitals and community clinics have neither the clinical skills nor the equipment to undertake complex care of major trauma. Delays are thus caused through multiple levels of transfer, leading to higher morbidity and mortality.

Transfer pathways are further hindered by the 'devil of distance' to definitive care. Provincial transfer policies must be flexible and EMS-

Table 1. Differences between trauma incidence and types per world region*

Pathology	Africa/South America	USA	Europe/Asia
Penetrating: blunt	40:60	15:85	2:98
Trauma as health problem – WHO	2nd leading cause of death after infective processes	Blunt trauma 4th leading cause of death; penetrating trauma lower than 20th leading cause of death	Vehicle trauma 10th leading cause of death, while penetrating trauma much less common

*Derived from Trunkey.¹

Political will

The first step to establish a trauma system is political engagement. Government must realise that trauma is a form of preventable disease, which can be reduced through legislation. The costs of establishing the system will be offset by the savings of economically productive life-years and improved outcomes,^{14,5} as has been demonstrated in the Developed World. The United Kingdom (UK)'s national project only received impetus when the government accepted that its trauma care was inadequate.^{6,7}

In view of the moves towards a national health system in South Africa, and with trauma a leading cause of death and disability, this factor should feature prominently on the political agenda.^{3,8} Equally needed are prevention services, in areas such as interpersonal

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driven to enable clinically based decisions to rapidly get the patient to the optimal level of care. Provincial staffing plans should establish posts for specialists in emergency medicine and surgery at regional hospitals and sub-specialist trauma surgeons at tertiary hospitals to oversee the implementation and maintenance of the system.

Private sector participation

In South Africa and elsewhere in Africa, care provision is a dichotomy. The highest proportion of health expenditure in South Africa is by the financially privileged and in the private sector, with a considerable amount also spent on chronic care of preventable disease in indigent patients. The private sector has well-resourced facilities but, being private, it follows that specialist medical staff in independent practice are not obliged to accept referred patients and to treat trauma except in life-threatening emergencies. The medical officer in a private emergency unit often has to try to refer the patient to a public facility for further care.^{14,15} This problem may be addressed by integrating the unconditional payment for comprehensive trauma care within a nationally funded care plan. The private sector also has skilled allied health and nursing personnel who can add value to the development of universally accessible and applicable systems.

Professional society accreditation

In the developed world, the assessment and designation of facilities as trauma care centres within a trauma system is undertaken by means of defined criteria compiled by professional organisations (e.g. American College of Surgeons Committee on Trauma) that have the expertise to assist the government in assessments and provide unbiased opinions on facilities to meet the criteria.

In South Africa, the Trauma Society of South Africa (TSSA) established such criteria, accepted by the Colleges of Medicine and the Health Professions Council of South Africa.¹⁶ It therefore makes sense that the TSSA, as a group of trauma professionals, assists in this task in South Africa.

Proper data management

Data collection and audits assist in determining public policy and the quality of care within a care system. Databases that collect identified data from multiple providers allow comparison of outcomes and determination of the beneficial effects of a trauma system, such as the TRACS system in the USA. A long-term study from Canada has also demonstrated this.¹¹

South Africa has a dearth of data. Government could consider universal implementation of the Trauma Society Trauma Bank in all public regional and tertiary hospitals; this would build up an accurate and comprehensive picture of the burden of disease of more severe trauma, to extrapolate the findings to public policy.

Purpose-driven governance – improved outcomes

Quality data can revise practice in line with good governance principles. Data from before-and-after studies of implementation of trauma systems show reduced overall costs and nonetheless improved outcomes.¹⁰ Additionally, health care funders can justify equipment and human resource expenses for cost-efficient care.

Post-trauma rehabilitation and support services

Rehabilitation services are not a priority in South Africa. However, international experience proves that early rehabilitation services increase the ability to re-establish economically productive employees for work. In most parts of South Africa, there are only acute in-hospital rehabilitation or long-term outpatient clinic-based facilities. Only one province has a formal 'residential' multidisciplinary rehabilitation

service for longer-term rehabilitation (Western Cape Rehabilitation Centre (WCRC) in Cape Town). This shortage blocks acute beds with patients who need post-acute in-facility rehabilitation, since they cannot be discharged to an outpatient service. The private sector has such facilities, and public-private partnerships could potentially provide these to a wider population. This sorely needed aspect of the system would have to be built up from scratch.

Practise the theory in a financially sound model

Theorising about the ideal system, and adopting a system that works in other countries, is easy. However, attempting to replicate developed-world care in the developing world is foolish and short-sighted. We need a financially sound model, building on the existing infrastructure, that will lead to cost-effective care, through refinement of personnel allocation, patient distribution and resource provision. Currently, no such system exists, but with co-operation and determination it can be initiated and established. The necessary steps are:

- acceptance by national government of the need for trauma systems
- integration of the command and control of pre-hospital, emergency department, hospital and post-hospital care of the injured
- review of existing facilities and services, compared with a defined standard (e.g. TSSA guidelines¹⁶) to determine optimal transfer and referral pathways separate from those for chronic care
- determination of the true burden of disease, morbidity and mortality through ongoing robust data collection
- development of rehabilitation facilities in all provinces
- audit and refinement of the system until improved outcome is demonstrated.

Conclusion

Trauma systems improve survival and decrease morbidity – but can only do so after universal acceptance and sustained application. The incidence and impact of South Africa's trauma burden can be reduced through the development and implementation of an Afrocentric trauma system that provides efficient, timely and cost-effective care. It is time to move from 'islands of excellence in a sea of indifference' to a co-ordinated patient-centred system.

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Chapter 3: The history of trauma care in SA and where we are today: *International Emergency Nursing*, 2013; 21: 118-122

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Trauma care in South Africa: From humble beginnings to an afrocentric outreach

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Introduction

Trauma can be the result when humans interact with each other or the environment. In South Africa, trauma care has been associated inextricably with the development of surgery and nursing, as well as the development of the current pre-hospital care system (Brysiewicz and Bruce, 2008). Throughout both World Wars, as well as during the struggle for democracy, and particularly in a more formal manner from the early 1980s, trauma care has developed in South Africa, with the country leading the way in many areas (Clarke et al., 2005).

South Africa actually preceded the USA by some years in the establishment of a trauma centre. In South Africa, the first trauma centre, called the Accident Service, was established in 1962 at the Johannesburg Hospital by Wilkinson, after his visit to Birmingham in 1960, and was supported by the Medical School of the University of Witwatersrand. Fol-

lowing this, other units were established at Grootte Schuur and Tygerberg Hospitals in the Western Cape, at Pelonomi in the Free State, Baragwanath in Soweto and, eventually, the newest unit at Inkosi Albert Luthuli Central Hospital, in Durban, KwaZulu-Natal, opened in 2007 (Cheddie et al., 2011).

With this brief background, this paper aims to present an overview of the history of trauma development in South Africa since the mid-1980s, the current situation and an outline of the educational initiatives that have taken place for the different members of the emergency care team. It also attempts to provide some insights into future opportunities in line with the national health care policies of the government. This is presented in the context of Africa attempting to overcome African challenges.

The recent history of trauma care in South Africa

In 1983, the Trauma Society of South Africa (TSSA) was formed with the purpose of setting standards and providing training in emergency care, with the focus on trauma care. This organisation brought together all levels of practitioner

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and included pre-hospital staff, nurses, general medical practitioners and specialists. As time progressed, the TSSA published a journal (*Trauma and Emergency Medicine*) and held regular conferences for the dissemination of research into trauma. The TSSA also became the custodians of the Advanced Trauma Life Support course (ATLS®) in South Africa in 1992. The focus of the TSSA changed more recently with the establishment of trauma systems and the recognition of Trauma Surgery as a sub-speciality of General Surgery, which was achieved in 2007 (Hardcastle et al., 2006, 2011).

The first formal emergency medicine structures were developed in the late 1990s and the Emergency Medicine Society of South Africa (EMSSA) was formed in conjunction with a group of interested and motivated physicians. In 2001, this society applied for, and received, affiliate membership with the International Federation for Emergency Medicine and was subsequently granted full member status in 2004 (Hardcastle et al., 2006). In 2009, the African Federation for Emergency Medicine (AFEM) was formed as a means of strengthening and widening support and coordination for all involved in the provision of emergency care throughout Africa (doctors, nurses and pre-hospital staff), and is dedicated to "Supporting Emergency Care Across Africa" (Brysiewicz and Wallis, 2010).

The need to start emergency nursing programmes arose from the fact that nurses working in tertiary hospitals realised that patients were not adequately stabilised in peripheral hospitals before being transported to tertiary hospitals for further management. The main aim was, therefore, to educate nurses working in rural and remote areas and peripheral hospitals to stabilise the critically ill patient before transportation, as it was felt that appropriate education would lead to decreased patient morbidity and mortality (Brysiewicz et al., 2011). In 2009, the Emergency Nurses' Society of South Africa (ENSSA) was established under the auspices of the Emergency Medicine Society of South Africa.

Pre-hospital care development in SA has progressed by leaps and bounds from the first doctor-led training programmes for paramedics in 1979 to the university-based degree courses currently on offer through the Universities of Technology. Today, the pre-hospital field has their own professional board at medical council level known as the Professional Board for Emergency Care of the Health Professions Council of South Africa. In addition, this past year has also seen the launch of a separate society for pre-hospital providers, the Emergency Care Society of South Africa (ECSSA).

Other professional societies active in the field of trauma care include the Critical Care Society of Southern Africa, the Burns Society and Childsafe-SA, the child accident prevention group (Hardcastle, 2011). The Association of Surgeons and the Colleges of Medicine, through the College of Surgeons and the College of Emergency Medicine, have also had a role in developing trauma care in this country which is aimed specifically at specialist level.

What is the real situation?

All of the preceding history will lead one to the conclusion that all is rosy in trauma care in South Africa, which is,

unfortunately, far from the truth. System development is still in its infancy, many government hospitals are still staffed by junior grade medical officers, there is a shortage of nurses and specialists and there is still a large disparity between the private and government sectors (Brysiewicz and Bruce, 2008; Hardcastle, 2011). The majority of emergency centres are under-resourced in terms of both manpower and equipment, with a distinct shortage of properly trained staff and essential medical equipment which are considered "standard of care" in the developed world (Hardcastle et al., 2011).

The "trauma teams" within the hospitals are not standardised, with many facilities still using a small team of one doctor, some nurses and a radiographer, thus having the need to call in support if a major trauma case is admitted. The training hospitals, the academic sub-specialist Trauma Centres (Level 1) and some facilities in the private sector, on the other hand, do have larger teams led by consultant trauma surgeons, with registrars from various disciplines and multi-skilled nurses (Cheddie et al., 2011). This disparity is likely to be associated with differences in outcomes with regard to both morbidity and mortality.

The challenges to the public service hospitals are increased by the fact that there is no fee-for-service and that trauma patients are mostly "non-paying" cases. Furthermore, the funding for public health care is defined by a fixed annual budget to each public hospital which has many competing health needs and is disbursed by the local medical managers. The staffing is also funded by this budget and, where funds are reduced, posts are often "frozen" when someone resigns or retires, increasing the workload to the other members of staff. This has led to distinct nursing shortages and shortages of specialists (especially with the ongoing "brain-drain" to the developed world).

While the emergency centres have problems with equipment and a huge workload, the treating surgical disciplines have challenges of their own, such as limited access to imaging facilities, bed-shortages in the wards and seldom having dedicated trauma wards. With limited exceptions, there are no dedicated trauma operation facilities in most public hospitals and the patients must compete for theatre space with caesarian sections and non-trauma emergency surgery, thus often leading to delays in treatment.

Although facilities in the private sector are fee-for-service, there is no formal regulation of standards. Many of the small "trauma units" are not really geared to treat major trauma, being nothing more than general practitioner minor casualty services. With the exception of a small number of accredited Private Level 1 trauma units, currently found only in Cape Town & Johannesburg, where dedicated trauma wards and a trauma ICU have been established, most private hospitals have no specific trauma wards and patients are accommodated in the ward of the specialist caring for them. Another challenge in the private sector is that all practitioners are in independent practice. Patients will not only be billed by the hospital for expenses incurred by the provision of the hospital service, but each clinician treating the patients also bills them, or their medical insurance – thus escalating the cost of private health care. Furthermore, because practitioners are in independent practice, no specialist is obliged to take on a trauma patient if they don't wish to, which often leaves the medical staff in

emergency centres searching for a specialist to admit and care for a patient (Hardcastle, 2010). This is especially important when there is a major polytrauma case, and often leads to a lack of coordination in the care of these patients (especially in an ICU).

Finally, audit and review are challenging due to the lack of a formal audit system at most public hospitals, despite the availability of the TraumaBank[®] registry of the Trauma Society of South Africa. No national trauma registry exists at the present time. The TSSA is attempting to gain government buy-into the system with the implementation of the National Health Insurance. Although many of the private institutions do subscribe to the TraumaBank[®] database, this gives a skewed impression of the trauma spectrum, given that the majority of paying patients come from a better economical sector than the trauma patients treated in the public sector and are mainly injured through blunt trauma mechanisms.

The burden of trauma is significant, with penetrating trauma still rating among the highest in the world, and unnatural mortality second only to HIV/infectious disease as cause of death (Hardcastle, 2011). A recent Burden of Disease study in KwaZulu-Natal has determined that the trauma burden is 18% of all emergency admission to public emergency centres (T. Hardcastle, PhD study, in progress). With Africa, and in particular South Africa, having the highest incidence of HIV disease in the same population groups at risk for traumatic injury, there is a reluctance among nurses, doctors and other professionals to work in the trauma field. Added to this is the problem of burnout and post-traumatic stress from poor coping mechanisms and limited support structures in the government hospitals which is where the majority of the trauma is managed (Brysiewicz, 2001; Brysiewicz and Bruce, 2008).

Despite the efforts of the Department of Transport to engage the community in the World Health Organisation's "Decade of Action on Traffic Safety", road safety remains a challenge with road deaths, particularly due to alcohol abuse, involving drivers and pedestrians alike. Other factors constituting particular problems include the ubiquitous "minibus taxis", heavy haulage vehicles and poorly maintained busses (Brysiewicz, 2001). While the efforts of the Departments of Transport and Health are laudable, they appear to be falling on deaf ears; the police continue their struggle to convict drunk drivers and speed-offenders and there are many other priorities facing the Health department. The TSSA has appointed a Trauma Prevention Coordinator who now attends the Road Traffic Management Corporation meetings, helping to influence the way road safety is promoted and to assist in policy development.

Despite the high incidence of injury and those in need of acute trauma care in South Africa, while there are numerous "fee for service" establishments in the private sector, unfortunately only one publicly funded formal rehabilitation centre exists in the country (Hardcastle, 2011; Toubkin, 2010). The inability to return the economically active worker to gainful employment after major trauma is truly a tragedy in a country with high unemployment, child-headed households and extreme poverty.

It is also unfortunate that although short-course education based on sound evidence-based principles have been developed many professionals are loath to undertake these

courses, or do so only to enhance their chances of promotion or with thoughts of emigrating to greener pastures. This may be partly explained by the cost of these courses and the lack of central funding for ongoing education (Brysiewicz and Bruce, 2008; Hardcastle, 2010, 2011).

What educational developments have occurred?

The inaugural ATLS[®] course was arranged in Durban in 1992 by Prof. Lynn Baker, and since then trauma training has always been a focus of medical education, albeit as a post-basic course. As South Africa approaches the twentieth anniversary of ATLS, over 15,000 doctors and almost 3900 auditors (nurses and paramedics) have been trained. Around 50 courses are presented annually around the country, with course completion mandatory for all trainees in the surgical disciplines (personal communication – ATLS-SA).

The first post-graduate medical qualification in emergency care was developed in 1986 by C. van der Merwe, M. Morris and J. White, with the establishment of the Diploma in Primary Emergency Care (initially as part of the Faculty of Family Medicine, currently resorting under the College of Emergency Medicine) as a part-time higher training in emergency care for non-specialists. This diploma has proven popular with general practitioners working in pre-hospital care and as casualty officers.

This was followed shortly by the introduction of the Advanced Cardiac Life Support, Pediatric Advanced Life Support and the Advanced Paediatric Life Support courses during the late 1990s. Surgical courses in trauma care (Definitive Surgical Trauma Care) were introduced in 1999 (Hardcastle et al., 2006) and the MIMMS/HMIMMS major incident course commenced in 2008. Other courses aiming to improve emergency care include the EMSB Burns Management Course of the Burns Society and the International Trauma Life Support (ITLS) course primarily directed at nurses and paramedics.

Nursing training in South Africa has progressed from being college-based "on the job" training over 3 years to a 4 year degree/diploma course with further post-basic/post graduate education possible, in particular, in either emergency nursing (which includes trauma) and intensive care nursing (Brysiewicz and Bruce, 2008; Subedar, 2009). Although some diploma and post-graduate trauma/emergency nursing and critical care nursing courses have been available to nurses, recognition of the qualification toward higher salary scales and professional promotion, however, is still sub-optimal (Brysiewicz and Bruce, 2008). The implementation of the so-called "occupation-specific dispensation" in the public service has already led to improved recognition of advanced nursing training, but the same, however, is not really true across the private sector.

Doctors have been able to obtain formal training through the establishment of the M.Med. (a Coursework Masters level specialist degree) in both surgery (since the 1990s) and emergency medicine (from 2004) together with the establishment of the College of Emergency Medicine fellowship, the FCEM. At surgical level, the recognition of trauma as a distinct sub-speciality of General Surgery in 2007 led to the establishment of the Trauma Certificate, which requires

a 2-year training rotation in both trauma surgery and critical care. Although part-time M.Sc. and M.Phil. (Emergency Medicine) degree courses have also been established, non-specialised medical professionals still undertake most of the trauma care at the coalface (Hardcastle et al., 2006; Hardcastle, 2011).

In the field of pre-hospital care, there has been a dramatic shift away from the well-known short courses (BLS/ILS and ALS paramedic), initially toward a 3-year National Diploma and currently towards a B-degree in Emergency Medical Care & Rescue offered through the Universities of Technology. With this change, the fear exists that, despite better trained paramedics, there may develop a numerical shortfall, as occurred when the colleges of nursing were reduced in number some years ago. The short courses have actually been extended in an attempt to prevent this from occurring.

Having mentioned all these developments, it should be noted that, outside formal degree courses and certificate courses, most ongoing trauma education is funded by the professionals themselves, especially when it comes to short courses and continuing professional development courses, although some industry funding assists in reducing the overall costs to participants.

Recent clinical experiences

In 2010, South Africa was firmly in the world spotlight when hosting the FIFA Soccer World Cup tournament. This provided great impetus in developing disaster management systems and promoting major incident training. Fortunately the tournament went off without a hitch, and although the system was never tested, we were, however, at least prepared (Hardcastle et al., 2010). During the planning phase of this tournament we were also given the opportunity to reassess our hospitals and pre-hospital trauma systems and attempt to push for upgrading of facilities and equipment, which was achieved to a greater or lesser degree from province to province. The outcome has improved pre-hospital ability to manage mass casualty situations.

The disparity between the private sector and the public sector medical facilities has become more pronounced over the recent past and this leads to a continued dichotomy of care, with the funded patients (20% of the population) consuming around 75% of the health care expenditure. The proposed National Health Insurance scheme may assist in redressing this discrepancy (Toubkin, 2010).

Another "area of need" is the shortage of trained clinical forensic practitioners and the resulting under-use of drug or alcohol screening, as well as the less than optimal care of victims of sexual violence, despite the legal requirement for such testing in certain circumstances (Abdool and Brysiewicz, 2009; Brysiewicz, 2001; Brysiewicz and Bruce, 2008; Hardcastle, 2010). There are diploma courses for doctors, mainly directed at post-mortem forensics. The University of KwaZulu-Natal offers a clinical forensics course, part-time over a 2-year period, open to nurses, paramedics and doctors, which covers both clinical and post-mortem forensics. It is, however a costly enterprise. Nurses in South Africa are also currently busy with the development of

forensic nursing and having this speciality of nursing recognised by the nursing licensing body.

The greatest challenge to trauma care in South Africa and Africa is the development of appropriate trauma systems. There is a problem in simply trying to apply expensive, litigation-driven Developed World systems to Africa, where some entire countries have less specialists than would be needed to staff one Level 1 trauma centre. As such, the need for "afrocentricity" in the planning and development of such systems with fiscal wisdom and realistic expectation is essential. For the establishment of such a system the cooperation across many government departments, NGOs, the community and the medical profession in all its forms is required, plus a willingness to change and progress, keeping the patient at the centre of this planning process (Hardcastle, 2011; Hardcastle et al., 2011).

Conclusion

Trauma care is a challenge in South Africa, one that has not been reduced significantly since the dawn of democracy in 1994. The only hope is that strict enforcement of standards and continued passion for education, together with a move to systematic care by all the health professionals involved in emergency care may lead to reduction in mortality from this preventable disease. For the future the implementation of accreditation systems, the more formal establishment of cost-effective trauma systems with South Africa and throughout Africa, the establishment of national trauma registries and the effective funding of emergency care, possibly through the National Health Insurance scheme will benefit the public of South Africa and Africa.

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Chapter 4: Trauma centre criteria for South Africa, with a systems focus: S Afr Med J, 2011; 101: 189-194

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Guideline for the assessment of trauma centres for South Africa

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Introduction. Trauma is a well-known leading cause of unnatural death and disability in South Africa. Internationally the trend is moving toward systematised care.

Aim. To revise the Trauma Centre Criteria of the Trauma Society of South Africa and align these with the terminology and modern scope of emergency care practice, using best-care principles as a prelude to the development of trauma systems in South Africa.

Methodology. Revision of existing documents of the Trauma Society of South Africa, the Emergency Medicine Society of South Africa and the Critical Care Society of Southern Africa, where these are relevant to the care of trauma. The committee attempted to harmonise these criteria with the goals of the World Health Organization essential trauma care guidelines for trauma centres and trauma systems. Wide expert consultation was undertaken to refine the criteria before final compilation.

Results and recommendations. Four levels of trauma care facility are outlined, with the criteria focusing on the trauma-specific requirements of the facilities and their place in the greater trauma system. Accreditation of hospitals according to the criteria will allow for appropriate transfer and designation of patient destination for trauma patients and will improve the quality of care provided. The criteria address structural, process and human resource requirements and medical aspects for the accreditation of various level of trauma centre.

Conclusion. There is a great opportunity to apply best practice criteria to improve the care of trauma in South Africa and improve patient outcome.

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1. Introduction

Trauma is a disease process that is intimately related to man's interaction with other people and the environment. Trauma is the leading cause of non-natural death and a major cause of permanent disability and the economically active population group is most affected, thus increasing the real costs of injury to society.¹

Great advances have been made in the treatment of trauma with the establishment, firstly in Birmingham in the UK^{2,3} and later in the USA, of so-called 'trauma centres' – comprehensive centres of excellence where each specialty and sub-specialty of medical provider and allied health professional is present to provide initial assessment, quality resuscitation and definitive care and to speed the recovery of the patient with appropriate rehabilitation facilities. This has positively impacted on overall outcome.^{4,5}

South Africa followed this trend by establishing major trauma services at Johannesburg,³ Groote Schuur, Tygerberg, Pelonomi and Inkosi Albert Luthuli Central hospitals. In the private sector Milpark and several other hospitals have established trauma facilities led by trauma surgeons.

Trauma is a large component of the emergency surgical and orthopaedic workload at most public hospitals.⁶ Trauma surgery is now a separate sub-specialist discipline in surgery,⁷ and emergency medicine is a specialty in its own right.⁸ This will improve overall care of trauma victims and others presenting with medical emergencies.

Initially the trauma system consisted only of 'centres of excellence' in a sea of indifference. However, it was soon apparent that including the entire spectrum of caregivers resulted in better outcomes and led to the surgeon-led trauma systems typical of many developed countries.⁹ Trauma systems, where the services and facilities outside the major trauma centres were included to provide optimal care and referral of the appropriate patient to the appropriate higher level of care facility, have improved outcomes. These systems include integrating the pre-hospital fire and medical rescue services (emergency medical services) into the matrix and developing sufficient inter-facility and inter-service communications systems to ensure that the right patient gets to the right level of care within a defined optimal period of time,^{4,5} including rehabilitation and allied health providers.¹⁰

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The Trauma Society of South Africa (TSSA) is at the forefront of the setting of standards for the accreditation of private and public trauma care facilities.

2. Methodology

David Muckart, then President of the TSSA, reviewed the American College of Surgeons Trauma Centre Criteria and placed them in the South African context.¹⁰ This document served as the basis for trauma centre development in South Africa. It was updated in 2004, and in 2007 the Colleges of Medicine of South Africa accepted it as the framework for sub-speciality training in trauma surgery. The document has also been accepted by the Health Professions Council of South Africa (HPCSA) for accreditation of institutions for training of surgeons and surgical sub-specialists.¹¹ The present document has been updated and ratified by the Executive Committee of the TSSA, including input from the Critical Care Society of Southern Africa, Emergency Medicine Society of South Africa and Association of Surgeons of South Africa. The requirements are in line with or exceed those of the World Health Organization and other national documents.¹²⁻¹⁹

These criteria will be refined regularly when suitably trained practitioners in emergency medicine and trauma surgery qualify and fill the positions in hospitals and emergency centres.

3. Disease profile

The management of trauma requires surgical capacity, whereas many emergencies can be managed at most hospital levels, provided suitably trained emergency medicine practitioners are available. A hospital's ability to manage trauma must therefore be independently assessed, so that it can be appropriately designated and correctly placed in the greater trauma system, while stressing that the trauma patient is managed by the entire emergency and surgical team.

4. Definitive care facilities

Essential to the development of a trauma care system is the designation of definitive trauma care facilities. The trauma care system is the network of facilities that provides a full spectrum of care for all injured patients. Trauma centres should not be confused with emergency centres, where initial emergency care is provided to all emergencies, including trauma. Hospitals may have one designation level of emergency centre and another level of trauma centre designation.

When adequate level I trauma centre resources are available, additional level II centres may not be necessary. Similarly, when level I and level II trauma centres can provide care for the volume of trauma patients in the region, level III trauma centres may not be necessary; however, accredited emergency centres are needed, as they treat a variety of emergencies. In less densely populated areas and rural areas, level II and level III trauma centres are essential. In trauma systems, the designating authority is responsible for determining the anticipated volume of major trauma patients and assessing available resources to determine the optimal number and level of trauma centres in the area. This is one of the challenges facing South Africa's health care system.

Additionally, effective trauma systems must have a lead hospital, which must be the highest level available within the trauma system. It should be designated as such with delegated authority to oversee the entire system through outreach and in-reach. In many areas, level I centres will serve as the lead hospitals. In systems in less dense populations, level II facilities may assume this role. In smaller community and rural settings, level III centres must serve as the lead hospitals. The guidelines have been expanded to include level IV facilities, as many communities have only clinics and primary health care facilities that must provide basic trauma care.

5. Goals of the guidelines

These standards are intended to provide initial classification of hospital care and the staffing, resources and equipment essential to provide quality care (Table I).

The system is divided into four levels of care, and a particular centre may be awarded a different level of trauma verification from their designation in terms of their emergency centre or hospital status. For example one could have a level II trauma centre within a level I emergency centre if the hospital meets all the criteria for a major emergency centre but does not meet all the criteria to be a level I trauma centre. Alternatively, a hospital that focuses on a particular organ system (e.g. a urology or heart hospital) might only be able to meet level IV trauma centre criteria.

6. Trauma centre descriptions: (Fig. 1, Table I)

6.1 Level I (major trauma referral centre)

The level I facility is a regional resource trauma centre, usually a tertiary care facility central to the trauma care system. Ultimately, all patients who require the resources of the level I centre should have access to it. It must be capable of providing leadership and total care for every aspect of injury, from prevention through rehabilitation, and have 24-hour availability of all major specialties. In its central role, the level I centre must have adequate depth of resources.

