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Trauma Care in Africa: A Status Report From Botswana, Guided by the World Health Organization's "Guidelines for Essential Trauma Care"

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Abstract
Background Trauma represents a significant and increasing challenge to health care systems all over the world. This study aimed to evaluate the trauma care capabilities of Botswana, a middle-income African country, by applying the World Health Organization's Guidelines for Essential Trauma Care.

Methods All 27 government (16 primary, 9 district, 2 referral) hospitals were surveyed. A questionnaire and checklist, based on "Guidelines for Essential Trauma Care" and locally adapted, were developed as situation analysis tools. The questionnaire assessed local trauma organization, capacity, and the presence of quality improvement activity. The checklist assessed physical availability of equipment and timely availability of trauma-related skills. Information was collected by interviews with hospital administrators, key personnel within trauma care, and through on-site physical inspection.

Results Hospitals in Botswana are reasonably well supplied with human and physical resources for trauma care, although deficiencies were noted. At the primary and district levels, both capacity and equipment for airway/breathing management and vascular access was limited. Trauma administrative functions were largely absent at all levels. No hospital in Botswana had any plans for trauma education, separate from or incorporated into other improvement activities. Team organization was nonexistent, and training activities in the emergency room were limited.

Conclusions This study draws a picture of trauma care capabilities of an entire African country. Despite good organizational structures, Botswana has room for substantial improvement. Administrative functions, training, and human and physical resources could be improved. By applying the guidelines, this study creates an objective foundation for improved trauma care in Botswana.

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Introduction

Mortality and morbidity owing to trauma is one of the leading health problems in the world today. Worldwide, an estimated nearly 6 million people die annually due to injuries

[1]. One in ten deaths globally is caused by trauma, and nine in ten occur in a low- or middle-income country (LMIC) [2].

Improvement in the organization of trauma care results in reduced trauma-related mortality. Nathens et al. [3] reported a 9 % lower injury mortality rate in the United States with a regional trauma system and an 8 % reduction in mortality owing to motor vehicle accidents (MVAs) after trauma system implementation [4]. In a systematic review of trauma literature from the United States, Mann et al. [5] found that implementation of systematic trauma care reduces mortality. In a low-income setting from northern Iraq and Cambodia, Husum et al. [6] found a significant impact on trauma outcome after implementation of a prehospital trauma system.

Survival after injuries varies considerably between countries of different economic levels. Mock et al. [7] found increased mortality with decreasing economic level in a study comparing outcomes for seriously injured patients in Kumasi (Ghana), Monterey (Mexico), and Seattle (USA) and that most of the deaths occurred before arrival at a hospital, concluding that improvement efforts in LMIC countries should focus on injury prevention, prehospital treatment, and emergency room care.

The World Health Organization (WHO) developed "Guidelines for Essential Trauma Care" (EsTC) in collaboration with the International Association for the Surgery of Trauma and Surgical Intensive Care. The guidelines were released in 2004 to "provide recommendations for improvements in trauma care through better planning and organization adjusted to economic realities in a low or middle income setting" [8]. The guidelines were previously used for situation analyses in Ghana, Vietnam, Mexico, India [9], Equador [10], Morocco [11], and Cambodia [12] and to revise national trauma guidelines in South Africa [13].

In 2005, a Norwegian-Botswana government-to-government project called "Human Resources to Assist Ministry of Health, Botswana" was established. Trauma care was identified as an area for collaboration. As part of and prior to a trauma training program, we wanted to describe and analyze the trauma system components in Botswana based on recommendations made by WHO's EsTC to highlight areas of improvement and to establish a baseline against which development can be compared. This is, to our knowledge, the first time this document has been used for a situation analysis of an entire country.

Methods and setting

Study settings

Botswana is an upper middle-income country in southern Africa with a gross national income per capita of $ 6260 (2009) [14]. The country has had one of the fastest growing economies in the world since its independence in 1966. The population is estimated at 1.95 million, and 60 % live in urban areas [15]. Communicable diseases such as human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) and tuberculosis account for 83 % of years of potential life lost, noncommunicable diseases account for 10 %, and injuries for 7 % [16]. A total of 20,000 people were registered as injured and 500 were killed after MVAs in 2008 [17], giving a mortality rate of 25 per 100,000, which is above the worldwide middle-income average of 19.5 and far above the high-income European region average of 7.9 [2]. Other significant contributors to the burden of injury in Botswana are falls and domestic violence.

Health care in Botswana

Botswana has a well-organized health care system. Primary health care is organized at several levels, from mobile stopping points through health posts to clinics. Clinics are staffed by nurses and occasionally also a doctor, and they serve a population of up to a few thousand [18]. The hospital system is divided into three levels [19].

