

## A Systematic Review of the Impact of Focused Trauma Education in Low-resource Settings

R.T. Petroze<sup>1</sup>, J.C. Byringiro, S. Jayaraman et al

<sup>1</sup>Department of Surgery, University of Virginia Health System, Charlottesville, VA USA

**Corresponding Author and Request for Reprints:**

Dr. Robin T. Petroze, MD, MPH

University of Virginia Health System

Box 800679 Charlottesville, Virginia 22908

Email: [rtp3z@virginia.edu](mailto:rtp3z@virginia.edu)

[434-982-4344](tel:434-982-4344) fax

**Background:** A variety of curricula have been developed to teach a systematic approach to the initial hospital management of injured patients, but limited data exists on the impact on patient outcomes, particularly in low-income countries.

**Methods:** We conducted a systematic review of the PubMed database to identify peer-reviewed articles from 1980 to 2012 that address the impact of focused trauma education in low-resource settings. Studies were limited to those conducted in a low or lower-middle income country, as defined by the World Bank. We also searched the table of contents for all available issues from 1996-2012 of the East and Central African Journal of Surgery (ECAJS) on Bioline International. Randomized controlled trials and studies describing educational initiatives with before-and-after studies were selected for detailed review.

**Results:** We conducted 19 PubMed searches, yielding 80 unique published articles. 14 articles met the criteria for full-text review after abstract review. One article from ECAJS met the criteria for full-text review. Four studies documented improved trauma knowledge following the educational intervention. Two studies re-evaluated knowledge retention at one-year and two-years. One study showed improvement in documentation of burn size and analgesic use. No studies were identified that evaluated the impact of a focused trauma education program on quantitative outcomes or resource utilization.

**Conclusions:** Very few studies evaluate quantitative outcomes following the implementation of focused hospital-based trauma education initiatives in resource-limited settings. More rigorous research design is necessary to evaluate patient mortality and resource utilization in low-income and lower middle-income countries.

