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Design, implementation and long-term follow-up of a context specific trauma training course in Uganda: Lessons learned and future directions

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ABSTRACT

Background: The Kampala Advanced Trauma Course (KATC) was developed in 2007 due to a locally identified need for an advanced trauma training curriculum for the resource-constrained setting. We describe the design, implementation and evaluation of the course.
Methods: The course has been delivered to over 1,000 interns rotating through surgery at Mulago National Referral Hospital. Participants from 2013 to 2016 were surveyed after completion of the course.
Results: The KATC was developed with local faculty and includes didactic and simulation modules. Over 50% of survey respondents reported feeling confident performing and teaching 7 of 11 course skills and felt the most relevant skill was airway management(30.2%). Participants felt least confident managing head trauma(26.4%). Lack of equipment(52.8%) was identified as the most common barrier to providing trauma care.
Conclusions: Providers are confident with most skill sets after taking the KATC. Minimal dependence on instructors from high-income countries has kept the course sustainable and maximized local relevance.

Introduction

Traumatic injury and violence account for approximately 5.8 million deaths per year worldwide, 32% more than malaria, tuberculosis and HIV/AIDS combined. Road traffic crashes alone are the leading cause of death among people age 15–29.[1] This burden is disproportionately shouldered by low and middle-income countries (LMICs) where more than 90% of injury deaths occur.[2] Additionally, for every injury related death, it is estimated that 10 to 50 people survive with some form of permanent disability.[3] Recognizing that trauma accounts for a significant amount of global disease burden, the UN has included halving the number of global deaths and injuries from road traffic crashes by 2020 in their sustainable development goals.[4]

If trauma fatalities in LMICs could be reduced to the rates of high-income countries (HICs), it is estimated that 1.7 to 1.9 million lives could be saved annually.[5] The Primary Trauma Care (PTC) training course, which teaches front-line healthcare workers how to deliver emergency medical care with only basic equipment, has been implemented in multiple countries and was demonstrated to enhance trauma management, improve staffing, and increase equipment availability.[6,7] There are a small number of additional short-term trauma training courses geared towards physicians and medical students that have been described in multiple LMICs including Haiti, Kenya, Nicaragua and Rwanda.[8–11] Reports of these courses have been over initial delivery but not over a sustained period of time.

In 2007, the general surgery post-graduate training program at Makerere University in Kampala, Uganda expressed interest in a

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course appropriate for trainees that could be delivered by local faculty. Existing course materials at that time were reviewed by local surgeons. PTC was noted to be designed primarily for rural health care workers and non-physician providers. It does not cover advanced skills such as intubation and chest tube insertion, which were felt to be essential for interns to know, as most go directly from their one year of post-graduate training into general practice. Although considered, as it is the standard for training physicians in HICs, the American College of Surgeons' Advanced Trauma Life Support (ATLS) course was deemed to be cost prohibitive and also posed logistical and practical challenges as it is designed with technology driven protocols intended for the high-resource setting. Given this gap, collaborators from Global Partners in Anesthesia and Surgery (GPAS) and local Ugandan faculty designed the Kampala Advanced Trauma Course (KATC), an advanced trauma-training curriculum tailored to resource-constrained settings. Hospital-based trauma training was considered an important adjunct to the prehospital trainings piloted through this collaboration at the time of KATC inception.[12] This analysis describes the design of the course and evaluates the perceived impact of the KATC by surveying a selection of course participants.

Materials and methods

Course design

The KATC is an advanced trauma training curriculum that is taught to all intern doctors (approximately 80 per year) while rotating through surgery at Mulago National Referral Hospital in Kampala, Uganda. These trainees provide most of the initial trauma assessments and resuscitations at the hospital. The course has been conducted approximately four times per year since 2008 and has trained over 1,000 doctors. In 2015, the course was expanded through offerings at three regional referral hospitals located in Mbale, Jinja and Soroti, which serve a collective patient population of over 9 million people.[13]

The program is administered over 3 half-days for a total of 12 h of instruction. See Table 1 for a sample course schedule. Three half-days (afternoons) were chosen to provide minimal disruption to patient care as interns provide a substantial portion of patient care in the hospital. Workshops were limited to no more than three per group each day to maximize retention of procedural skills.

