Trauma Education and Care in the Jungle of Ecuador, Where There is no Advanced Trauma Life Support

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Background: **The advanced trauma life support course is not available or affordable to rural areas in low-income countries. A trauma continuing education course was created to educate physicians of rural hospitals in the jungles of Ecuador.**

Methods: **A basic trauma care course was designed based on local resources and location of injury, including rudimentary health posts in the jungle, rural hospitals, and definitive referral centers. Course effectiveness was evaluated by a comparison of test scores before and after the course. A multiple choice questionnaire was given. Comparison to previous test scores was also performed. Paired Student's *t* test was used for statistical analysis. An objective structured clinical examination (OSCE), based on the course design, was administered.**

Results: **Twenty-six rural physicians participated in the course. Mean test scores significantly improved from pretest to post-test (72% to 79%; $p = 0.032$). Knowledge deficiencies in prehospital care, extremity injury care, and patient evaluation adjuncts significantly improved from 23% to 87%, 23% to 100%, and 31% to 100%, respectively. Test results after the course showed improvements in all major categories tested. Twelve of the 26 participants were repeat test takers from a course provided 2 years earlier. These participants showed improved pretest scores compared with their highest previous test score (76.8% versus 68.5%; $p = 0.0496$). Compared with first-time test takers, these participants showed improved pretest (76.8% versus 68.4%) as well as post-test (81% versus 76%) scores. Twenty-five of the 26 physicians participated in the OSCE, with a pass rate of 76%. The OSCE identified various strengths and deficiencies based on patient location and available resources. In rudimentary health posts, management was adequate for hemorrhage control (65%), immobilization (77%), and early transfer to rural hospitals (92%). Prehospital communication was inadequate (53%). Rural hospital management was adequate for primary evaluation (60%) and resuscitation (74%) but poor in secondary patient evaluation (53%), adjuncts (25%), and transfer to definitive referral centers (11%). OSCE scores differed from multiple choice questionnaire test results.**

Discussion: **Where there is no advanced trauma life support, a tailored trauma course and evaluation can be effective in educating local providers. A well-designed competency evaluation (multiple choice questionnaire and OSCE) is helpful in identifying deficient local aspects of trauma care. The course design and evaluation methods may serve as a model for continuing trauma care education in developing countries.**

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Trauma constitutes a major health concern in developed nations; however, an increasing awareness of the trauma burden in developing countries has led many to consider it a global epidemic, with 90% of fatalities occurring in low- and middle-income countries.[1–4] More specifically, rural trauma has different connotations than urban trauma and has lead some to regard it as a challenge in the care of the injured patient in this decade.[5] In 2003, national statistics in Ecuador showed that the fatality rate from trauma (motor vehicle collisions and aggressions combined) was 29.5 per 100,000 inhabitants, representing one of the leading causes of mortality.[6] The advanced trauma life support (ATLS) course has been instrumental in improving trauma care in the United States and has successfully been replicated internationally.[7,8] In spite of this, ATLS is not available or affordable to rural areas in low- and middle-income countries, such as Ecuador, where it is mainly restricted to urban areas such as Quito and Cuenca.

In 2003, an initial site evaluation was performed in the province of Morona Santiago in the jungle of Ecuador. Morona Santiago is one of the largest of the 22 provinces (23,797 km^2). It is located on the southeastern border of Ecuador and has a population of 127,775. Seventy percent of the province is located in the Amazon jungle. It has six rural hospitals and multiple health care clinics.

The site evaluation determined that traumatic injuries are not uniform across the province, trauma care and management is rudimentary, a basic definition of trauma is lacking among the health care administrators and workers, basic knowledge of trauma care is poor, and resources for effective trauma care management are not present or recognized.[9] In

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light of these findings, a basic trauma course was developed based on a "patient pathway system", which involved tracing the management of the injured patient through the continuum of care in the province, from the initial site of injury in the jungle to rudimentary health posts (RHPs) and health centers, continuing on to rural hospitals (RHs), and subsequently to definitive referral centers (DFCs) outside the province. On this premise, a trauma continuing education course that specifically addressed the assessment and management of the injured patient (considering local resources) was created to educate physicians of rural hospitals and health centers in the jungles of Ecuador.

The purpose of the course was to introduce the concept and promote local awareness of trauma, to educate rural physicians in basic principles of trauma management and resource utilization, and to develop competency in life-saving skills needed for the care of trauma victims. This outreach for rural trauma education in a third world country is a project of the International Trauma System Development Program sponsored by the Divisions of Trauma, Critical Care, and Emergency Surgery at Virginia Commonwealth University.

MATERIALS AND METHODS

A basic trauma care course was designed to accommodate available resources and location of injury, two important local factors. The locations of injury are RHPs (in the jungle areas), RHs, and DRCs. These areas signify the pathway a patient must travel to obtain essential trauma care.