**Key Words:** global health; trauma education; low-resource settings; trauma outcomes; trauma team training

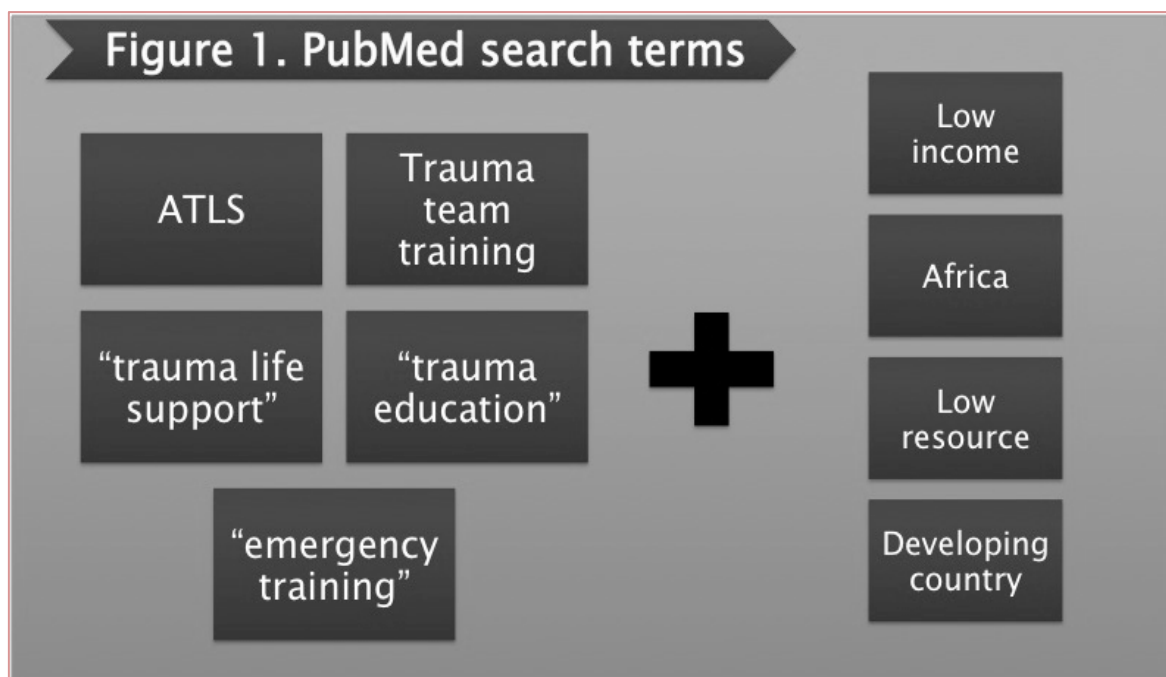
### Introduction

Injuries result in a growing burden of global morbidity and mortality, leading to 16% of the global burden of disease<sup>1</sup>. Accounting for nearly 10% of the world's deaths, injuries cause more deaths than HIV/AIDS, malaria and tuberculosis combined<sup>2,3</sup>. Injuries are also the leading cause of death in youth around the world<sup>4,5</sup>.

Trauma is present among every society and socioeconomic strata, but death and significant disability due to injuries disproportionately affect the poorer countries of the world where the availability of prevention programs, emergency services, prompt resuscitation and surgical management are more limited. Only 3.5% of surgical procedures performed annually around the world are performed in the poorest one-third of countries<sup>6</sup>. Over 90% of injury deaths occur in low-income countries<sup>7,8</sup>. As international public health efforts focusing on infectious disease begin to make progress, the worldwide burden of disease is shifting to injuries, cancers, and other non-communicable diseases (NCDs). Road traffic accidents, for example, are one of the most rapidly rising causes of death in low-income countries, with increasing international efforts being directed at prevention and training<sup>9,10</sup>.

Adequate trauma care necessitates planning and enacting an adequately resourced and standardized approach for pre-hospital and hospital-based emergency care. Due to economic and resourcing constraints, formal pre-hospital emergency medical services may be limited or non-existent in low-income countries <sup>11,12</sup>. Yet, addressing early care of the injured patient is fundamental to reducing the global morbidity and mortality due to injuries <sup>13</sup>.

A variety of curricula have been developed to teach a systematic approach to the initial management of injured patients in both the pre-hospital and early hospital-based setting <sup>14-17</sup>. Developed in the 1970s, the American College of Surgeons Committee on Trauma’s (ACSCOT) Advanced Trauma Life Support (ATLS) course is the most widely recognized and has been formally used in over 60 countries <sup>18</sup>. A recent systematic review and meta-analysis suggests that the development of pre-hospital trauma response systems decreases mortality in developing countries, but limited data exists, on the impact of ATLS or similar team-based courses taught at the hospital level on patient outcomes, particularly in low-income countries <sup>19-21</sup>. This study seeks to review the published literature regarding the impact of focused hospital-based trauma education on trauma mortality and resource utilization in low-resource settings.