The KATC curriculum includes didactic modules on initial assessment, airway management, burns, musculoskeletal trauma, thoracoabdominal trauma, shock, head injury and pediatric trauma. In addition, it includes practical sessions focusing on primary survey, airway management, secondary survey, chest drainage and basic life support (BLS). BLS was included as local physicians felt this needed to be reemphasized even to intern doctors, and that resuscitation situations are commonly encountered in clinical practice. The KATC also teaches an expanded set of definitive skills like fracture management, saphenous vein cut down (used in this setting given the unavailability of triple lumen catheters and intraosseous needles), and burr holes. This is because after their one year of post-graduate training, interns go on to become medical officers, with a wide range of clinical responsibilities. They often work in rural hospitals where they are the only doctor. Since materials can be expensive, low-cost simulation methods have been developed – for example using goat heads for burr holes, making leg models using sponges and IV tubing for venous cut down and using goat ribs attached to a cardboard box for chest tube insertion.

As the course content was developed, discussions between trainees and faculty acknowledged that it should include both management strategies tailored to local resource limitations, as well as diagnostic and treatment modalities available in high-income countries as trainees also wished to be aware of resources available elsewhere. Pre and post course tests were piloted in 2007. Item analysis was performed the pre and post test questions, which were adjusted as necessary. Questions are revised to reflect any content changes and reevaluated as needed. As with ATLS, a score of 80%, or 16 questions correct of 20, on the post-course written test is considered passing. Students who do not pass the course are offered remediation via participation in a moulage where they are asked to demonstrate how they would manage different scenarios and given real time feedback.

Course modules were refined through the years and have been administered by local Ugandan faculty, costing approximately $1000 per course and supported through philanthropy. Modules cover the approach to trauma assessment and management, with an emphasis on local epidemiology and clinical scenarios, and

Table 1
Sample course schedule.

Interactive Lectures					
		Day One	Day Two		Day Three
2:00–2:30pm		Pretest & Overview	Burns		Shock
2:30–3:00pm		Initial assessment	Musculoskeletal trauma		Pediatric trauma
3:00–3:30pm		Airway management	Thoracoabdominal trauma		Head injury
Skills Stations					
	Time	Station 1	Station 2	Station 3	Station 4
Day One	4:00–4:30pm	Primary Survey Group 1	Airway Group 2	Primary Survey Group 3	Airway Group 4
	4:30–5:00pm	Primary Survey Group 4	Airway Group 3	Primary Survey Group 2	Airway Group 1
Day Two	4:00–4:30pm	Secondary Survey Group 3	Chest Drainage Group 3	Secondary Survey Group 1	Chest Drainage Group 2
	4:30–5:00pm	Secondary Survey Group 4	Chest Drainage Group 3	Secondary Survey Group 2	Chest Drainage Group 1
	5:00–5:30pm	Application of Plaster of Paris (all groups)			
Day Three	4:00–4:20pm	BLS Group 1	Venous Cut Down Group 2	BLS Group 3	Venous Cut Down Group 4
	4:20–4:40pm	BLS Group 2	Venous Cut Down Group 3	BLS Group 4	Venous Cut Down Group 1
	4:40–5:10pm	Burr Hole (all Groups)			
	5:10–5:40pm	Post- test And Closing			

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workup and initial management geared to the resource-limited setting (Table 2). Course modules and materials have been openly available on the GPAS website and have been shared over the years with colleagues requesting materials in other similar settings.[14]

Survey design

We designed a post-course questionnaire to assess the impact of the KATC. The questionnaire was drafted by course organizers and faculty, piloted with a small group of trainees, and revised. Focus areas included skills acquisition, assessment of relevance of specific skills to participants' current practice, and identification of areas in which participants desire further training. These topics were chosen to provide a trainee perspective of course effectiveness and to assist in both course revision and modification as needed.[15]

The questionnaire was converted to electronic format and in 2016 and was sent to all trainees who completed the KATC between 2013 and 2016 via email. Participants from 2008 to 2012 were not included to minimize recall bias. We also administered the same questionnaire via phone interviews to those who did not respond to email.

