



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

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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

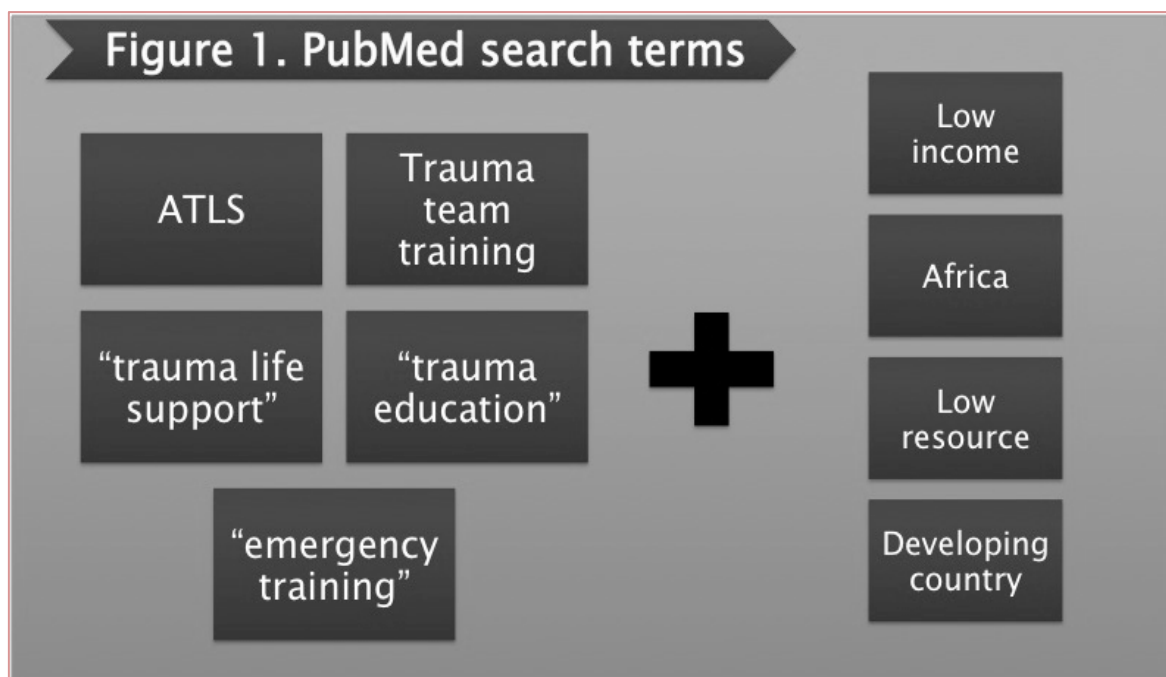
Introduction

Injuries result in a growing burden of global morbidity and mortality, leading to 16% of the global burden of disease¹. Accounting for nearly 10% of the world's deaths, injuries cause more deaths than HIV/AIDS, malaria and tuberculosis combined^{2,3}. Injuries are also the leading cause of death in youth around the world^{4,5}.

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 countries⁶. Over 90% of injury deaths occur in low-income countries^{7,8}. 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^{9,10}.

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 ^{11,12}. Yet, addressing early care of the injured patient is fundamental to reducing the global morbidity and mortality due to injuries ¹³.

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 ¹⁴⁻¹⁷. 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 ¹⁸. 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 ¹⁹⁻²¹. 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