<p>Level I: Major trauma centre Level II: Urban trauma centre Level III: Community hospital Level IV: Primary health care centre</p>

Fig. 1. Trauma centre levels.

Because of the large personnel and facility resources required for patient care, education and research, most level I trauma centres are university-based teaching hospitals. However, other hospitals willing to commit these resources may meet the criteria for level I recognition.

Level I trauma centres are also responsible for providing leadership in education, research and system planning that extends to all hospitals caring for injured patients in their region. Medical education programmes should include undergraduate and postgraduate training in trauma for doctors and nurses, and involvement with the training of pre-hospital providers. Education may include continuing medical education, personnel exchanges, outreach and other approaches appropriate to the local situation. Research and prevention programmes are essential for a level I trauma centre.

6.2 Level II (urban trauma centre)

The level II trauma centre is a hospital that is also expected to provide initial definitive trauma care regardless of the severity of injury, with 24-hour medical cover, including the common specialties.

However, depending on location, patient volume, personnel and resources, the level II trauma centre may be unable to provide the same comprehensive care as a level I trauma centre. Patients with complex injuries, e.g. requiring advanced and extended surgical critical care, may therefore have to be transferred to a level I centre. Level II trauma centres may be the most prevalent facility in a community and manage most trauma patients.

The level II trauma centre can be an academic institution or a public or private community facility located in an urban, suburban or rural area. Educational outreach, research and prevention programmes are similar to those required by a level I trauma centre, but, research is not

Table I. Verification criteria for trauma centre levels

	Level			
	I	II	III	IV
A. Hospital organisation				
1. Trauma service (trauma care from patient entry)	E	D	D	
2. Designated head of trauma (registered trauma surgeon)	E	D	D	
3. Trauma multidisciplinary team	E	D	D	
4a. Designated head of EM (registered EM specialist)		E	D	
4b. Designated head of EM (registered medical practitioner)		E	D	
5. Hospital departments				
a. EM	E	E	D	D
b. General surgery	E	E	D	D
c. Anaesthesia	E	E	D	D
d. Orthopaedic surgery	E	E	D	
e. Neurosurgery	E	D	D	
B. Clinical capabilities				
Clinical discipline availability				
1. In-house 24 hours a day (available within 10 minutes)				
a. EM	E	E	E	D
b. Trauma surgery/trauma critical care	E	D	D	
2. On call and available within 20 minutes				
a. General surgery	E	E	D	
b. Anaesthesiology	E	E	D	
3. On call and available within 60 minutes				
a. Anaesthesiology	n/a	n/a	E	
b. Cardiac surgery	E	D		
c. Cardiology	E	D		
d. General surgery	n/a	n/a	E	D
e. Emergency medicine	n/a	n/a	E	
f. Family medicine				D
f. Hand surgery	E	D		
g. Infectious diseases		E	D	
h. Intensive care	E	D		
i. Internal medicine	E	E	D	
j. Microvascular surgery	E	D		
k. Neurosurgery	E	D	D	
l. Nuclear medicine				
m. Obstetrics/gynaecology	E	E	D	
n. Ophthalmic surgery	E	D	D	
o. Oral/maxillofacial surgery	E	D		
p. Orthopaedic surgery	E	E	D	
q. Paediatric surgery		E	D	
r. Paediatrics	E	E	D	
s. Plastic surgery	E	E	D	
t. Pulmonary medicine	E	D		
u. Radiology	E	E	D	D
v. Thoracic surgery	E	D		
w. Urology	E	D	D	
x. Vascular surgery	E	D		
C. Facilities/resources				
1. Emergency centre	I	II	III	IV
a. Personnel				
1. Designated doctor in charge of the shift	E	E	E	D
2. Doctor with special competence in care of critically injured is a designated member of the trauma team and is physically present in the emergency department 24 hours a day	E	E	D	
3. ATLS*-trained personnel 24 hours a day	E	E	D	D
4. ACLS™-trained personnel 24 hours a day	E	E	D	D
5. APLS®/PALSTM-trained personnel 24 hours a day		E	D	

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6. Nursing personnel with specific training in trauma care who provide continual monitoring of the trauma patient from hospital arrival to disposition in ICU, OR or patient care unit	E	E	D	D
b. Equipment for resuscitation				
Required for patients of all ages. Shall include but not be limited to:				
1. Airway control and ventilation equipment, including laryngoscopes, endotracheal tubes of all sizes, bag-mask resuscitator, pocket masks, rescue devices and oxygen	E	E	E	E
2. Pulse oximetry	E	E	E	E
3. End-tidal CO ₂ determination/tube placement detector device	E	E	E	E
4. Suction devices (portable or wall mounted)	E	E	E	E
5. Electrocardiograph monitor defibrillator/pacer	E	E	E	E
6. Standard intravenous fluids and administration devices, including large-bore IV catheters	E	E	E	E
7. Apparatus to establish central venous catheter and venous pressure monitoring	E	E	D	D
8. Sterile surgical sets for:				
a. Cricothyroidotomy	E	E	E	E
b. Thoracotomy and tube thoracostomy	E	E	D	D
c. Vascular access (cutdown)	E	E	E	E
d. Chest decompression	E	E	E	E
9. Drugs necessary for emergency care as per EDL	E	E	E	E
10. X-ray availability, 24 hours a day	E	E	D	D
11. Two-way communication with emergency transport system	E	E	D	D
12. Skeletal traction devices	E	E	E	E
13. Arterial catheters and monitoring devices	E	E	D	
14. Thermal control equipment				
a. For patient – patient warming	E	E	E	D
b. For blood and fluids – high capacity	E	E	D	
c. For blood and fluids – fluid warming	E	E	E	D
2. Operating theatre				
a. Personnel				
Operating room adequately staffed in-house and immediately available 24 hours a day	E	E	D	D
b. Equipment				
Required for patients of all ages. Shall include but not be limited to:				
1. Cardiopulmonary bypass capability	E	D		
2. Operating microscope	E	D		
3. Thermal control equipment				
a. For patient – patient warming blanket		E	E	E
b. For blood and fluids – high capacity		E	E	E
c. For blood and fluids – fluid warming		E	E	E
4. X-ray capabilities including c-arm image intensifier available 24 hours a day		E	E	D
5. Endoscopes	E	E	D	
6. Craniotomy instruments	E	E	D	
7. Equipment appropriate for fixation of long bone and pelvic fractures	E	E	D	
3. Post-anaesthetic recovery room (ICU is acceptable)				
a. Personnel				
1. Registered nurses	E	E	E	
b. Equipment				
1. Equipment for the continuous monitoring of temperature, haemodynamics and gas exchange	E	E	D	
2. Equipment for the continuous monitoring of intracranial pressure	E	D	D	
3. Pulse oximetry		E	E	E
4. End-tidal CO ₂ determination		E	E	E
5. Active patient warming device	E	E	E	
4. Intensive care unit for trauma patients with trained staff	E	E	D	
a. Personnel				
1. Trauma specialist ultimately responsible for trauma care	E	D		
2. Physician with training in critical care available to ICU 24 hours a day	E	E	D	
3. Nursing: 24 hours nursing acuity per patient (ICU)	E	E		
12 hours nursing acuity per patient (HC)	E	D		

b. Equipment				
Appropriate monitoring and resuscitation equipment for all ages shall include but not be limited to:				
1. Airway control and ventilation equipment, including laryngoscopes and endotracheal tubes of all sizes, bag-mask resuscitator, pocket masks, rescue devices and oxygen		E	E	E
2. Mechanical ventilation equipment	E	E	D	
3. Pulse oximetry	E	E	E	
4. End-tidal CO ₂ determination		E	E	E
5. Suction devices		E	E	E
6. Monitor defibrillator	E	E	E	
7. Invasive pressure monitoring		E	E	D
5. Additional clinical services				
a. Physiotherapy	E	E	E	
b. Psychotherapy	E	D	D	
c. Occupational therapy	E	D	D	
d. Dietetics	E	D	D	
e. Acute haemodialysis capability		E	D	
f. Acute burn care capability	E	E	D	
g. Acute spinal cord/head injury management capability		E	E	D
h. Access to comprehensive rehabilitation service	E	E	D	
6. Specialist radiology services				
a. Computed tomography	E	E	D	
b. Interventional radiology	E	D	D	
c. Magnetic resonance imaging		E	D	D
d. Sonography	E	E	E	
7. Clinical laboratory service (available 24 hours a day)				
a. Full blood count	E	E	E	
b. Urea and electrolytes	E	E	E	
c. Blood glucose	E	E	E	E
d. Urinalysis	E	E	E	E
e. Blood typing and cross-matching	E	E	D	
f. Coagulation studies		E	E	D
g. Thrombo-elastography	E	D	D	
h. Comprehensive blood bank or access to banked blood with adequate storage facilities		E	E	D
i. Blood gas, lactate and pH determinations		E	E	D
j. Microbiology	E	E	D	
k. Drug and alcohol screening	E	E	D	
D. Quality assurance/quality improvement				
1. Documented evidence of ongoing quality improvement programme	E	E	E	E
2. Outcomes-based trauma registry	E	E	D	
3. Morbidity and mortality review	E	E	E	
4. Trauma CPD (multidisciplinary) – at least monthly	E	E	D	
5. Pre-hospital care feedback (documented)	E	E	D	
6. Published on-call schedule must be maintained for all specialties deemed essential	E	E	E	
7. Times and reasons for trauma divert must be documented and reviewed	E	E	E	
E. Outreach programme				
Telephone and/or on-site consultations with physicians and nurses of the community and outlying areas	E	D	D	
F. Preventive/public education				
1. Epidemiology research				
a. Collaborate with other organisations in injury prevention education	E	D	D	D
G. Trauma research programme (own or in collaboration with an academic department)				
1. All research must have ethics approval				
1. All research must have ethics approval	E	E	E	E
2. Regular meeting of multidisciplinary research groups	E	D		
3. Evidence of multidisciplinary research productivity				
a. Presentation at local/regional/national meetings	E	D		
b. Publications in peer-reviewed journals	E	D		

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H. Trauma service support personnel			
Trauma programme manager (co-ordinator) – direct reporting to hospital manager/clinical executive/medical manager and trauma director	E	D	
I. Organ procurement activity			
Required referral of potential donors (documented evidence)	E	E	E
J. Helipad access (all applications for verification received after 1 January 2011)			
	E	D	D
K. Other			
1. Annual declaration by the head of trauma that standards have been maintained, in order to maintain verification status	E	E	D
2. Re-verification inspection required every 3 years	E	E	E
3. Access to clinical forensic support services	E	E	E
<small>E = essential for verification at that level (all essential must be met for grading); D = desirable, but not essential for verification at that level; blank = not applicable to that level of care; n/a = not applicable; ICU = intensive care unit; OR = operating room; EDL = Essential Drugs List; HC = high care; CPD = continuing professional development.</small>			

an essential criterion. In areas where there is no level I centre, the level II centre should be responsible for education and system leadership.

6.3 Level III (community hospital)

The level III trauma centre serves communities without immediate access to a level I or II institution. Level III trauma centres can provide prompt assessment, resuscitation, basic emergency operations and stabilisation, and arrange for possible transfer to a facility that provides definitive trauma care. They must have prompt availability of general surgeons or general practitioners with surgical expertise, and planning for care of injured patients requires established early transfer systems and standardised treatment protocols. Level III trauma centres are generally not appropriate in an urban or suburban area with adequate level I and/or level II resources.

Most rural hospitals, and perhaps some smaller urban hospitals, will be level III facilities.

6.4 Level IV (primary health care facility)

Level IV trauma facilities provide basic trauma life support before patients are transferred for definitive care. Most will exist in remote areas where no higher level care is available, may be a clinic rather than a hospital, and may or may not have a doctor available. However, because of geographical isolation, the level IV trauma facility is the primary care provider. If willing to make the commitment to provide optimal care, given its resources, the level IV trauma facility should be integral to the inclusive trauma care system.

A level IV trauma facility must have a good working relationship with the nearest level I, II or III trauma centre to develop a rural trauma system with realistic standards based on available resources. Optimal care in rural areas can be provided by skilful use of existing professional and institutional resources supplemented by treatment guidelines that result in enhanced education, resource allocation, and appropriate designation for all levels of providers. The level IV facility must have a committed health care provider who can provide leadership and sustain the affiliation with other centres.

7. Implementation

Requests by a hospital or state health system for assessment will result in the following. The Verification Committee of the Trauma Society will provide a questionnaire document followed by a visit to verify the centre at the standard requested. Verification will be for 3 years

provided all criteria are complied with and annual reports prove that the standard is being maintained.

The College of Surgeons has accepted the criteria as binding on training institutions that intend to train in the sub-speciality of trauma surgery. The HPCSA has accepted the criteria for the recognition of training in trauma by surgical trainees and sub-speciality trainees.¹¹

8. Conclusion

Trauma care is being refined in South Africa, which has a great legacy of trauma surgical leadership and innovation. The TSSA, the professional body of experts in this field, wishes to enable all public or private hospitals/institutions to know the required standards and encourages application for accreditation. Applications for accreditation of a service should be in writing to the President of the Trauma Society, at assa@worldonline.co.za.

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Chapter 5: The protocol

Hypothesis and Objectives

Motivation for the Study

The motivation for the study is to optimize the care of the trauma patient providing a holistic comprehensive service to the patient in a timely fashion in low and middle income countries with South African Province as a model.

Relevance of the study

The relevance of the study is that the subjective perception of haphazard trauma service delivery needs to be accurately quantified in a more objective manner to define its inadequacies and design a more efficacious system of trauma care. This is examined within the context of a continuing high trauma disease burden.

Hypothesis

The hypothesis is, therefore, that the current informal trauma system in KZN is inefficient and that a re-assessment of the burden of disease will emphasise the need to establish a comprehensive, coordinated trauma system.

Objectives:

1. To examine the prehospital trauma burden in KZN and the distribution differences between the different districts, by means of GIS mapping of the relative disease burden. To determine ambulance availability, across services, including aeromedical services. To provide questionnaires to senior EMRS staff detailing their qualitative impressions of the current system
2. To examine the public health sector hospital trauma burden across the province, by assessing admission records of the respective public hospitals and to GIS map the relative disease burden across districts. To assess the hospital assessment records provided by hospital administrators and the FIFA assessment team in terms of structure, process and human resource components.
3. To examine referral consults to the only existing designated Major Trauma Unit (IALCH) in KZN to determine if potential patients are justified referrals and if more facilities are needed due to the refusals from "no beds"; and to determine whether

similar units should be developed with the same capacities in various existing regional areas to efficiently spread the workload and reduce morbidity.

Setting:

Province of KwaZulu-Natal, Department of Health and Emergency Medical Rescue Service, private Emergency Medical Services and all acute care hospitals.

Participant Selection and Privacy Issues

Participants are mainly health care providers from the pre-hospital and hospital sectors.

Patient data are numerical rather than individual in nature.

Patient data will be anonymously reviewed via the EMRS data collection system to determine injury types, mechanism and initial care destination. Most of the data in the needs assessment will be derived from the staff questionnaires and physical site visits.

Informed Consent will be obtained from the health care providers by a non-identifying signature mark placed on the questionnaire prior to completion. Only the researcher will have access to the raw data questionnaires once returned. No staff names will be required to maintain privacy and assure freedom to express opinions openly.

Measurements

The tools discussed in the literature review will be the comparators for the data analysis together with any national and provincial benchmarks identified through ongoing research.

Perceived Or Measured Outcomes

The expected outcome improvements that would be expected for a functional system include:

- Reduced time to patient assessment at an appropriate facility
- Reduced time to transfer to an appropriate higher level of care
- Appropriate level of care in the pre-hospital environment
- Improved quality of triage at district and regional centres
- Decreased time to operative intervention
- Patients with high Injury Severity Score rapidly bypassed to a suitable major trauma unit (regional or central)

- Reduced number of ICU and ventilator days
- Reduced hospital stay
- Increased access to appropriate rehabilitation services
- Decreased incidence of missed injury and physician error
- Decreased overall and late trauma mortality

Data Analysis: Simple statistical analysis will be utilized to compare the data to existing norms and standards – the statistical assessment has been discussed with Prof DJJ Muckart, who has a background in Trauma Outcomes Research (for his M. Med Sci.).

Sample Size: Since the studies are largely qualitative in nature rather than quantitative no sample size was proposed. Gross numerical values will be collected to determine trends rather than specific comparison groups. Return of questionnaires for an adequate response required a 60% response rate, which was achieved.

Funding

No funding was secured, but the project required minimal funding, and the researcher purchased a computer from accumulated research funds for the project.

Contributors and Authorship

The Researcher is the First Author on the submitted linked papers published in the peer-reviewed literature concerning the development of this Trauma System.

All relevant contributors who meet the criteria for authorship are credited as co-authors of these papers, since they closely advised the author on the interpretation of the data and the formulation of the papers and any other experts who contributed to the final product of the papers are offered a mention in acknowledgements.

Ethical Considerations

The project is approved by the Post-graduate and Biomedical Research Ethics Committees (BE011/10) prior to commencement, as suitable for a PhD, and assent from the Provincial Health Research Committee at Natalia was provided. No patient is identified in any article or publication and only collated anonymous data are presented. All participants who completed

proformas and/or questionnaires were expected to provide implied informed consent by completion of the questionnaire, so as to prevent them from being identified by name. Only the researcher and the BREC / Post-grad committee have access to the raw data, the latter only by written request. The Ethics committee concluded that this is low-risk research with maximal potential benefit to future patients if the system is achievable and becomes functional. The social value in potential cost containment to the Health Service and reductions in hospital stay with resultant higher return to gainful employment after recuperation of the injured patient is significant. The latter aspect impacts on the dignity of the patient in terms of better patient care.

The remainder of the PHD is presented in the following manner

The following research projects were prospectively undertaken:

Part 1: Current resources: Needs and Capabilities Assessment

Questionnaires were sent out to the staff at EMRS, after permission from the relevant provincial and district authority was granted. An analysis of the EMRS service (staff numbers and competency; vehicles and serviceability; rescue capability; equipment ideals and the actual situation), the location of bases and the current transfer and bypass protocols for the KZN service was undertaken as part of this phase of the research. Data already collected for the planning for FIFA2010 Health preparedness was also utilized in this context. This included a comparison to the existing FIFA-2010 Health Preparation guidelines to enable assessment of the standard of care actually available during the Soccer World Cup. An analysis of the current staffing status, level of current trauma care training of staff in the hospitals of each district, regional or major hospital under the KZN DOH jurisdiction was compared to the existing criteria for the primary care hospitals as determined by Trauma Society of South Africa (CHAPTER 4), WHO, COHSASA and the proposed National DOH Package of Care. This series of needs and capabilities assessments has provided the background data for a situation analysis of the current status of trauma care in the province and has allowed comparison to the international and national existing standards. The data has been divided into pre- and in-hospital groups and combined with the relevant clinical data (structure, process and disease-burden) to produce two comparative studies and to identify areas of excellence and deficiencies that must be addressed to achieve quality service delivery. These are presented as CHAPTERS 6 and 7.

Part 2: Burden of disease – Current Data

A current burden of disease study has been conducted through the EMRS and the Hospital system (CHAPTERS 6 and 7) to determine the amount and mechanisms of trauma treated and the end destination of these patients at initial transfer from scene. The data were additionally Geographical Information System mapped to examine the regional distribution of the trauma burden per district in the Province. In the paper that resulted from this data was included a “Needs Assessment” to enable a skills and resource development process to be implemented by KZN-DOH to improve patient care ensuring that staff who will treat these patients do so with standard-compliant equipment and consumables. The number of inter-hospital transfers until a trauma patient arrives at a source of definitive care and the waiting times to such transfers in the context of the IALCH Trauma Unit are also examined (CHAPTER 8). The data was derived from the call sheets as logged on the EMRS dispatch computer logs and utilized anonymous data and from data on file at IALCH trauma service.

Part 3: Propose an Afrocentric trauma system

Based on the published papers, a proposal for changes to the current system, as required to enable optimal patient care, is provided in CHAPTER 9. This is formulated promoting a comprehensive trauma system, capable of identifying the “at risk” patient and transferring them to the most appropriate level of care, from community to advanced care.

Proposed future implementation phase: Provided the provincial authorities are satisfied that the proposal is in line with optimal patient care, the proposed system should be piloted. The pilot study would need to cover a rural and an urban area and include EMRS and certain designated hospitals within a defined timeframe. More definite layout of this phase of the research will only be possible once the concept is accepted by the DOH, which has not yet occurred.

Part 4: Future audit of outcomes once implementation has occurred

This would use existing Trauma Quality Audit facilities/tools previously developed during a Trauma outreach project in conjunction with the existing professional organization documents. The studies will all be largely observational and any intervention will depend upon implementation by DOH-KZN. The impact on patient care will be indirect and no physical patient contact is expected during this research, however retrospective analysis of patient data (anonimized) can form part of the burden of disease study. Generally, the patient

data will relate to numbers of patients with a certain mechanism of injury rather than examining individual patient files. This has commenced in part through the establishment of the Provincial Trauma Epidemiology program at the Natalia Head Office. This team effort will also describe a quality assurance (QA) model for trauma care in accordance with the Province's QA guidelines. Aspects of Part 3 and part 4 are aimed at being on-going post-doctoral studies.

Chapter 6: Prehospital Burden of Trauma in KwaZulu-Natal: World J Surg, 2013, 37:1513-1525

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The Prehospital Burden of Disease due to Trauma in KwaZulu-Natal: The Need for Afrocentric Trauma Systems

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Abstract

Background Trauma is one of the leading prehospital disease profiles in South Africa in general and in KwaZulu-Natal (KZN) in particular. The present study was designed to review the prehospital burden of injury in KZN, identify trauma burden to ambulance ratios, analyze system deficiencies, and propose a prehospital trauma system that is Afrocentric in nature.

This article forms part of a series of studies toward a PhD in Trauma Systems for the lead author.

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Methods Approval from the relevant ethics authorities was obtained. Using a convenience data set all Emergency Medical Service (EMS) call data for the months of March and September 2010 were reviewed for the three main EMS providers in KZN. Data were extrapolated to annual data and placed in the context of population, ambulance service, and facility. The data were then mapped for area distribution and prehospital workload relative to the entire province. Questionnaire-based assessments of knowledge and deficiencies of the current system were completed by senior officers of the provincial system as part of the analysis of the current system.

Results The total annual call burden for trauma ranges between 94,840 and 101,420, or around 11.6 trauma calls per thousand of the population per year. Almost 70 % of calls were either for interpersonal intentional violence or vehicular collisions. Only 0.25 % of calls involved aeromedical resources. Some 80 % of patients were considered to be moderately to seriously injured, yet only 41 % of the patients were transported to a suitable level of care immediately, with many going to inappropriate lower level care facilities. Many rural calls are not attended within the time norms accepted nationally. Deficiencies noted by the questionnaire survey are the general lack of a bypass mechanism and the feeling among staff that most EMS bases do not have a bypass option or feel part of a system of care, despite large numbers of staff having been recently trained in triage and major trauma care.

Conclusions The prehospital trauma burden in KZN is significant and consumes vital resources and gridlocks facilities. A prehospital trauma system that is financially sustainable and meets the needs of the trauma burden is proposed to enable Afrocentric emergency care planning for low and middle income regions.

Introduction

Trauma is the second most frequent cause of mortality in KwaZulu-Natal province (KZN), the largest and most populous province of South Africa [1]. Trauma affects the young and productive population subgroup, and in this respect is similar to HIV/AIDS, the leading killer in the province. KwaZulu-Natal lies on the East coast of South Africa and has a population of almost 11 million [2], with approximately 50 % of the population living in the rural areas outside the two major cities of eThekweni (Durban) and uMsimduzi (Pietermaritzburg). Healthcare provision is divided into eleven health districts (Table 1; Fig. 1—population distribution)

South Africa is one of the few countries in Africa to have a formalized emergency medical service (EMS)[3–5], divided into private and public services, the latter being free-access. There is, at present, no formalized single emergency call center, and each of the services independently dispatches vehicles and personnel to reported incidents (this places South Africa somewhere between World Health Organisation prehospital trauma system grading level 2 and level 3) [6]. In KZN the majority of the emergency service vehicles in the public sector are staffed by basic or intermediate life support paramedics, whereas advanced life support (ALS) paramedics work from rapid response vehicles, mostly situated in the larger towns and the urban areas, many of these being aligned to private services. The majority of the population (87.5 %) is uninsured and relies on public ambulance services. Much has been published in the past about the fatal disease burden of trauma in South Africa[7–9]; however, little is known about either the prehospital or hospital overall burden of trauma in the country.

The purpose of the present study was to determine the trauma prehospital burden to this province suffering from resource constraints and the “devil of distance” for many

rural patients living in a province with undulating terrain. From available data, the ratio of trauma to ambulance availability was reviewed. System deficiencies were identified and a proposal for a prehospital trauma system was developed.

Methods

The study received UKZN-BREC (BE011/010) and Provincial Research Office approval, and permission for the use of de-identified call data was granted by the Netcare Ethical Committee and the Medical Director of ER24. The strategy employed a convenience data set of all EMS dispatches for a “trauma call” during the months of March and September 2010. These months were chosen to avoid “holiday bias” in December and the effect of the FIFA2010 Soccer World Cup, played in June–July of 2010.

Using extrapolation, these data were converted to a predicted annual incidence, using two methods to enable range prediction, classified by injury severity (where available) and then mapped per health district within the KZN province to reflect calls per 1,000 population. Finally, the data were placed into “facility” context by assessing trauma burden per staff and vehicle status per district and by access to major hospital (delivery destination). To illustrate the relative severity of the trauma burden, certain of the variables were geographic information system (GIS) mapped with standard mapping software [10]. From the available EMS structural data, a system was proposed for providing more efficient prehospital trauma care from an Afrocentric perspective.

The trauma causes were divided into three groups, namely vehicular related, interpersonal violence (with penetrating trauma as a separate subgroup where available), and other trauma (this includes domestic, industrial, other penetrating or blunt injury). Burn injuries were not included initially; however, these were reported for a number of the regions and the data were extrapolated to establish a regional burn incidence. The various causes of trauma were also evaluated per region to determine the spectrum of injury by region, and to determine whether rural regional variation differs from urban areas.

