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# "A short trauma course for physicians in a resource-limited setting: Is low-cost simulation effective?"

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ABSTRACT

*Introduction:* Morbidity and mortality from intentional and unintentional injury accounts for a high burden of disease in low- and middle-income countries. In addition to prevention measures, interventions that increase healthcare capacity to manage injuries may be an effective way to decrease morbidity and mortality. A trauma curriculum tailored to low-resource settings was implemented in Managua, Nicaragua utilising traditional didactic methods and novel low-cost simulation methods. Knowledge gain in attending and senior residents was subsequently assessed by using pre- and post-written tests, and by scoring pre- and post-simulation scenarios.

*Materials and methods:* A 5-day trauma course was designed for Nicaraguan attending and senior resident physicians who practice at six hospitals in Managua, Nicaragua. On days 1 and 5, participants underwent pre- and post-training evaluations consisting of a 26-question written exam and 2 simulation cases. The written exam questions and simulations were randomly assigned so that no questions or cases were repeated. The Wilcoxon signed-rank test was used to compare pre- and post-training differences in the written exam, and the percentage of critical actions completed in simulations. Time to critical actions was also analyzed using descriptive statistics.

*Results:* A total of 33 participants attended the course, including 18 (55%) attending and 15 (45%) resident physicians, with a 97% completion rate. After the course, overall written examination scores improved 26.3% with positive mean increase of 15.4% ($p < 0.001$). Overall, simulation scores based on the number of critical actions completed improved by 91.4% with a positive mean increase of 33.67 ($p < 0.001$). The time to critical action for completion of the primary survey and cervical spine immobilisation was reduced by 55.9% and 46.6% respectively.

*Conclusions:* A considerable improvement in participants' knowledge of trauma concepts was demonstrated by statistically significant differences in both pre- and post-course written assessments and simulation exercises. The participants showed greatest improvement in trauma simulation scenarios, in which they learned, and subsequently demonstrated, a standardised approach to assessing and managing trauma patients. Low-cost simulation can be a valuable and effective education tool in low- and middle-income countries.



## Introduction

Worldwide, intentional and unintentional trauma resulted in 5.1 million (9.6%) deaths in 2010, and low-and middle-income countries account for an estimated 90% of injury-related deaths [1,2]. Available injury surveillance data from Nicaragua is limited; however injury surveillance in one regional hospital reported 15% of Emergency Department (ED) visits were for injuries [3].

Although preventative measures, such as transportation laws, are crucial to decreasing morbidity and mortality from non-accidental trauma, improving trauma care by allocating resources to healthcare capacity building could have immediate effects on

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patient outcomes. The Advanced Trauma Life Support (ATLS) course unifies trauma care among healthcare providers in the United States, and has been shown to improve provider clinical skills, management of multiple trauma patients, organisation, and priority approaches [4]. Modified ATLS courses introduced in low- and middle-income countries have resulted in trauma skill competency in hospital providers, and have demonstrated a decrease in morbidity and mortality in a few countries [5–11].

Medical simulation has been shown to augment traditional didactic curricula and better assess the overall clinical skills of trainees in multiple training scenarios ranging from neonatal to trauma resuscitations [12,13]. Simulation lends itself particularly well to trauma training, as it both emphasises, and provides an opportunity to assess a team-based approach. Procedure labs are another important component of the traditional ATLS course as they allow healthcare providers to practice important skills without risking patient injury. Because simulation and procedure labs usually require expensive resources such as mannequins or models, there is a paucity of data regarding their educational effectiveness for trauma education in the developing world.

The objective of this study was to assess the effectiveness of a short trauma course, which utilises traditional didactic, as well as newer simulation methods, developed specifically for use in low-resource settings.