Primary hospitals have few doctors and provide basic inpatient and outpatient services. These hospitals are nonspecialist facilities with laboratory and radiology services. Some have basic surgical capabilities, such as those for cesarean section and ectopic pregnancies. Emergencies are usually received in an examination room in the outpatient department (OPD). Typically, they have a catchment area of 10,000–30,000 inhabitants.

District hospitals are the first level for referral. Most are nonspecialist facilities, but a few provide specialist services such as gynecology, pediatrics, surgery, otolaryngology, and anesthesiology. They have a catchment area of up to 250,000 inhabitants. Most have a more or less developed emergency room (treatment room for all emergencies) in the admission area of the hospital. They have operating theaters, and anesthesia service is provided by nurse anesthetists. Some hospitals use their regular outpatient department rooms for emergencies. These rooms are often small and not equipped for emergency care.

The two referral hospitals, Nyangabgwe in the north and Princess Marina in the south, provide specialist services in most fields. Both are regional trauma centers, with system responsibility in their region and surgical subspecialties. Injured persons are received in an emergency room in the Accident and Emergency (A&E) Department by nonspecialist doctors and nurses.

Government ambulances are generally in good condition but are sparsely or not equipped. Large hospitals have five to seven ambulances; small hospitals may have three to five

ambulances; and clinics may have one. Considering the number of outpatient visits and admissions, transport distances, interhospital transfers, and the fact that some patients are transported home after hospital care, there is a lack of ambulance services. The two-person crew has no medical training. Trauma victims are often transported to a hospital or the nearest clinic by police or private cars. A private emergency medical transportation system is accessible through payment or a medical aid system. There is no national emergency number.

Trauma team training program

As part of the bilateral cooperation between Botswana and Norway, in 2007 it was agreed that a trauma training program would be provided to all Botswana government hospitals. The training concepts were developed in Norway and are known as the Better and Systematic Team Training (BEST) approach [20]. It is a nonprofit training concept with a main focus on multiprofessional trauma team training using simulations. The training program period was from November 2007 until November 2009. The trauma care capabilities in the country were evaluated by a situation analysis prior to training at the individual facilities.

Data collection

A total of 27 facilities at three levels were surveyed, covering all somatic government hospitals. Four private hospitals (three of which were mining hospitals) and clinics were not a part of this study. Data for physical resources and skills for one district hospital were missing. For data collection, we developed two forms: a questionnaire and a checklist.

A checklist and a questionnaire based on WHO's EsTC were developed after the pilot training course in 2007 by the first author, who at that time was employed by the Ministry of Health, Botswana, in collaboration with Norwegian training partners. The draft for the checklist was revised according to WHO's "Checklist for surveys of trauma care capabilities" and input from the trauma committee in Francistown and other local partners.

The checklist assessed 64 items of equipment: whether it was immediately available in the emergency room, available in the hospital, or not available at all for the three hospital levels. Equipment with similar characteristics were, for the purpose of this study, grouped together; for example, oxygen wall/oxygen bottle/oxygen concentrator were grouped as oxygen supply. Items assessed, but of less importance for immediate hospital based trauma care and diagnosis, were left out of the study (e.g., otoscope, Magills forceps), making the number of items 34. An item was considered available if it could be presented in working condition or for items of multiple sizes that most sizes of the item were available (e.g., oropharyngeal airways, endotracheal tubes). Desirable and possibly required items were upgraded to essential because of Botswana status as a middle-income country according to the classification and recommendation of the EsTC checklist. Next, the checklist assessed timely availability of 59 trauma-related skills separated into 24 h per day/7 days per week/365 days per year (24/7/365)—sometimes and never. The 24/7/365 availability is separate from "sometimes" by being a service that can be provided at all times, even during the night and on weekends and holidays. Items and procedures related to drugs and rehabilitation were excluded. Then, the 34 skills considered most relevant and important according to established principles for acute hospital-based trauma care, were selected (e.g., airway, breathing, and circulation were considered most important, but capabilities for fracture treatment were also relevant for preventing disability). The first three elements of the checklist (airway, breathing, circulation) are shown in Appendix 1.

The questionnaire assessed local trauma resources in terms of manpower, organization, and the presence of quality improvement activity (see Appendix 2). The terms used in Appendix 2 are defined in Appendix 3.

Norwegian team members interviewed local personnel providing trauma care using the questionnaire and the checklist prior to the first course at each hospital. In primary and district hospitals, these persons were the head or acting head of the facility, the doctor and nurse responsible for the OPD, a radiographer, and a laboratory technician. In larger facilities, it also included the head of the A&E and surgical departments. All interviews were performed in a person-to-person setting. Next, at least one of the Norwegian team members inspected the facility together with the previously mentioned local personnel, who presented their facility and the various departments. The interviews and data collection at each hospital were done by the same person. An important part of the inspection was the evaluation of the emergency room (OPD/A&E) during the simulations/team training part of the training program, which provided a good basis for an objective assessment of local trauma care capacity/function. The final scoring or assessment for the checklist and the questionnaire resulted from synthesis of information gained through interviews, physical inspection, simulation part of the program, and finally discussion among the Norwegian team. The training program and collection of data went on for 2 years (November 2007 to November 2009). In total, for all hospitals, three persons were responsible for data collection after careful discussion of definitions and assessment criteria to ensure similarity in observations.