Data were analyzed using SPSS (Ver. 24; SPSS, Inc., Chicago, IL) for descriptive statistics.

Results

A total of 106 of the 295 trainees who completed the KATC between 2013 and 2016, responded (response rate of 36%). Among the respondents, 11.3% completed the course in 2013, 29.2% in 2014, 16.0% in 2015 and 43.4% in 2016. Respondents completed the course an average of 1 $\pm$ 1 year prior to survey administration. Mulago was the most common training site (74.5%), followed by the regional referral sites - Soroti (13.2%), Jinja (7.5%) and Mbale (4.7%). Respondents were 75.5% male and the median age was 27 (IQR 26–29). Seventy-four percent of respondents were interns at the time of the survey and 26% were clinical officers. At the time they were surveyed, 90.6% of respondents were in clinical practice. The median number of trauma cases per week was 4 (IQR 2–9).

Fig. 1 summarizes participants' comfort level with the skills taught in KATC after taking the course. A majority of respondents felt confident performing and teaching most skills, including airway management, shock, burns, chest trauma, BLS, log rolling and c-spine management. Over 80% of participants were confident performing all skills with the exception of venous cut-down.

Participants were asked to identify which skills they learned from the KATC they found most important to their current practice, the results of which are summarized in Fig. 2. Airway management (30.2%) and shock (27.4%) were the most commonly identified, followed by chest trauma (16.0%) and BLS (15.1%). Fig. 3 summarizes skills where respondents felt that they needed the most additional support. Head trauma (26.4%) and saphenous vein cut

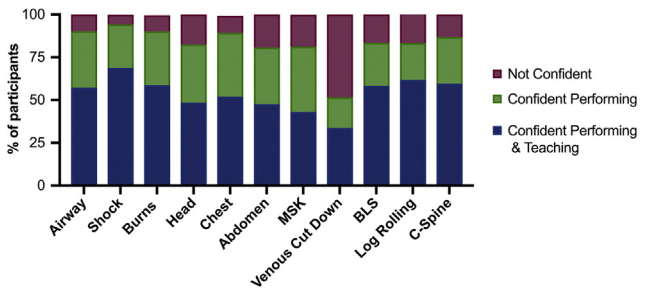

Fig. 1. Participants comfort level with skills after the KATC.

Table 2
Management strategies from local providers in resource-limited settings.

Airway
- Use the drip chamber and bag spike from IV tubing as for a cricothyroidotomy
- Not all patients meeting intubation criteria may be able to be supported if intubated, so triage is needed for those requiring mechanical ventilation

Shock
- Allow for permissive hypotension in non-head injured patients with uncontrolled hemorrhage[39]
- Use of starch-based colloids for plasma volume expansion if other fluid is not available[40]

Head Injury
- In the absence of a CT scanner, obtain a skull X-Ray. Perform a Burr Hole if[41]:
  - o Skull fracture with a new neurological deficit.
  - o Any fracture involving a sensitive area (Broca's area, Wernicke's area, occipital region)
  - o Any fracture with materializing signs (anisocoria, unilateral weakness of any limb)
  - o Decrease in GCS greater than 2 points
  - o Focal convulsions
- Falling GCS in the absence of ventilator in a patient with increased respiratory effort - cricothyroidotomy should be performed immediately to secure the airway, especially in the setting of facial trauma[42]