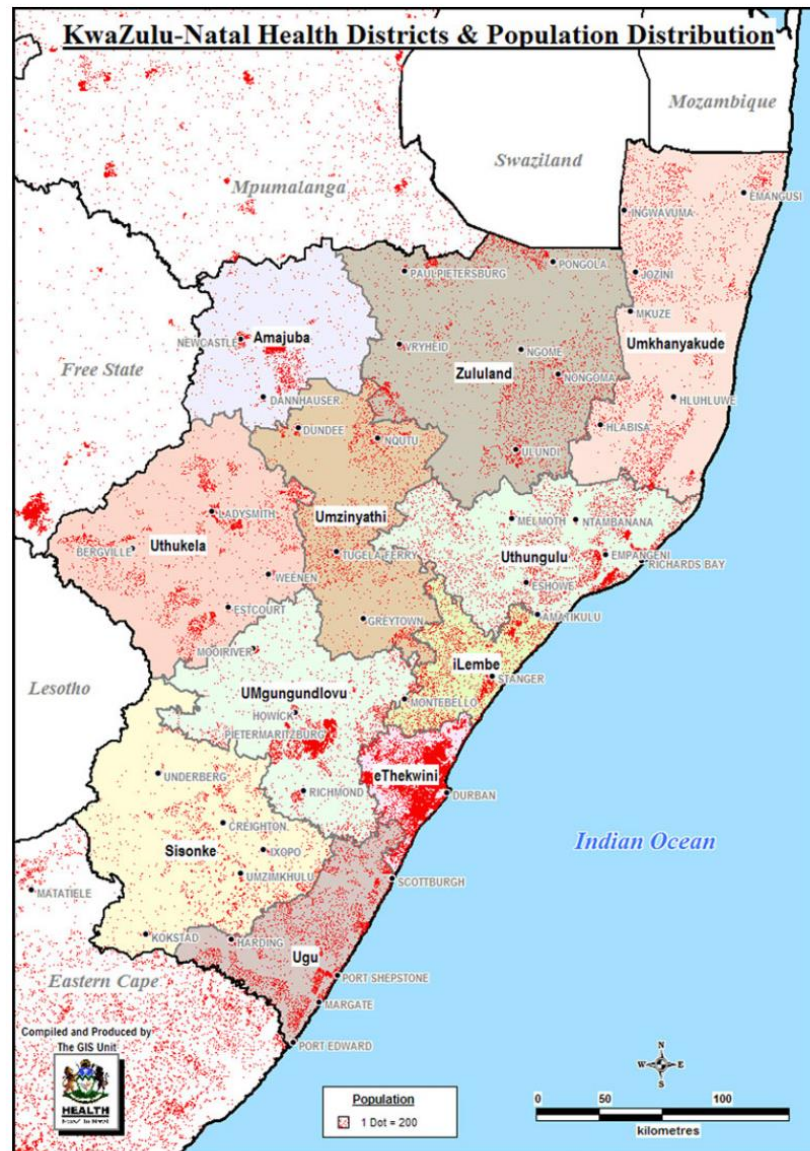
Results

For the 2 months under review, the total trauma-related call volume for the three EMS services was 16,903 calls from the data provided, which was incomplete for two districts. This would equate to an annual minimum trauma call volume for the KZN province between 94,840 and 101,420 calls, using a predictive system of either monthly

Table 1 Population by district: KwaZulu-Natal (2010)

DC21: Ugu District Municipality	729,052
DC22: UMgungundlovu District Municipality	960,819
DC23: Uthukela District Municipality	680,333
DC24: Umzinyathi District Municipality	472,682
DC25: Amajuba District Municipality	484,673
DC26: Zululand District Municipality	833,037
DC27: Umkhanyakude District Municipality	593,718
DC28: Uthungulu District Municipality	917,451
DC29: iLembe District Municipality	580,307
DC43: Sisonke District Municipality	308,999
Durban: eThekweni Municipality	3,199,944
	Total 9,761,016

Fig. 1 Map showing the health districts and population density in KwaZulu-Natal (KZN)

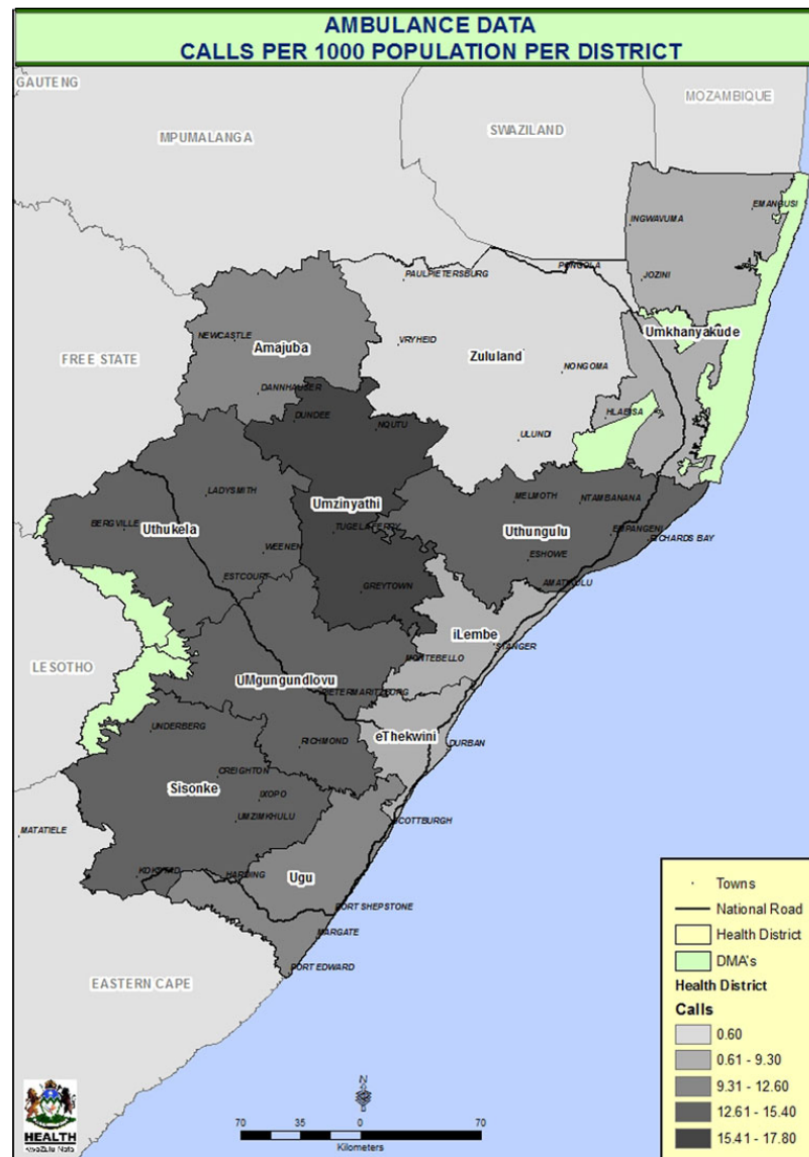


averages totalled for one year or the total of the two months multiplied by six, respectively. Using the two possible systems resulted in a 6.5 % variance between the two possible systems to calculate the annual trauma volume. Put into population context, this equates to 11.6 trauma events requiring emergency ambulance activation per 1,000 population in the province per annum, with certain of these events presenting multiple patients. The distribution of these ambulance calls across the province is GIS-mapped

in Fig. 2. In terms of ambulances per district, the distribution is mapped in Figs. 3 and 4.

During the study period, there were 2,042 operational EMS staff across the province; however, most were only basic life support (BLS) qualified, with only around 70 ALS providers for the entire patient cohort. Assuming all worked an equal number of shifts and saw a similar spectrum of disease, then each EMS provider would be exposed to between 46 and 50 trauma calls per operational

Fig. 2 Map outlining the distribution of trauma ambulance calls per 1,000 population per health district, KZN (Color figure online)

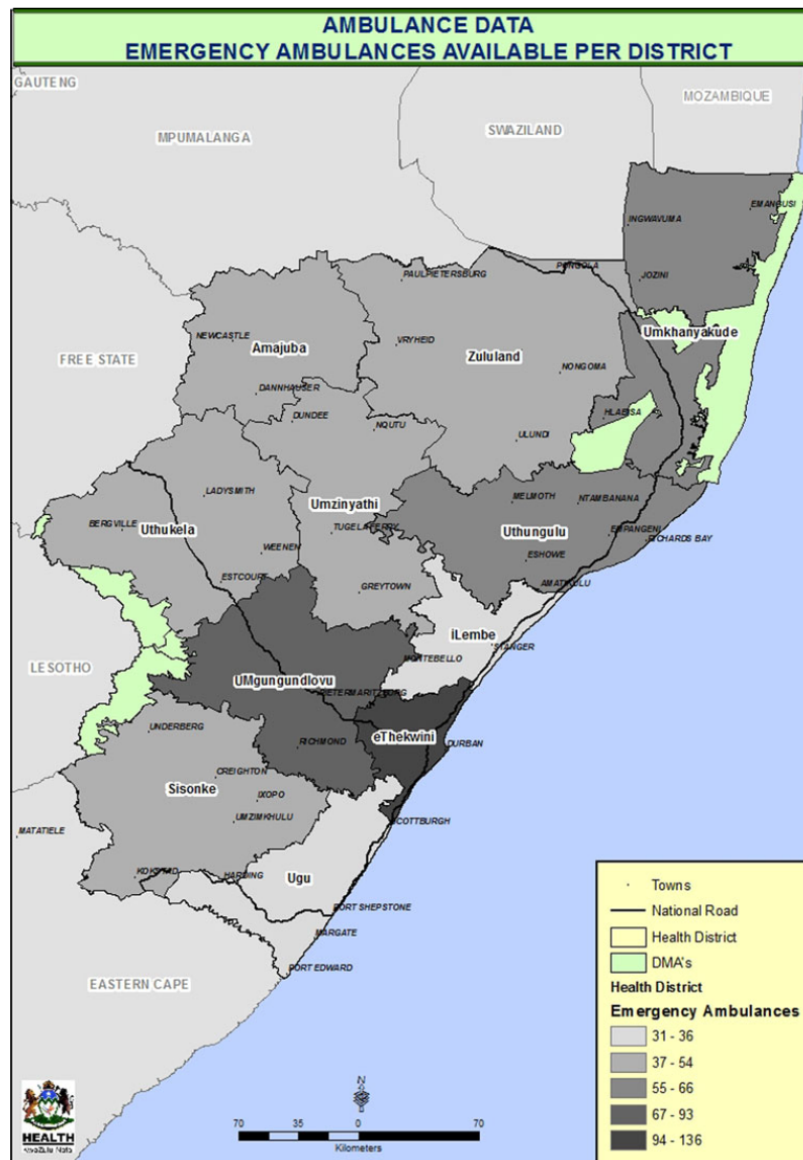


staff member. There are, however, only between six and ten ambulances per 100,000 population (including private services) operating on a daily basis, thus increasing the risk of delays and increased morbidity. Of these ambulances, 66 % of the public EMS vehicles have over 150,000 km completed service mileage. They are based at 70 public and 12 private EMS bases, with 80 % of the bases having fewer than six ambulances each. There are two rotor wing aeromedical aircraft, one private rotor wing aeromedical

aircraft, and one fixed wing aeromedical aircraft, which combined to undertake fewer than 300 flights for trauma during 2010.

Regarding relative trauma volume by cause, overall violence-related trauma occupies 39.7 % of the workload (Fig. 5), while vehicular collisions are second, with 31.9 % of the trauma burden (Fig. 6). Other trauma, which includes burns, was the third cause overall at 28.4 % (Fig. 7). The predicted number of burn cases for the

Fig. 3 Map showing the relative distribution of available ambulances per health district, KZN (Color figure online)

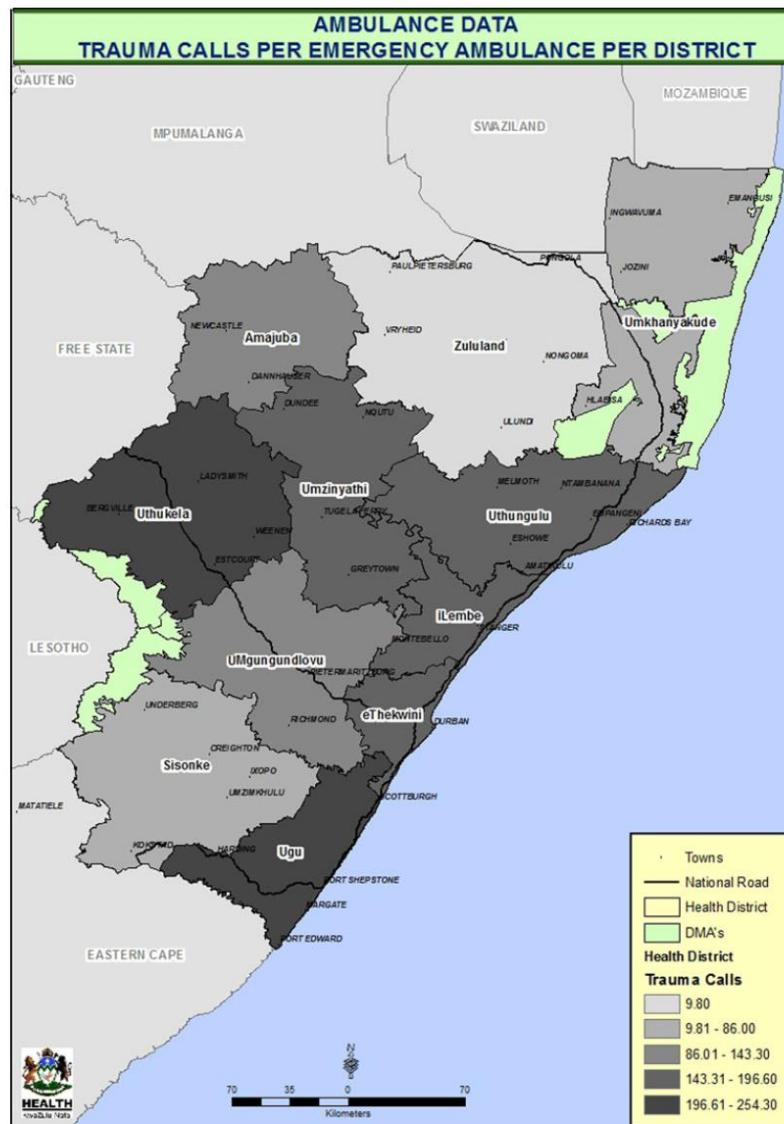


province is 7,099 per annum. The high rates of assault and gunshot injury relative to the overall trauma burden is of particular significance, along with the vehicle-related trauma, as these are potentially preventable injuries. This is especially concerning in light of the United Nations WHO Decade of Action 2011–2020 [11]. This was true for nine districts; however, two districts showed a different trauma spectrum, with the Amajuba and uThukela districts (both rural) having “other trauma” as the leading cause of injury,

while the two private services had a much higher vehicular collision rate and much lower interpersonal violence rates (Table 2). This is expected because most of the private services are based in urban areas with higher ALS staff availability. The private services responded to 3.5 % of the overall number of calls reviewed, mostly in the eThekweni, uMgungundlovu and Ilembe districts.

Three districts had large numbers of “exempt” calls, those where the EMS response was made and the call was

Fig. 4 GIS plot showing the trauma calls per ambulance per health district, KZN (Color figure online)

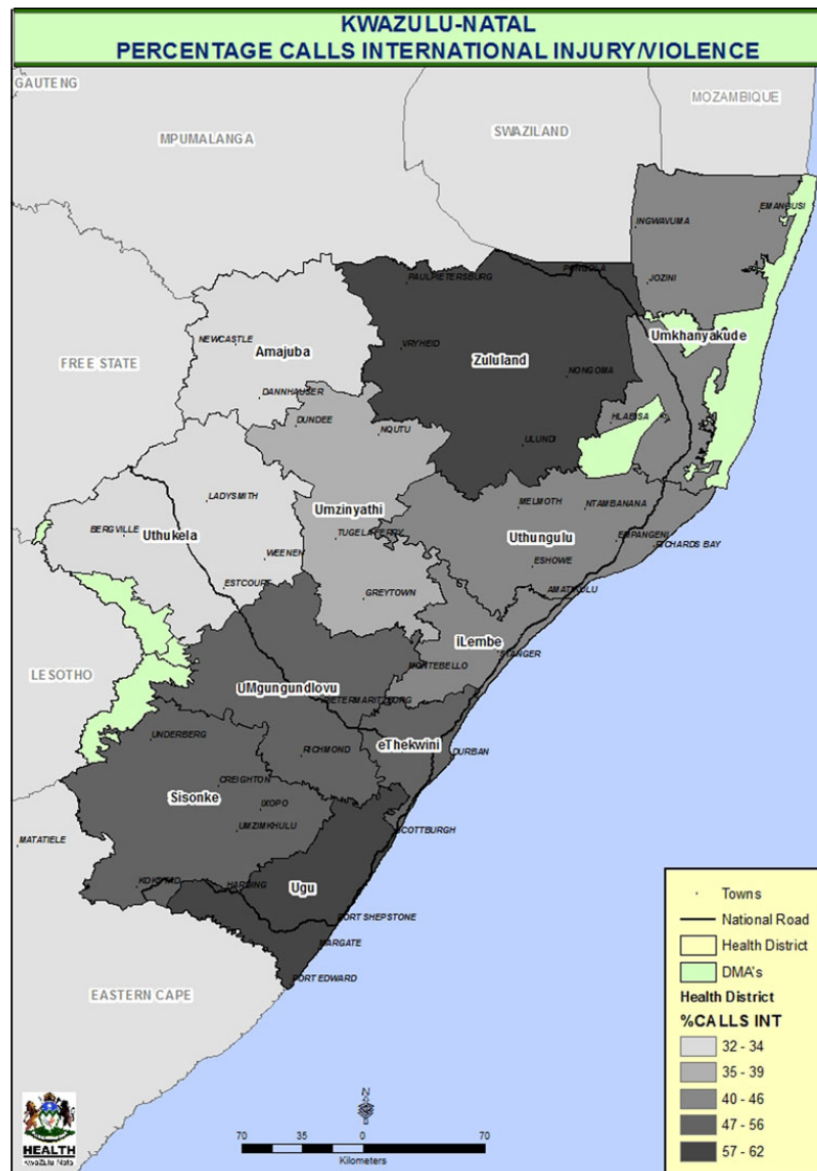


either a hoax or the patient had left the scene prior to EMS arrival. All three of those districts were largely rural in nature, and control center records show that less than 35 % of all calls in these rural regions were attended to in under 40 min (the national norm for rural responses) [12]. Overall, 6,609 unnecessary responses were recorded, where no patient was found or transported.

Regarding the severity of injury, the EMS use a four-part triage system with red implying life-threatening injury,

yellow a stable stretcher case, and green walking wounded. Code blue indicates that the patient was dead on arrival. Injury classification had been recorded by the control centers for 13,133 cases (77.7 % of all calls received). The spread of injury severity across the province was as follows: 80.3 % of cases were coded “yellow”; 15.6 % were cases of severe trauma and were coded “red,” whereas only 3.7 % of the cases were coded “green” and a minority of 0.4 % were dead on arrival. This implies that 80 % of

Fig. 5 GIS plot showing the relative distribution of violence-related trauma calls to the ambulance service per health district, KZN (Color figure online)

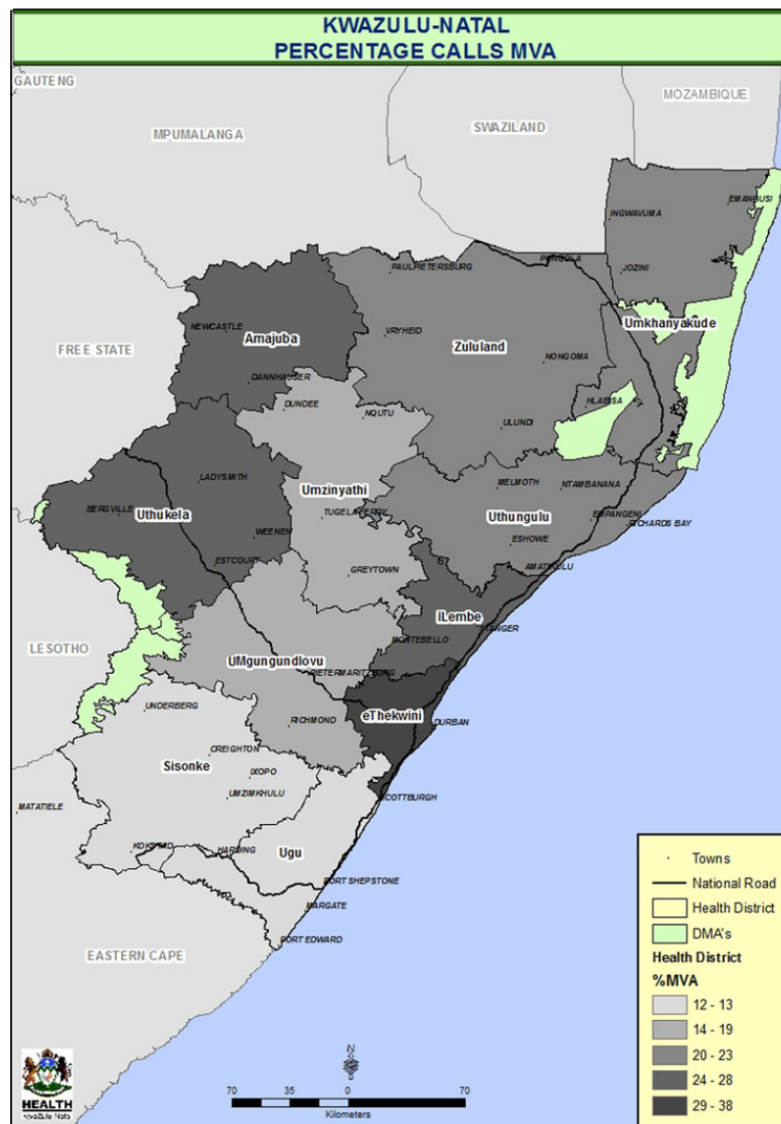


the patients should be treatable in appropriately equipped and staffed regional hospitals and that the majority of trauma victims should bypass small clinics and district hospitals. Only 15 % of cases will require care in a fully equipped level 1 trauma center, and there is only one such center in the province.

When examining definitive care destination, however, it was noted that almost 57 % of trauma cases were transferred to district hospitals, which have limited imaging and

surgical facilities, whereas 40 % were taken to regional hospitals and 1 % to tertiary or quaternary hospitals, whereas only 0.42 % were taken to the private hospital sector facilities. A further 1.6 % of cases were inappropriately taken to community (nurse-run) clinics. Around 2.7 % of transfers required transfer out of the district, thus further reducing the limited numbers of ambulances available for emergency cases in these districts (Fig. 6). All code blue patients were transported to state forensic

Fig. 6 GIS plot showing the relative distribution of motor vehicular trauma per district, KZN (Color figure online)

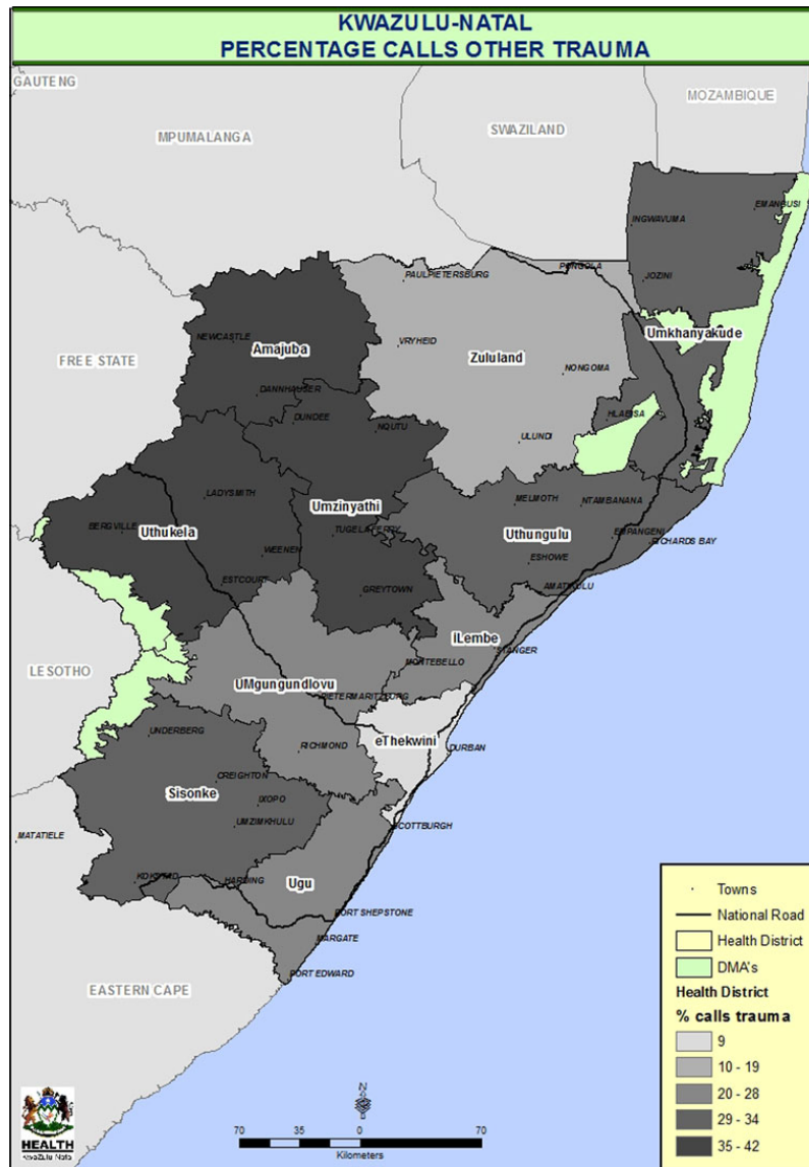


mortuaries, as SA law require a medico-legal post-mortem in these cases [13].

As part of the process of gauging the need for a trauma system in the prehospital phase of care, qualitative questionnaires were sent to 29 senior ambulance personnel (“Zonal Officers”) across the province, and the following recurring themes were noted: 83 % of respondents had knowledge of the free triage and mass casualty system training in the province and they indicated that over 460

staff had been trained. Despite this, 55 % felt there was no established system to bypass district hospitals effectively when injury severity clinically justifies such bypass. When appropriate, it was often left to the individual advance life support practitioner, incident commander, or hospital medical officer to recommend such bypass maneuvers. In fact, 18 of the officers responded that all patients are initially taken to the closest hospital or clinic, even when this is not the best facility for the patient, as this is what the

Fig. 7 GIS plot showing the distribution of “other trauma” per district, KZN (Color figure online)



current referral pathway dictated. A further five officers suggested the district hospital is appropriate only for minor and moderate injuries, and that major cases (code red) should be offered bypass to larger regional hospitals. Three officers said they never offer bypass as an option for their patients.

When asked which patients they would bypass, the responses were varied and included the following: 17 suggested only major cases, while one each stated cases of

prolonged transfer distance and mass casualty situations, respectively. Four officers suggested bypass for those needing computed tomography (CT), surgery, or orthopedic intervention, as these specialties are available only at regional facilities. Only two respondents suggested that only helicopter cases qualified for service upgrade and bypass.

Finally, the officers were asked to comment on what they felt was necessary to improve the system once implemented. Seventeen suggested upgrading receiving

Table 2 Variance of call type per service and district

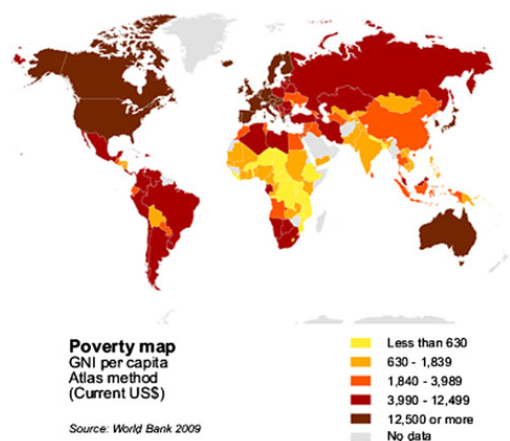
District	% Calls motor vehicle accident	% Calls intentional injury/violence	% Calls other trauma
Ugu 21	12	62	26
UMgungundlovu 22	18	55	27
Uthukela 23	26	32	42
Umzinyathi 24	19	39	42
Amajuba 25	25	34	41
Zululand 26	22	58	19
Umkhanyakude 27	23	43	34
Uthungulu 28	21	46	33
iLembe 29	28	44	28
Sisonke 43	13	56	31
eThekweni Unicity	38	53	9
ER24	71	6	23
Netcare911	64	13	23

hospitals at the district level. In particular they mentioned provision of adequate staff, training for the medical and nursing staff in trauma care, improvement of equipment (especially for ventilation), provision of imaging at all hospitals (CT scanner) to reduce transfers, and allowing EMS staff to directly discuss patients with regional center staff if the triage category suggested the need for a higher level of care. They also mentioned predesignation of trauma centers and increased access to aeromedical evacuation as priorities for improving outcome.