The Research and Development Office, Ministry of Health, Botswana approved the study.

Table 1 Hospital characteristics and human resources for trauma care in Botswana

Resources	Primary hospitals ($n = 16$)	District hospitals ($n = 9$)	Referral hospitals ($n = 2$)
Beds	21–74	65–400	525–540
Trauma cases annually	20–150	25–350	3500–5500
Doctors	3–6	5–13	80–100+
Specialists	0–2	0–4	35–50
Surgeons	0	0–1	6–10
Nurse anesthetists	0–3	2–6	4–7
Physician anesthetists	0	0–1	6–7
Doctors, accident and emergency	0	0	4–6

Results

Hospital characteristics and human resources for trauma care in Botswana are summarized in Table 1. There were no specialists in surgery in the primary hospitals; in addition, four of these hospitals had no nurse anesthetist, and 10 had one.

No hospitals had local trauma guidelines, systems for audit, education plans, defined trauma teams, or conducted educational trauma simulations. In the two referral hospitals, in-service lectures were conducted aiming at training A&E staff about triage and preparedness for mass casualties. Two hospitals had a local trauma committee. The first hospital was the initiator of the BEST training program; the second was established in response to the pilot course. One hospital had a trauma manual. All hospitals registered their admissions and outpatient visits; trauma was included in these registers in all but four hospitals. Separate trauma registries were found in two primary hospitals, one district hospital, and one referral hospital and contained varying extents of information on sex, age, time of visit/admission, main injury mechanism, and main findings; however, there was no detailed information for injury severity scoring. Injury severity scoring was about to be implemented in the referral hospital.

The physical resources for initial resuscitation and diagnosis of trauma victims at the three hospital levels in Botswana are summarized in Table 2. Oxygen availability was good at all hospital levels. Oxygen face masks generally had no reservoir. Physical resources were fairly good for basic airway management at the primary and district hospital levels. There were major deficiencies at the primary and district hospital levels regarding physical resources for advanced airway/breathing management, including self-inflating ventilation bags, face masks, laryngoscopes, endotracheal tubes, and surgical/needle cricothyrotomy sets. This especially applied to pediatric equipment. Chest tubes for children were not available in 11 facilities.

Ventilators were present in the emergency room in both referral and one district hospital, for the remaining district hospitals available in main operation theaters (anesthesia machine). Ventilators were found even at the primary level but are not deemed essential according to the guidelines.

Vascular access was in general limited to peripheral percutaneous intravenous access. Equipment for intraosseus access was, with three exceptions, not part of the armamentarium at any level. Sets for surgical cutdown were found nine places.

There were shortages of monitoring equipment at all levels. Pulse oximeters were found in 22 hospitals, and electrocardiography (ECG) was available in 15. In six and four facilities respectively, these items were found in emergency rooms/OPD rooms used for emergencies; for the rest they were located in the main operation theaters. Laparotomy sets were present in 13 primary and all 8 district facilities.

Diagnostic capabilities for basic trauma care were present at all hospital levels including plain radiography and even portable X-ray machines in some places. In one hospital, lack of radiologic services was due to a technical breakdown. Basic laboratory services, including hemoglobin and electrolyte assays, were available at all hospitals. Some hospitals reported a lack of reagents. All 26 hospitals had blood transfusion capabilities but limited supplies, both in the type and number available. Ultrasonography was, except for two primary facilities, a service of district and referral hospitals and was performed by radiographers.

The knowledge, skills, and human resources were assessed in the format of questioning: "How often is your hospital able to perform the following procedure?" stratified into "24/7/365," "sometimes," and "never." The results are summarized in Table 3.

Generally, primary hospitals are basic facilities with a limited capacity for severe trauma care. Except for administration of oxygen, the skills for basic and advanced airway management and spine immobilization were limited, especially at the primary hospital level but also at the district hospital level. A total of 3 hospitals were not able to provide endotracheal intubation at all, and this service could be provided on a "sometimes" basis in 18. Recovery position was an unknown procedure in 11 hospitals. Chest tube insertion was a procedure that could be provided by all doctors caring for injuries in only 11 locations.

