

Assessing the gap between the acute trauma workload and the capacity of a single rural health district in South Africa. What are the implications for systems planning?

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Abstract

Introduction This study focuses on a single rural health district in South Africa, and attempts to establish the burden of disease and to review the capacity of the district hospitals to deal with this load.

Methods Ethical approval to undertake this study was obtained from both the University of Kwa-Zulu Natal and the Department of Health. The audit was performed over a 6-month period in the four district hospitals of rural Sisonke District. There were four components to this audit.

1. Information on the hospital incidence of acute trauma in Sisonke was also sourced from the epidemiology unit of the Department of Health in Pietermaritzburg
2. Each of the district hospitals was visited and the medical manager was interviewed. The medical manager was asked to complete the World Health Organization's Tool for Situational Analysis to Assess Emergency and Essential Surgical Care. (SAT).
3. The operative registers were reviewed to determine the number of index cases for trauma. This information was used to determine the unmet need of acute trauma in the district.

4. Each hospital was classified according to the Trauma Society of South Africa (TSSA) guidelines for levels of trauma care.

Results The annual incidence of trauma in the Sisonke District is estimated to be 1,590 per 100,000 population. Although there appeared to be adequate infrastructure in the district hospitals, the SAT revealed significant deficits in terms of capacity of staff to adequately treat and triage acute trauma patients. There is a significant unmet need for trauma care in Sisonke. The four district hospitals can best be classified as Level IV centers of trauma care.

Conclusion There is a significant burden of trauma in the Sisonke District, yet the capacity to deal with this burden is inadequate. Although the physical infrastructure is adequate, the deficits relate to human resources. The strategic choices are between enhancing the district hospitals' capacity to deal with acute trauma, or deciding to bypass them completely and deliver all acute trauma patients to large regional trauma centers. If the first option is chosen, urgent intervention is required to build up the human resource capacity of district hospitals.

Keywords Acute trauma · District hospitals · Rural health · Global surgery · Burden of disease · Surgical capacity

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Introduction

Over the last two decades, the importance of the role of curative surgical services in sub-Saharan Africa has been better appreciated [1]. However, there is a dearth of credible and reliable data on the burden of surgical disease and the capacity to deal with this burden. Trauma is a surgical disease with an estimated high incidence in sub-Saharan

Africa [1, 2]. Little is known about the burden of injury in rural South Africa, and there is also a paucity of information about the capacity of the health system in rural South Africa to deal with this burden. This study focuses on a single health district, namely the Sisonke District in south-western Kwa-Zulu Natal, and has several linked objectives. It attempts to establish the burden of injury in the Sisonke District, to quantify the surgical capacity of the district hospitals in the area to deal with this burden and to establish the unmet burden of trauma and injury in the Sisonke Health District, and to classify the four district hospitals in the Sisonke District according to published guidelines for the assessment of trauma centers in South Africa.

Quantifying the gap between the capacity of a health system and the burden of disease it is expected to manage requires appropriate metrics [3]. The World Health Organization has developed a Tool for Situational Analysis to Assess Emergency and Essential Surgical Care (SAT) [4]. This tool analyses structure, and to a lesser extent process of care, and is a six page tick box type questionnaire that captures information about the physical resources, the human resources available to treat surgical conditions, and the type of surgical procedures offered at the institution. Questions that relate to structural issues have a high reliability. However, questions related to process are less reliable, and the quality of a process is difficult to measure [3, 4].

The Trauma Society of South Africa (TSSA) has published guidelines to classify hospitals according to the level of trauma care they can deliver [5]. District hospitals and local health care clinics would generally be classified as level III centers. According to the guidelines, the level III trauma center must provide assessment, resuscitation, basic emergency operations, stabilization, and transfer of acute trauma patients. They must have prompt availability of general surgeons or general practitioners with surgical expertise, and must plan the care of injured patients. This requires appropriate transfer systems and standardized management guidelines. Level IV trauma facilities provide basic trauma life support before patients are transferred to definitive care.

Setting

The Sisonke District is a rural area in south-western Kwa-Zulu Natal Province and has a population of 450,000–500,000 people. Edendale Hospital is a regional hospital in the city of Pietermaritzburg and is the referral hospital for the four district hospitals in the Sisonke Health District. Each district hospital is visited once a month by a surgical specialist from Edendale Hospital.

Aims and objectives

This study had four objectives:

- To quantify the burden of trauma in Sisonke by ascertaining the volume of disease and quantifying the severity of the disease.
- To quantify the capacity of the district hospitals in Sisonke to deal with this burden.
- To quantify the unmet need using data from the operative registers of the district hospitals and comparing the incidence of index procedures for trauma against the predicted need for these procedures.
- To classify the four district hospitals in Sisonke according to the published guidelines for the classification of trauma centers.