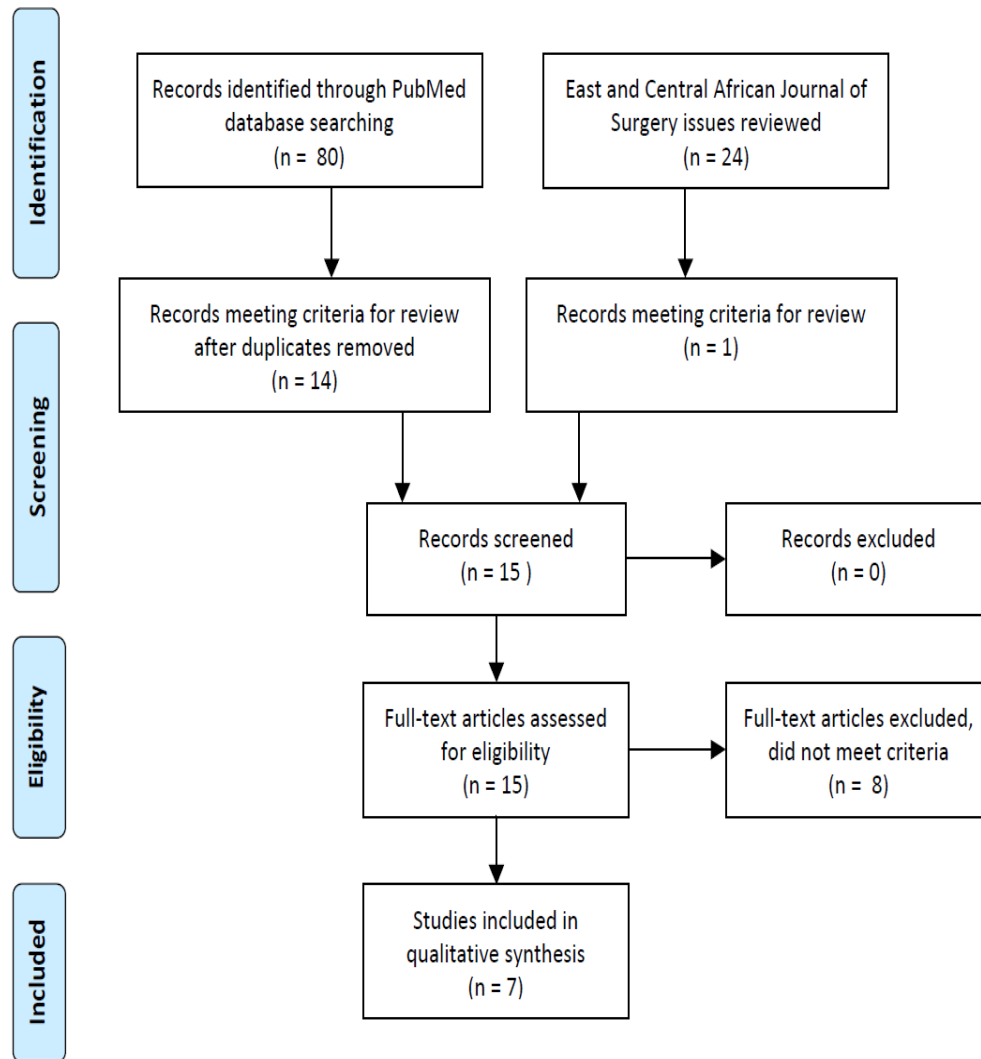


### Material and Methods

We conducted a systematic literature review of the PubMed database to identify peer-reviewed articles published between 1980 and 2012 that address the impact of focused hospital-based trauma education in low-resource settings. Studies were limited to those conducted in a low or lower-middle income country, as defined by the World Bank in 2012. World Bank classification utilizes the Atlas Method and 2011 GNI per capita (USD) of the 188 World Bank member countries to define low-income as \$1,025 or less and lower-middle income as \$1,026-\$4,035. [22] We also searched the table of contents for all available issues from 1996-2012 of the *East and Central African Journal of Surgery (ECAJS)* on Bioline International, a local peer-reviewed journal not available on PubMed, as representative of local journals that may not be available on PubMed, but are read by local surgeons. Search criteria included combinations of “ATLS”, “low-income”, “Africa”, “trauma team training”, “trauma life support”, “trauma education”, “low-resource”, “developing”, and “emergency training”, as shown in Figure 1.