Discussion

South Africa is considered by many to be a mixed developed and developing country (Fig. 8 from World Bank data), with parts of the country comparable to well-resourced international cities and other parts comparable to very poorly resourced low to middle income countries. [14] The EMS in South Africa is far more developed and established than in most other parts of Africa, where reliance on passers-by and informally trained first-aiders is the norm and ambulances are few and far between [15, 16].

Trauma, as a relative disease-burden, has been examined both regionally [17] and nationally from various aspects, although the prehospital burden has largely been ignored, with the last large series reported in 1996 [18, 19]. Mostly these studies have focussed on mortality and not the live-patient cohort. Relative to other countries, South Africa has advanced training and fairly modern facilities for prehospital emergency care; however, much of this is located in

**Fig. 8** World map demonstrating the economic levels of African countries (Color figure online)

the urban regions where the effectiveness of ALS has been questioned [20, 21]. Trauma also consumes much more of the health care budget and constitutes relatively more of the emergency workload relative to other developed countries [22]. The additional challenge to the EMS in South Africa is the high level of brain drain among the highest levels of emergency care providers [23, 24].

Despite these advantages and challenges, previous reviews have demonstrated that there is a semi-formal system of care in South Africa, which is split into a private sector and a public sector [12, 25, 26]. There is professional cooperation, with the private sector aiming to capture the insured section of the health care sector comprising <20 % of the population, with some mistrust between the two sectors evident [27]. This is coupled with a referral pathway largely based on a system relevant to primary medical healthcare conditions, such as maternal-child health, infectious or chronic disease. In addition, the system is burdened by numerous mass-casualty events [4, 28–32]. This leads to the inappropriate delivery of severely injured patients to inadequately equipped facilities, which were not designed for trauma care, necessitating subsequent transfer, often with delayed dispatch of ALS prehospital services, which are engaged in treating minor and moderate injury cases [28, 32]. These services are often already overwhelmed, as noted by the fact that only between 30 and 40 % of all emergency patients arrive at hospital in an ambulance [33]. Violence and motor vehicle incidents make up the lion's share of the work, in a similar spectrum to that recorded previously, with no apparent reduction over time [34–36]. In keeping with this study, the previous Durban study showed that only about 15–20 % of cases comprise major trauma [28].

Previous local studies have shown that care at a major trauma center leads to less morbidity, mortality, and missed injury, especially for the more severely injured [37, 38]. Studies from other parts of Africa have demonstrated reduced morbidity and mortality through community participation and basic prehospital system development [39–41]. Similar studies from other parts of Africa have shown that the lack of EMS services lead to higher complication rates, longer prehospital times, and multiple transfers [41–44]. It is interesting to note from the present study that the EMS providers themselves determined this to be a challenge to optimal care and illustrates the blatant link to poorer outcomes. The need for a more formal all-encompassing trauma system is readily apparent. Most of the steps to achieve this will be fairly simple and cost-efficient, such as bypass to appropriate “first contact” facilities and upgrading the lower levels of hospital facility.

As far back as 1998, the Cape Town Summit, endorsed by the Trauma Society of South Africa, called for Emergency Medical Systems that took account of the world’s economic constraints and proposed that these require change in the delivery of health care in both the developing and developed world. The proposal they offered was a step-wise evolutionary system adaptable to many different practice environments [45, 46]. South Africa is now fairly advanced on the template proposed at the summit; however, the same is not true of many other African countries. The Cape Town model proposes beginning with self-care and prevention, progressing to access and intervention by trained providers, and completion of care in a properly staffed, equipped, and regionally credentialed hospital, such as facilities that meet the recently proposed local South African standards [46, 47].

To place this in perspective, it is interesting to compare the trauma prehospital event rate of 11.6 per 1,000 population to other local or international data. Regionally, the total ambulance call rate is listed in data on hand as 72/1,000 population, implying that trauma is approximately 15 % of the total ambulance workload in KZN. No other local data have been published looking at the prehospital trauma burden, while the reported hospital burden is around 40 per 1,000 [48]. This total includes all ambulance transports in the public sector, except planned outpatient transports. Comparatively, the rates are far in excess of those reported from developed countries, with Wales reporting a rate of 19 per 100,000 and Norway 30 per 100,000, while other developing countries also report much lower rates, with Pakistan varying between 9 and 23 per 100,000, depending on the underlying injury mechanism [49–52]. This begs the question of what prehospital trauma system will work in under-resourced countries. The World Health Organisation document for essential prehospital care suggests that the components of an efficient

prehospital care system must include, at a minimum, prompt communication and activation of the system, the prompt response of the system, and the assessment, treatment, and transport of injured people to formal health-care facilities, regardless of whether they are urban or rural. This system may be constituted of one or more tiers of care, but it must have a lead organisation, appropriate cost-effective staffing of at least the basic level of EMS response, and disaster planning. Funding options and the need for political and legislative considerations are highlighted, similar to points highlighted recently in a South African publication. Additionally, the WHO and TSSA documents suggest that there is a need for medical oversight of the EMS service, regular audits, and quality assurance [22, 47, 53].

In the context of the present study, the system must optimize the number of ambulances per geographical region, determine and appropriately equip predetermined receiving facilities, and establish the option of bypassing limited resourced facilities. Putting more advanced emergency care practitioners in the rural areas would potentially reduce prehospital mortality. Additionally, the WHO document highlights the need for bypass to allow prehospital providers to take patients to the appropriate level of care [53].

Can this be done cost effectively in Africa? Recent studies have shown that trauma systems are cost-effective; however, these studies also show that it takes about 10 years to realize the cost benefits [54]. To ensure success in constructing more efficient systems, health departments need to demonstrate courage in putting the structure and processes in place, knowing that the ends must justify the means in Africa. The data presented in this study also show the need to redesign the system in South Africa to make it more inclusive and cost effective, with bypass as a simple initial stage in this process.

A logical system must include a single national number, with universal access from mobile and landline telephony, integration of private and public service providers into a coordinated control structure to ensure efficient resource utilization, using regionalized control centers with rapid access to other emergency services. Using the TSSA guidelines and the WHO Trauma System Evaluation tool will enable South Africa to reach at least a level 3 rating and aspire to level 4 [6, 47]. Predesignation of trauma facilities, both private and public, will ensure that patients reach the closest appropriate care facility rapidly. The funding for all emergency cases, especially trauma, should be from the central government, with universal payment to prevent a dichotomy of service provision, such as the planned National Health Insurance scheme proposed recently by the South African health ministry [22, 47, 48, 55].

The present study has some limitations, including the fact that it was undertaken in a single province in one of the more developed countries in Africa. Thus the generalizability of the results may not be high, although trauma is recognized across the continent as a major challenge. Additional limitations include reliance on recorded data interpreted secondhand from call-center records, which may lead to the possibility of underreporting of the trauma burden. In fact, approximately 5 % of all potential calls were excluded by the researchers due to lack of clarity of the underlying cause. It was known to the researchers that two of the districts provided incomplete data, thus the total trauma burden is at best an estimate of the minimum burden. This may have led to an underestimation of up to 5 % of the true trauma burden. Third, this study only included data from the two large nationally functioning private ambulance services, while there are numerous small private services in the province, probably providing care to as much as an additional 2 % of cases. Thus the true underestimate may be as high as 7 %, meaning that there would most likely be closer to 110,000 trauma calls to EMS per annum. In addition, it has been noted that a significant proportion of trauma cases present to definitive care via their own transport [34, 35, 56].

Conclusions

The burden of prehospital trauma in South Africa is significant and higher than in most developed countries; at about 18 % of the overall emergency burden of disease, however, this consumes vital resources and reduces the availability of ambulances, already at a premium, for other non-trauma emergency cases. The optimal system will deliver the patient with appropriate severity to the correct level of care, but will bypass non-doctor primary care services and inappropriately resourced district services for moderate and major severity cases. A system must be inclusive and incorporate all services from EMS to rehabilitation, rather than focusing on one or two super-specialized major trauma centers, which should be maintained as a regional lead resource.

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Chapter 7: Hospital Disease Burden and Facility Assessment for Trauma Care: World J Surg 2013, 37:1550-1561

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An Assessment of the Hospital Disease Burden and the Facilities for the In-hospital Care of Trauma in KwaZulu-Natal, South Africa

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Abstract

Background Trauma is a significant cause of morbidity and mortality in South Africa. The present study was designed to review the hospital trauma disease burden in light of the facilities available for the care of the injured in KwaZulu-Natal (KZN), South Africa's most populous province.

The primary outcomes were the annual hospital burden of trauma in KZN, determined through data extrapolation, and evaluation of the data in light of available hospital facilities within the province of KZN, a developing province. The data were obtained through review of the trauma load in relation to all emergency cases at all levels of hospitals.

Methods Hospital administrators in KZN were requested to submit trauma caseloads for the months of March and September 2010. Caseloads were reviewed to determine the trauma load for the province per category using two extrapolation methods to determine the predicted range of annual incidence of trauma, intentional versus non-intentional trauma ratios and population-related incidence of trauma. The results were GIS mapped to demonstrate

variations across districts. Hospital data were obtained from assessments of structure, process, and personnel undertaken prior to a major sporting event. These were compared to the ideal facilities required for accreditation of trauma care facilities of the Trauma Society of South Africa and other established documents.

Results Data were obtained from 36 of the 47 public hospitals in KZN that manage acute emergency cases. The predicted annual trauma incidence in KZN ranges from 124,000 to 125,000, or 12.9 per 1,000 population. This would imply a national public hospital trauma load on the order of at least 750,000 cases per year. Most hospitals are required to treat trauma; however, within KZN many hospitals do not have adequate personnel, medical equipment, or structural integrity to be formally accredited as trauma care facilities in terms of existing criteria.

Conclusions There is a significant trauma load that consumes vital emergency center resources. Most hospitals will need extensive upgrading to provide appropriate care for trauma. An inclusive trauma system needs to be formalized and funded, especially in light of the planned National Health Insurance for South Africa

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Introduction

South Africa has a legacy of political turmoil and inter-personal violence. Since the transition to democracy the focus of health care in South Africa has shifted from hospital-centered care to primary care [1]. KwaZulu-Natal (KZN) (Image 1) is South Africa's most populous province, with a population of almost 11 million persons [2]. Trauma varies in scale and mechanism from minor injury, suitably treated at the community hospital level, through to major trauma requiring intensive care and surgical

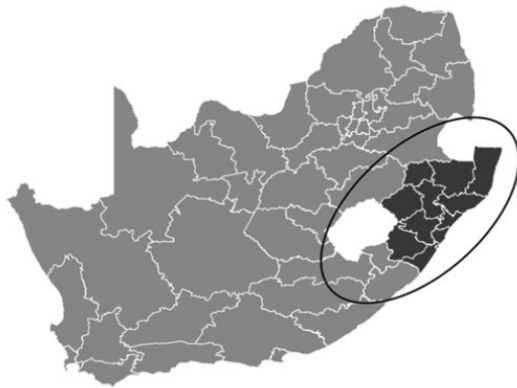


Image 1 Map demonstrating the location of KwaZulu-Natal within the borders of South Africa

intervention. It is known, however, that most trauma patients will be in need of medical care, and thus nurse-led clinics are generally an inappropriate care-level for this disease entity, as even simple suturing is outside the nursing scope of practice [3].

There have been a number of studies over the years examining the mortality burden of trauma in South Africa [4–9], as well as some older studies looking at the overall disease burden [10–13]. To date, however, there have been no recent large-scale studies of the trauma disease burden of live patients admitted to government hospitals providing an overview of these patients generally. Additionally, there are limited data on how well hospitals are equipped, staffed, and prepared for dealing with major trauma, despite national standards existing for the primary care environment.

Aim

The goal of the present study was to review the overall trauma burden of disease in KZN and the facilities available at hospitals in the province as a precursor to the design and establishment of a definitive care trauma system within the province. With such information, the study aimed to place the trauma burden into a national perspective and to provide insights into the adaptations needed prior to the implementation of the planned National Health Insurance, which will need to fund the care of trauma patients.

Methods

A questionnaire was sent to all 47 government hospitals in KZN that treat trauma cases. The questionnaire was

designed to obtain data regarding the trauma caseload, specifically in terms of gunshot wounds, stab wounds, motor vehicular trauma, and other blunt injury for the months of March and September 2010. Drownings, other medical emergencies, and snake bites were excluded. These months were chosen as they represented a “normal” month outside the holiday season (December–January) and outside the FIFA World Cup period (June–July), when no major school vacations occur, thus providing a reasonable average spread of injuries. The data were extrapolated to predicted annual figures (trauma range) by two calculation methods (average of 2 months \times 12 and the total sum of the 2 months \times 6), extended to national figures, and compared to the overall emergency case-census as provided by the Provincial Health Head Office. These results were Geographic Information System (GIS) mapped where relevant. Facilities were physically assessed by a team of specialist trauma and emergency professionals prior to the FIFA 2010 Soccer World Cup (the lead author of this article being one of the members of the team), which took place in June–July 2010. These assessments were compared to the Essential Trauma Care Guidelines (EsTC), the Trauma Society of South Africa Trauma Centre Accreditation criteria (TSSA) recently published by the society, and the expected district service delivery standards of the Department of Health for the accreditation of hospital facilities [14–16]. Based on these results, a proposal will be formulated for the establishment of an inclusive Afrocentric trauma system.

Results

Responses were received from 36 of the 47 hospitals in KZN (77%). The raw data are summarized in Table 1. Based on the calculations, the range of trauma per annum was between 124,908 and 125,652 cases as a minimum for the hospitals represented. Converting this to an expected case load for all hospitals would yield approximately 160,000 cases per year. This equates to an annual trauma load of 12.9 per 1,000 population, or one in every 77 members of the population. Figure 1 is the Geographical Information System (GIS) map of the overall hospital burden per district. This means that trauma constitutes at least 17.8% of the overall emergency cases treated in the province (total provincial emergency head count for 2010 was 706,346). Of these trauma patients, 44% were treated at urban hospitals, 12% at rural regional hospitals, and 44% at rural district hospitals. Extrapolating these data to the national population equates to over 750,000 trauma cases per year requiring hospital level healthcare.

The total trauma load included 65% from intentional trauma and only 35% from unintentional injuries (this

Table 1 Raw data for the district and regional hospital trauma burden in KwaZulu-Natal

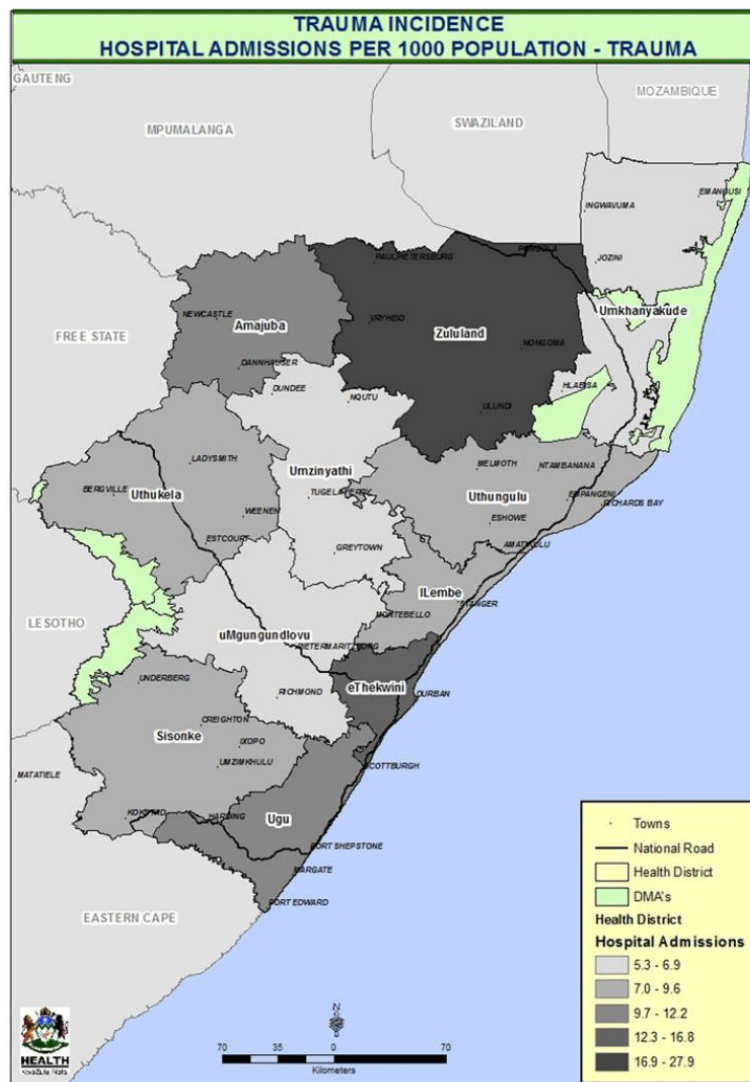
Region	March						September						Per district Rate per 1,000 per year	Per district Population count			
	Hospital	Stab	GSW	MVA	Assault	Burn ^a	Total March	Stab	GSW	MVA	Assault	Burn ^a			Total Sep	Total Averages	Simple tot 2-mo
Amajuba	1	120	9	98	3	3	230	209	8	62	0	0	279	255	509	Amajuba 48,4673	
	2	40	0	75	34	34	149	30	2	138	46	46	216	183	365		
Total		160	9	173	37	37	379	239	10	200	46	46	495	438	874		
eThakwini	1	119	10	337	344	344	810	108	13	236	332	689	689	750	1,499	eThakwini 3,199,944	
	2	105	50	210	130	130	495	98	31	191	149	469	482	964	1,499		
	3	43	12	139	41	41	235	32	4	83	39	158	197	393	393		
	4	153	26	364	315	315	858	26	199	303	337	865	865	1,723	1,723		
	5	330	26	536	1,274	89	2,255	243	19	387	843	61	1,553	1,904	3,808		3,808
	6	38	1	56	199	199	294	23	1	88	160	160	272	285	566		566
Total		788	125	1,642	2,303	2,303	530	267	1,288	1,860	1,860	3,011	4,480	8,953	8,953		
Ilembe	1	160	22	77	86	86	345	144	9	86	62	62	301	323	646	Ilembe 580,307	
	2	3	30	38	38	38	73	9	4	34	44	44	91	82	164		
Total		162	25	107	124	124	418	153	13	120	106	106	392	405	810		
Sisenke	1	5	1	5	2	2	13	5	0	1	36	42	42	27	55	Sisenke 580,307	
	2	12	1	78	103	103	194	12	1	88	120	221	208	208	415		
Total		17	2	83	105	105	207	17	1	89	156	221	235	235	470		
Umkhanyakude	1	7	2	20	32	32	59	14	3	26	23	66	66	64	125	Umkhanyakude 308,999	
	2	12	1	3	8	8	24	12	1	3	8	24	24	24	48		
	3	3	3	16	4	4	26	5	0	37	13	55	41	81	81		
	4	13	1	28	43	43	85	26	3	14	70	113	99	198	198		
	5	7	4	33	31	68	143	7	0	12	50	22	91	117	234		234
Total		42	11	100	118	118	204	64	7	92	164	221	345	345	686		
Ugu	1	16	3	26	53	53	104	24	7	44	73	10	158	131	264	Ugu 593,718	
	2	10	0	172	172	172	510	8	137	137	316	461	485	971	971		
	3	4	0	25	64	64	93	23	4	50	79	156	156	249	249		
Total		30	3	223	117	117	510	55	11	231	152	461	485	971	971		
uMgungundlovu	1	10	2	10	32	32	54	9	0	11	35	55	55	55	109	uMgungundlovu 960,819	
	2	64	10	66	85	85	225	71	8	91	79	249	238	474	474		
	3	4	1	2	2	2	9	3	0	4	0	7	8	16	16		
	4	53	1	27	42	42	123	5	1	41	74	121	122	244	244		
Total		131	14	105	161	161	413	88	9	147	188	461	423	843	843		
uMzinyathi	1	23	0	76	44	44	143	23	0	112	39	0	174	159	317	uMzinyathi 960,819	
	2	0	26	26	26	26	26	3	7	7	45	10	18	36	36		
	3	8	4	26	55	55	93	9	3	38	45	95	94	188	188		
Total		31	4	128	99	99	262	32	6	157	84	204	271	541	541		
uThukela	1	18	6	46	33	33	103	18	7	45	33	103	103	103	206	uThukela 680,333	
	2	44	8	127	156	156	335	45	16	163	161	385	360	720	720		
Total		62	14	173	189	189	468	63	23	208	194	463	463	926	926		

Table 1 continued

Region	March				September				Total Averages for 2 mo	Rate per year	Per district Rate per 1,000	Per district Population count							
	Hospital	Stab	GSW	MVA	Assault	Blunt ^a	Burn	Total					Stab	GSW	MVA	Assault	Blunt ^a	Burn	Total
uThungulu	1	2	1	0	0	0	0	1	1	0	0	0	0	1	2	4			
	2	22	31	21	16			59	137	18	31	29		137	114	227			
	3	15	30	252	263			560	560					560	560	1,120			
	4	4	2	10	32			48	72	1	12	53		72	60	120		uThungulu	
Total		43	64	283	311			66	87	19	43	82		87	736	1,471		917,451	
Zululand	1	5	0	21	44			70	87	0	36	46		87	79	157			
	2	297	108	459	621			1,485	1,485	108	459	621		1,485	1,485	2,970			
	3	118	5	90	193			406	334	5	68	154		334	370	740		Zululand	
Total		420	113	570	858			10,768	10,155	113	563	821		10,155	1,934	3,867		833,037	
10,471	20,925							125,550	Total					Total	20,925	20,925		averages	
	X6 =								Total averages										X12 = 125,652

^a Blunt indicates unintentional blunt injury
GSW gun shot wound; MVA motor vehicle accident

Fig. 1 Total distribution of Trauma Burden per 1,000 population across KwaZulu-Natal health districts

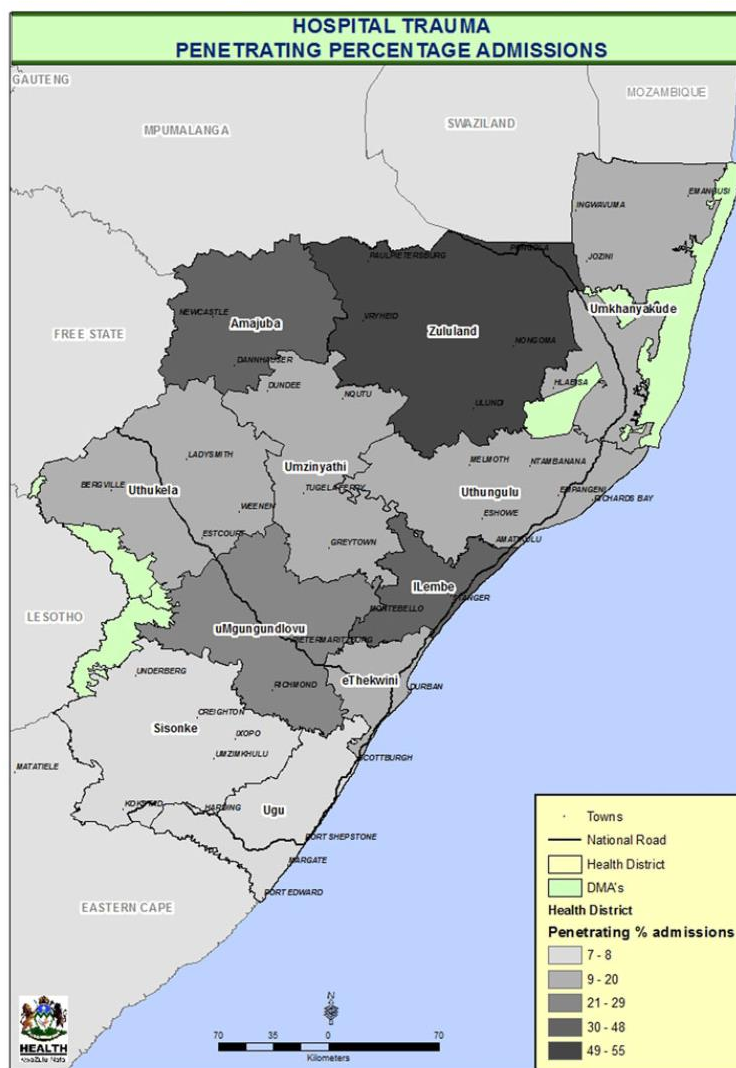


being the motor vehicle collisions [MVC] and “other” groups). Of the intentional trauma admissions, 35 % were due to penetrating injury, either stab wounds or gunshot wounds. Figure 2 illustrates the distribution of the penetrating trauma across the districts, showing that most districts averaged between 21 and 48 % penetrating injuries. When comparing the urban spectrum of injury to the rural environment, there was no distinct variation when examined in context of the population distribution. The ratio of gunshots to stab wounds in the group of penetrating trauma was noted as 1:4. Motor vehicle accidents were the greatest contributor to the trauma burden. Overall, 36 % of all

trauma admissions were due to vehicular trauma (Fig. 3 demonstrates the variation in incidence across the health districts). Other mechanisms (blunt or penetrating non-intentional injuries, burns, and falls constituted the rest of the trauma burden (Fig. 4 demonstrates the variation in incidence across the health districts). The need for appropriate assessment facilities, with appropriate imaging, is therefore essential, as is the need for surgical capability.