The skills for recognizing and monitoring bleeding patients as defined in the Guidelines were limited at the

Table 2 Physical resources for initial resuscitation and diagnosis of trauma victims at the three hospital levels in Botswana

Resources	Primary hospitals ($n = 16$)			District hospitals ($n = 8$)			Referral hospitals ($n = 2$)		
	AT	AH	NA	AT	AH	NA	AT	AH	NA
Airway/breathing									
Oxygen supply	11	4	1	8	0	0	2	0	0
Oropharyngeal airway	11	4	1	6	2	0	2	0	0
Suction unit powered	11	5	0	8	0	0	2	0	0
O_2 mask	12	4	0	8	0	0	2	0	0
Cervical collars stiff	1	0	15	0	0	8	1	1	0
Cricothyrotomy set surgical/needle	1	1	14	0	0	0	1	1	1
Bag-valve-mask—adult	7	4	5	5	2	1	2	0	0
Bag-valve-mask—pediatric	4	5	7	5	2	1	1	0	1
Laryngoscope—adult	10	5	1	5	3	0	2	0	0
Laryngoscope—pediatric	9	4	2	5	3	0	2	0	0
Endotracheal tube—adult	7	7	2	6	2	0	2	0	0
Endotracheal tube—pediatric	6	7	3	6	2	0	2	0	0
Chest tubes—adult	6	8	2	4	4	0	2	0	0
Chest tubes—pediatric	3	4	9	3	3	2	2	0	0
Nasogastric tubes	13	3	0	6	2	0	2	0	0
Pulse oximeter	1	11	4	4	4	0	1	1	0
Arterial blood gas	0	0	16	0	0	8	0	2	0
Ventilator	–	–	–	1	7	0	2	0	0
Circulation									
Crystalloids	15	1	0	8	0	0	2	0	0
Colloids	10	4	2	5	2	1	2	0	0
IV access/infusion	15	1	0	8	0	0	2	0	0
Intraosseous needle	0	0	16	1	1	6	0	1	1
Fluid warmer	1	5	10	0	2	6	0	1	1
Blood transfusion capabilities	16	0	0	8	0	0	2	0	0
ECG capability	1	8	7	2	2	4	1	1	0
Hemoglobin/electrolyte assays	16	0	0	8	0	0	2	0	0
Urinary catheters	15	1	0	8	0	8	2	0	0
Surgical sets; venous cutdown	3	2	11	3	0	5	1	0	1
Diagnosis/other									
Plain radiology	1	14	1	1	7	0	0	2	0
Portable radiology	0	4	12	1	3	4	0	2	0
Ultrasonography	0	2	14	0	5	3	0	2	0
Computed tomography	–	–	–	0	0	8	0	2	0
Splints for fracture immobilization	0	3	10	2	2	4	1	1	0
Emergency laparotomy sets	0	13	3	0	8	0	0	2	0

Items designated as desirable in the guidelines are upgraded to essential because of Botswana's status as a middle-income country. Primary hospitals compare to general practitioner-staffed hospitals in the resource matrix, district hospital to specialist hospital, and referral hospital to tertiary hospital

IV intravenous, *ECG* electrocardiography, *AT* available in the emergency room, *AH* available in the hospital, *NA* not available, – not applicable at that level

Data are missing for one district hospital

primary and district levels: Five and six hospitals of these levels, respectively, were assessed to have sufficient skills. Intraosseous vascular access was, with three exceptions, an unknown procedure; whereas venous cut-down could be provided "sometimes" or "always" in 21 hospitals. Control of external hemorrhage by deep packing was available on a 24-h basis in one hospital and "sometimes" in seven; wrapping potential pelvic fractures was available on a 24-h basis in one facility and "sometimes" in six.

Table 3 Knowledge, skills, and human resources in Botswana trauma hospitals assessed in the format of a questionnaire[a]

Parameter	Primary hospital ($n = 16$)			District hospital ($n = 8$)			Referral hospital ($n = 2$)		
	A	S	N	A	S	N	A	S	N
Airway/breathing									
O_2 administration	14	2	0	7	1	0	2	0	0
Chin lift/jaw thrust	3	13	0	3	5	0	2	0	0
Insertion of oropharyngeal airway	1	15	0	4	4	0	2	0	0
Recovery position	2	7	7	1	3	4	2	0	0
Log roll	0	5	11	0	3	5	2	0	0
Assisted ventilation	2	13	1	4	4	0	2	0	0
Endotracheal intubation	0	13	3	3	5	0	2	0	0
Needle thoracostomy	0	10	6	0	6	2	1	1	0
Chest tube insertion	6	10	0	3	5	0	2	0	0
Circulation									
Assessment shock	3	13	0	2	6	0	2	0	0
Monitoring	4	8	4	2	6	0	2	0	0
IV access	14	2	0	8	0	0	2	0	0
Intraosseous access	0	0	16	0	1	7	1	1	0
Peripheral cutdown	1	12	3	0	6	2	1	1	0
Deep packing	0	4	12	0	3	5	1	1	0
Pelvic wrap	0	3	13	0	2	6	1	1	0
Transfusion capabilities	14	2	0	7	1	0	2	0	0
Head injuries									
Consciousness, pupils	5	10	1	4	4	0	2	0	0
Monitor/treat ICP	–	–	–	–	–	–	0	2	0
Computed tomography	–	–	–	0	0	8	2	0	0
Burr holes	–	–	–	0	0	8	1	1	0
Neck injuries									
Surgical skills for exploration	–	–	–	0	2	6	2	0	0
Chest injuries									
Skills/equipment thoracotomy	–	–	–	0	0	8	1	1	0
Abdominal injuries									
DPL	0	1	15	0	3	5	1	1	0
Ultrasonography	0	2	14	4	3	1	2	0	0
Skills/equipment laparotomy	2	6	8	1	5	2	2	0	0
Extremities									
Basic immobilization (slings, splints)	9	4	3	5	3	0	2	0	0
Closed reduction fractures	12	4	0	5	3	0	2	0	0
Skin traction in fractures	–	–	–	2	5	1	2	0	0
Skeletal traction in fractures	–	–	–	0	1	7	1	1	0
External fixation	–	–	–	0	0	8	2	0	0
Internal fixation	–	–	–	0	0	8	1	1	0
Fasciotomy CS	–	–	–	0	5	3	2	0	0
Amputation	–	–	–	0	3	5	2	0	0