PRISMA 2009 Flow Diagram



**FIGURE 2:** Diagram of systematic search. Adapted from: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

Studies conducted concerning the impact of pre-hospital education and opinion papers or reports of education initiatives without impact assessment were included in the initial search, and the references of all studies were further examined to identify other potentially relevant studies. Further inclusion criteria included educational programs conducted to treat patients in an emergency room (or equivalent) setting. Exclusion criteria included trauma epidemiology studies without an educational component, generic (non-focused) surveys of prior trauma education, studies conducted in upper-middle income or high income settings, education geared

towards community prevention, or education for surgical technique without an initial trauma management component. Randomized controlled trials and studies describing educational initiatives with before-and-after studies were selected for detailed review

## Results

We conducted a total of 19 PubMed searches using the pre-defined search combinations. Figure 2 diagrams the flow of study selection. After removing duplicates, the search yielded 80 published articles. Based upon title and abstract review, 14 articles met the criteria for full-text review. *ECAJS* has 24 available issues from 1996-2012 online; one article met the criteria for full-text review. Table 1 shows the 15 articles selected for full-text review, including the discipline, research methods, country, target audience, type of educational program described, subset of trauma patients targeted with the education, and rationale for inclusion or exclusion from the final review.

Following the initial search and abstract review, 15 articles were selected for full-text review. Several studies described cross-sectional surveys of current physicians, trainees, and medical students to ascertain the presence or absence of prior trauma education and the subjective need for further training<sup>23-25</sup>. These studies were excluded from the final review, as they did not describe a focused trauma education initiative. The search yielded four Cochrane systematic reviews specifically targeting controlled studies evaluating outcomes following focused trauma education<sup>15, 16, 26, 27</sup>. We included only the updated Cochrane reviews of the impact of advanced trauma life support training in the hospital setting for the final review<sup>15, 16</sup>. Two studies described a mission-based outreach program.

The paper from the Kyrgyzstan mission was excluded, as it did not provide detailed information on a formal education program. [28] We included the burn study from the Zambian mission project in the final review since the education objectives and outcomes were included in the article<sup>29</sup>.

Table 2 provides further details on the objective and conclusions of the seven articles included in full review. No studies were identified that evaluated the impact of a focused trauma education program on quantitative outcomes. The objective and outcomes of the seven articles meeting criteria for detailed review are described.

## Discussion

Appropriate and effective training within a sustainable healthcare system is imperative to reducing the global burden of death and disability due to injuries. In many low-income and lower middle-income countries, physician shortages and material and infrastructure resource limitations challenge the ability to adequately manage trauma in the immediate post-injury period. Focused trauma education courses such as ATLS teach a systematic approach to early management of the injured patient and are the standard of care in many resource-rich settings to guide early hospital interventions, but their effectiveness has yet to be established in resource-limited settings. One could hypothesize that improving education around the use of these resources and teaching a system of efficient care could both improve mortality and resources utilization. We conducted a systematic review of the literature that failed to identify any studies that specifically evaluated the impact of a focused trauma education program on quantitative outcomes such as patient mortality or hospital resource utilization. While this may not be surprising, it is important to evaluate as more attention is directed towards building trauma capacity in many low-resource countries, both to document the effectiveness of these programs and to be just stewards of scarce development dollars.