The data from the hospitals used for the facility assessments were physically corroborated by the medical expert teams undertaking hospital preparations for the Soccer World Cup event. When comparing the facility

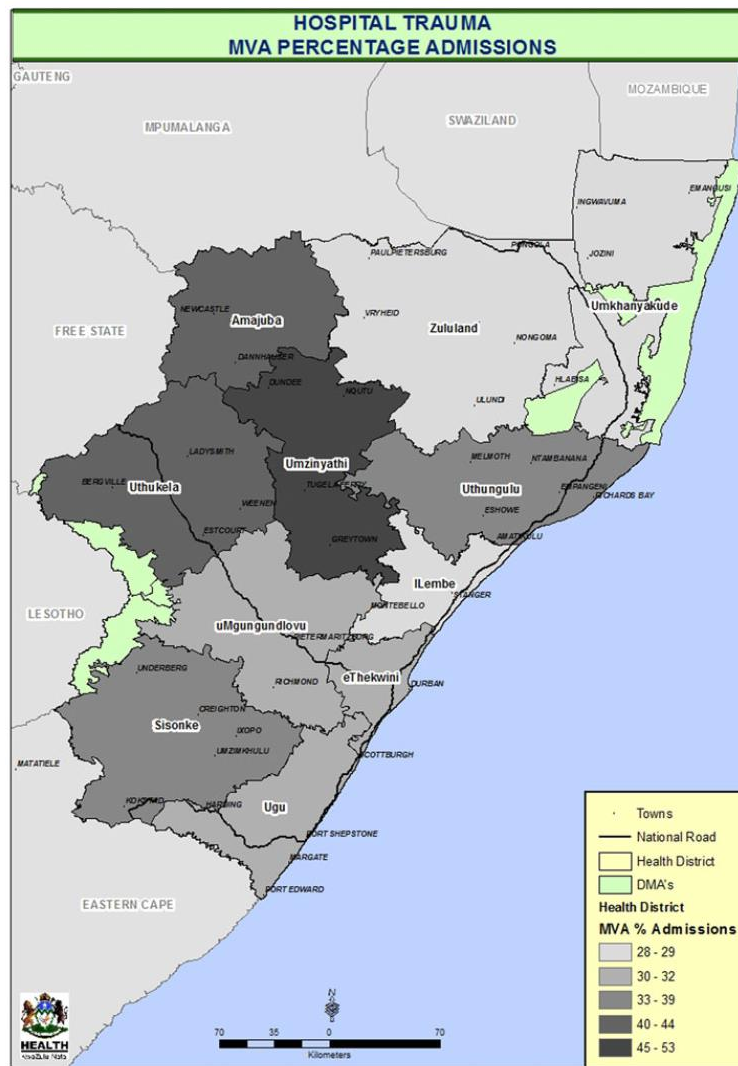
Fig. 2 Penetrating trauma distribution per 1,000 population across KwaZulu-Natal health districts



assessments to the Essential Trauma Care (EsTC) and Trauma Society of South Africa (TSSA) criteria [14, 15], only one hospital met all the criteria for level 1 status, whereas most regional hospitals (66 %) met the criteria for level two status. Even within these facilities, however, only three hospitals had a formal trauma service, with the rest using the general surgical service. Four had inadequate access to emergency operation facilities for trauma and were competing with other emergencies, including caesarean sections, for operating room time. There was a shortage of intensive care unit (ICU) facilities at these regional hospitals, and the imaging services were variable in

availability (some only daytime full service; head scans only after hours). Quality assurance programs were documented for only seven of these regional facilities. Regarding specific criteria, an average of 41 % (range: 12.5–80 %) of staff were Advanced Life Trauma Support (ATLS) [17] trained, and 53 % (range: 10–74 %) had medical resuscitation training. Only 46 % (range: 12.5–75 %) had training in disaster management, such as the one-day hospital major incident medical management & support (HMIMMS) course offered free of charge to all health care providers in preparation for the recent Soccer World Cup event [18]. Further challenges include the lack

Fig. 3 Motor vehicle trauma distribution per 1,000 population across KwaZulu-Natal health districts

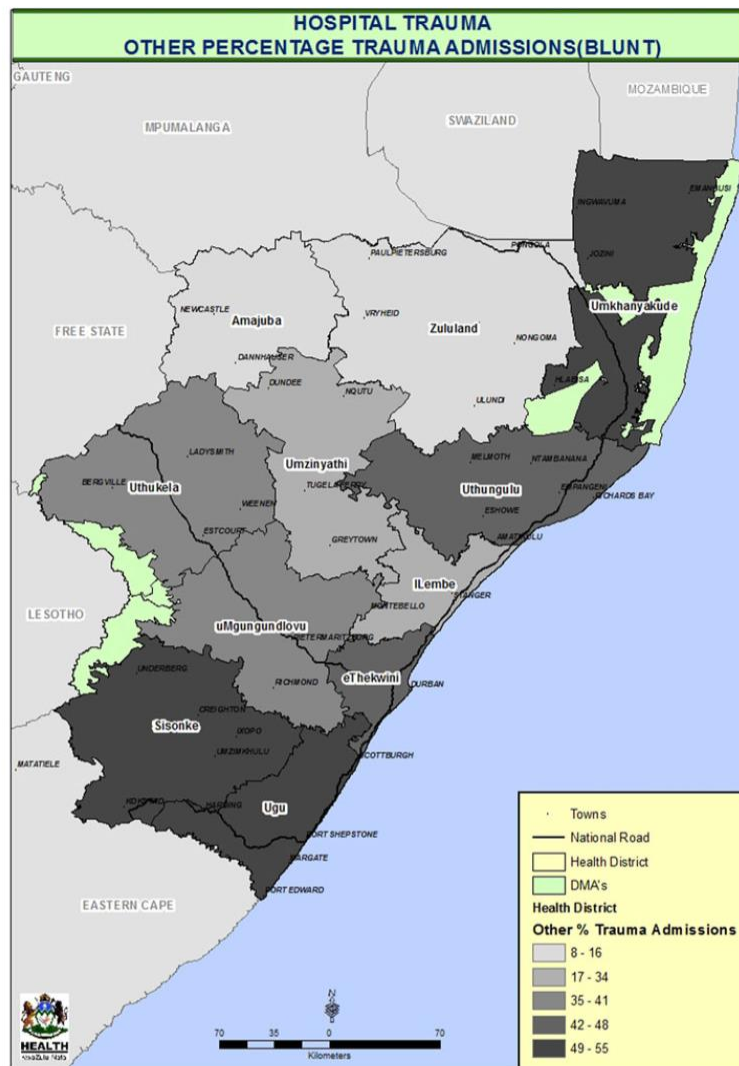


of a uniform trauma registry, limited access to computerized databases—both of which lead to concerns regarding data accuracy—and a distinct shortage of designated space for emergency care within the already overloaded hospital system. The limited trauma data have been addressed partially through the introduction of mandatory injury data reporting to the Provincial Head office Epidemiology Unit, and this, we hope, will mature into a proper Provincial Trauma Registry.

Most district hospitals would be expected to meet level three trauma unit status; however, deficiencies were noted in at least 50 %, such that the commitment to establishing

an effective trauma system appears to be lacking at the regional and national government level. For example, 54 % of district facilities assessed had inadequate resuscitation area facilities, none had in-house CT-scanners, and only 62.5 % had emergency mobile X-ray units, and 58 % did not have access to an emergency operating room. Only 25 % of district hospitals had an emergency observation ward, despite the need to hold many patients awaiting transfer to a higher level of care. Sixty-two percent of medical staff had no formal trauma training, and 50 % of the hospitals had inadequate helicopter landing facilities, despite the rural nature of many hospitals. Only 12.5 % of

Fig. 4 Blunt and domestic trauma per 1,000 population across the KwaZulu-Natal health districts



district hospitals had documented trauma or emergency quality assurance programs. This is highly relevant in a country where public transport incidents involving buses, minibus-taxi, and heavy duty vehicles are an everyday occurrence, and many of these district hospitals are the first “port of call” for trauma victims.

Discussion

Injuries in low and middle income countries (LMIC), which include South Africa, are acknowledged to

contribute significantly to death and disability, as well as loss of life-years [4]. In an effort to address the high mortality and morbidity, it is essential to work on establishing systems of care that are cost efficient, functional, and show a long-term outcome improvement [14, 19]. The challenge is that most governments want to see instant results; however, a number of recent studies have shown that it may take as long as 10 years before a significant mortality reduction becomes evident [20–22]. Most of the relevant reports, however, come from developed high income countries with large healthcare budgets. Africa and other developing regions suffer from the financial burdens

that make establishing such systems more difficult. It was for this reason that the World Health Organization and the International Association for trauma Surgery and Intensive Care (IATSIC) group formulated the Essential Trauma Care Guidelines [14], which have been widely adopted or implemented in various forms within LMIC across a number of continents [23–25].

When comparing the current KZN predicted injury burden determined in the present study with previous publications from South Africa and elsewhere in the world, it is noted that the incidence of 1,290 per 100,000 population is far higher than the trauma burden in the developed world, with rates around 13–20 per 100,000, although it seems to have been reduced from the initial studies in 1999 that suggested a figure closer to 66 per 1,000 population [26–28]. The results compare most strikingly to an epidemiological study from Canada, where the categories “fall” and “other” injury were the highest, at a combined rate of 420 per 100,000, while penetrating injury was only 9.5 per 100,000. The overall rate of all injuries in Canada requiring hospital treatment was 5.34 per 1,000 of the population, half the rate in KZN, and included categories not reviewed in the present study [29]. The difference with the study from 1999 is that it included not only injuries treated in hospitals but also minor injuries treated at community clinics, or by general practitioners and traditional healers, whereas the current study examined hospital admissions at district and regional facilities only and excluded any case remotely unclear as being due to trauma. In contrast, the former study included a category of “other trauma” that may have included a number of conditions (such as drowning, animal bites, or poisoning) not included in the present study. Using the extrapolation method described in the study by Matzopoulos et al. [26] would estimate the current injury burden at about 1.5 million cases per year (about 34/1,000) at a minimum for the entire country, which is still less than previous estimates, although closer to their one estimate of 40/1,000 of the population.

It is interesting that when comparing the South African data to that from other parts of Africa there are stark contrasts, with interpersonal violence contributing a much higher percentage of the injury burden in South Africa (35 %), whereas motor vehicle collisions predominate in other parts of Africa, following a distant second to human immunodeficiency virus (HIV) and other communicable diseases [30–35]. Even the study from a rural district hospital in KZN [36] showed that almost 13 % of patients transported there by ambulance as “walking wounded” were considered by the treating doctor to have an “urgent-care” traumatic injury.

The system of care theoretically in operation within South African health facilities has been described in detail in previous publications [37, 38]. The concern is that these

articles generally focus on urban facilities and academic medical establishments. The broader scenario is far from ideal, with the physical facilities not meeting national core standards [16], not to mention the EsTC or TSSA criteria [14, 15]. There is slow uptake and apparent lack of interest in available short-courses for further training [38]. The national district hospital core standards, for example, require that doctors at district hospitals are able to perform emergency surgery for trauma, yet most of the district hospitals in KZN (58 %) do not even have access to an operating room in emergencies. Where these are present the resources compete with emergency cesarean section and other urgent operations. Across the country facilities are crumbling for lack of maintenance; computerized tomography scanners break down and repairs are delayed, necessitating multiple transfers of patients to receive needed care [39].

This is of particular concern as the National Department of Health is planning to embark on a comprehensive National Health Insurance initiative over the next few years [40]. Of importance is that the current plan does not specifically address trauma care or other emergency medical problems, despite mentioning in the preamble the fourfold problem of HIV-AIDS, maternal and child-health, diseases of lifestyle, and injuries [40]. Additionally, it is widely acknowledged that there is a major shortage of health care providers of all grades in South Africa [37, 41, 42]. This is compounded throughout Africa. The first step the government can take is to invest in human capital, through funding training of staff across the spectrum to better manage the trauma patient. This is especially important given the fact that around 30 % of rural practitioners do not feel competent to undertake emergency trauma surgery (laparotomy) independently [43].

To realistically determine the injury burden to the country it would be prudent to establish a national trauma registry, collecting a limited data set that can guide system development and confirm the disease severity and average length of stay in hospital enabling costing to be performed [14, 15]. A simple Department of Health trauma registry has recently been designed for KZN and is in the initial stages of data collection. The next step is the upgrading of all health facilities to at least the minimal standards expected by national and international norms [14–16].

If one compares the facilities in Africa to the American system [44] it would take most of the specialists within an entire country to staff one major trauma center meeting American standards. This is impractical and thus it is essential that Afrocentric solutions are designed for African systems. Combined with the need for simple solutions is the limited availability of critical care services in Africa, which form an essential component of care for severe trauma [45, 46]. It will indeed take a strong political will to

change the situation for the benefit of all of the people of South and Sub-Saharan Africa [47]. The need is great, yet funding is finite and limited, but to reduce mortality from injury, all levels of care should meet the basic standards, whether in terms of functional equipment, access to surgical services, a basic staffing norm, or rapid transfer to higher levels of care. An established system is better than islands of excellence within a sea of indifference, where the care is provided in a haphazard fashion [19].

In Africa one should consider the role of a “trauma center” as a specialist hospital, with not only multiple subspecialist disciplines present, but providing an overarching leadership role within the greater system, working with the single goal of mortality reduction. This has certainly worked in the UK, where mortality has been reduced through direct access to a dedicated facility for severely injured patients [48]. In Africa the need for such centers is no less, but thoughtful planning is required to locate these lead facilities in a manner to enable optimal access without overloading the health budget. Using the EsTC guidelines and the TSSA criteria will enable the Department of Health to devise suitable patient flow pathways and bypass systems so that the most severely injured patient can gain access to a suitable level of care without undue delay. These centers should not be for “all comers,” but for the small severely injured subgroup, but they should provide outreach and retrieval teams, thus offloading the other facilities of major cases and providing guidance and leadership of the overall system. It is proposed that one such center should cater to a population of some 2–3 million persons in high trauma regions and 4–5 million in lower trauma regions of the continent.

For a population as dispersed and with the geographic layout of rural KZN (and typical of much of rural Africa), the ideal system would thus entail the expansion of the ambulance services and a referral system to bypass smaller facilities and transport the severely injured directly to the regional facilities where surgical capacity and ancillary services exist. Upgrading the number of regional facilities and regionalizing certain specialist disciplines (e.g., neurosurgery) would reduce the time to surgical intervention. It would also enable rational use of the limited number of CT scanning facilities, thus allowing timely care. A recent letter in *World Journal of Surgery* has highlighted the limited role that specialist surgeons are able to play at district level hospitals because of the need for ancillary services [49]. This system should, at least, be generalizable to the rest of South Africa, because the geography and relative population densities are similar throughout the country, and from previous studies [26] the trauma distribution appears to be relatively comparable. The country has one health registration authority and one set of national prehospital treatment protocols, so improving access to the system should be generalizable as well.

It has been shown that, even within institutions caring for major trauma in KZN, the care is variable and inconsistent, which corroborates the findings of the facility audit [50]. This often results in missed injury and unnecessary morbidity or even mortality [51]. To prevent these adverse outcomes, the hospitals participating in the trauma system need to be inspected by an independent non-governmental organization and be formally accredited, have quality improvement programs in place, and have a lead authority with government-endorsed executive authority [14–16, 19]. This way the currently unmet needs of surgical disease in general may be partially addressed [52]. This is especially true in light of the high injury burden (12,9/1,000), which is higher than the 1,6/1,000 reported from Uganda [53].

Finally, the remaining challenge to the establishment of trauma systems in Africa is the distinct lack of rehabilitation facilities, especially residential step-down rehabilitation facilities, thus leading to much lower levels of return to gainful employment. This is so although rehabilitation is recognized in both the EsTC and TSSA guidelines as essential for a trauma care system. Unfortunately, rehabilitation is not seen as an integral part of the trauma care process, which results in bed-blockages to the acute care hospital system and prolongs recovery times considerably. This is not a new problem and not one isolated to South Africa, with similar problems reported from Ghana [54, 55]. At least South Africa has dedicated physiotherapists and occupational therapists who attempt to rehabilitate rural patients against trying odds and while facing ethical dilemmas [56].

Trauma costs money; however, litigation costs the country far more! Appropriate care of trauma has been demonstrated to be cost-effective in numerous studies [57–59], with sustained cost-saving over time with efficient system design of approximately \$36,000 per life-year saved. In a national study from the USA published in 2010 [59] it was found that although trauma centers are more expensive (especially the initial care), the benefits in terms of lives saved and quality of life-years gained outweigh the costs, particularly for the most severely injured patients. The costs of trauma care vary from around 6,396 ZAR (\$540) to 25,000 ZAR (\$2,200) per patient for gunshot wounds, depending on the calculation method used [60–62], whereas for traffic injuries the cost approximates 3,886 ZAR (\$300) per patient per day [60]. It is, however, important to look at the “real” cost of traffic collisions, which approximate R11 million (\$800,000) per day when all costs (policing, medical, repair, rehabilitation, and legal aspects) and not simply medical expenses are included, applying the model of the Council for Scientific and Industrial Research. It should also be noted that pedestrian injuries account for up to half of the medical costs! [63]. Optimizing the transfer of patients, provision of

appropriate equipment, staffing, and other resources at the correct levels of care should result in overall cost savings. These cost savings are further enhanced through multi-sectorial prevention initiatives [19, 64].

Limitations

The present study is limited by the fact that the patient data were retrieved from casualty records collected by ward clerks, thus limiting reliability. In addition, the data were re-interpreted by one person (T.H.), who excluded anything that appeared to be non-trauma, thus potentially reducing the overall numbers. The totals may thus be a significant underestimation of the true trauma burden; however, they do reflect at least a minimum trauma burden. Further, the hospital assessments were significantly different when self-reported (by local hospital managers) compared to the inspection teams. Some of the TSSA criteria [15] were not specifically included in the hospital assessments, thus reducing the direct applicability of the local criteria.

Conclusions

Trauma, particularly interpersonal intentional violence and motor vehicular collisions, constitute a major health care burden on the South African public health system, constituting 18 % of the emergency care burden. The current primary-care focused referral pathways and hospital equipment norms are not suitable for dealing with major trauma. A national trauma registry capturing basic data would ensure that the true trauma burden is recorded. Upgrading facilities to meet minimum national standards is essential prior to establishing and formalizing trauma systems, or instituting the proposed National Health Insurance plan across South Africa. Any trauma system that is implemented will require a central government funding buy-in from all parties and continuous performance improvement programs to ensure compliance and improve patient outcomes, with legislative and political support.

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Chapter 8: Appropriate use of current resources – Do we need more Level 1 Centres? *World J Surg* 2013, 37: 1544-1549

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Utilisation of a Level 1 Trauma Centre in KwaZulu-Natal: Appropriateness of Referral Determines Trauma Patient Access

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Abstract

Background Appropriate referral of major trauma patients to an accredited Level 1 Trauma facility is associated with improved outcome. A new Level 1 Trauma Centre was opened at Inkosi Albert Luthuli Central Hospital in March 2007. This study sought to audit the referral pattern of external consults to the trauma unit and ascertain whether the unit was receiving appropriate referrals and has adequate capacity.

Methods An audit was performed of the referral proformas used in the unit to record admission decisions and of the computerised trauma database. The audit examined referral source (scene vs. interhospital), regional distribution, and final decision regarding admission of the injured patients. The study was approved by the UKZN Ethics Committee (BE207/09 and 011/010).

Results Of the 1,212 external consults, 540 were accepted for admission while the rest were not accepted for various reasons. These included 206 cases where no bed was available, 233 did not meet admission criteria (minor injury or futile situation), and 115 were for subspecialty management of a single-system injury. Finally, 115 were initially refused pending stabilisation for transfer at a regional facility. Twenty-six percent of the cases were referrals from the scene, with an acceptance rate of 96 %. Most patients (59 %) were from the local eThekweni region.

Conclusion Major multiorgan system trauma remains a significant public health burden in KwaZulu-Natal.

A Level 1 Trauma Service is used appropriately in most circumstances. However, the additional need for more hospital facilities that provide such services across the whole province to enable effective geographical coverage for those trauma patients requiring such specialised trauma care is essential.

Introduction

Trauma is a significant public health burden in South Africa in general, and in KwaZulu-Natal (KZN) in particular, with interpersonal violence and motor vehicle collisions still prominent as causes of unnatural death, many related to alcohol misuse [1]. For every one death, around four survivors will require hospital treatment and about half of these will need surgery and/or intensive care for severe injury [2]. KZN is a large province on the east coast of South Africa with a largely rural population outside the two main urban centres of eThekweni and Pietermaritzburg. With a population of almost 11 million, this province is home to almost 20 % of the entire South African population within its borders (Fig. 1 shows where KZN lies within the Republic of South Africa).

Previous studies from international and local centres have demonstrated that the admission of severely injured patients to dedicated trauma services improves outcome and that trauma systems that take the most severely injured patient directly to the appropriate centre decrease mortality even further [3–5].

In March 2007 the first Level 1 Trauma Centre in KZN (Trauma Society of South Africa criteria [6]) opened at the Inkosi Albert Luthuli Central Hospital (IALCH) in Durban, a modern tertiary/quaternary hospital built to serve the population of the entire KZN region and surrounding areas.

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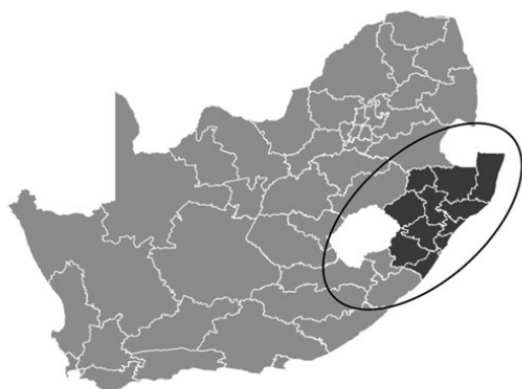


Fig. 1 Map showing location of KZN within South Africa

The unit functions as a “consultant/attending-led service” aimed directly at the management of complex multisystem trauma. A consultant/attending is present for each admission, whilst every referral is discussed and approved or denied by the on-duty consultant. The current informal design of the local trauma system is one exclusive level 1 accredited trauma centre for the entire province with ten level 2-equivalent (regional) centres throughout the province which provide rapid access to definitive care and step-up care for complex cases at the Level 1 Trauma Centre. Thirty-six district (level 3- or 4-equivalent) hospitals manage the majority of minor injuries. The emergency services can admit directly to the Level 1 Trauma Centre after a telephone consultation with the duty consultant from within the eThekweni and Pietermaritzburg regions. None of the other hospitals is currently formally accredited as any formal form of trauma centre.

The Trauma Unit at the Level 1 Trauma Centre consists of a resuscitation area, a surge capacity area, two trauma operating rooms, and an integrated Trauma ICU/High-Care Unit of currently 10 beds, with the capacity to expand to a total of 16 beds. Currently, six high-care beds are not commissioned due to a lack of nursing staff. A written set of admission criteria was designed at the inception of the unit and was widely disseminated to hospital and emergency medical services (EMSs, see Table 1). The neurosurgical and vascular surgical services (located at IALCH) have additional access to other ICU beds for single-system injuries admitted under their care, although when their facilities are full the Trauma ICU accepts the overflow; those patients are considered internal referrals.

Approximately 6 months after inception of the Level 1 Trauma Unit at IALCH, every external referral (i.e., excluding bed requests from within IALCH) has been captured on a standardised data proforma. All inpatient data are recorded in an electronic patient record.

This study aimed to review the utilisation of the referral system and identify whether the unit is appropriately used and has adequate capacity and resources for the current workload and to assess the reasons for denial of access in the case of referrals refused admission.

Methods

An audit was undertaken of the referral data proformas. This was conducted by analysing a computerised database of the referral data from 2007 to end of May 2011. The patients were categorised into five groups: accepted; refused due to no bed being available in the Trauma ICU; refusal as patient did not meet admission criteria to a Level 1 Trauma Centre; refusal as the patient required further urgent intervention(s) prior to transfer; and refusal because the patient had an isolated injury requiring other specialist discipline (e.g., neurosurgery, vascular, plastics, burns) rather than multisystem injuries requiring care at the Level 1 Trauma Centre. The data proformas were then assessed as to the appropriateness of the referral and the ability of the unit to accept deserving cases, while those patients who did not meet the admission criteria were deemed as inappropriate referrals. Referrals were additionally categorised with respect to the source of the referral *vis-à-vis* direct from the scene or from another hospital.

UKZN-BREC Ethics approval was obtained for the databases and related studies (BE207/09 and BE011/010).

Results

During the study period 723 patients were admitted and treated by the Trauma Unit at the Level 1 Trauma Centre, which includes 183 “internal” referrals from within the institution by other treating disciplines (e.g., neurosurgery or vascular surgery). The raw data are outlined in Table 2. A total of 1,212 outside referrals were received, for which the call-report proformas were complete for 1,209 patients. Of these, 540 were accepted as meeting the criteria, with 147 (26 %) being brought directly from the scene of injury by EMSs. Of the 669 patients who were refused acceptance to the unit, 206 were due to the lack of availability of Trauma ICU facilities at the Level 1 Trauma Centre (i.e., no inpatient Trauma ICU bed), while 233 were refused because they did not meet the predefined published admission criteria. An additional 115 trauma patients were not initially accepted for admission to the Level 1 Trauma Centre, but advice and instructions were given to the referring doctors (at regional or district hospitals) to undertake certain procedures or interventions to stabilise the patients to enable safe transfer to the Level 1 Trauma

Table 1 Admission and transfer criteria—IALCH Level 1 Trauma Unit

Anatomic	<ul style="list-style-type: none"> • Multiple regional injuries • Severe blunt chest or abdominal trauma • Penetrating trauma to trunk or neck with unstable physiology • Major pelvic injury • Trauma in pregnancy beyond 24 weeks • Major head injury with another organ system injury or physiological abnormality
Mechanism	<ul style="list-style-type: none"> • Prolonged entrapment • Multiple-casualty incident • Rollover or ejection from vehicle • Fall from height >6 m
Physiology	<ul style="list-style-type: none"> • Hypotension despite fluid therapy • Clinical coagulopathy of trauma • Post-damage control surgery at base • Intubation and ventilation for extensive lung contusion with hypoxia • Renal impairment post-trauma (crush or myonephropathic syndrome, AKIN 2 or 3) • Prehospital Revised Trauma Score <8
Age and comorbidity	<ul style="list-style-type: none"> • Age >55 or <5 years of age • Cardiovascular or respiratory disease • Diabetic on insulin or high-dose oral drugs • Trauma in obese patient

Centre thereafter. In these latter cases, the patients had met admission criteria but were not stable enough for immediate transfer. For another 115 patients (from other hospitals where they had already been fully resuscitated and assessed), the referring doctor was advised to contact the relevant subspecialist discipline directly because the patient had sustained a single-system injury that did not require the facilities of the Level 1 Trauma Centre but instead required that specific discipline's acceptance and expertise. These patients were already in a facility with resources to perform surgery or further resuscitation prior to interhospital transfer.

Table 2 Accepted and refused patients per category

Category	
All admissions	723
Internal admissions accepted	183 (excluded from analysis)
External consult accepted	540
External consult refused (reason)	Refused patients (<i>n</i> = 669)
No bed	206
Not meeting criteria	233
Need intervention	115
Need single discipline	115

The age distribution of referrals was between 1 and 78 years for those accepted and <1 to 92 years old for those who were refused. The Trauma Unit also serves as a paediatric trauma receiving facility that accepts any patient from approximately 18 months of age. One hundred eighty-nine referrals were children (defined as under the age of 13 by national consensus) and the rest were adolescents and adults.

Referrals were direct from emergency services at the scene in 147 cases and from other regional or district hospitals in the remaining 1,062. Subanalysis of the 1,212 referrals, of which 1,209 data proformas were fully completed, included 307 with penetrating trauma (175 gunshots, 123 stab wounds, and 9 other penetrating injuries) and 850 with blunt trauma (714 transport-related injuries consisting of 381 motor vehicle collisions and 333 pedestrian-vehicle collisions, 91 blunt assaults, and 45 falls from heights), and 46 for other reasons, such as the need for dialysis. On nine occasions the unit was consulted to receive patients from multiple-casualty incidents. Since 96 % of the scene calls were accepted, this implies that there was insufficient resource availability of major trauma facilities and possibly under-triage by the emergency services.

The regional referral pattern was as follows: 59 % from the eThekweni region, 20 % from the Northern region (Area 3), 13 % from the South Coast, and 8 % from the inland region (Area 2). The low number of referrals from Area 2 is due to the presence of two large hospitals that receive trauma and which are staffed with trauma specialists. In 2011, a distinct increase in the referrals from Area 3 was noted during a period when the main trauma receiving hospital in that region had a staffing crisis [see map of population distribution within KZN (Fig. 2)].