Abdominal Trauma
- Consider laparotomy without imaging if patient is hemodynamically unstable or has signs of hollow viscus rupture
- Non-operative management of solid organ injury is controversial - must take extra care to ensure that the patient is in a monitored setting, getting true serial exams, able to mobilize OR quickly

Extremity Trauma
- If compartment syndrome is suspected and unable to perform ABIs palpate the affected limb compartments and feel for tension in the tissues; if compartments are tense, this should raise concern and fasciotomy should be considered[41]

Burns
- Alternative dressings include as honey (superficial second degree), papaya (deep second degree), eusol, diluted vinegar or bleach (infected burns)[43]
- Resuscitation can be performed with an enteral rehydration solution if IV fluid is unavailable or unable to obtain IV access[43]
  - o Homemade: 1L clean water, 1 tsp salt, 2 tbsp sugar.
  - o Drink 1L/hr sipping q5minutes
- Upper airway burns with no resources to ventilate – elevate head of bed and give high flow oxygen, consider nasotracheal tube or non-cuffed endotracheal tube through nose, early tracheostomy

Pediatric Trauma
- Give weight-based fluid boluses every 2 h to avoid overhydration in the absence of fluid pumps
- In the hypothermic patient use large polyethylene paper placed between the sheets to encourage heat retention, fill gloved with warm water and place around the child

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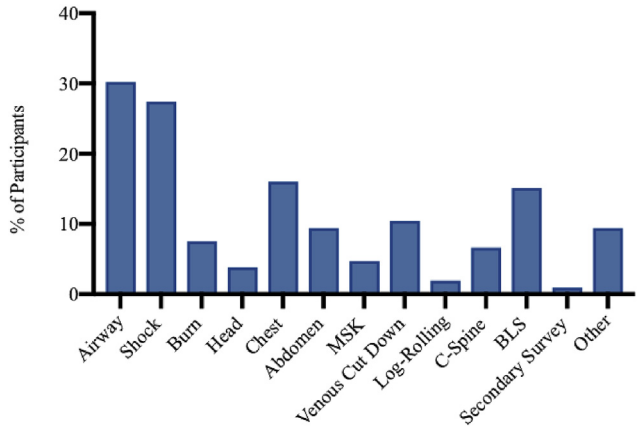

Fig. 2. Participants identification of the most important skills learned from training.

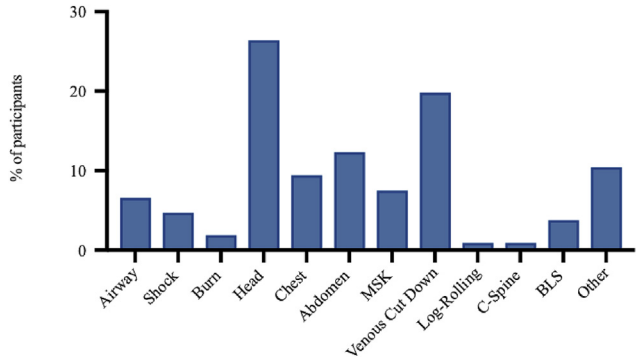

Fig. 3. Participants identification of skills for which they would like additional support.

down (19.8%) were most commonly identified.

Fig. 4 summarizes barriers that respondents identified to providing adequate trauma care in their current practice. Lack of adequate equipment (52.8%) and inadequate staffing (22.6%) were most commonly identified.

Discussion

Though the overall global burden of injuries has decreased since 1990, this decrease has not been evenly distributed, as the burden of injury due to falls and road-traffic crashes has increased in Asia and Sub-Saharan Africa during this time period.[16] Many traumatic injuries are treatable with surgical interventions, which have been demonstrated to be cost-effective compared with other public health interventions.[17–20] The global demand for healthcare workers is expected to double by 2030, and adequately training local healthcare workers and developing high-quality health systems are essential steps towards improving healthcare delivery in LMICs.[21–24]