**Table 1. Articles screened with full-text review**

Authors, Year	Discipline	Research Methods	Setting (Country)	Target Audience	Education Subset	Trauma Subset	Include?
Chintamani, et al <sup>37</sup> . 2005	Surgery / Emergency	Prospective cohort study	India	Tertiary hospital	None	Head injury	Exclude, no educational intervention
Adewole, et al <sup>25</sup> . 2009	Dentistry	Cross-sectional survey	Nigeria	Teaching hospital	Prior training (ATLS)	Dental injuries	Exclude, no focused education
Oginni, et al <sup>24</sup> . 2007	Surgery / Education	Cross-sectional survey	Nigeria	Surgical Residents	Prior training (ATLS)	All injuries	Exclude, no focused education
Jayaraman, et al <sup>16</sup> . 2009	Surgery / Emergency	Systematic review	Global	Hospital	ATLS	All injuries	Include
Shakiba, et al <sup>26</sup> . 2004	Surgery / Emergency	Systematic review	Global	Hospital	ATLS	All injuries	Exclude, updated review
Jayaraman, et al <sup>15</sup> . 2010	Surgery / Emergency	Systematic review	Global	Pre-hospital	ATLS	All injuries	Exclude, pre-hospital
Sethi, et al <sup>27</sup> . 2001	Surgery / Emergency	Systematic review	Global	Pre-hospital	ATLS	All injuries	Exclude, updated review
Edwards, et al <sup>29</sup> . 2011	Surgery	Retrospective chart review, Before and after analysis	Zambia	Mission hospital	American Burn Association/Children's Burn Foundation (ABA/CBF) team	Burns	Include
Bergman, et al <sup>14</sup> . 2008	Surgery / Emergency	Prospective pre-post test and immediate post-course survey	Tanzania	Teaching hospital	Trauma Team Training (Canadian Network for International Surgery)	All injuries	Include
Ottomann, et al <sup>28</sup> . 2009	Surgery	Descriptive	Kyrgyzstan	Referral hospital	German burn teams	Burns	Exclude, no focused education
Mock, et al <sup>31</sup> . 2005	Surgery / Emergency	Cross-sectional descriptive survey, prospective pre-post test	Ghana	Rural doctors	Locally developed trauma course	All injuries	Include
Akiode, et al <sup>33</sup> . 2005	Surgery / Education	Cross-sectional survey, quasi-experimental design	Nigeria	Medical students	Single trauma lecture	All injuries	Include
Tortella, et al <sup>30</sup> . 1996	Surgery / Emergency	Prospective pre-post test and immediate post-course survey	Nigeria	Hospital	Locally developed trauma course	All injuries	Include
Zonies, et al <sup>23</sup> . 2012	Surgery / Education	Cross-sectional survey	Global	Medical students	Prior training	All injuries, burn	Exclude, no focused education
Kakande, et al <sup>32</sup> . 2001	Surgery	Descriptive, post-course evaluation	Uganda	Teaching hospital	Essential Surgical Skills course (CNIS)	All injuries	Include

**Table 2.** Articles included in final review

Authors, Year	Research Methods	Country	Education Subset	Objective / Description	Outcome
Jayaraman, et al <sup>16</sup> . 2009	Systematic review	Global	ATLS	Cochrane review for randomized controlled trials, quasi-experimental, and controlled before and after studies	No studies identified, so no evidence of outcomes impact
Edwards, et al <sup>29</sup> . 2011	Retrospective chart review, Before and after analysis	Zambia	ABA/CBF team course	Before and after evaluation of clinical mission that does some teaching	Improvement in documentation of burn size and analgesic use
Bergman, et al <sup>14</sup> . 2008	Prospective pre-post test and immediate post-course survey	Tanzania	Trauma Team Training (CNIS)	Focused trauma teaching, primary objective is trauma course	Significant improvement in trauma resuscitation knowledge and high course satisfaction
Mock, et al <sup>31</sup> . 2005	Cross-sectional descriptive survey, prospective pre-post test,	Ghana	Locally developed trauma course	Focused trauma teaching, primary objective is trauma course	Significant improvement in trauma knowledge and high one-year subjective retention
Akiode, et al <sup>33</sup> . 2005	Cross-sectional survey, quasi-experimental design	Nigeria	Single trauma lecture	Evaluate retention of trauma lecture	Statistically significant difference in knowledge immediately post-lecture and two years later
Tortella, et al <sup>30</sup> . 1996	Prospective pre-post test and immediate post-course survey	Nigeria	Locally developed trauma course	Focused trauma teaching, primary objective is trauma course	Significant improvement in trauma knowledge and high course satisfaction
Kakande, et al <sup>32</sup> . 2001	Descriptive, post-course evaluation	Uganda	Essential Surgical Skills course (CNIS)	Focused surgical skills, trauma skills and management subset	Subjective high course satisfaction

We did find a variety of studies evaluating the positive aspects of trauma education programs in low-income countries. Several studies suggest, for example, that educational initiatives can positively impact provider practices and student or provider knowledge. Studies evaluating these interventions focus on pre-post examinations and surveys to suggest effectiveness<sup>14, 30-33</sup>. While the majority of trauma educational initiatives target overall trauma assessment, initial management and resuscitation, we found several studies specific to initial burn management as a subset of the trauma population<sup>23, 28, 29</sup>.