Desirable resources in the guidelines are upgraded to essential because of Botswana's position as a middle income country. Primary hospital corresponds to GP, district to specialist, and referral to tertiary hospital in the resource matrix

Data are missing for one district hospital

ICP intracranial pressure, *DPL* diagnostic peritoneal lavage, *CS* compartment syndrome, – not applicable at that hospital level

[a] "How often is your hospital able to perform the following procedure?" Answers were as follows: N: never; S: sometimes; A: always (24/7/365)

Generally, we found that primary and district hospitals had limited physical and human resources for managing specific injuries. In all, 5 hospitals reported skills and equipment for 24-h-a-day emergency laparotomy; 11 hospitals could provide emergency laparotomy "sometimes." Diagnostic peritoneal lavage was not a commonly performed procedure, in contrast to a "four-quadrant abdominal tap."

All hospitals (except one) were familiar with the Glasgow Coma Scale (GCS) score and the recognition of altered mental status. None of the hospitals would consider executing a burr hole in a patient with a head injury who was developing unilateral pupil dilatation. Ultrasonography could be performed in seven of eight district hospitals—but in only half of them on a 24-h basis.

Basic orthopedic services such as closed reduction of fractures was performed in all hospitals, even primary ones; but basic immobilization could not be provided in three facilities because of the lack of immobilization devices. More advanced orthopedic interventions were available only at referral hospitals. The same conditions applied to major soft tissue damage repair.

Discussion

This study establishes the status of trauma care in the middle-income African country of Botswana before introduction of a national trauma team training program. Whereas similar studies have focused on regions of countries [9–11, 21] or nationally representative samples from all over the country [12], our study provides for the first time a picture of hospital-based trauma care capabilities in an entire country.

The main findings were that Botswana is insufficiently supplied with human and physical resources for basic trauma care. At the tertiary level, equipment, personnel, and diagnostic capabilities approximate the recommendations from the WHO EsTC. Tertiary hospitals have the range of specialists needed for basic trauma care and treatment of most specific injuries. Primary and district facilities did not meet the recommendations at several points when it came to physical resources and skills. These findings seem to correlate with findings in similar assessments from South America, Africa, and Asia [9–12, 21]. The highest-level facilities assessed seem to be more adequately staffed, equipped, and trained although with deficiencies; and districts are covered by generalist hospitals or clinics with very limited trauma care capacity and a substantial trauma load, especially along the major roads, which highlights the need for improved trauma care in rural areas.

Important elements of hospital-based trauma care are human resources (staffing and training), physical resources (infrastructure, equipment, supplies), and administrative functions/organization.

Staffing and training

Trained health care workers are essential for improved outcomes [22]. Studies from other LMICs have shown that prehospital trauma training programs can reduce mortality [6, 23, 24]. The same was shown for hospital-based care from Trinidad, where regular implementation of an Advanced Trauma Life Support (ATLS) course led to reduced mortality in severely injured patients [25]. All of the primary and most of the district hospitals in Botswana are managed by general practitioners, who have limited surgical training. To serve at primary or district hospitals, doctors need surgical experience to perform at least cesarean sections. If they do not have relevant training, they are required to practice at a referral hospital before they start working at a primary or district hospital. There are no such requirements or other training for trauma care, even if severe trauma is quite common and referral distances are long.

The system of rotations is another important issue. All health care workers are Ministry of Health employees; they are not employed at the individual facility. Staffs rotate among facilities as well as internally among departments rather frequently unless they have any kind of specialty, which only applies to a small number of the workers. These facts combined with nonexistent trauma education and limited training activities make capacity-building difficult.