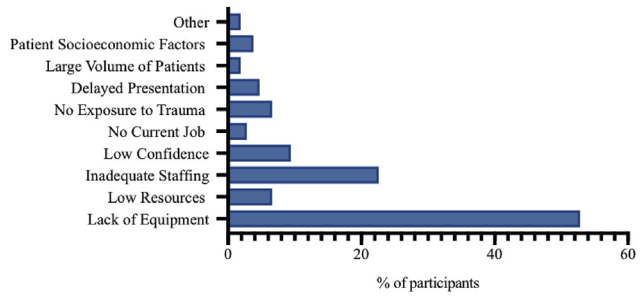

Fig. 4. Participants identification of barriers to providing adequate trauma care in their current practice.

The Essential Trauma Care Guidelines released through the World Health Organization in 2004 identified ongoing trauma education as one of the most important aspects of trauma system development in order to improve the skills of providers at all levels of the health system.[25] Recently, comprehensive evaluation of these guidelines showed that few countries had implemented policy changes at the national level, however trauma education for front line providers was one of the most common areas of implementation in resource-limited areas.[26] Previously described collaborative efforts to improve trauma education in Uganda have supported prehospital training.[12] Additional more recent efforts have focused on more advanced operative trauma training for surgeons-in-training.[27]

KATC fills some gaps in trauma training in Uganda. PTC is a well-established course that focuses on teaching basic trauma life support skills to a wide range of providers of all levels of training (nurses, non-physician providers, physicians) at the district hospital level.[28] PTC has been successful and widely implemented, but focuses on the primary and secondary survey.[29] Meanwhile, the accepted standard for training in high-income countries is ATLS, which has been shown to improve clinical skills, organization and prioritization when managing injured patients.[30] However, a number of issues have been raised for ATLS implementation in LMICs.[31,32] The start-up costs are prohibitive for most LMICs at upwards of $80,000.[33] A recent cost-effectiveness analysis of ATLS in Mongolia estimated the operating costs to be between $182 to $1417 per student, whereas the KATC is far less expensive at approximately $40 per student.[34] Additionally, much of the course content relies on the use of equipment (such as a CT Scan), facilities (such as an ICU with ventilators) and referral to a higher level of care. Such resources are often unavailable in LMICs.[33] Its proprietary nature and the logistical requirements, such as the mandatory 4 to 1 student to faculty ratio, have posed additional challenges for some LMICs. Addition of an optional module in the ATLS manual on management of the injured patient in the austere environment would perhaps be the most applicable to LMICs.[35]

After the initial pilot of KATC in 2008–2009, there was substantial interest from the surgery department and local hospital leadership to continue the course. In addition, trainees who had taken the course continued to provide feedback strongly encouraging continuation of the course if possible, especially noting that protected time for educational workshops was limited during a busy clinical internship and that skills were widely applicable. Though a resource-limited setting with a substantial workforce shortage, Uganda has content experts in all areas of injury care who have been involved in course design and delivery over the last 10 years. We had initial concern whether there would be sustainable support at the instructor level to continue the course, but local instructors have led all courses. Minimal dependence on instructors from high-income countries has allowed the course to be sustainable financially and also maximized its local relevance. There have not been any major changes to the course since 2007. The lecture topics have remained the same, and venous cut-down, chest tube insertion and primary survey have always been included as skills stations. Sometimes the local course directors have varied some of the other skills stations (casting, burr hole, secondary survey, BLS, etc) depending on faculty availability on a given day. A universal slide template was introduced in in 2012 to ensure each lecture included local epidemiology if available, pathophysiology principles, ideal treatment in HICs, and locally tailored treatment. Course recommendations have also been updated continuously to reflect

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the most current trauma literature. Over the years there has been uneven stability in the health service, with substantial changes in infrastructure, such as major hospital renovations, and also in the workforce, with numerous strikes among interns, doctors, and other health workers, that have affected the training environment. Nonetheless, the course has been sustained and delivered through these periods to ensure that intern doctors are exposed to these skills during this part of their training.