ATLS is an expensive program to implement, which may limit its applicability to low-resource settings. Multiple studies have further stressed the importance of matching trauma education to available resources. Teaching hospitals in Nigeria and Ghana, for example, have developed their own trauma education course derived from ATLS principles and adapted to local availability of materials and infrastructure as well as local injury epidemiology<sup>30, 31</sup>. Adapting to local resources also means considering the cadre of healthcare providers available. The Canadian Network for International Surgery's (CNIS) Trauma Team Training course exemplifies the move to develop a team-based approach rather than focusing solely on physicians<sup>14</sup>.

Our study provides only a limited and focused review of trauma education in low-resource settings. We have also used 2012 World Bank classifications of low-income and lower-middle income countries to define low-resource settings, which may limit the studies included for review<sup>22</sup>. Several examples exist in the literature from countries classified in 2012 as upper

middle-income or high-income that may help to guide future study development but were not eligible for inclusion in our study, such as a locally-developed course in Ecuador<sup>34, 35</sup>. The Canadian International Development Agency funded an ATLS program in Trinidad and Tobago from 1986-1990 that is the only available study to show improved patient outcomes and physician application of ATLS procedures<sup>20, 36</sup>.

## Conclusion

Very few studies evaluate quantitative outcomes following the implementation of focused trauma education initiatives in resource-limited settings. More rigorous research design is necessary to evaluate patient mortality and resource utilization in low-income and lower middle-income countries, which becomes an important component of sustainability development programs for trauma care worldwide. Research evaluating specific teaching methodologies that are sensitive to resource limitations may be useful. Concomitant infrastructure and resource development may be needed to show sustainable improvement.

**Funding:** No funding was received for this specific project. RTP was supported by a Fogarty International Clinical Research Fellowship, NIH and International Clinical Research Fellows Program at Vanderbilt University, USA (R24 TW007988) from July 2010-June 2011 and by NIH 5-T32-AI-078875-03, PI: Robert G. Sawyer from July 1, 2012, to June 30, 2013. TR and DLD receive support from the Montreal Hospital Foundation for travel-related expenses for global health initiatives.

### *Full list of Authors:*

Robin T. Petroze, MD  
Department of Surgery, University of Virginia  
Health System, Charlottesville, VA USA  
Email: [rtp3z@virginia.edu](mailto:rtp3z@virginia.edu)

Jean Claude Byringiro, MMed  
Department of Surgery, School of Medicine,  
University of Rwanda, Butare, Rwanda  
Email: [jcbiringiro@yahoo.fr](mailto:jcbiringiro@yahoo.fr)

Sudha Jayaraman, MD, MSc  
Division of Trauma, Critical Care and Emergency  
Surgery, Virginia Commonwealth University,  
Richmond, VA USA  
Email: [sudhapjay@gmail.com](mailto:sudhapjay@gmail.com)

Georges Ntakiyiruta, MMed  
Department of Surgery, College of Medicine and  
Health Sciences, University of Rwanda, Butare,  
Rwanda  
Email: [georgentakiyiruta@yahoo.co.uk](mailto:georgentakiyiruta@yahoo.co.uk)

Dominique Savio Mugenzi, MMed  
Department of Surgery, Kigali University  
Teaching Hospital, Kigali, Rwanda  
Email: [mugdomsav@yahoo.fr](mailto:mugdomsav@yahoo.fr)

Tarek Razek, MD  
Centre for Global Surgery, McGill University  
Health Centre, Montreal, Canada  
Email: [tarek.razek@muhc.mcgill.ca](mailto:tarek.razek@muhc.mcgill.ca)