Lack of personnel and particularly specialists is a significant problem in Africa [26]. We found that primary and district hospitals in Botswana had limited human and physical resources and therefore limited diagnostic capabilities for managing specific injuries. Because of the lack of personnel, few hospitals could in practice provide 24/7/365 anesthesia service, and a nurse anesthetist was on call from home after-hours, indicating that time to definitive care (airway control, hemorrhage control) might be prolonged. Time to relevant intervention is related to outcome [27], as is timely arrest of internal bleeding [28]. It should therefore be noted that only a few hospitals could provide emergency laparotomy on a 24/7/365 basis; therefore, most such patients must be transferred to the next level, even though there is no specialist service in the receiving facility. During the daytime this can be achieved by air lift but only by road ambulance after dark. As an example, a primary hospital might be located 300 km away from the district hospital, which is also only occasionally staffed with a surgeon, and 700 km from a tertiary level hospital, which always has surgical capabilities. In countries without a formal emergency medical service (EMS) system, it is known that most trauma deaths occur before the patient reaches the hospital (e.g., in Ghana the incidence is >80 %

[7]. This is partly due to the fact that transport from accident scene to hospital may take several hours. This is also the case at many locations in Botswana.

Trauma teams with preassigned roles are increasingly implemented in developed countries and have been shown to reduce mortality [29]. A major benefit from trauma team organization is a reduction in time to definitive surgery [30]. Efforts have been made to introduce the concept to African countries, but the size and composition of such a team may differ from that in developed countries owing to resource restrictions. An evaluation of a trauma team training program in Tanzania reported significant knowledge gain and improved performance after the course [31].

Equipment

We found that there were major deficiencies regarding equipment, especially at the primary and district levels. Because some hospitals at the same level had certain items and some did not, the lack of items was at least partly caused by poor organization and not by availability, as has been shown in other studies [9]. In many hospitals, equipment missing in the emergency room was found in another area of the hospital and was not being utilized optimally; thus, the equipment was not available for emergency use. This was also the case for more costly equipment (e.g., ECG instruments, pulse oximeters).

Administrative functions

Noteworthy was the nearly complete absence of trauma administrative functions, such as a trauma committee at the national or local level and quality improvement activities defined as "a method of improving care by monitoring the elements of diagnosis, treatment, and outcome" [32]. Such improvement programs have documented an effect even in LMICs in various fields and in regard to trauma in Khon Kaen, Thailand [33], where identification of preventable deaths and corrective interventions led to reduced mortality. A key component of quality improvement is a trauma registry with severity scoring for outcome evaluation and monitoring of the process of care [32]. However, creation and maintenance of a trauma registry requires substantial investments of both money and human resources [34], which might impose a challenge for LMICs.

Limitations

The strength of this study was that it was a national study with complete coverage of one country's hospital system. However, the study did not cover clinics, which are expected to treat a substantial number of trauma cases from rural areas. Nor did the study address prehospital care. The importance of the prehospital phase of trauma management, although not covered in our study, must be underlined. The study was limited to government hospitals. Private hospitals play only a minor role in the Botswana health care system and to an even lesser degree in trauma care.

Our study was focused on infrastructure and human and physical resources; it did not cover outcome measures. Improved outcome is what improvement efforts are about. However, the basis for improved outcome is necessary infrastructure, equipment, and human capacity. Data collection went on over a 2-year period. Theoretically, the status of a specific hospital might have changed during that time period. We find this unlikely, however, because we found no significant differences between hospitals surveyed early versus later during the study period.

Information about trauma care skills depended on information provided by care givers and is therefore highly subjective. Informants may tend to overreport their capabilities. Even our own observations are subjective to some degree, especially for skills, although we tried our best to make an objective assessment.

Conclusions

Despite a quite well-developed public health care system, relatively little attention has been paid to injury compared to other major health challenges in Botswana, such as HIV/AIDS. This study has, aided by WHO's EsTC, highlighted the current status of hospital-based trauma care in this country. It also indicates several areas for improvement. Improvements in availability and organization of equipment for basic trauma care are of major importance for patient care and outcomes, especially in primary and district hospitals.

Trauma administrative functions need to be developed at all levels. Trauma care should be incorporated into each hospital's training and quality improvement activities. Attention should be given to initial assessment, team organization, and teamwork. All doctors caring for injuries must be trained in life-saving procedures according to the level of the hospital and national policies.

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Conflict of interest None.