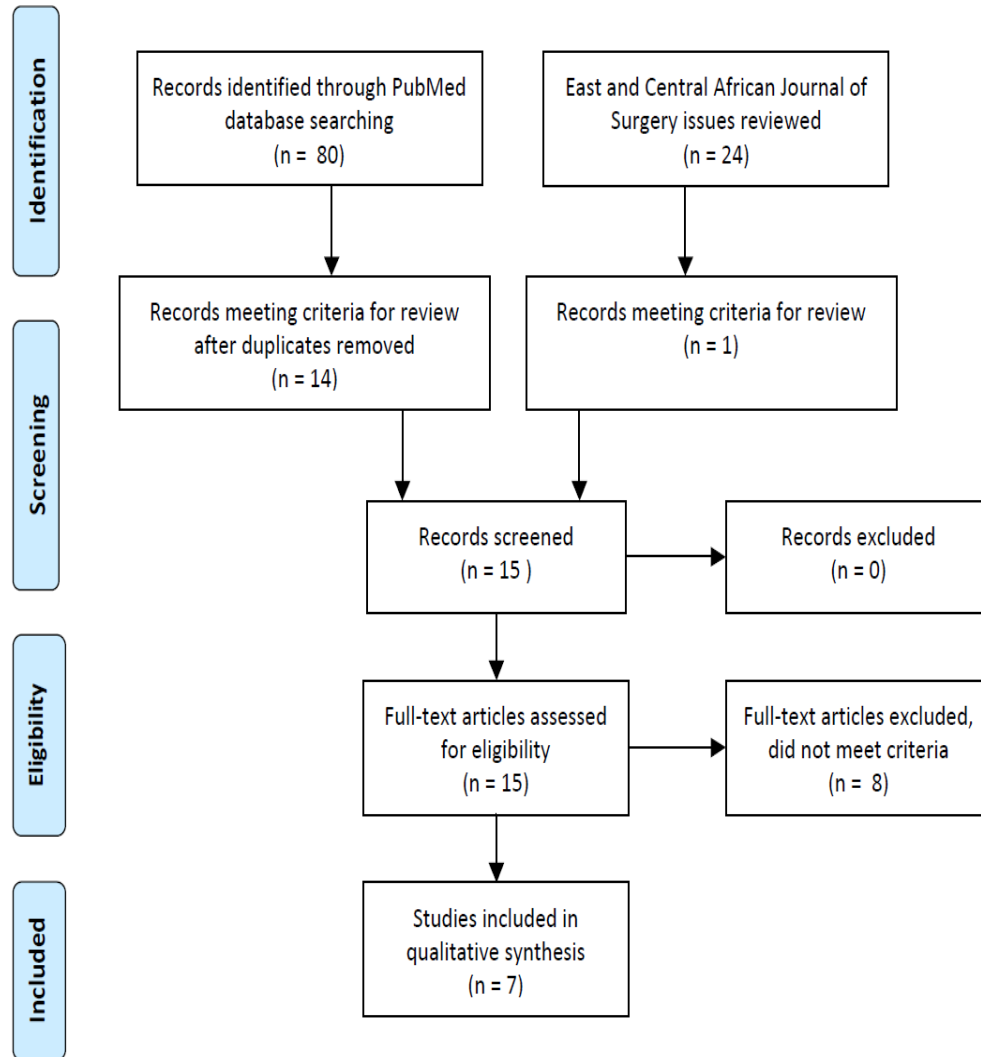


FIGURE 2: Diagram of systematic search. Adapted from: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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 training²³⁻²⁵. 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^{15, 16, 26, 27}. We included only the updated Cochrane reviews of the impact of advanced trauma life support training in the hospital setting for the final review^{15, 16}. 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 article²⁹.

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 ³⁷ . 2005 | Surgery / Emergency | Prospective cohort study | India | Tertiary hospital | None | Head injury | Exclude, no educational intervention |
| Adewole, et al ²⁵ . 2009 | Dentistry | Cross-sectional survey | Nigeria | Teaching hospital | Prior training (ATLS) | Dental injuries | Exclude, no focused education |
| Oginni, et al ²⁴ . 2007 | Surgery / Education | Cross-sectional survey | Nigeria | Surgical Residents | Prior training (ATLS) | All injuries | Exclude, no focused education |
| Jayaraman, et al ¹⁶ . 2009 | Surgery / Emergency | Systematic review | Global | Hospital | ATLS | All injuries | Include |
| Shakiba, et al ²⁶ . 2004 | Surgery / Emergency | Systematic review | Global | Hospital | ATLS | All injuries | Exclude, updated review |
| Jayaraman, et al ¹⁵ . 2010 | Surgery / Emergency | Systematic review | Global | Pre-hospital | ATLS | All injuries | Exclude, pre-hospital |
| Sethi, et al ²⁷ . 2001 | Surgery / Emergency | Systematic review | Global | Pre-hospital | ATLS | All injuries | Exclude, updated review |
| Edwards, et al ²⁹ . 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 ¹⁴ . 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 ²⁸ . 2009 | Surgery | Descriptive | Kyrgyzstan | Referral hospital | German burn teams | Burns | Exclude, no focused education |
| Mock, et al ³¹ . 2005 | Surgery / Emergency | Cross-sectional descriptive survey, prospective pre-post test | Ghana | Rural doctors | Locally developed trauma course | All injuries | Include |
| Akiode, et al ³³ . 2005 | Surgery / Education | Cross-sectional survey, quasi-experimental design | Nigeria | Medical students | Single trauma lecture | All injuries | Include |
| Tortella, et al ³⁰ . 1996 | Surgery / Emergency | Prospective pre-post test and immediate post-course survey | Nigeria | Hospital | Locally developed trauma course | All injuries | Include |
| Zonies, et al ²³ . 2012 | Surgery / Education | Cross-sectional survey | Global | Medical students | Prior training | All injuries, burn | Exclude, no focused education |
| Kakande, et al ³² . 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 ¹⁶ . 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 ²⁹ . 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 ¹⁴ . 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 ³¹ . 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 ³³ . 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 ³⁰ . 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 ³² . 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^{14, 30-33}. 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^{23, 28, 29}.

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^{30, 31}. 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 physicians¹⁴.

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 review²². 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^{34, 35}. 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^{20, 36}.

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.

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