Methodology

Burden of disease

The burden of trauma in the Sisonke District was established by sourcing hospital trauma data from the epidemiology unit of the Department of Health in Pietermaritzburg. Based on the reported hospital incidence and the reported population density, incidence of injury and admission as well as mortality per 100,000 of the population were derived. The severity of the trauma presenting to the district hospitals was estimated by reviewing the standard Emergency Rescue Services classification of patients presenting to the district hospitals, and by determining the number of patients requiring admission and the number requiring transfer to a higher center of care.

- Green Code patients were injured but able to walk.
- Yellow Code patients were injured and required either a stretcher or wheel chair, but had normal physiology.
- Red Code referred to any patient who was transported in a stretcher with one or more documented deranged physiological markers.
- Blue codes referred to patients who died prior to arrival at the hospital.

Surgical capacity

Each of the district hospitals was visited and the medical manager was interviewed. The medical manager was asked to complete the World Health Organization's SAT to provide an overview of the capacity of each hospital to deal with its burden of trauma. Capacity was classified as infrastructure and human-resource-related capacity. The SAT lists equipment needed for acute care and provides three possible

answers: not available, sometimes available and always available. Similarly, it asks if certain procedures are done at an institution and it offers a yes/no choice. If the answer is negative, the SAT asks if patients are referred for the procedure, and then asks the reason why the particular procedure is not performed. There are three possible reasons: lack of skills, lack of drugs, lack of equipment.

Estimating the unmet need

The investigators reviewed the operative registers for the 6-month period of January 2012–June 2012 to document what trauma-related surgery was being performed at each district hospital. Two index cases were used, namely orthopedic reduction and laparotomy. We used published estimates of the need for orthopedic reduction and laparotomy as a basis to establish the unmet need for these procedures. Otieno et al. [1, 6] have suggested that at least half of all patients admitted as a result of blunt trauma need some form of fracture reduction. A survey of households in rural Pakistan estimated the incidence of the annual need for laparotomy to be to be 1,364/100,000 of the population [13]. The researchers derived this figure by interviewing the matriarch of each household about cases of illness that would potentially require surgical intervention, and about mortality from a wider range of surgical emergencies.

The estimated incidence rates were 1,531/100,000 persons per year for injuries; and 1,364/100,000 for acute abdomen. The overall rate for minor and major surgical procedures was 411/100,000 persons per year, and appeared to be low and the mortality rates were correspondingly high: 55/100,000 persons per year for injuries and for acute abdomen [7]. Data from Malawi has reported a rate of 4,062 laparotomies performed in total for a population size of 11 million, giving a rate of 36/100,000 population per year for the entire country [1].

Classifying the hospitals

The published trauma center guidelines were used to classify the four district hospitals in Sisonke according to the level of care they are able to provide [5]. Data was extracted from the SAT forms to complete the published guidelines.

Results

Burden of disease

During the 6-month period under review, a total of 3,673 trauma patients were seen at the four district hospitals in the Sisonke District. These comprised 1,008 Road Traffic Collision (RTC) victims, 929 non-intentional blunt

injuries, 943 blunt assault victims, 784 stab victims and nine Gunshot (GSW) victims. This gives a ratio of 1,937:1,736 (1:1) of non-intentional to intentional injury. The ratio of blunt to penetrating trauma is 1,872:793 (2:1). The national census indicates that the total population of the Sisonke District is 461,419. Using this denominator, the annual incidence of trauma in the Sisonke District is $7,346/461,419 = 0.0159$ or 1,590 per 100,000 population.

Severity of disease

There were 29 Blue codes and 17 inpatient deaths recorded. This gives a mortality rate of 1 %. A total of 48 (1 %) red code patients were received and a total of 111 (3 %) patients required transfer up to a higher level of care. All the red code patients were transferred to a regional center after stabilization. A total of 680 (19 %) trauma patients were admitted.

Surgical capacity

Situational analysis forms were completed by all four hospitals in the district.

- **Infrastructure**

All four of the hospitals that were audited reported that the appropriate emergency equipment were available for all patients all of the time, and each hospital had two functioning operating rooms.