Discussion

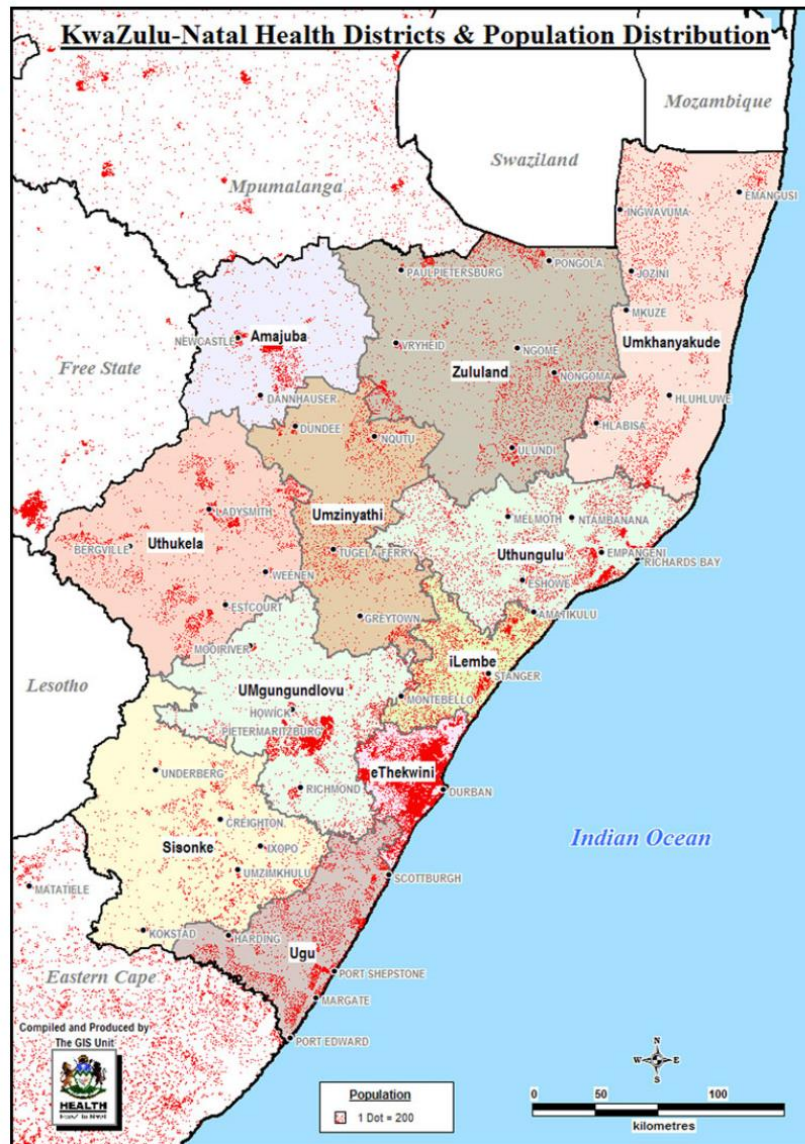
Trauma, despite being eminently preventable, remains a scourge of young people and the leading cause of death in the economically productive and childhood age ranges worldwide, with road-related trauma and interpersonal violence high on the list of underlying causes [7, 8]. In sub-Saharan Africa, notwithstanding the significantly increased trauma burden seen compared with other continents, this increase in both trauma morbidity and mortality is overshadowed by the HIV/AIDS pandemic, infectious diseases, and maternal-health issues, all of which consume resources for disease prevention and primary care.

Appropriate care of the trauma patient requires a functional, well-integrated, and cohesive trauma system. Without a properly designed and functioning trauma system, the overall efficacy and quality of patient care

delivered and therefore subsequent patient outcome and healthcare performance analysis will be adversely affected [9–13]. Failure to operate functioning trauma system is a cause of poor patient outcome, irrespective of the experience and capability of individual clinicians and resources available at local levels. Trauma system design has progressed from the original concept of exclusive systems with all patients cared for in major hospitals with expensive

and highly specialised services to inclusive systems, with multiple levels of care. Studies in the developed world have shown that inclusive systems provide earlier access to appropriate care for minor and moderate injuries at local facilities (Levels 2 and 3 Trauma Centres) [9]. When combined with suitable prehospital emergency care components and competent triage to a Levels 2 or 1 facility within an optimum timeframe, these inclusive systems

Fig. 2 GIS map of population distribution shows the largely rural population of KZN



have demonstrated overall mortality reduction compared with an exclusive trauma system [3, 4, 10–13].

This audit of referrals to the Level 1 Trauma Centre, which operates solely as a Level 1 Trauma Centre within an inclusive informal provincial/state-wide trauma system for a large province in a middle-income developing country, identified a number of interesting findings.

First, there is an under-resourced intensive care component for trauma in the province, since most of the refusals were due to the lack of an inpatient ICU bed. This has been highlighted in other studies of general ICU bed availability in South Africa [14]. In fact, the American College of Surgeons recommends a Level 1 Trauma Centre for every 1,000,000 people (personal communication, Dr. Rajan Gupta, Dartmouth University, Lebanon, NH, USA). This is both impractical and fiscally nonviable for the South African trauma system model [15]. However, two such centres for a province with a population that is 20 % of the entire country is not an unreasonable expectation. Moreover, a Level 1 Trauma Centre is more than just a hospital with multiple specialities; it is a specialist hospital with a specific expertise in the management of major complex trauma patients that has been shown to reduce overall mortality [5, 16].

Second, an inclusive system ensures that the correct patient is referred to the correct level of care [17]. As the KZN system is still a very informal one, many referrals were deemed inappropriate because (1) consultations were received for very minor isolated injuries that could be successfully managed at smaller institutions, or (2) or the referred patient had a futile prognosis as a result of either late presentation to hospital or the severity of the injury. In the case of 115 consultations, the treating facility had not evaluated or managed the patient appropriately so it was requested to (a) undertake adequate initial assessment and/or instigate appropriate initial/further resuscitation of the patient, (b) perform necessary initial procedures such as airway management, chest drainage, and damage control surgery (when appropriate and where suitable facilities existed and were already available), or (c) stabilise the patient to enable a safe transfer to the Level 1 Trauma Centre, which frequently requires the patient to survive long-distance travel and lengthy interhospital transfers. The “devil of distance” is one of the major challenges in this under-resourced and largely rural province.

Since most cases of penetrating trauma can be managed successfully at Level 2 facilities, the lower number of penetrating trauma referrals (25 %) is reflected by the lower need for ICU admission in this group. Most of the referrals were for complex blunt trauma (70 %) or dialysis (not always available at other regional hospitals), thus ensuring that the Level 1 Trauma Centre ICU is admitting patients who will derive maximum benefit from a transfer to the Level 1 facility [5]. This predominance of blunt trauma in our ICU

cohort is higher than the overall trauma mix reflected in other studies [15]. The age spectrum demonstrates that the need for specialised trauma care at the extremes of age has been recognised by all levels of care providers across the trauma system within the KZN province.

Far too many cases are still admitted as interhospital transfers (88 % of referrals), indicating that the prehospital triage, especially outside the eThekweni Metropolitan Region, could be improved by educating the EMS providers, both private and public, to correctly identify complex major trauma patients, even if they do not need immediate intubation, ventilation, or urgent surgery and to refer these patients directly to the Level 1 Trauma Centre facility. This has been achieved in other developing world trauma systems [18], and outreach programs are being instituted to address this weakness. Successful implementation of this elsewhere has been possible through efficient trauma system design and involvement of the EMS providers, from preliminary planning of the trauma system design through its development to eventual subsequent completion and implementation [19]. We also provide a typed discharge summary to all referring hospitals with the intention of trying to educate them as to when the referrals are appropriate or not, and to detail treatment given at the Trauma Unit.

The practical implications of this study for South African trauma care are the following: there is the need for at least one additional Level 1 Trauma Centre in this province and, through extrapolation, around 10–12 such centres are required within the South African national public health system. At present there are only four similar centres throughout the rest of South Africa. Second, to be able to establish more formal trauma systems, the EMS services must be included more in the planning and effective implementation of patient distribution to the appropriate clinical facility and the EMS control centres need to be more involved in directing these transfers to the appropriate clinical facility.

Finally, to enable a formal hospital trauma system to be properly implemented and function effectively and successfully, all hospitals involved in the trauma system must be adequately upgraded as necessary and suitably equipped in addition to being formally accredited in accordance with the Trauma Society of South Africa criteria to the appropriate level. Ongoing audit and quality assurance is essential as this will determine if reduction in mortality is being achieved across the whole trauma system, as has been demonstrated for the Level 1 Trauma Centre under review in this instance [5, 20].

Conclusion

Major multiorgan system trauma remains a significant public health burden in KZN. A Level 1 Trauma Service is used

appropriately in most circumstances. However, additional hospital facilities that provide such services across the whole province to enable effective geographical coverage for those trauma patients requiring such specialised trauma care will likely reduce trauma mortality even further. Formalisation and proper implementation of an inclusive trauma system will enable the more appropriate transfer and earlier admission of trauma patients with multisystem injuries to a suitably equipped and appropriately staffed facility direct from the scene of the incident/injury.

Acknowledgments The role of the rotating trainees in surgery, orthopaedics, and anaesthesia is acknowledged in the comprehensive completion of the referral proformas at the time of each external referral. The GIS Unit of the Department of Health population density map is used with the permission of the Provincial Research Office. This study was part of the PhD on Trauma Systems at UKZN for Dr. T. Hardcastle and is both a Trauma Unit Class Approval Study BREC-BE207/09 and a PhD approval BE011/010.

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Chapter 9:

Summative Assessment: What would the ideal local trauma system be like in light of the limitations of the current research results?

This dissertation provides a background to frame an ideal trauma system. An ideal trauma system is the one that gets the correct patient to the correct level of care within the shortest possible time and provides for effective in-hospital care, morbidity reduction and efficient rehabilitation such that the patient is restored to gainful function in society. The ideal trauma system will also work to reduce the incidence of injury through active prevention programs and inter-ministerial agencies (such as collaboration with police, education, social development and cooperative governance agencies).

The ideal trauma system in Africa is one which encompasses all of these goals to a greater or lesser extent and develops along with the economy of the region that it services. It will address community participation, formalised emergency services and both hospital and rehabilitation care, within a culturally acceptable context. The complexity of this interplay of non-medical and social factors is illustrated in figure 1, adapted from the 2008 World Health Report and highlight the complexity in the local African context (see chapter 2 & 3). (highlighted items by current author)

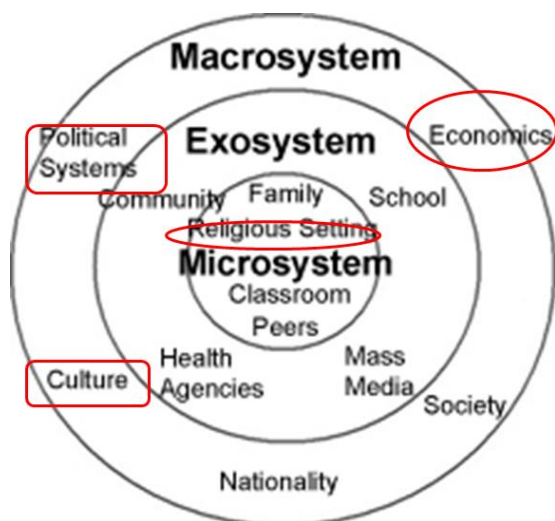


Figure 1: The interplay between non-medical and socio-cultural aspects in development of health systems (Adapted from: World Health Report, 2008, WHO, Geneva)

Costing of Trauma Care:

A costing exercise was performed as part of the Provincial Burden of Disease and Future Costing [1] proposal and examines the available costing in light of the published current disease burden and expected future projections. The costing was undertaken with the cooperation of the Epidemiological Unit at Natalia (Dr E Lutge).

- South Africa spends over 8% of the GDP on healthcare, yet has poor overall health outcomes. [2] Only around 50% of this expenditure is in the public health sector, serving over 80% of the population, while the rest is spent on private healthcare – this makes the need for a middle-road option, that may lead to improved outcomes vital
- This is generally a difficult area to theorise about – staff to patient ratios and the numbers per individual patient, especially with poly-trauma (multiple system injury) involvement makes calculating salaries difficult, however for each major trauma patient on average will be one specialist surgeon, radiologist, anaesthesiologist, intensivist, 2 medical officers/registrars and three to five nurses. This is without including the 24 hour radiography service, laboratory requirements and NHLS 24 hour staffing or blood-bank and consumables required, which vary per type and severity of trauma.
- After calculating the best averages of the cost to province at current rand value the running costs of trauma care (excluding fixed costs such as staff salaries and facility costs) is around:

Event	Cost per event	Number of uses per year	Cost to Province
Emergency Visit	R730	59% of total	R78 679 400
Ward Bed	R4865 per day	25-30% (calc on 30%) average 19 days per patient	R 4 221 414 015
HDU Bed	R5000 per day	10-15% average 5 days per patient	R 456 700 000
ICU Bed	R6500 per day	10-15% average 5 days per patient	R 593 710 000

- Most patients will spend half of the ICU time in a High-care (monitored bed).
Total costs for ICU care are therefore in the order of R1,44 Billion per year

- Total predicted cost of clinical trauma care to the KZN province is therefore at least **R5 350 503 415** per annum excluding costs related to structural upgrades that may be required and staff salaries.

The complexity and current fiscal cost of trauma have been briefly outlined above. It is clear that to achieve these goals in KZN further costing studies will be needed to examine the cost of the infrastructure improvement and human resource implications required.

The study has demonstrated that the current system in KwaZulu-Natal is not compliant with national norms and the following suggested changes would enable a better level of service provision:

Emergency Medical Services:

- At the level of Emergency Medical Services it would be essential to combine and centralise the Dispatch and Control Centres [3] for all the private and public emergency services into regional centres, accessible from the single access number, preferably with direct access to on-line medical advisors and with direct contact with other services, both professional (such as Fire, Police, Traffic services etc.) and volunteer (such as NSRI, Red Cross, St Johns Ambulance etc.)
 - These dispatch centres should be able to screen calls and determine if an ambulance is required versus a simple transport vehicle, especially for non-trauma and minor trauma cases.
 - Scene paramedics should guide the Control Centre as to the severity of the patient and the eventual destination.[4]
 - Independent audit by an outside accrediting body would prevent undue competition and fair call distribution.
 - Dispatch protocols should be clearly written to allow for hospital-bypass to higher level of care when required.
- The number and level of staffing (ILS) are required by national norms is not currently achieved in the KZN province, despite being budgeted for. The numbers of ambulances must be increased, so that the National norm of 1 ambulance per 10000 population in the province is attained. It is further suggested that consideration be given based on the high proportion of incidents in the two Metropolitan areas,

demonstrated in the studies that the ratio of vehicles and staff should allow for 1:7000 population.

- Further the data supports the fact that there should be distributed better distribution of the ambulances according to the relative need, with the districts of Sisonke, uThukela and uMzinyathi clearly requiring more vehicles and staff for the burden of disease identified.
- The data from the prehospital study showed that there was underutilisation of the aeromedical services. Due to the distances involved and the terrain of the province it is recommended to increase the utilisation of aeromedical services, at least for interfacility transfer, but also for direct patient access at the scene and a 24 hour service with twin-engine machines would be ideal.[4]

Care Pathways:

- Emergency care pathways should be established enabling hospital bypass of small (District) hospitals directly to upgraded regional facilities for all cases of suspected or definite major injuries. To achieve this patient-identification will require more ALS staff being allocated to the more rural areas, possibly combining their function with the rescue-role, for which they are also trained. This is essential to avoid the step-wise transfer pattern used for primary care and routine elective medical care currently in operation, that lead to delays in reaching definitive care. Improving the care pathways can only be effective if the regional facilities are properly provisioned and staffed. Currently 34% are inadequately staffed and equipped, even to Level 2 standards, with appropriate specialists, and 24-hour radiology and full laboratory services, while only 1 hospital meets Level 1 TSSA standards.[5]

Hospitals resources:

These resources are an integral part of fulfilling the trauma care pathways to improving service delivery.

- These hospitals should be pre-designated by the Province, but will mostly need to be upgraded in terms of both equipment and staff compliment to meet the minimum stated national standards. [5,6,7] This applies, in particular to the three large regional hospitals serving eThekweni, namely Addington, RK Khan and Prince Mshyeni, all of which have budgeted revitalisation plans, not yet implemented, and require upgrading

to meet Level 2 criteria. Thereafter, all these hospitals should be inspected and accredited (or given recommendations for improvements required) by the TSSA as the independent accrediting body for Trauma Care in South Africa. Once these are implemented it will be essential to assess the quality of care and whether this reduces the overall cost of care and the risk of litigation to the Province. By showing a commitment to the care of trauma the overall care of emergency patients will also improve although this dependent upon the fiscal reality.

- There should a step-wise introduction of at least 5 upgraded pre-determined major trauma receiving facilities (meeting Level 1 criteria)[6], spread regionally through the province to prevent the current underservicing of major trauma due to the lack of overall capacity of the existing centre at IALCH, given the workload determined by the disease burden.
- Obviously this needs further research to determine the optimal place and the size of the Level 1 facilities, within the fiscal constraints. It is proposed that these major trauma centres be established at the following places, in addition to the existing IALCH facility, which must also be fully commissioned: Port Shepstone, Empangeni, Pietermaritzburg and somewhere in the Newcastle/Ladysmith area based on the 15% trauma burden requires supportive ICU care and as determined by the GIS mapping of the disease burden. By so doing the entire province is covered by a network of well-equipped and specialist-led facilities for optimal time to definitive care. Existing facilities will need some degree of revitalisation and the establishment of formalised trauma services as part of the surgical service.
- As with other specialties the province should consider employing a Provincial Lead Clinician for Trauma, to help coordinate oversight and leadership with protocol design and quality assurance, thus ensuring continuity of care from one facility to another.
- Regarding the rest of the proposed hospital care system, over-and-above the 5 major trauma facilities, based on the GIS mapping of the burden of disease, it is recommended that for each of these major centres there are one or two “Level 2” step-down regional hospitals in urban areas and in the more rural areas the larger district hospitals be upgraded to “level 2” status, in particular Kokstad Hospital, Mseleni and Hlabisa hospitals, which are all isolated and have the physical capacity for expansion. All the other district hospitals should be at least “Level 3” compliant. Currently less

than 50% of the district hospitals have either emergency operation rooms, or imaging and laboratory facilities on a 24 hour basis.

What are the potential implementation strategies?

Ideally this system should be instituted across the entire province. Ideally, because it is envisaged as a system, it is hard to see how it could be implemented as a pilot project examining only a smaller area.

Decent continuous data:

- Establish a regional Trauma Registry (this is currently in progress), to track and audit disease burden and patient outcomes. The registry should at least track injury mechanism, patient age and gender, initial and final treatment destination, morbidity and eventual outcome. The potential for this to become a national basic registry would address the currently unmet need. [8]
- The public health department should be engaged to undertake primary and secondary prevention interventions so that the overall trauma disease burden is addressed at source. These public health initiatives must be in line with the overall system focus. This is essential in that up to 60% of the trauma burden is preventable.
- Establish a separate budget for Trauma and Emergency, combining pre-hospital and hospital acute care, such that the real cost of management can be determined and to avoid compromising the rights of the patient with elective/chronic medical needs.[3]

Other aspects required for a functional trauma system not directly addressed in the current research but exportable from current literature:

- Community first-aid care: for example mandatory First-Aid training as part of the driver-licence renewal process every 5 years [9] shown in Ghana and Madagascar to reduce erroneous bystander treatment.[10,11]
- A universal emergency contact number, such as the 107 or 112 number.
- Formal residential acute-rehabilitation facilities within the KZN province and improved outpatient rehabilitation services.

In conclusion, better care for trauma is associated with better systems of care for all other emergencies, as has been demonstrated in previous studies, thus the implementation of such

trauma systems aims to address trauma care initially, but all patients may benefit in the end.[12-14]

Appraisal of the limitations and contribution of this research

The limitations of the current research must be stated realistically. Much of the international literature relies upon expert opinion, rather than empiric data. Some of the critique from reviewers of the research papers illustrate that there are still gaps in the knowledge base. For example, the one reviewer of the prehospital data highlighted the risk of under-estimates of the true burden of disease based on the accuracy and detail in the dataset. He also highlighted the need to examine further the outcome of the severe trauma subgroup, which we have partly accomplished with the Trauma Centre Utilisation paper.[15]

Regarding the hospital disease burden paper, the one reviewer noted that data from only 36 of the 47 acute care hospitals was included. This shortcoming was addressed with extrapolation of the data to the rest of the hospitals. The explanation being that the non-responding hospitals were mostly deeply rural and we had similar data from other similar hospitals to do a reasoned extrapolation. In similar vein the extrapolation to national data was questioned and the response to this concern was that national burden is similar, although there are minor variations across districts, but the numbers match previous studies from other parts of the country. Indeed one of the results of this study has been the implementation of a simple trauma data registry at the Provincial Head Office, which actually shows that for the first three months captured thus far the data suggests our figures are probably an under-representation by about only 5% when population changes are considered over time. This data is still in the developmental stage and cannot be used as a reference at this point in time, which is another limitation of the current study.

In the utilization paper, the reviewers noted that hiring of additional ICU nurses may allow for optimal use of the currently non-commissioned beds. We responded that this is not within our ability to do – as we are a government hospital, we are subject to national staff funding in a country with multiple competing priorities. The reviewer also queried if a cost analysis had been performed. This was not done since this is difficult to do in a South African public hospital for various reasons and was not within the ambit of this study. Previous costing studies from SA that showed many gaps in trying to identify real costs, thus we decided not

to include this.[16] Subsequent to the publication of the paper, this researcher was requested to be part of a Provincial planning team and undertook a forward-planning exercise to cost and estimate the future trauma burden, the results of the costing are included in this chapter to place the proposal in cost-perspective.

The reviewers queried whether we have any data on those patients who were turned away due to lack of ICU beds. We did not have that data, and explained that while many of them were likely sent to either private hospitals or kept in the local ICU it was not data that we could access. A number would also have probably died, especially those from far away or who were very severely injured.

It is hard to design a holistic trauma system based entirely on the original work in this thesis and one therefore has to realise there are limitations and many research questions related to the further development of trauma systems in the province. These have to include the fiscal considerations of the implementation of elements of the items proposed.

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Chapter 10: Future directions and proposals – Why is this work novel?

In spite of these deficiencies, outlined in the limitations, I believe that that thesis makes a significant contribution to the topic and is relevant to the future planning of trauma care in the broader context of the proposed changes in the health sector.

This document coalesces my clinical training in trauma with my academic interests in trauma systems and a passion to improve the lot of the injured patient in KZN and beyond. It is this passionate interest which has led to the framework of this thesis.

What makes the research novel in the context of trauma is that this is the first time that geographic information system mapping [1,2] has been used to plot the varied prevalence of injury across the province. It is also the first time that a province-wide audit of the disease burden was combined with the facility assessments to understand the reasons for delayed transfer to definitive care or the challenges faced by various providers of trauma care.

Aspects of this research have led to invitations to contribute to the literature on the subject. This includes 2 peer-review journal editorials highlighting the challenges faced by African health care workers regarding injury, in both children and adults, and a number of review articles on: Ethics of Trauma, Missed injuries, [3] and Trauma Systems [4].

I believe it provides novel data and insight on the burden of trauma at the pre hospital and hospital level, the state of our provincial hospitals equipment and manpower to deal with trauma and the capacity of a level one centre to deliver effective trauma care for the most seriously injured. This local data provides the foundation to start designing a proper trauma system, the key elements to which my data contributes, having been outlined above. It provides the impetus for future studies to address other aspects of a developing a more holistic trauma system and the need to firmly place a prospective trauma registry on the health care agenda.

The trauma system proposed here is useful only if implemented and subjected to verification testing. In future it would be helpful for the Provincial Department of Health of KwaZulu-

Natal to agree to pilot the more formalised Afrocentric Trauma System in the province and undertake audits of the effectiveness and potential cost-saving aspect of this system.

Other potential places where the system may be of value are smaller countries in the SADC region, such as Botswana, where there are only one or two major hospitals, and many smaller regional or district facilities, where such a system could be built up from the beginning (personal communication, Dr Michael Walsh, University of Botswana). The relatively small total population of that country makes the potential of doing the pilot project there appealing.

To achieve either of these goals will entail the approval of this PhD submission, thus giving credibility to the presentation to these government bodies, also increasing the chances of acceptance by such bodies.

The other future research potential is to expand the newly established Trauma Data Bank at the Dept. of Health, Epidemiology Unit into a more expansive Trauma Registry, which could be exported to South Africa as a whole.

The results of the research have also led to plenary speaker invitations to 8 local and 4 international conferences addressing Trauma Systems in the developing world. One of these conferences led to a significant input into the South African standards for the CSIR-IUSS “built-environment” draft regulations for hospital design.[5]

Finally, in an international context I am very proud that the World Health Organisation has recognised my efforts in this field by asking me to be the South African contributor to a recent international survey on Emergency Medical Services. [6]

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4. See Addendum 1 part 2
5. See Addendum 1 part 3
6. See Addendum 1 part 4

Chapter 11: Summary and Recommendations

KwaZulu-Natal has an extensive trauma burden (at least 160000 cases per year of moderate and severe trauma) spread across this vast province with a large population, many of whom dwell in very rural areas. Currently the majority of prehospital services are uncoordinated and lead to over-servicing of minor pathology by ambulance services leading to lack of resources for the prehospital care of major trauma, or leading to mainly private sector providing care to indigent patients after major injury, particularly in urban areas. Rural areas are particularly underserved, both in terms of the numbers of ambulances and the level of qualification of available personnel.

The hospital services are already providing care to the injured, yet the delays to definitive care due to the “primary care” oriented referral pathway need to be urgently addressed. The result of the pathway is that many hospitals are ill-equipped and have poor processes in place for initial and on-going care of the major injury victim, especially while awaiting transfers, which further delays the access to definitive care. The majority of hospitals have lack of access to imaging and surgical care either due to lack of expertise or lack of financial capacity. A major province-wide equipment and human resource upgrade is required to effectively implement a trauma system that will benefit all the people of the province.

The way forward needs to be mapped out both fiscally and strategically. Key elements of any implementation strategy would be to mandate all provincial hospitals to be inspected by the Trauma Society verification committee to identify the weaknesses at each hospital and then to actively pursue a revitalisation process. It would be useful to also designate about 5 major regional trauma care facilities and staff these as required for a Major Trauma Centre (TSSA Level 1). These five centres would then become the hubs for the receiving of any major and moderate trauma, thus building up expertise and reducing missed injury. By undertaking regionalisation the burden on the current one major trauma centre would be reduced and it would be enabled to focus on the major urban area it was originally intended to service.

In addition it would be preferable to have some degree of coordination and common care pathways for trauma across the five regional units and thus a provincial trauma lead clinician would add value to this process through leadership and guidance.

This submission provides information on the first phase of developing a good trauma system, the infrastructure and logistics of providing physical care. Other aspects of the holistic approach encompassing all aspects of care of the injured which are not addressed in this submission are equally important. They are rehabilitation and re-integration into gainful employment in society and preventative strategies to reduce the incidence of injury both by statutory and non-governmental organisations.

It illustrates there is a need to progress from centers of excellence to a comprehensive system that provides the right level of care to the appropriate patient within a reasonable timeframe, across the region, and allows for early and efficient transfer systems and patient flow to both upper and lower levels of care.

Addendum 1: Other publications and invited presentations resulting from the PhD research

1. Articles in peer-reviewed journals examining aspects pertinent to the research, but not directly related to the main thesis

Article

The ethical and medico-legal issues of trauma care

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Ethical issues confront trauma clinicians on a daily basis. This article highlights the similarities of trauma ethical dilemmas to those faced by other emergency care providers and takes the reader through the inpatient aspects of trauma care.

Ethics is the application of moral principles that are accepted appropriate behaviour, such as trust between a doctor and his/her patient.¹ Although the interpretation of universal ethical principles may differ within different cultures and peoples, they follow a common trend across most cultures, namely beneficence, justice, non-maleficence and the dignity of persons.

Most commonly, laws are a set of written proscriptions guiding the behaviour of society and setting moral principles.¹ Not all laws are ethical and not all breaches of ethics are illegal, and therefore the mitigation of breaches of one may not result in prosecution via the courts, yet professional organisations may discipline members who breach their ethical principles.

Trauma care seeks to ensure optimal management of the injured. This requires rapid decision-making and procedural skills. Most importantly, trauma care requires the performance of these skills often without having the opportunity to truly obtain the informed consent of the individual patient. This is due to the patient's condition at the time of first interaction with the emergency caregiver.

In South Africa, trauma is the leading cause of unnatural death across all age groups.² Because trauma is so common, ethical and medico-legal aspects of the care of the trauma patient are essential for the practising medical officer, emergency physician or trauma surgeon.³ This applies not only to the provision of care but also to the evidentiary process, including medical report-writing, and the need for audit and review. The latter is undertaken through morbidity-mortality meetings and formal clinical audits, which may lead to publications.

This review of ethics and legal issues in trauma seeks to broaden upon a recent article in this journal⁴ by addressing the issues specifically in relation to the trauma patient. In addition, I address some aspects of trauma research and clinical dilemmas that extend beyond the emergency centre to the operation room and the intensive care unit (ICU).