Appendix 1

Checklist equipment

Hospital: **Date:**

	Not available	Immediately available in trauma room	Available in hospital
Airways & Breathing: equipment			
Oropharyngeal airway			
Oxygen & equipment			
• Oxygen wall w/flowmeter			
• Oxygen bottle/regulator/flowmeter			
• Oxygen consentrator			
• Nasal prongs or cannula			
• O2 mask w/tubing wo reservoir			
• O2-mask w/tubing w reservoir			
Suction & equipment			
• Suction, manual			
• Suction, electric			
• Suction, pneumatic wall			
• Suction catethers			
Nebulization mask			
Self inflating bag 1500 ml w/res			
Self inflating bag 500 ml w/res			
Endotracheal intubation			
Laryngoscope			
Laryngoscope blades			
• Adult			
• Children/Infant			
Endotracheal tubes range			
• Children			
• Adult			
Introducing stylet			
Magills forceps			
Laryngeal mask airway			
Ventilator			
Needle cricohyreotomy set			
Surgical cricothyreotomy set			

Circulation; equipment	Not available	Immediately available in trauma room	Available in hospital
Crystalloids			
Colloids			
Blood transfusion capabilities			
Units of blood today			
Chest tubes			
• Children			
• Adult			
Underwater seal bottle			
Intravenous infusion sets			
Intravenous infusion sets luer			
Intraosseous needle			
Pressure cuffs for infusion			
Urinary catethers/collecting bags			
Blood warmer			
Infusion pump			
Fluid warmers			
Iv cannula 0.6-2.2 millimeter			

Checklist skills

How often will your hospital be able to perform the following if necessary?

Airway: knowledge & skills Q2	Never	Yes 24/7/365	Yes Sometimes	Do not know
Assessment of airway compromise				
Manual manoeuvres				
chin lift, jaw thrust				
recovery position				
Log roll				
Insertion of oropharyngealal airway				
Use of suction				
Assisted ventilation using bag–valve–mask				
Endotracheal intubation				
Cricothyroidotomy				

Breathing: knowledge & skills Q2	Never	Yes 24/7/365	Yes Sometimes	Do not know
Assessment of respiratory distress and adequacy of ventilation				
Administration of oxygen				
Needle thoracostomy				
Chest tube insertion				
Three-way dressing (open chest injury)				

Circulation knowledge & skills Q2	Never	Yes 24/7/365	Yes Sometimes	Do not know
Assessment of shock				
Compression for control of haemorrhage				
Splinting of fractures for haemorrhage control				
Deep interfascial packing for severe wounds (e.g. landmine)				
Pelvic wrap for haemorrhage control				
Knowledge of fluid resuscitation				
Peripheral percutaneous intravenous access				
Peripheral cutdown access				
Intraosseous access for children under 5 years				
Transfusion knowledge and skills				
Monitoring				
Knowledge of resuscitation parameters				
Differential diagnosis of causes of shock				
Recognition of hypothermia				
Use of warmed fluids				
Knowledge of core rewarming				

Appendix 2

Hospital characteristics and human resources for trauma care.

Hospital level	
Number of beds	
Primary/District hospitals	
• Number of doctors	
○ Any specialists?	
• Number of Anaesthetic Nurses	
• Number of nurses in OPD	
Referral hospitals:	
• Number of surgeons	
• Number of anaesthetists	
• Number of AE physicians	
• Number of AE nurses	
Aprox. number of trauma patients a year	

Do the hospital have:	No	Yes
Local trauma guidelines?		
Trauma manual/check list?		
Trauma committee?		
Local Trauma Registry?		
System for trauma audit? (If "Yes", please specify below)		
Plan for trauma education? (If "Yes", please specify below)		
Trauma simulation?		
Posters in trauma room (e.g. GCS)? (If "Yes", please specify)		
Defined trauma team?		
If "Yes" is the team activated by specified alarm criteria?		

Appendix 3 Definitions

Trauma guidelines guidelines that define the trauma patient, local trauma care structure, activation criteria for trauma teams, roles for team members, qualifications for team leader, available resources, transfer policies

Trauma manual written in hospital practice guidelines for initial triage, assessment, and treatment of injuries, aiming at standardizing the care given to trauma victims

Trauma committee an organizational structure aiming at developing and implementing trauma care strategies at the individual hospital

Trauma registry a separate local registry for trauma cases, regardless of whether it might be severity adjusted

System for trauma audit a system for identifying cases of preventable trauma deaths or suboptimal care and corrective plans and monitoring the process

Plan for trauma education trauma-specific systematic educational efforts

Trauma simulations team organization and training activities in the emergency room using simulations

Posters in the trauma room posters on the wall in the emergency room guiding systematic trauma care

Defined trauma team team organization with preassigned roles and adapted to local resources

Alarm criteria predefined criteria (e.g., trauma mechanism, physiologic status, anatomic injuries) that activate a team response