- **Human resources**

Table 1 lists the staff available to perform anesthesia and general surgery. There were no specialists available in any of the institutions. In terms of general doctors who

Table 1 Situational analysis data per hospital

	CTK	EG Usher	Rietvlei	SAH
Number of operating rooms	2	2	2	2
Distance to referral center	100–200	250	100–200	80–100
Surgeon	–	–	–	–
Anaesthetist	–	–	–	–
Obstetrician	–	–	–	–
General doctors who perform surgery	1	4	4	5
General doctors who administer anaesthesia	–	4	6	6
ATLS	–	2	–	–
ACLS	–	2	1	–
Diploma in Anesthetics	–	1	–	–

CTK Christ the King Hospital, EG Usher Memorial Hospital, Rietvlei Hospital; SAH Saint Apollinaris Hospital; ATLS Advanced Trauma Life Support course; ACLS Advanced Cardiac Life Support course

were comfortable with either general surgical procedures or general anesthetics, the picture was heterogeneous. A single hospital had one staff member capable of performing surgery and no staff comfortable with the administration of a general anesthetic. The number of staff who had completed one of two acute care courses is summarized in the table and was low. Only a single doctor had completed a Diploma in Anesthetics from the College of Medicine of South Africa. No doctors had completed a Diploma in Surgery or a Diploma in Emergency Care.

The unmet need

During the 6-month period, 58 orthopedic reductions and 11 laparotomies were performed at the district hospitals in the Sisonke District. A total of 680 trauma patients were admitted, with a ratio of blunt to penetrating trauma of 2:1. Using the estimate that half of all trauma admissions need some form of fracture reduction, about 340 patients required an orthopedic reduction. Only 58 reductions were performed during this period, implying a deficit of 290 orthopedic reductions. Similarly, using the reported incidence of laparotomy from rural Pakistan of 1,364/100,000 of the population would suggest that there should be 3,419 laparotomies every 6 months in the Sisonke District. The actual number of 11 in the four district hospitals implies a considerable unmet need.

Classifying the hospitals

We attempted to classify each of the four district hospitals according to the described levels of care. Table 2

summarizes this by listing the procedures that must be available according to level of care and levels of care with data from the completed SAT forms for each of the four institutions.

Discussion

This study has confirmed the findings of several other studies of injury patterns in South Africa. The ratio of intentional to non-intentional trauma is one is to one, and an exceedingly high level of interpersonal violence blights rural South Africa [2]. This phenomenon seems to be stubbornly resistant to injury prevention programs and crime enforcement, and remains a cause for concern. However, the low rate of GSWs reported from Sisonke suggests that gun control policies are reducing the availability of these weapons and is cause for cautious optimism. Trauma patterns in South Africa are changing and the emerging new aspect of the epidemic is that of road traffic related injury. Rapid urbanization and the increasing numbers of vehicles on the roads contribute to major burden of disease and RTCs are associated with significant morbidity, mortality and cost [8, 9].

The accuracy of epidemiological data in South Africa and the developing world in general remains of concern. The information obtained from this 6-month review of hospital-reported figures suggests an incidence of 1,590 per 100,000. This is almost double the estimated incidence from a recent report that was based on a province-wide survey of 2 months extrapolated to a year, which suggested

Table 2 The TSSA guidelines for the classification of trauma centers as they pertain to the district Hospitals of Imabli

Level III and Level IV	Level III	Level IV	CTK	EG Usher	Rietvlei	SAH	Tayler Bequest
On call and available within 20 min							
General surgery	D	D	No	No	No	No	No
Anaesthesiology	D	D	No	No	No	No	No
On call and available within 60 min			General doctor available	General doctor available	General doctor available	General doctor available	General doctor available
Anaesthesiology	E	E	–	–	–	–	–
General surgery	E	E	–	–	–	–	–
Emergency medicine	E	E					
Resuscitation	E	E	Y	Y	Y	Y	Y
Surgical airway	E	E	N	N	N	N	N
Intercostal chest drain	E	E	Y	Y	Y	Y	Y
Acute burn management	E	E	Y	Y	Y	Y	Y
Closed reduction	E	E	Y	Y	Y	Y	Y
Open treatment	D	D	N	N	N	N	N
Joint dislocation	E	E	Y	Y	Y	Y	Y

E essential, *D* desirable

a figure of 840 per 100,000 [2]. Nordberg estimated the incidence in Kenya to be 3,000/100,000, Kobusingye in Uganda estimated it to be 1,690/100,000 and Ahmed in Pakistan estimated it to be 1,531/100,000 [7, 10, 11]. It has been shown repeatedly in research from South Africa that hospital-based mortality data does not capture the actual mortality rate, as many corpses are taken directly to the state mortuary. This results in a significant under-reporting of trauma-related mortality rates [12, 13]. The rate of 1 % reported in this audit is almost certainly a case of gross under-reporting. The development of an appropriate trauma registry and injury surveillance program is urgently needed, and this registry must incorporate forensic data if it hopes to provide meaningful information [13, 14].