What makes the emergency centre a unique ethical environment?⁴

The patient seldom chooses the venue or caregiver in an emergency, thus increasing the frustration of the patient and the family if they are not in a venue they would prefer.

Prior conditions and medical history are not often available to the emergency care provider, complicating the care and increasing the chance of error. Because there is no prior health care provider-patient relationship, establishing rapport is more difficult.

Providers of care have little choice but to treat the patient, whether or not they have a reasonable chance of reimbursement, and must provide life-sustaining, often expensive treatment without prejudice to all who present to their institution. Transferring the indigent patient to a public facility also has a number of complex issues outside the scope of this discussion.

What makes the emergency centre a unique medico-legal environment?

The patient may not be able to provide consent to treatment, as treatment is often required to be life-saving without time for formal consent processes. Furthermore, the patient may not be in a sound frame of mind to allow for ethically and legally valid consent. Because multiple providers of care may be required, especially in the case of polytrauma, the patient's autonomy is further reduced. In addition, the risk of missed injury is increased because of loss of information at handover in situations of multiple transfers of care.⁵

Access to the emergency centre is a guaranteed constitutional right (Section 27.3), thus leading to the corollary that inadequately equipped or staffed units may be subject to legal sanction, should service delivery be inadequate or should a patient be refused initial assessment and appropriate resuscitation.^{1,3} Adding to this stressful situation, specific medical conditions that carry a medico-legal obligation are often treated in the emergency centre, such as sexual assault, interpersonal family violence, drug-related injuries⁶ and elder abuse.⁷

Certain injury mechanisms (motor vehicle collision) carry a legal duty to undertake certain investigations, such as blood alcohol tests, when requested by appropriate authorities.⁸

Appropriate documentation of the clinician's actions are essential, firstly for one's own record keeping, and secondly to enable completion of medico-legal documents at a later stage (J88 or affidavits). Memory may be poor after a stressful resuscitation, and certain elements of the clinical process may unwittingly be excluded from the notes.

What makes the trauma patient unique from a medico-legal and ethical perspective?

As mentioned earlier, the patient is in unfamiliar surroundings, possibly in a facility not of their choosing, with injuries that may include a spectrum from minor to life-threatening. In addition, the patient usually does not disclose or may not disclose the presence of risks to the health provider due to diseases (such as HIV) that existed prior to the injury – thus necessitating the use of extensive

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personal protective devices and making the experience even more unpleasant for the patient.

The trauma may have occurred during commission of an offence, in which case the patient may be under guard, or may even be concealing weapons or contraband. This could necessitate an 'invasion of privacy' to identify or remove such items.

The severity of the injury may be such that ongoing care of the individual patient is futile, and this can lead to disagreement with the family or friends of the patient with regard to further treatment. Patient capacity or ability to participate in the informed consent process may be compromised and the patient is therefore managed by the clinical team on the basis of the best interests principle, with clinicians relying on proxy consent or substituted judgement.^{1,9} It follows, therefore, that because of the circumstances highlighted above, the risk of liability and more importantly vicarious liability¹ always hangs over the head of the clinician like the sword of Damocles.

What is the standard of care and when may it change?

The standard of care is per the 'reasonable practitioner' approach¹ in the light of the severity of the injury and the facilities at the disposal of the health care provider.

A comprehensive handover from prehospital providers should be received, and the doctor should independently assess and appropriately manage the initial resuscitation with early referral to an appropriate co-ordinating discipline, which would ideally be a registered sub-specialist trauma surgeon subsequent to the recognition of that sub-speciality in 2007.³

The standard of care may have to be modified to do the 'most for the most' in so-called 'disaster' situations when patient numbers outstrip facility resources. In South Africa, this is the situation in many facilities every weekend because of the trauma load on our public health system. For this reason the National Department of Health has adopted the Major Incident Medical Management and Support system (MIMMS) as the new national major incident management system, with a ruthless but rapid triaging system.¹⁰

In addition there are triage systems that can be utilised for the care of individual patients on a day-to-day basis, such as the South African Triage Score, to optimise the timing of patient care and allow for rational resource utilisation. These are of particular relevance on busy weekends in our public hospitals.¹¹

The SA Triage Score allows patients to be treated ethically yet scientifically, with reasonable access to care based on the urgency of their underlying injury or condition, thereby utilising the principles of non-maleficence and justice in the management of the emergency patient.

Rational resource use in these circumstances has been an accepted part of South African ethics and law.¹ Comfort care for the unsalvageable should always be offered.¹²

What about care beyond the emergency centre?

Modern trauma care is largely a mix of operative and non-operative care, with many patients requiring admission to an intensive care or high-dependency unit environment. These sections of the hospital have their own ethical and medico-legal issues for the

trauma patient and the treating clinician. The standard of care required is the same as for the emergency centre, however, namely a reasonable practitioner and facility standard.

Although the Trauma Society of South Africa has set standards¹³ that may be complied with in order to ethically offer this reasonable standard of care, these are not currently enforceable.

Many of our public hospitals are staffed by foreign-qualified doctors, some of whom are in training positions. The ethical dilemma this situation produces includes different cultural and philosophical outlooks,¹⁴ often with a different level of skill or experience that leads to doubts and confusion in the mind of the clinician.¹⁵

The concept of damage control surgery for both general and orthopaedic injuries¹⁶ has led to staged and repeated operative procedures, the need for and complex nature of which patients are often not able to comprehend. This leads to frustration on the part of relatives and patients and often to lack of co-operation from the patient.

It may become evident, often only after some of these procedures have been performed, that because of the severity of injury, treatment is futile. Again the international literature can provide guidance in the institution of palliative care principles in the trauma patient in the ICU¹⁷ after suitably informing the family of the prognosis. Withholding or withdrawing life-supportive care is a medical decision, and in terms of South African law the family cannot insist upon continuing futile support.^{1,18}

What about research in emergency scenarios in South Africa?

Research in South Africa was previously not governed by legislation. However, the National Health Act No. 61 of 2003 for the first time brought all research under the ambit of statutory law. There are specific clauses in the regulations¹⁹ governing research in emergency situations that allow research ethics committees to waive consent if this is justified by the protocol submitted, or to allow for delayed consent from the next of kin (section 5.9). The same regulations, however, limit this research to 'minimally invasive observational research' (section 5.14), both in the emergency centre and in the intensive care unit. This certainly hampers the research of new therapeutic modalities and necessitates a re-think of this aspect of the regulations, especially with regard to new devices and procedures in the surgical field.

The need for formal ethical approval for retrospective case series and audit reviews has also led to a decrease in the research output of both South African and international researchers, as they are frustrated with the processes for ethical approval for low-risk retrospective academic research. The reason for the frustration is that many research ethics committees require formal good clinical practice-type processes, even for non-interventional anonymised data assessment.²⁰⁻²²

Part of this frustration stems from the multiple steps in obtaining final consent in some facilities, where first a university ethics committee then the hospital management must approve the protocol; then final approval from the university is obtained, and after this approval from the provincial health services is still required. Streamlining this process to one committee with broad representation would encourage research. In a situation where there is a dire necessity for clinical research in trauma settings, it is unethical for

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bureaucratic processes to delay or obstruct research. A research ethics committee should do what it has been set up to accomplish: facilitate ethical research!

What are some of the controversies in the international trauma and emergency literature that may be relevant to South Africa?

The high prevalence of HIV among the trauma population is well known in South Africa, yet testing without informed consent is considered unethical in this country. It may be time to consider the American Centers for Disease Control guideline for HIV opt-out testing in emergency centres²³ to provide clinicians with the knowledge to address less common organisms when treating the septic complications that commonly follow severe trauma, particularly when there is ICU admission. This would also serve to improve clinician safety.

There are a number of novel therapeutic products designed for use in the injured patient in the developed world that are not yet available in South Africa. Many of the newer haemostatic devices and products are not yet registered by the Medicines Control Council, while patients are compromised due to a lack of currently available suitable alternative therapeutic strategies. The lengthy time delays associated with registering a new drug or device result in obstruction to access of necessary medical care. The ethical dilemma faced by the treating clinician in this situation is immense, especially in light of beneficence and non-maleficence. Acting in the best interests of the patient would require use of the proven new and better treatment option, an option that is denied to the patient because of regulatory hurdles blocking access. Streamlining the processes for the introduction of novel modalities is required for products that can be life-saving in emergency situations.

Conclusion

Trauma is an aspect of emergency care that extends far beyond the emergency centre, with many additional medico-legal and ethical concerns. This brief overview has sought to highlight some of these dilemmas and to encourage the consideration of alternative methods to address these issues. In addition, much-needed research in this field is requisite and should be encouraged.

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Missed injury – decreasing morbidity and mortality: A literature review

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Summary

This brief literature review examines the causes of missed injury, the typical clinical pictures that are associated with missed injury and techniques and procedures to help avoid missing injury in the light of the recent literature, while highlighting the cost implications for clinicians.

Missed injuries are defined variously as injuries identified after the initial period of resuscitation (primary and secondary survey of Advanced Trauma Life Support[®]), although they may also be injuries identified after a defined time period after injury, such as 12 or 24 hours.^{1,2} However, there is no absolute definition, since some missed injuries may present long after the traumatic event (e.g. penetrating injuries of the diaphragm presenting many months to years later as a hernia).

Missed injury has been a source of concern to clinicians for many years, and the first series examining the influence of missed injury from South Africa was reported by Gordon in 1986.³ While missed injury is not new, what is surprising is that injuries are missed even in developed countries with experienced units.^{2,4}

Incidence

Why make such an issue about missed injuries? Missed injuries occur with a remarkable degree of regularity in recognisable patterns, with the same or similar patterns of injuries being missed repeatedly in most reported series from around the globe.

Looking at South African original publications on missed injuries, the first, from 1986, examined missed injuries in children in a newly developed paediatric trauma unit and detected a 2.5% incidence in the children admitted to the wards, whereas only 0.3% of children 'treated and released' were found to have a missed injury.³

Muckart and Thomson⁵ subsequently reported their experience with torso trauma from KwaZulu-Natal, finding a 2.6% missed injury rate for penetrating trauma and a 4% rate for blunt trauma. They noted that the consequences were grave, with a 44% mortality rate overall for this subgroup, which increased to 88% if the missed injury was missed at urgent surgery.

Depending on the definition of missed injury, the incidence varies from around 1.3% to as high as 39%.^{6,8} Most commonly there is a human factor involved in the misdetection of the injury.⁹ Of all missed injuries identified, the sub-group that requires a change in management (i.e. clinically significant injuries) is between 15% and 22% of the total.^{6,7}

More recently, Clarke and co-workers from Pietermaritzburg presented their experience, also reporting a 2.5% incidence, but

attempting to classify the cause of the misdiagnosis. They found that 41% of missed injuries were due to inadequate clinical assessment, while 32% were due to errors related to imaging (wrong investigation or misinterpretation), thus implying that 73% were due to human error.¹⁰ One further study examined technical issues around chest drains, but this was not directly related to missed injury; rather misplaced or incorrect technical methods were identified, with the potential for iatrogenic injury.¹¹

The true incidence of missed injury in South Africa is unknown, because we have only local databases and no comprehensive trauma registries; many of the former are paper based and therefore less robust than electronic databases. The Trauma Society has attempted to rectify this by establishing the Trauma Bank database, but uptake has been variable.

A number of recent international studies on the subject have been identified. These include a review of the largest patient cohort to date from the Los Angeles group in the USA,¹² where 35 000 patients were reviewed. Of these 1% had a complication identified. Only 14% of these complications (58 patients) were due to a missed injury; however, 64% necessitated a management change. This highlights the low level of missed injury in a modern, level 1 trauma centre in a developed country.

Malhorta *et al.* from Virginia examined 1 353 trauma patients and had a 50% follow-up rate at 4 weeks after injury (692 patients).¹³ In this follow-up group they identified only 17 patients with a missed injury that required medical intervention, i.e. 2.5% of the follow-up group, in keeping with previous publications.

Finally, Ekeh and colleagues examined the incidence of missed injury to the aortic arch when plain film radiography of the chest was compared with computed tomography (CT) scans, and found that there would be an 11% missed injury rate when relying only on the chest film.¹⁴ This leads to the conclusion that better screening tests, such as trauma CT, are recommended for patients with blunt chest trauma, even if the plain film is normal. Interestingly, 50% of the controls in their study with a normal aorta had an abnormal plain radiograph, again demonstrating the poor sensitivity of this test.

Which injuries are missed?

Missed injuries can be detected across the entire spectrum, but there appear to be certain groups of injuries that are more likely to be overlooked or remain unsuspected.

Cervical spinal injuries continue to be overlooked or missed, due to inadequate clinical assessment, inadequate imaging, or not evaluating abnormal films with further imaging, both of the injury and the rest of the spine.¹⁵ Fortunately the majority of these injuries are stable injuries with no adverse sequelae.¹⁶ Thoracic or lumbar

spinal fractures are missed due to inability to do a proper clinical examination, and a low threshold to image these regions should be maintained.¹⁷ CT is regarded as the gold standard, for both adults and children.^{18,19}

Chest injuries that are often missed or underestimated include pneumothorax or haemothorax, missed when the imaging is undertaken early after injury or where the clinical picture gradually evolves, for example with progression of pulmonary contusion. Older patients are at an increased risk of having a chest injury underestimated.²⁰ Other chest injuries that may be overlooked include diaphragm injury (particularly penetrating injuries), aortic injury when the initial chest film is reported as normal, and occasionally missed penetrating cardiac injury.¹⁶

The abdomen is another area of concern, since blunt small-bowel injury may be masked by a decreased level of consciousness, lack of initial abdominal signs, and other distracting injuries.²¹ Small-bowel and pancreas injuries are more common when a liver injury is present.²¹ The concept of the solid organ injury that 'has bled' and has now stabilised, allowing for selective non-operative management, is well established. It is recognised that there is a higher incidence of delayed diagnosis of bowel injury in this group, with a higher morbidity but no statistical increase in mortality.²² There is a need for increased vigilance in this group of non-operatively managed patients.

The other areas of concern in the abdomen are the retroperitoneum and the ureters, which are often not visualised with penetrating injury and may only be diagnosed appropriately with imaging studies. Included with the abdomen is the perineum, another area where injuries may be missed, due to inadequate removal of clothing or through avoidance of rectal or genital examination. Missed injuries here lead to high rates of sepsis.²³ The consequences of missed abdominal injury are devastating, with the need for admission to an intensive care unit (ICU), multiple re-laparotomies, the risk of multiple organ dysfunction or failure and prolonged hospital stay for survivors, while the mortality of abdominal sepsis remains high at around 25%.^{16,22,23}

Up to 50% of all missed injuries in a number of studies have been reported as occurring in the extremities and other bony tissue.^{6,7,24} Injuries that are easily overlooked in the rush of the resuscitation phase are those to the small bones of the hands and feet, to ligaments (particularly knee dislocation), and to the facial bones. These should be actively searched for in the post-resuscitation period.

Neurovascular injuries that are missed are of particular concern as they may lead to avoidable limb loss or even loss of life. These injuries often occur in compromised patients (head or spinal injury) who are difficult to evaluate. Blunt cervical vascular injury with resultant stroke, peripheral nerve deficits and undetected compartment syndrome occur in this patient group, and close clinical observation and liberal fasciotomy are invaluable.

Less commonly, myoglobinopathies and renal failure ('crush syndrome') occur when soft-tissue injury or reperfusion injury are underestimated. Risk groups include those who have been assaulted with blunt objects ('sjambok injury') or those with blunt multiple injury. Liberal screening with serum creatine kinase or urine myoglobin will prevent renal impairment.²⁵ Adequate fluid resuscitation will avoid the complications.

Foreign bodies may be missed by inadequate imaging (glass) or through deliberate concealment (criminal activity) and may be a

source of later litigation. Finally, other underlying disorders may mask clinically relevant findings or may be inadvertently identified after trauma with resultant potential for inappropriate intervention on the assumption that it is a traumatic injury (e.g. a stab wound of the neck with an abnormal contrast study that turns out to be achalasia).²⁶

Why are injuries missed?

The reasons for injuries being missed are complex and multifactorial. The high levels of diagnostic uncertainty associated with emergency patients, the need for time-dependent decision making, multiple care providers and surrounding distractions all increase the chances of missing injuries. Numerous handovers of care also result in loss of information. The quality of the system in which the provider is working also influences the risk of missing an injury.²⁷ All of these factors lead to a lack of 'dual-process' thinking – an imbalance between protocol and common sense, for example not following a particular line of investigation as per protocol because there are other distracting injuries or competing priorities.

Mis-triage occurs where older and very young patients are difficult to assess, when clinicians lack experience or skills, such as limited ATLS training and lack of trauma nursing skill, or in the presence of mainly junior staff, as is typical in many of the rural hospitals in South Africa. System issues include rural hospitals not referring appropriate patients timeously, or a delay in availability of blood results, radiology results and other investigations. In South Africa, cost containment plays a very definite role, such as not doing a test to save money when the test is clinically indicated. However, this can never be a justifiable defence in a claim for damages incurred through inadequate testing.

When all the above are viewed as intertwining concentric circles with multiple interplay, several factors can be identified, both internal and external, that affect error occurrence in a care system.²⁸ These include patient factors, technological factors, the health worker's physical and emotional state, ambient climatic and working conditions, the physical structure of the facility, social, legal and cultural influences, and finally the quality of the hospital organisation.

Clarke *et al.*¹⁰ have devised a taxonomy for missed injury, and Thomson and Greaves⁷ have proposed a standard reporting system for missed injuries – both are valid and highly recommended for practice quality assurance.

What are the consequences of missed injuries?

Fortunately, most missed injuries are unlikely to cause significant morbidity or mortality. These injuries do not usually prolong ICU stay,²¹ although limb injuries may decrease long-term quality of life. In most cases the higher mortality is related to the severity of other readily identified injuries rather than missed injuries. Although as many as 30% of injuries may be considered 'significant', few (<2%) are lethal.¹⁵ One recent autopsy study revealed that 6.5% of deaths were attributable to missed or delayed injury diagnosis.²⁹ Pfeifer and Pape, in a meta-analysis of 17 studies, state that there was an equal mix of minor and major missed injuries, with a very low (1 - 4%) incidence of life-threatening complications.⁶ The fact that health care is expensive, particularly in the light of the planned National Health Insurance,³⁰ and the cost of litigation is increasing, should lead to awareness of and vigilance regarding missed injury.

How do I avoid missing injuries next time?

Croskerry²⁷ advises that reducing dependence on memory by written protocols, regular review of the patient in context (what he calls 'metacognition'), and optimising the local treatment environment can decrease clinical error. The use of clinical decision nodes and feedback loops will enhance this review process. One example pertinent to the trauma patient is known as the Tertiary Trauma Survey, first described by Enderson in 1990.²

The Tertiary Trauma Survey^{2,6,7}

This concept is outlined in terms of the frequently asked questions pertinent to the topic.

First, why perform a Tertiary Survey? A significant proportion of delayed diagnoses are radiology related, with some of the results only available after the secondary survey is complete. About 6% of these injuries will require surgical intervention, or other changes in management.

Second, what does the Tertiary Survey comprise? It should include a complete review of the patient's clinical findings and incorporate all body systems, a review of all radiology and blood results and a review of all procedural interventions that have been performed during the resuscitation and definitive care phases, so as to allow for determination of further care plans.

Third, who should be screened with a Tertiary Survey? Ideally all trauma patients should be reviewed in this way, although outpatient studies have determined that the missed injury rate is usually <1% for patients discharged home after initial assessment, so the risk is reduced in this patient cohort. Certainly all admitted patients should be included, especially those admitted to an ICU.

Fourth, when is a Tertiary Survey performed? Recommendations are that it should be done either on arrival in the ICU or after 24 hours after admission to a ward, as this gives time to get all the relevant documentation and allows the resuscitation phase to be completed. It can, however, be performed on an outpatient basis, although the stated risk is lower for these patients.

Finally, how does a Tertiary Survey proceed? The most important concept of the Tertiary Survey is that it is a team-based review, which should include at least one unbiased senior staff member, preferably not previously involved with the case. In the context of blunt trauma it is also ideal to have orthopaedic input because of the high rate of missed musculoskeletal injury. It has been demonstrated that the Tertiary Survey is more useful in blunt than penetrating trauma, since the operative indications are often more clearly defined in the penetrating trauma subgroup.

Conclusion

In summary, to err is human, so missed injuries are not an embarrassment. However, although no witch hunts should be instigated when injuries are missed, continuous audit is essential in preventing repeated errors! Missed injuries will occur, so one must actively investigate to find them, as such injuries may delay healing or cause multiple-system compromise. Deal with these injuries rapidly once they are identified, as they can increase morbidity and mortality. Develop suitable systems to improve care so that missed injury is minimised, otherwise the risk remains that litigation may follow.

This paper was presented as a plenary overview lecture of missed injury at the Emergency Medicine in the Developing World congress held in Cape Town on 24 - 26 November 2009.

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Invited Editorials in Peer-reviewed Journals: AfJEM and JETS

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EDITORIAL

Trauma care in Africa: Triumphs and challenges

Trauma has largely shaped the development of emergency surgery throughout the ages, with many of the advances in emergency care and resuscitation emanating from the battlefield.¹ Africa is a continent of contrasts – part developed world, part developing world; rich and poor combined. Trauma follows infectious disease as the second leading killer of the people of Africa.² Much interpersonal violence has taken place in Africa – from liberation struggles, to civil wars, to genocides³; yet the everyday trauma of the mechanised killing machine, known commonly as the motor vehicle, is the real menace to the youth of Africa.⁴

The triumphs (because there are achievements in African trauma care – not everything is negative): although the significant amount of trauma has been damaging to the population, it has forged the development of expert surgeons, orthopaedists and emergency physicians; this plethora of pathology has led to advancements in both operative and non-operative management of penetrating trauma, pioneered in South Africa⁵; the adoption of the Advanced Trauma Life Support (ATLS) course (initially in South Africa (next year marks the 20th anniversary of the first SA course), and then in parts of North Africa and most recently in Nigeria)⁶; the Definitive Surgical Trauma Care course for surgeons was pioneered in South Africa (1999) and has become a worldwide respected training initiative.⁷

The speciality of Emergency Medicine⁸ is another triumph in Africa, with South Africa being the first country in Sub-Saharan Africa to formally register such clinicians.⁹ The emergency medicine physician is specially trained to treat the entire trauma load, as well as those who are acutely medically ill. In the United States and other “western” societies, the Emergency Physician is the entry point into the hospital system. They are trained to acutely assess, manage and then

coordinate with the surgical colleagues. Ghana, West Africa, has successfully started residency training in Emergency medicine, and several other countries are looking to follow suit. A South African led initiative brought about the establishment of the African Federation of Emergency Medicine, which serves as the professional organization for the continent.

The work performed in smaller African countries such as Ghana in developing structured trauma care systems and driver first aid,^{10,11} and in Nigeria where truck drivers are trained to provide proper basic First Aid to road traffic injuries¹² are worth recognizing. The World Health Organisation has spearheaded the Essential Trauma Care (EsTC) and Prehospital Trauma Care programs to draw attention to the increasing burden of trauma in the developing world.^{13,14}

The challenges (changeable conditions and things to improve upon): war is tragic and the loss of life, the use of child-soldiers and the rape and pillage of towns and villages throughout the continent stand in stark contrast to the relative peace in the First World; the fact that doctors who provide trauma and emergency care can themselves become victims of murder or rape is a true atrocity^{15,16}; child abuse remains a significant cause of suffering and injury¹⁷; the limited research into the underlying causes, and characterization, of the increasing burden of injury limit the ability of many countries to enact proper strategies for intervention.

While South Africa has made some strides in providing an accreditation system for trauma-capable hospitals by engaging all the role players in the development of the criteria, the challenge is to expand this to other countries. Another challenge is to develop Afrocentric trauma systems that will be relevant to our countries, which in varying stages of development. These systems would also have to be economically feasible for the majority of countries to implement.^{18,19} Adapting the aforementioned EsTC programs to align with the Trauma Society of South Africa criteria may be the answer.

Along with many aspects of health care in Africa, money is an incredible challenge.²⁰ As a result of lack of funding, the majority of African governments cannot provide Emergency Medical Services, even at a basic level. Thus, many trauma patients die at the roadside for lack of access to available facilities. The burden of disease is frightening in severity and number, especially when one examines the relative lack of access to operative facilities and intensive care units across Africa.^{18,21}

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Training is an area of concern, with insufficient trauma training in most medical school curricula.²² This training must include prevention, resuscitation, acute management and rehabilitation aspects, as all of these are under-developed in most African countries. This training should ideally extend beyond the "trauma centres" to include the rural level providers who are often the initial point of patient contact. As there are insufficient medical professionals practicing in most nations, there is a delicate balance between providing service while allowing personnel to attend courses to increase knowledge. If your small hospital only has two practitioners, who will see the patients while they are away updating their skills? When training is available, many cannot afford to attend the courses or may be deterred through the difficulty in getting access to the training venues.

Furthermore, at the local facility level, many Emergency Centres are lacking in the design, layout and ancillary services (including access to properly trained referral specialists) to provide a trauma care service to patients that is cost-effective and also scientifically based. In addition in many African countries the trauma is managed by surgeons primarily trained in orthopaedics and this delays care for non-bony injuries. The role of the cross-trained emergency medicine physician, who can aggressively resuscitate and undertake appropriate diagnostic work-up, cannot be understated.

In summary, much has been achieved in the care of the trauma patient, yet many challenges remain. The road ahead in Africa should take a three pronged approach: research to gain better understanding; pointed training to increase and standardize knowledge, and continent wide collaboration to hasten the development of systems in all countries. It behoves all who look after emergency patients, irrespective of discipline, to become competent and remain up-to-date in the assessment and treatment of the injured. We must work to develop systems that are relevant to Africa and ensure that the disease is attacked at all levels: from prevention, to treatment, to rehabilitation.

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Expert Commentary

The injured child in Africa

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In this issue of JETS, Dr. Ademuyiwa and colleagues provide a comprehensive literature overview of the challenges and stumbling blocks in providing trauma care to the most vulnerable “poorest of the poor” in Africa – the child in a low-income country.^[1] As an example of the injury burden, when this author reviewed pediatric trauma at his previous institution over a 6-year period, the age group 0–13 years comprised 36% of the total trauma load of a large teaching hospital (treating both adults and children) in the northern suburbs of Cape Town, South Africa, with nearly 8000 children treated for injuries annually (data on file—previously presented at International Trauma Congress 2006, Durban).

Africa is indeed a continent of contrasts with relatively well-equipped and supported semi-First-World facilities in parts of the continent (South Africa, Egypt, Botswana, parts of Nigeria, Zambia, Uganda and Namibia), yet with non-existent facilities in many other parts of sub-Saharan Africa. The burden of disease is very different from many other world regions, especially the developed world, with tuberculosis, other infectious disease, malnutrition and the ravages of HIV-AIDS high on the list of mortality determinants.^[2]

With this focus on communicable disease and a lack of recognition by governments in lower and middle income countries (LMIC) that trauma is a distinct preventable disease, the services treating trauma are indeed struggling. These “islands of excellence” are trying to cope with the general “sea of indifference” as shown by many governments and health services in Africa.^[3]

The greatest challenge is one of access, particularly access to care for the indigent patient, more so for children, since there is only one dedicated state-funded children’s hospital with a

major trauma center in sub-Saharan Africa (Red Cross Children’s Hospital, Cape Town, South Africa). Simple solutions to access and prehospital care have paid off in places like Ghana, where the work of Drs Mock, Quansah and the World Health Organization (WHO) team led to basic system development in that country.^[4] This has been reviewed in some detail by the authors and is well worth noting. There is much written on trauma in general in the published literature; yet, there is a dearth of child-specific publications, hence the importance of this review.