## Materials and methods

*Course overview:*

A 5-day trauma course was developed based on major concepts in trauma care, injury surveillance data, and the resources available in Nicaragua. To tailor the course to the specific practice environment we assisted the hospital administration in conducting injury surveillance over a 3 month period in preparation for the course, practiced in two of the Managua hospitals, and utilised World Health Organisation guidelines to assess the availability of hospital supplies and procedures in Managua [14]. The didactic and simulation components of the course included 18 lectures, 3 procedure labs, and 4 live simulation cases. Nicaraguan attending and senior resident physicians practicing at six different hospitals in Managua, Nicaragua were selected by La Universidad Nacional Autónoma de Nicaragua – Managua (UNAN), the organisation that houses the equivalent of Continuing Medical Education, to participate in the course. Participants were divided into two groups for written exam purposes and underwent simulations in pairs.

On days 1 and 5, participants underwent pre- and post-training evaluations consisting of two distinct 26-question written exams (tests A and B) and two distinct simulation cases (cases 1 and 2 and cases 3 and 4). On day 1, half of the participants were randomly assigned to Group A, which completed test A and completed simulation cases 1 and 2. The other half, Group B, completed test B and simulation cases 3 and 4. On the last day, the written and simulation cases were reversed for each group. Participants also underwent training on thoracostomy, cricothyrotomy and pericardiocentesis utilising low-cost models, but were not scored on procedural technique.

Fifty-two written questions testing basic trauma knowledge were reviewed for content by board certified attending physicians in emergency medicine, and were randomly assigned to create test A and test B, each with 26-questions. After undergoing the trauma course, participants completed the alternative written test and simulation cases. A final debriefing question and answer session was performed for the written test and simulation components of the course.

*Ethics:*

Approval from the Ethics Committee of La Universidad Nacional Autónoma de Nicaragua – Managua and the Lifespan (Rhode Island Hospital) Institutional Review Board (IRB) was obtained prior to study implementation. All study participants underwent informed consent on the first day of the trauma course.

*Course content*

After completing the pre-course evaluation, participants received traditional didactic lectures from either board certified emergency medicine or trauma surgery attending physicians. The 18 lectures covered basic trauma concepts, such as primary and secondary survey, head trauma, spine injuries, and radiology. The cost of the initial course was $74.18 per participant (Appendix E).

*Procedure labs:*

Participants broke in to groups of 6–7 persons and rotated through three procedure stations: tube thoracostomy, cricothyrotomy, and pericardiocentesis. Procedure labs were designed so that participants could potentially replicate this teaching technique with faculty and residents at their home institutions. The procedures were performed with medical equipment available in local institutions to simulate hospital resources (See Procedure Lab Supplement).

*Simulation cases*

Simulations were videotaped for educational purposes and were performed utilising Nicaraguan community members, who underwent a brief training as standardised patients. The trained standardised patients along with two Brown University staff members, who served as a nurse and case facilitator (e.g. adjusted patient vital signs and clinical condition based on management by course trainees), participated in the simulation cases. Simulation cases were scored based on (1) a completion checklist scored out of 100 and (2) time elapsed to complete pre-identified actions. These were scored in real-time and verified by reviewing videos of the encounters. The four simulation case patients were a gunshot wound to the abdomen resulting in haemorrhagic shock, blunt trauma in pregnancy, closed head injury requiring airway management, and a tension pneumothorax from a motorcycle crash along with a second victim in traumatic cardiac arrest. Completion checklists were tailored for each simulation case; for example, for the "blunt trauma in a pregnant patient" case, assessing foetal heart tones was a critical action. For a complete list of critical actions, please refer to the supplement. Time to primary survey (airway, breathing, circulation) completion and cervical spine immobilisation were calculated for each simulation team. A debriefing session was held the last day of the course to provide feedback to participants regarding management strengths and pitfalls.

## Analysis

Data was entered in to STATA, checked for errors, and used to calculate descriptive characteristics, written and simulation scores. Six of the 52 questions had a difficulty index $<0.2$, where less than 20% of participants answered the question correctly, and were not considered valid and omitted from the analysis, resulting in Test A with 23 questions and Test B with 23 questions. The Wilcoxon signed-rank test was used to compare pre- and post-training differences in the written exam and the percentage of critical actions completed in simulations. A mean reduction in the