Dan L. Deckelbaum, MD, MPH  
Centre for Global Surgery, McGill University  
Health Centre, Montreal, Canada  
Email: [dan.deckelbaum@muhc.mcgill.ca](mailto:dan.deckelbaum@muhc.mcgill.ca)

Robert Riviello, MD, MPH  
Department of Surgery, Brigham and Women's  
Hospital, Boston, MA USA  
Email: [robertriviello@gmail.com](mailto:robertriviello@gmail.com)

Robert G. Sawyer, MD  
Department of Surgery, University of Virginia  
Health System, Charlottesville, VA USA  
Email: [rws2k@virginia.edu](mailto:rws2k@virginia.edu)

James F. Calland, MD  
Department of Surgery, University of Virginia  
Health System, Charlottesville, VA USA  
Email: [calland@virginia.edu](mailto:calland@virginia.edu)

Patrick Kyamanywa, MMed, MPH  
Department of Surgery, College of Medicine and  
Health Sciences, University of Rwanda, Butare,  
Rwanda, Email: [pkyamanywa@nur.ac.rw](mailto:pkyamanywa@nur.ac.rw)

## References

1. Lopez AD MC, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *Lancet*. 2006 May 27 2006;367(9524):1747-1757.
2. World Health Organization (WHO). Injuries and violence: the facts. Geneva: World Health Organization; 2010.
3. World Health Organization (WHO). Global Burden of Disease: 2004 Update. Geneva: World Health Organization, 2008.
4. Harvey A, Towner E, Peden M, Soori H, Bartolomeos K. Injury prevention and the attainment of child and adolescent health. *Bull World Health Organ*. May 2009;87(5):390-394.
5. Towner E, Towner J. Child injury in a changing world. *Glob Public Health*. 2009;4(4):402-413.
6. Weiser TG, Regenbogen SE, Thompson KD, et al. An estimation of the global volume of surgery: a modelling strategy based on available data. *Lancet*. Jul 12 2008;372(9633):139-144.
7. World Health Organization (WHO). World report on road traffic injury prevention. Geneva: World Health Organization, 2004.
8. Lagarde. Road traffic injury is an escalating burden in Africa and deserves proportionate research efforts. *PLoS Med*. 2007;4(e170).
9. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. *Plos Medicine*. Nov 2006;3(11).
10. Ameratunga S, Hajar M, Norton R. Road-traffic injuries: confronting disparities to address a global-health problem. *Lancet*. May 6 2006;367(9521):1533-1540.
11. Mock C, Kobusingye O, Joshipura M, Nguyen S, Arreola-Risa C. Strengthening trauma and critical care globally. *Curr Opin Crit Care*. Dec 2005;11(6):568-575.
12. Mann NC, Mullins RJ, MacKenzie EJ, Jurkovich GJ, Mock CN. Systematic review of published evidence regarding trauma system effectiveness. *J Trauma*. Sep 1999;47(3 Suppl):S25-33.
13. Mock C, Joshipura M, Goosen J, Lormand JD, Maier R. Strengthening trauma systems globally: the Essential Trauma Care Project. *J Trauma*. Nov 2005;59(5):1243-1246.
14. Bergman S, Deckelbaum D, Lett R, et al. Assessing the impact of the trauma team training program in Tanzania. *J Trauma*. Oct 2008;65(4):879-883.
15. Jayaraman S, Sethi D. Advanced trauma life support training for ambulance crews. *Cochrane Database Syst Rev*. 2010(1):CD003109.
16. Jayaraman S, Sethi D. Advanced trauma life support training for hospital staff. *Cochrane Database Syst Rev*. 2009(2):CD004173.
17. Husum H, Gilbert M, Wisborg T. Training pre-hospital trauma care in low-income countries: the 'Village University' experience. *Med Teach*. Mar 2003;25(2):142-148.
18. Radvinsky DS, Yoon RS, Schmitt PJ, Prestigiacomo CJ, Swan KG, Liporace FA. Evolution and development of the Advanced Trauma Life Support (ATLS) protocol: a historical perspective. *Orthopedics*. Apr 2012;35(4):305-311.
19. Henry JA, Reingold AL. Prehospital trauma systems reduce mortality in developing countries: a systematic review and meta-analysis. *J Trauma Acute Care Surg*. Jul 2012;73(1):261-268.
20. Vestrup JA, Stormorken A, Wood V. Impact of advanced trauma life support training on early trauma management. *Am J Surg*. May 1988;155(5):704-707.
21. Ali J, Adam R, Butler AK, et al. Trauma outcome improves following the advanced trauma life support program in a developing country. *J Trauma*. Jun 1993;34(6):890-898; discussion 898-899.
22. World Bank. data.worldbank.org. 2012.
23. Zonies D, Maier RV, Civil I, et al. Trauma and burn education: a global survey. *World J Surg*. Mar 2012;36(3):548-555.