Our survey results showed that in general, the course had a positive impact on the training of new interns. After taking the course, the majority of respondents felt comfortable at least performing the skills covered with many comfortable both performing and teaching the skill. Overall, airway and shock management were identified as the most useful skills learned from the course; whereas participants felt that they would like more practice with venous cut down and head trauma. A variety of barriers to trauma care were identified including lack of equipment and adequately trained staff. Respondents also made note that additional barriers included inadequate prehospital care, with patients presenting hours to days after their injuries occurred, and patient socioeconomic factors such as lack of funds for prescription medications. Trainees highlighted equipment shortages as the most critical limiting factor to care of injured patients – multiple prior studies have also suggested that equipment deficiencies have limited trauma care, though such a comprehensive hospital-based assessment has not been done in Uganda.[36,37] A recent study revealed a very low surgical volume in Ugandan regional hospitals, and human resources, equipment, and patient factors were all thought to contribute.[13]

Implementation of the course has faced a number of challenges. Frequently, all interns cannot attend all three days of the course given their substantial clinical responsibilities. Identifying and training new trainers is difficult as interns graduate and go on to work in various parts of the country with a wide range of clinical responsibilities. Follow-up with participants can be challenging as many go on to work in rural settings with inconsistent access to internet and cellular phone networks.

This study has limitations. This study is retrospective and is subject to all the biases inherent to its type. Response rates were highest for those who had taken the course the year of survey administration, and there may be differences in the responses of participants who answer the survey immediately after the course compared with one or two years later. Immediately after completing their internship, physicians in Uganda are required to work as medical officers, often in rural hospitals, with limited access to email or phone service. This likely contributed to the low response rate among participants who completed the course in the earlier years. Reliable sustained data through emergency department, ward, and hospital-wide databases regarding trauma morbidity and mortality have been difficult to sustain. Previous work has shown the difficulty with hospital-based data collection due to lack of adequate baseline medical documentation, need for trained personnel to manage the database and the high cost of database maintenance and necessary equipment.[38] As a result, as well as due to multiple confounders, impact on these outcomes is difficult to assess. Additionally, no baseline skills assessment was performed, and we were unable to observe any changes in performance either in the hospital or via simulation at follow up intervals. This was due to limited resources and lack of access to a functioning sim lab.

While not formally reported as a part of this longer-term follow-up study, course evaluations completed at the time of the course have provided feedback that it is much appreciated by the interns as didactic opportunities are limited. Over the years multiple instructors and trainees have observed that the course has improved relationships between the faculty and the interns and increased interest in surgery among the participants. Additionally, although we have not assessed this specifically, it has been noted that that the interdisciplinary nature of the course has provided networking between the different surgical subspecialties.

Future directions for this work include our intent to directly assess the significance, strengths and weaknesses of the KATC through closer trainee follow up after the course to assess changes in knowledge base and information retention using a mixed-methods approach. We are also currently in the process of developing a practice reporting tool to assess changes in practice patterns before and after the course and observing participants while they treat trauma patients in their workplace to assess how they are using the skills from the course.

In direct response to local requests, after success piloting the course in Jinja, Soroti and Mbale, we are in the midst of the scale-up of trauma and surgical skills training to three additional sites in Uganda in a manner that allows for ownership and delivery of the course by local providers in order to ensure sustainability. In addition, an operative trauma and resuscitation course as well as a course focused on pediatric emergency surgical care have been developed and implemented in Kampala that we plan to offer in conjunction with KATC at designated training sites.

Overall, KATC has led to the increased confidence of providers in most of the essential skill sets. Using this survey and future evaluations, we will work with local providers to scale up trauma training in order to decrease the burden of traumatic injury in Uganda and eventually other LMICs.

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Declaration of competing interest

This is to certify that for the manuscript entitled: *Design, Implementation and Long-Term Follow-Up of a Context Specific Trauma Training Course in Uganda: Lessons Learned and Future Directions,* all of the authors listed below have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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