There remains some light at the end of the tunnel. A number of international aid agencies have established teaching centers in Africa, such as the Aga Khan Hospital, the Emory Global Surgery Program (together with the Pan African Association of Christian Surgeons)^[5] among many other similar ventures. The hope is that they address the issues from an Afrocentric perspective within a cost-effective framework and not try to replicate First-World ideas in a rural setting. The WHO has established tools^[6] to enable governments to work on system development, and the Trauma Society of South Africa has set criteria for Trauma Centers relevant to South and southern Africa, with the intent to enable system development.^[7] South Africa is also the first country with Trauma Surgery as a surgical sub-specialty after training in General Surgery, which includes the care of the injured child and must therefore look to support the rest of Africa in training staff to meet this need.^[7] Cost-effective trauma registries, such as the TraumaBank® of the Trauma Society of South Africa, may additionally assist in this endeavor.^[7] The Trauma Society of South Africa has a website (www.traumasa.co.za) where resources are available to assist in the provision of trauma care to Africa.

Active programs of injury prevention are essential, especially when one reviews the incidence of motor vehicle collisions in the pediatric population, where up to 84% of these cases were injured as pedestrians.^[8] This is an indictment on the lack of prevention, especially as we enter the WHO Decade of Action on Road Safety 2011–2020! Additionally, interpersonal violence is prevalent in parts of Africa, where a culture of violence remains as a consequence of foreign imperialist oppression.

The establishment of the African Federation of Emergency Medicine (www.africanemergcare.ning.com) has also directed the attention of the emergency medicine fraternity squarely on Africa and the organization is intending to publish a journal, relevant

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to Africa, in the near future. The establishment of emergency medicine standards for Africa, together with the passion of African surgeons for improving the plight of the injured child, will ensure a mortality and morbidity reduction over time, in a similar fashion to that seen in the First World; however, African governments need to realize that the initial cost will only be realized over an 8–10 year period.

In conclusion, it remains for me to congratulate the authors of the review for their fortitude and courage to address the needs of the injured child and to recommend this thoughtful overview to our readers.

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2) Overview of Trauma Systems: Arab Health Vol 3; 2011: 26 – 28

TRAUMA CARE BEYOND ATLS®: FROM OPERATIVE SKILL TO SYSTEM DEVELOPMENT

By Dr Timothy Craig Hardcastle, Principal Trauma Surgeon – IALCH, Deputy Director of the Trauma Service, Honorary Senior Lecturer in Surgery: University of KwaZulu-Natal, South Africa



▷INTRODUCTION

Trauma is the result of man's interaction with man and the environment. Trauma remains the second major killer of humankind. Motor vehicle collisions, interpersonal violence and wars are continuously in progress around the world. The relative shortage of healthcare providers and the focus of much of the Health Programs of governments on infectious disease and diseases of lifestyle

detract from the care provision for this preventable entity.

The care of the trauma patient has undergone major improvements in recent years with the multi-national adoption of the Advanced Trauma Life

«Trauma remains
the second major
killer of humankind»

Support® program in many developed and developing countries, with improvements in the outcome of the patient surviving to hospital admission. Unfortunately, however, often the results end in the Emergency Room, with little thought given to the further in-hospital care of the patient. This is certainly true of the developing world but is also true for certain parts of the developed world.

In mature trauma care environments

the improvement in disease survival to discharge takes in excess of 10 years to bear fruit. The reasons for this improvement in overall survival are determined by a number of aspects. These include the development of inclusive systems, with multi-disciplinary trauma-specific programs incorporating pre-hospital care, emergency room care, early appropriate surgical and orthopaedic care and trauma-focused intensive care. The greatest subsequent advance has been the incorporation of multidisciplinary in-hospital and free-standing rehabilitation services in returning patients to an economically productive environment.

The question that remains is how to develop such systems of care in a cost-efficient and yet outcome-based manner. This short article will attempt to provide an overview of the answer to this question.

► DEVELOPING THE SYSTEM

Development of a system starts with an understanding of the burden of disease, establishing the need for improved trauma care and getting government health department buy-in to the process. This is particularly important in the light of the World Health Organisation (WHO) Declaration on Emergency Care and the Decade of Action on Road Safety.

The next step is training, both of the prehospital providers and the in-hospital providers. This training can be through formal college- or university-based courses or through so-called short-course training. South Africa has become the first country to formalise trauma surgery as a full sub-speciality accredited by the health authorities. Short courses include: prehospital: PHTLS or ITLS; in-hospital: ATLS® / TNCC® for the emergency room; and advanced courses for the surgical teams such as DSTC™.

The training must focus on getting the patient to the correct level of care within the least amount of time, without delaying definitive operative care, through prolonged resuscitation. The next step is to teach surgical skills, as is taught on the Definitive Surgical Trauma Care (DSTC™) and similar courses, where the operative approach called 'Damage Control' and 'Damage Control Orthopaedics' is utilised to treat the physiologically unstable patient.

The treating healthcare workers need

«In mature trauma care environments the improvement in disease survival to discharge takes in excess of 10 years to bear fruit»

to understand that trauma patients have more than anatomical injury only; in fact, physiological derangement together with the inflammatory response kills, when prolonged fluid resuscitation is continued and appropriate "abbreviated" surgery is not undertaken expeditiously. This requires that the system include suitable laboratory and imaging services, which may be used for both diagnosis and treatment (e.g. endovascular therapy).

Damage Control Surgery has become the 'catch-phrase' of the nineties and today. Originally described by Rotondo and Schwab in 1993 and extended to the bone and soft-tissue injuries by Scalea and Pollack in 2000. The focus is to stop the bleeding, stop potentially infective contamination (source control) and temporise the patient to 'fight another

day', then stabilise them physiologically in the Intensive care unit (ICU), with the goal to return to the operation room with a patient in a condition to tolerate reconstructive procedures.

The intensive care of the severely injured patient must be a team effort and the trauma patient has different needs to the non-trauma patient in ICU, including the need for further surgical procedures, haemostatic resuscitation and the provision of prophylactic, rather than therapeutic antimicrobial treatment. The system must ensure that the patient who will require ICU care is transferred to the highest level of care in the system rapidly, preferably through direct transfer. Ideally the surgeons treating the trauma patient should be trained in intensive care and be the 'captain of the ship' for the duration of the care of the patient, until stepped down to rehabilitation facilities.

The third step in setting up patient-centred systems of trauma care is the credentialing and accreditation of trauma facilities to set up a network of hospitals that can treat the varied levels of injury severity. The American College →





«The treating healthcare workers need to understand that trauma patients have more than anatomical injury only»

of Surgeons Committee on Trauma, the Royal Australasian College of Surgeons and the Trauma Society of South Africa have recently compiled such criteria for their regions, while the WHO Essential Trauma Care programs (EsTC-Guidelines and Prehospital Trauma Care) are relevant to lower income countries.

The fourth step in this process is continuous data collection and the establishment of registries to enable the audit of outcome and resource utilisation. To this end there are a number of commercially available systems such as NTRACS (American College of Surgeons), TraumaBank (Trauma Society of SA) and others, which allow for accurate data collection and review.

Early appropriate care comes to naught when the rehabilitation programs and even residential rehabilitation facilities are not a part of the inclusive trauma system. The role of the physical or occupational therapist, dietician, speech and swallowing therapist among other team members

cannot be understated, both in the acute care hospital and in the rehabilitation centres outside the hospital environment. This remains the greatest challenge in lower-and middle-income countries.

When all these steps have taken place the bodies that fund healthcare must realise that the establishment of systems *per se* is not a 'quick-fix'. It takes around 10 years for the long-term results of the system to show improved survival and cost-efficiency. This was elegantly demonstrated in two recently published studies. In the first study it was demonstrated that Delaware's inclusive trauma system, in which all hospitals providing acute care participate, was associated with an incremental, significant decrease in mortality of the most critically injured patients, which was more substantial than the American

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national average.

In the review of an inclusive Canadian trauma system (Quebec), a statistically significant mortality reduction for critically injured patients could only be demonstrated between 1999 and 2006, ten years after the completion of the system implementation. When reviewed this mortality reduction was a massive 24% suggesting that regionalised inclusive trauma systems may provide better care for trauma victims. It should be noted, however, that in lower-income countries this reduction in mortality may be identified even earlier with the utilisation of ongoing audits. The two recent studies from Durban both demonstrated a low missed injury rate and a mortality reduction with the establishment of a dedicated trauma service with trauma-surgeon led teams providing initial and definitive care.

Prevention is also an essential component of the system, which implies that not only healthcare providers, but also law enforcement, social services, fire services and non-governmental organisations must be involved in the design and implementation of a trauma system. The use of the Haddon Matrix approach will identify both upstream and downstream interventions to reduce the incidence of trauma and guide interventions to reduce the impact of injury.

▷ CONCLUSION

Across the world trauma systems are in different stages of development, with the low-middle income countries at the infant stage and parts of the developed higher income countries at either the implementation or audit stages. Different systems work for different countries (e.g. from the American 'paramedic to hospital system' with limitation of scene time, to the French 'stay and play' doctor-based pre-hospital care). Each world region must decide what is most appropriate to their income range and ability to provide care, however it is well demonstrated that good systems reduce mortality and morbidity. Most importantly a commitment is required to ongoing development of prevention programs to curb a disease process that is mostly preventable. 

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Addendum 2: Other documents for examiners reference: BREC Ethics Approval

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 4058

**PROTOCOL: A Trauma System for KZN- Local development for local need.
 REF: BE011/010.**

EXPEDITED APPLICATION

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application dated 14 January 2010.

The study was provisionally approved pending appropriate responses to queries raised. Your responses dated 10 August 2010 have been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval and may begin as from 11 August 2010.

This approval is valid for one year from 11 August 2010. To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

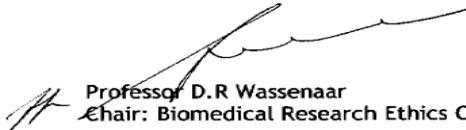
Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2004), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at <http://research.ukzn.ac.za/ResearchEthics11415.aspx>.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **RATIFIED** at a full sitting of the Biomedical Research Ethics Committee meeting to be held on **14 September 2010**.

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely



Professor D.R Wassenaar
Chair: Biomedical Research Ethics Committee

Proof of annual renewal is available for review if requested by the examiners.

Post-graduate Education Committee Approval:



31 August 2010

Professor SR Thomson
Department of Surgery
NRMSM

Dear Professor Thomson

PROTOCOL: "A Trauma System for KZN. Local Development for Local Need"
TC Hardcastle 209542793 – PhD Surgery


The Postgraduate Education Committee ratified the approval of the abovementioned study on 31 August 2010.

Please note:

- The Postgraduate Education Committee must review any changes made to this study.
- The study may not begin without the approval of the Biomedical Research Ethics Committee.

May I take this opportunity to wish the student every success with the study.

Yours sincerely



Professor SJ Botha
Chair: Postgraduate Education Committee

CC. Dr TC Hardcastle

Biomedical Research Ethics Committee
Westville Campus

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Founding Campuses:

- Edgewood
- Howard College
- Medical School
- Pietermaritzburg
- Westville

Addendum 3: Copies of Questionnaire and data proforma documents

Copy of EMS Questionnaire

**TRAUMA RESEARCH QUESTIONNAIRE
IALCH – TRAUMA SYSTEM READINESS
SECTION EMRS:**

Dr T C Hardcastle from the Trauma Service at IALCH, as the centre of excellence for trauma care in the province of KZN, is undertaking a research project that incorporates all aspects of the trauma care process, with the intention to determine the outreach needs and protocol deficiencies that delay care of trauma victims. This project is part of his research toward a PhD degree. The project is approved by UKZN-BREC (BE011/010) and the Provincial Research office at Natalia.

Participation is voluntary and all responses will be anonymous. However, the more participants, the better the system we can propose. By completion of the questionnaire I certify that I understand the nature of the study and participate in this study voluntarily. I understand that I am under no obligation to complete this questionnaire.

To be completed at each EMRS base by the Zonal officers, base managers and by all district managers.

Please complete the following survey as we attempt to prepare the province for overall improved Trauma Care

We are seeking to understand the reasons for delays in the continuity of trauma care and seeking to find practical solutions to improve care by limiting time to definitive treatment. This is known as “translational research”

- List the location of your EMRS base

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- How many of the staff members have completed a certified disaster course (in-house or DOH-MIMMS)

--

- Did you know about the FREE training available in preparation for FIFA2010?

Yes	No
-----	----

- What are the referral patterns for trauma?
 - Who goes to the local receiving hospital directly?

--

- Who will your service / base staff bypass to regional level without stopping at a local hospital?

--

- Who makes the bypass decision and what is the level of training that determines the ability to make that decision?

Decision maker:	Level of training:
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- What determines the regional hospital destination?

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- Is there a system in place to bypass the smaller regional hospital to allow a severely injured patient to go directly to an ICU-capable centre? If you answer YES describe the system.

System:	
YES	NO
Describe:	

- If the bypass system discussed above exists – what degree of knowledge about the system exists at grassroots provider level?

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- How would you as an EMRS provider like to see the system change to enable better trauma care to be provided to your clients? Please share your thoughts without concern for bias. All responses will be reviewed.

Thank you for helping us to improve the quality and expediency of care to the people of this beautiful province.

T Hardcastle: Principal Trauma Surgeon & Research Leader

IALCH Trauma Unit

(Assisted by Ms Melissa Finlayson on behalf of the management of EMRS)

**Hospital Disease Burden Data Proforma – Example – Regional Hospital
TRAUMA RESEARCH QUESTIONNAIRE
IALCH – TRAUMA SYSTEM READINESS**

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REGIONAL REFERRAL / SATELITE TEACHING HOSPITAL QUESTIONNAIRE:

This questionnaire should be completed by the hospital manager and the HOD/CMO of the Surgical Service. The HOD/CMO of Casualty Unit should separately complete a copy of this questionnaire. (i.e. at least three per hospital)

For the purpose of this study TRAUMA is defined as the treatment of the injured patient, not including psychological counseling or medical emergency

Basic Data

- Name of Hospital

- Total Medical staff (MB, ChB or equivalent / higher)

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- Total Registered Nurses working in Casualty

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- Total other Nurses in Casualty

--

- Number of Doctors working in casualty or trauma unit?

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- Number of the medical staff with accredited additional trauma training (ATLS or similar) who work in the casualty

Number	Number with ATLS or similar

- Number of locum staff working in the Casualty area and percentage of these staff who are ATLS certified

Number	Number with ATLS or similar

- Referral Major Hospital if applicable:

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- What challenges do you face in arranging and initiating a transfer?

Time to arrange transfer	<1 Hr	1-2 Hr	2-4 Hr	>4 Hr		How often does this impact on patient outcome in your experience?	alwa ys	ofte n	usuall y	seldo m	neve r
Ability to get hold of a referral doctor and willingness to take your patient	easy	difficult				How often does this impact on patient outcome in your experience?	alwa ys	ofte n	usuall y	seldo m	neve r
Wait for EMRS availability at correct level of care	<1 Hr	1-2 Hr	2-4 Hr	>4 Hr		How often does this impact on patient outcome in your experience?	alwa ys	ofte n	usuall y	seldo m	neve r
Shortage of equipment and sundries in local facility and transfer team	How often does this occur in your unit?					How often does this impact on patient outcome in your experience?	alwa ys	ofte n	usuall y	seldo m	neve r

- Surgical Service.

Surgeon (Number)	Yes	No	Fellowship Trained	Yes	No
Registrars / MO's	Yes		No	Number:	

- Number of surgeons who have undertaken additional trauma training:
 - E.g. 2 surgeons both ATLS trained = 100%

Number	Course	Percentage of Total
	ATLS	
	DSTC or DSTS	
	CRISP or REST	
	MIMMS or HMIMMS	

Hospital Equipment in Casualty:

- How many resuscitation trolleys with complete airway equipment?

1	
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2	
3	
4 or more	

- Is chest drain equipment readily available?

Yes	No
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- How many ventilators (mobile or transport)?

1	
2	
3	
4 or more	

- How often is the equipment checked?

Weekly		
2X per week		
Daily		
After every resuscitation	Yes	No

- How much Ringers Lactate or similar fluids are available?

Ringers Lactate:

Other resuscitation fluids:

- How much blood is kept in storage on-site?

- How much FDP?

- What basic blood and other investigations are available at your hospital?

Blood Gas	
U&E	
FBC	
Clotting Screen	
Pregnancy Test	
Urine Dipstix	
Fingerprick Hb only	

- What imaging studies are available?

Chest films	Yes	No
Neck Films	Yes	No
Pelvis AP	Yes	No
Limb X-rays	Yes	No
Skull films	Yes	No
Basic contrast study (e.g. Cystogram)	Yes	No

- Are plain films routinely performed as per ATLS Gold Standard Protocol?

Yes	No
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- What advanced imaging capability exists at your centre:

CT Scan	Yes	No
Angiogram (catheter or on-table type)	Yes	No
C-arm imaging	Yes	No

Ultrasound	Yes	No	
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- Is there a radiologist experienced in trauma to report the radiology or do you do it yourself?

Radiologist	Yes	No	Do it myself	Yes	No
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- Is there access to an emergency operation room and anaesthesia equipment to perform life-saving surgery (e.g. "Damage control" laparotomy or thoracotomy) or must the patient be referred to another hospital for this treatment?

Anaesthesia equipment and operator	Yes	No
Theatre with appropriate sets	Yes	No

- Describe the operative facilities and surgical sets available to your service:

Laparotomy	Yes	No
Thoracotomy	Yes	No
Sternotomy	Yes	No
Basic or Damage-control orthopaedics	Yes	No
Vascular Surgery	Yes	No
Comprehensive orthopaedic sets	Yes	No

- Describe the deficiencies and challenges in your hospital to optimal trauma care provision and cite how you suggest this be improved.

Free text box

- Are there any unique facilities or additional capabilities not normally found at a regional hospital that you provide for trauma patients?

Free text box

- Are you and the staff trained in Disaster Medicine for Mass Casualty?

Disaster Trained	Yes	No
MIMMS Course	Yes	No
MIMMS course: Number of staff trained:		

Thank you for assisting us to assist you in caring for the trauma patient in this beautiful province.

T Hardcastle: Principal Trauma Surgeon & Lead Researcher: The IALCH Trauma Team

Addendum 4: The protocol as approved by PGEC in 2010

Included here is the actual protocol as the other aspects of the proposal are included in Chapter 1 and the Addenda.

Hypothesis And Objectives

Relevance And Motivation For The Study

The motivation for the study is to optimize the care of the trauma patient providing a holistic comprehensive service to the patient in a timeous fashion.

The relevance of the study is that the subjective perception of a haphazard trauma service delivery needs to be accurately quantified in a more objective manner to define its inadequacies and design a more efficacious system of trauma care. This in the context of a continued high trauma burden.

The hypothesis is, therefore, that the establishment of a comprehensive, coordinated trauma system will impact positively on the outcome of the trauma patient by ensuring that the correct patient is delivered to the appropriate level of care within an accepted timeframe and that this patient will receive quality care and rehabilitation.

Methods:

The proposal is for a PhD by compilation of related papers, based on the methodology outlined below.

The following methods are proposed:

Study Design (see details under “Phased Analysis”)

The first part of the study is to be a review of the existing Trauma System literature and will be formatted into a peer review article for submission to a professional journal.

Thereafter, the following research projects will be prospectively undertaken:

Study 1: Current resources: Needs and Capabilities Assessment

The study will be largely designed around an initial series of questionnaires (Appendix 3) sent out to hospitals of all levels willing to participate after permission from the relevant provincial and district authority is granted. This will also be undertaken within the EMRS of the regions provided permission from the Chief Ambulance Officer of the province is obtained. Data already collected for the planning for FIFA2010 Health preparedness may also be utilized in this context. This series of needs and capabilities assessments will provide the background data for a situation analysis of the current status of trauma care in the province in comparison to the international and national existing standards. The intention is to produce a comparative study and to identify areas of excellence and deficiencies that must be addressed to achieve quality service delivery.

Study 2: Burden of disease – Current Data

A current burden of disease study will be conducted through the EMRS system to determine the amount and mechanisms of trauma treated and the end destination of these patients at initial transfer from scene. A component of this study will examine the number of inter-hospital transfers till a trauma patient arrives at a source of definitive care and the waiting times to such transfers in the context of the IALCH Trauma Unit. The data will be derived

from the call sheets as logged on the EMRS dispatch computer logs and will utilize patient name anonymous data.

Study 3: Pilot trauma system

Based on the initial two analyses the intention is to derive a proposal for changes to the current system, as required to enable optimal patient care. This will be formulated in an article for submission to a professional journal, promoting a comprehensive trauma system, capable of identifying the “at risk” patient and transferring them to the most appropriate level of care.

Provided the provincial services are satisfied that the proposal is in line with optimal patient care, the proposed system could be piloted. The pilot study would need to cover a rural and an urban area and include EMRS and certain designated hospitals within a defined timeframe. More definite layout of this study will only be possible if the preceding two studies are completed and the concept is accepted by the DOH.

Study 4: Audit if implementation undertaken

Provided changes are implemented, an audit of the effect on outcome of the changes in patient care is planned. This would use existing Trauma Quality Audit facilities/tools previously developed during a Trauma outreach project in conjunction with the existing professional organization documents. The studies will all be largely observational and any intervention will depend upon implementation by DOH-KZN. The impact on patient care will be indirect and no physical patient contact is expected during the research, however retrospective analysis of patient data (anonymized) can form part of the burden of disease study. Generally, the patient data will relate to numbers of patients with a certain mechanism of injury rather than examining individual patient files.

Setting:

Province of KwaZulu-Natal, Department of Health and the affiliated emergency health services (EMRS and acute care hospitals)

Phased analysis:

1. An analysis of the EMRS service (staff numbers and competency / vehicles and serviceability / rescue capability / equipment ideals and actual situation), the location of bases and the current transfer and bypass protocols for the KZN service by means of data proformas – Phase one should take around two months to complete provided the questionnaires are timeously returned
2. An analysis of the current staffing status, level of current trauma care training of the hospital staff of each district, regional or major hospital under the KZN DOH jurisdiction in comparison to the existing criteria for the primary care hospitals as determined by Trauma Society of South Africa, WHO, COHSASA and the proposed National DOH Package of Care.

A proforma and a questionnaire as derived for the data collection and a comparison to accepted standards as denoted above will be undertaken to provide a situational analysis of the province as a whole and then region by region – this phase should take around 6 – 8 months. This will also include a comparison to the existing Fifa-2010 Health Preparation guidelines to enable assessment of the standard of care actually available during the Soccer World Cup.

3. Compilation of a “Needs Assessment” based on the results of the first two phases to enable a skills and resource development process to be implemented by KZN-DOH to

improve patient care by staff that will treat these patients with standard-compliant equipment and consumables. – Around 4 months

4. Describe a quality assurance (QA) model for trauma care in accordance with the Province's QA guidelines

Derived proposal:

Propose a Trauma System for the KZN-DOH to enable this province to provide quality appropriate trauma care to the injured in this province. This system must include all aspects of care in a coordinated manner. – Around 4 months

Providing DOH provincial buy-in the proposal can be implemented in the DOH-KZN. Ideally it would be province wide, but a selected pilot project may be more feasible. The researcher will aim to enlist the buy-in to the project by early engagement of the provincial health management echelon and ongoing interaction with the management.

System audit

The system may then be monitored as a pilot project to determine the efficiency of the proposed system by determining whether trauma morbidity and mortality decrease. This will be assessed at the regional level through feedback from the Morbidity and Mortality reports submitted to DOH by all hospitals and review of improved standards of care in line with proposed patient care guidelines. This final phase may take around 6 months, but will require provincial DOH buy-in and implementation for it to be possible. The researcher will aim to enlist the buy-in to the project by early engagement of the provincial health management echelon and ongoing interaction with the management.

Needs Assessment Qualitative And Quantitative

Patient/Participant Selection

Participants will mainly be health care providers from the pre-hospital and hospital sectors. Patient data will be numerical rather than individual in nature.

Patient data will be anonymously reviewed via the EMRS data collection system to determine injury types, mechanism and initial care destination. Most of the data in the needs assessment will be derived from the staff questionnaires.

Informed Consent will be obtained from the health care providers by a non-identifying signature mark placed on the questionnaire prior to completion. Only the researcher will have access to the raw data questionnaires once returned. No staff names will be required to maintain privacy and assure freedom to express opinions openly

Measurements

The tools discussed in the literature review will be the comparators for the data analysis together with any national and provincial benchmarks identified through ongoing research.

Perceived Or Measured Outcomes

The expected outcome improvements that would be expected for a functional system would include:

- Reduced time to patient assessment at an appropriate facility
- Reduced time to transfer to an appropriate higher level of care
- Appropriate level of care in the pre-hospital environment
- Improved quality of triage at district and regional centres
- Decreased time to operative intervention

- Patients with high Injury Severity Score rapidly bypassed to a suitable major trauma unit (regional or central)
- Reduced number of ICU and ventilator days
- Reduced hospital stay
- Increased access to appropriate rehabilitation services
- Decreased incidence of missed injury and physician error
- Decreased overall and late trauma mortality

Data Analysis: Simple statistical analysis will be utilized to compare the data to existing norms and standards – the statistical assessment has been discussed with Prof DJJ Muckart, who has a background in Trauma Outcomes Research (for his M. Med Sci.).

Sample Size: Since the studies are largely qualitative in nature rather than quantitative no sample size is proposed. Gross numerical values will be collected to determine trends rather than specific comparison groups. Return of questionnaires for an adequate response will require a 60% response rate.

Ethical Considerations

The projects will be approved by the Post-graduate and Biomedical Research Ethics Committees prior to the project commencement and will obtain assent from the PHRC in Natalia. No patient will be identified in any article or publication and only collated anonymous data will be presented. All participants who complete proformas and/or questionnaires will be expected to provide informed consent by completion of the questionnaire so as to prevent them from being identified by name (See appendices – discussed with Prof Wassenaar – Chair of BREC). Only the researcher and the BREC / Post-grad committee will have access to the raw data, the latter only by written request. The researcher’s opinion is that this is low-risk research with maximal potential benefit to future patients if the system is achievable and becomes functional. The social value in potential cost containment to the Health Service and reductions in hospital stay with resultant higher return to gainful employment after recuperation of the injured patient is significant. This last aspect also impacts on the dignity of the patient in terms of better patient care.

Limitations of the Study

These studies will be potentially limited by the willingness of staff to participate in the answering of questionnaires, the reliability of the data capturing at the EMRS control centres or hospitals and the willingness of the DOH-KZN to trial a pilot system which is eventually derived. The further limitation is that the proposed system may offer no advantage to the severely injured patient over the current “system” i.e. that the model does not work.

Funding

No funding is secured, but the project could begin without funding. The only costs would be that of printing, postage and packaging of the questionnaires for distribution and the compilation of a Microsoft® Excel spreadsheet with coded locked columns to safeguard identifiers. The researcher has access to a computer and printer facility.

Time Lines

Timeline for PhD Research

2009 – Project proposal and discussion with supervisors

2009 – Register as PhD Student and submit to PGEC and BREC

2009 – 2010 Review literature on Emergency Research and write an overview of

Trauma Research in SA as introductory paper (*still optional*)
2010 – Complete the Burden of Disease and Questionnaire phase (Needs assessment)
2010 – Write up the literature overview as Paper 1: Trauma systems – An overview
2011 – Write up “Needs assessment” phase as Paper 2: Trauma care in KZN
2011 – Proposal system to DOH to suggest pilot project – Proposal as Paper 3: A Trauma System for KZN – Afrocentric development
2012 – Implement, Assess and Review the Pilot System – Paper 4: Does a trauma system make a difference to patient outcome?
2012 – 2013 Final collation of Papers and compilation of PhD submission for examination

Contributors And Authorship

The Researcher intends to be First Author on a minimum of 4 – 5 linked papers for publication in the peer-reviewed literature concerning the process of the development of this Trauma System.