We have identified an unmet need for laparotomy in Sisonke District. This is not unusual in Africa, and data from Malawi has reported a rate of 4,062 laparotomies performed in total for a population size of 11 million, giving a rate of 36/100,000 population per year for the entire country [1, 7]. We have previously documented that there is a very low rate of appendectomy in the rural hospitals of Sisonke District. Almost all patients requiring a laparotomy will be referred through to the regional hospital [14, 15]. This means that the procedures are being performed, but not at the district hospitals to which they initially present. However, we have shown in other studies that there is a high rate error of assessment associated with trauma care and that there is a significant degree of diagnostic delay in recognizing the need for surgical exploration in patients with acute appendicitis [14–16]. This suggests that the system is not functioning optimally and that district hospitals are not achieving their objectives, which should be resuscitation, assessment and appropriate referral of patients with acute abdominal pathology. [17, 18] The low rate of fracture fixation is perhaps a better proxy marker for the state of rural trauma care in South Africa, as simple closed reductions should be performed in district hospitals. Some of these reductions may have taken place in sites other than the operating room and our figure may under-estimate the actual rate of fracture reduction.

This situational analysis data demonstrates that the district hospitals in the Sisonke District are relatively well equipped in terms of infrastructure and equipment. Almost all the equipment listed as necessary for resuscitation was available all the time for all the patients. The human resource component, however, is deficient. This is both in terms of number of staff available and in the level of training the staff have undergone. The two standard courses for emergency care competency are the Advanced Trauma Life Support (ATLS) and Advanced Cardiac Life Support (ACLS) courses. In none of the hospitals have all the staff completed all of these courses, and in certain hospitals none of the staff have completed any of these courses.

Although the hospitals had medical staff available for emergencies, there was minimal capacity for task differentiation. The Diploma in Anesthetics is a pragmatic and useful qualification, which ensures that a non-specialist anesthetist is competent to administer a general anesthetic. At time of the survey, there was only a single doctor in one of the hospitals who had completed this qualification.

The deficits identified in this audit are not deficits in physical infrastructure, but rather inadequate human resources. The Bellagio Essential Surgery Group published recommendations for increasing access to surgical care in sub-Saharan Africa [19]. They recommended that services be strengthened at the district hospital level. The WHO in the text “Surgical Care at the District Hospital” states that basic abdominal surgery should be undertaken at district hospitals [17, 18, 20]. There is a gap between what the WHO text describes and what is actually delivered in rural district hospitals in the Sisonke District, and there have been similar findings in other rural health districts in South Africa [17, 18]. To close this gap requires a major investment in educational programs, as well as a change in focus. Any educational course needs to develop surgical and anesthetic capacity amongst rural staff. The role of the diploma in surgery needs further definition, as this should directly train a cohort of generalists in basic emergency surgery. It must include a major component dealing with obstetrical surgery. The Diploma in Anesthetics needs to be propagated to teach the appropriate skills needed [17, 18]. The Department of Health has run a surgical outreach program for over a decade and although this has managed to deliver specialist care to rural hospitals, it has been less successful at developing surgical capacity in the rural hospitals [17, 18].

There is interest in developing a trauma systems approach to acute trauma care in South Africa [5, 21]. There is evidence to show that patients taken directly to a level I center have a better outcome than those taken to non-trauma centers initially [21]. The transfer of red-code patients to district hospitals with limited surgical capacity is problematic. The four hospitals reviewed collectively have limited capacity to deal with critically injured trauma patients and all the red code patients ultimately required transfer to a regional center. We have shown that there is a high rate of error associated with the assessment and transfer of trauma patients from rural hospitals to regional centers [16].

The solution to this problem needs to be innovative. It is unlikely that a blanket, one size fits all, solution is feasible. There appear to be two distinct strategic options. Option one is to decide that district hospitals have a minimal role to play in acute surgical care, and rather increase the capacity of regional centers until they are capable of dealing with huge volumes of trauma patients. In such a

system, injured patients would bypass district hospitals and be taken directly to a regional center. This would require the development of new regional trauma centers and the strengthening of current ones. The other option is to strengthen care at the district centers. However, it may be that strategic planners need to select a number of pilot district hospitals where conditions are suitable for such a development. It is unlikely that all district hospitals would be willing or capable of taking part in such a program.

Conclusion

There is a significant burden of trauma in the Sisonke District. The capacity to deal with this burden of disease is inadequate. Whilst the physical infrastructure is adequate, the deficits involving the human resources to deal with and manage acute trauma are significant. It would appear that this situation is not just confined to Sisonke, but applies to many rural health districts in South Africa, and this must be regarded as a major public health problem. We need to adopt a structured coordinated public health approach to develop innovative locally appropriate interventions to help reduce the impact of this epidemic. The strategic choices are between enhancing the district hospitals capacity to deal with acute trauma patients, or deciding to bypass them completely and deliver all acute trauma patients to large regional trauma centers. If the first option is chosen, urgent intervention is required to build up the human resource capacity of district hospitals by training healthcare personnel in safe surgery and anesthesia.

Conflict of interest None.

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