References

1. WHO (2004) The global burden of disease: 2004 update. World Health Organization, Geneva
2. WHO (2009) Global status report on road safety. World Health Organization, Geneva
3. Nathens AB, Jurkovich GJ, Rivara FP et al (2000) Effectiveness of state trauma systems in reducing injury-related mortality: a national evaluation. J Trauma 48:25–30
4. Nathens AB, Jurkovich GJ, Cummings P et al (2000) The effect of organized systems of trauma care on motor vehicle crash mortality. JAMA 283:1990–1994
5. Mann NC, Mullins RJ, MacKenzie EJ et al (1999) Systematic review of published evidence regarding trauma system effectiveness. J Trauma 47:S25–S33
6. Husum H, Gilbert M, Wisborg T et al (2003) Rural prehospital trauma systems improve trauma outcome in low-income countries: a prospective study from North Iraq and Cambodia. J Trauma 54:1188–1196
7. Mock CN, Jurkovich GJ, nii-Amon-Kotei D et al (1998) Trauma mortality patterns in three nations at different economic levels: implications for global trauma system development. J Trauma 44:804–812
8. Mock C, Lormand JD, Goosen J et al (2004) Guidelines for essential trauma care. World Health Organization, Geneva
9. Mock C, Nguyen S, Quansah R et al (2006) Evaluation of trauma care capabilities in four countries using the WHO-IATSIC guidelines for essential trauma care. World J Surg 30:946–956. doi:10.1007/s00268-005-0768-4
10. Aboutanos MB, Mora F, Rodas E et al (2010) Ratification of IATSIC/WHO's guidelines for essential trauma care assessment in the South American region. World J Surg 34:2735–2744. doi:10.1007/s00268-010-0716-9
11. Tacfouti N, Bhatti JA, Nejjari C et al (2010) Emergency trauma care for severe injuries in a Moroccan region: conformance to French and World Health Organization standards. J Healthc Qual 33:30–38
12. Nakahara S, Saint S, Sann S et al (2009) Evaluation of trauma care resources in health centers and referral hospitals in Cambodia. World J Surg 33:874–885. doi:10.1007/s00268-008-9900-6
13. Hardcastle TS, Steyn E, Boffard K et al (2011) Guideline for the assessment of trauma centres for South Africa. S Afr Med J 101:189–194
14. World Development Indicators & Global Development Finance (2010) World Bank Data, The World Bank, Washington, USA. www.databank.worldbank.org
15. The World Bank (2010) World Development Indicators & Global Development Finance 2009. World Bank Data, The World Bank, Washington, USA. www.databank.worldbank.org
16. WHO (2006) World health statistics. World Health Organization, Geneva
17. MVA (2008) Annual report 2008. Motor Vehicle Accident Fund, Botswana
18. Seloilwe ES, Thupayagale-Tshweneagae G (2007) Community mental health care in Botswana: approaches and opportunities. Int Nurs Rev 54:173–178
19. WHO (2009) country cooperation strategy, 2008–2013 Botswana. World Health Organization Regional Office for Africa
20. Wisborg T, Brattebo G, Brinchmann-Hansen A et al (2008) Effects of nationwide training of multiprofessional trauma teams in Norwegian hospitals. J Trauma 64:1613–1618
21. Arreola-Risa C, Mock C, Vega RF et al (2006) Evaluating trauma care capabilities in Mexico with the World Health Organization's guidelines for essential trauma care publication. Rev Panam Salud Publica 19:94–103
22. Mock C, Kobusingye O, Joshipura M et al (2005) Strengthening trauma and critical care globally. Curr Opin Crit Care 11:568–575
23. Ali J, Adam RU, Gana TJ et al (1997) Trauma patient outcome after the prehospital trauma life support program. J Trauma 42:1018–1021
24. Arreola-Risa C, Mock CN, Lojero-Wheatly L et al (2000) Low-cost improvements in prehospital trauma care in a Latin American city. J Trauma 48:119–124
25. Ali J, Adam R, Butler AK et al (1993) Trauma outcome improves following the advanced trauma life support program in a developing country. J Trauma 34:890–898
26. WHO (2006) World health report 2006: working together for health. World Health Organization, Geneva
27. Driscoll PA, Vincent CA (1992) Variation in trauma resuscitation and its effect on patient outcome. Injury 23:111–115
28. Henderson KIM, Coats TJ, Hassan TB (2000) Audit of time to emergency trauma laparotomy. Br J Surg 87:472–476
29. Petrie D, Lane P, Stewart TC (1996) An evaluation of patient outcomes comparing trauma teams activated versus trauma teams not activated using TRISS analysis. J Trauma 41:870–875
30. Driscoll PA, Vincent CA (1992) Organizing an efficient trauma team. Injury 23:107–110

31. Bergman S, Deckelbaum D, Lett R et al (2008) Assessing the impact of the trauma team training program in Tanzania. J Trauma 65:879–883
32. WHO (2009) Guidelines for quality improvement programmes. World Health Organization, Geneva
33. WHO (2010) Strengthening the care for the injured: success stories and lessons learned from around the world. World Health Organization, Geneva
34. Moore L, Clark DE (2008) The value of trauma registries. Injury 39:686–695