24. Oginni FO, Fagade OO, Temisaren TO, Takure AO. Attitude of Nigerian surgical residents towards trauma care. *Niger Postgrad Med J.* Jun 2007;14(2):105-108.
25. Adewole RA, Sote EO, Oke DA, Agbelusi AG. An assessment of the competence and experience of dentists with the management of medical emergencies in a Nigerian teaching hospital. *Nig Q J Hosp Med.* Sep-Dec 2009;19(4):190-194.
26. Shakiba H, Dinesh S, Anne MK. Advanced trauma life support training for hospital staff. *Cochrane Database Syst Rev.* 2004(3):CD004173.
27. Sethi D, Kwan I, Kelly AM, Roberts I, Bunn F. Advanced trauma life support training for ambulance crews. *Cochrane Database Syst Rev.* 2001(2):CD003109.
28. Ottomann C, Kleinschmidt A, Gohlke G, Biedermann I, Hartmann B. Development and restructuring of a burn centre in an emerging nation, based on the example of Kyrgyzstan. *Burns.* May 2009;35(3):437-442.
29. Edwards D, Heard J, Latenser BA, Quinn KY, van Bruggen J, Jovic G. Burn injuries in eastern Zambia: impact of multidisciplinary teaching teams. *J Burn Care Res.* Jan-Feb 2011;32(1):31-38.
30. Tortella BJ, Swan KG, Donahoo JS, et al. Trauma life support education: a didactic and caprine laboratory course for Nigerian physicians. *Injury.* Jun 1996;27(5):329-331.
31. Mock CN, Quansah R, Addae-Mensah L, Donkor P. The development of continuing education for trauma care in an African nation. *Injury.* Jun 2005;36(6):725-732.
32. Kakande I, Lett R, Obote WW, Namuyuga M. Surgical Skills course. *East and Central African Journal of Surgery.* 2001 2001;6(1):53-55.
33. Akiode O, Musa AA, Shonubi A, Lesi FE. Basic trauma life support: knowledge of medical students. *Niger Postgrad Med J.* Mar 2005;12(1):14-17.
34. Adam R, Stedman M, Winn J, Howard M, Williams JI, Ali J. Improving trauma care in Trinidad and Tobago. *West Indian Med J.* Jun 1994;43(2):36-38.
35. Aboutanos MB, Rodas EB, Aboutanos SZ, et al. Trauma education and care in the jungle of Ecuador, where there is no advanced trauma life support. *J Trauma.* Mar 2007;62(3):714-719.
36. Ali J, Adam R, Stedman M, Howard M, Williams JI. Advanced trauma life support program increases emergency room application of trauma resuscitative procedures in a developing country. *J Trauma.* Mar 1994;36(3):391-394.
37. Chintamani, Khanna J, Singh JP, et al. Early tracheostomy in closed head injuries: experience at a tertiary center in a developing country--a prospective study. *BMC Emerg Med.* Oct 14 2005;5:8.