The course was comprised of didactic lectures and practical skills sessions. Lecture topics included introduction to trauma, introduction to emergency medical services, triage, burns, and snakebites (Table 1). Snakebites were especially addressed since there is a high incidence in the jungle areas of Ecuador, and the majority of patients use home remedies as treatment. The hands-on sessions included instruction on emergency medical service communications skills, airway management, musculoskeletal injury, thoracic injury, and radiographic diagnosis of trauma injuries.

Table 1 List of Lectures and Skill Sessions

Lectures	Skill Sessions
Introduction to Trauma	Primary Evaluation and Resuscitation
Introduction to EMS	Secondary Evaluation and Resuscitation
Trauma Definition and Kinematics	EMS Prehospital-Hospital Communication
Assessment and Management	Kinematics of Trauma
Airway Management	Airway Management
Shock and Fluid Resuscitation	Thoracic (pig lab)
Thoracic Trauma	Musculoskeletal Immobilization lab
Abdominal and Pelvic Trauma	Radiology
Neurotrauma	Trauma Registry
Musculoskeletal Trauma	
Burns	
Snakebites	
Triage	

EMS, emergency medical services.

Six physicians served as course instructors. One of the instructors was a trauma/critical care surgeon, two were general surgeons, two were general surgery residents, and one was an anesthesiologist. Five of the instructors successfully completed ATLS, and three were ATLS instructors. The course took place during a period of 3 days in a rural location accessible to the students.

The course participants were selected from the six rural hospitals in the province. The Ministry of Health and each hospital's director were involved in the selection process. Preference was given to physicians directly involved in acute and emergency care. Twenty-six students (24 rural physicians and 2 general surgeons), representing two-thirds of all practicing physicians in the Province of Morona Santiago, participated in the course. One essential requirement was for the students to participate in the entire course and in the evaluation process.

Pretests and post-tests were administered and consisted of 30 multiple choice questions. Nine pretest questions, chosen at random, were repeated on the post-test. Twelve test topics included airway, head injury, shock, hemorrhage, thoracic trauma, abdominal trauma, pelvic injury, extremity injury, burn, mechanism of injury, prehospital care, and patient evaluation adjuncts. Fisher's exact test was used to statistically compare the pretest and post-test scores by individual topics. Paired Student's t test was used to statistically compare the results of repeated questions from the pretest to post-test. The course's effectiveness over time was also evaluated by comparison of pretest scores to the course's previous test scores (performed 2 years earlier). A paired Student's t test was used for statistical analysis. A p value less than 0.05 was considered statistically significant.

An OSCE, based on course design, was also administered to all students at the conclusion of the course. The OSCE, presented by an instructor, was one of two trauma scenarios. One trauma scenario involved a patient in a motor vehicle collision and the other a patient after a fall from a tree. Both scenarios are common in the rural province of Morona Santiago. Students were randomly assigned to the trauma scenario topic. One scenario was used as practice, and the other for the actual OSCE. Students were required to communicate each aspect of trauma care for patients following the patient pathway system, starting from the jungle, moving through the RHPs and ending at the DRC. The OSCE grading system is based on major categories including mechanism of injury, prehospital communication, patient evaluation, resuscitation, immobilization, and transfer. Examiners were taught to complete a checklist of items that the students were required to address. Each item was of equal value. Examiners also gave students a "Pass" or "Fail" grade and were told to identify those with instructor potential.

Students were given course evaluation forms to score instructors, lectures, and skill sessions. The rating was based on a 5-point Likert scale (1 = poor, 5 = excellent). A certificate of completion was awarded to all participants.

RESULTS

Twenty-six rural physicians participated in the course and completed both pretests and post-tests. Sixty percent correct was considered a passing score. Mean test scores significantly improved from 72% on the pretest to 79% on the post-test ($p = 0.032$). On pretests, students obtained the highest percent correct in head injury (90%), abdominal trauma (94%), and pelvic injury (92%). Comparing pretest to post-test scores, significant improvement was noted in extremity injury (23% to 100%; $p < 0.0001$), prehospital care (31% to 87%; $p < 0.0001$), and adjuncts to physical examination (23% to 100%; $p < 0.0001$). Students were deficient in the airway topic (42%) on the post-test and had a statistically significant decrease in abdominal trauma scores from 94% to 72% ($p < 0.0001$) (Table 2). Students improved significantly on the repeated questions from pretest to post-test ($p < 0.0001$). More specifically, only 1 student did worse on the repeat questions; 2 did the same, and 23 improved.

Twelve of the 26 participants were repeat test takers from a similar course provided 2 years earlier. These participants, compared with new members, showed improved pretest (77% versus 68%) and post-test (81% versus 77%) scores (Fig. 1). To assess knowledge retention and show the course's effectiveness over time, the highest test score from 2 years earlier (both pretests and post-tests combined) was compared with the present pretest score, and this comparison revealed significant improvement in performance, with $p = 0.0496$ (Fig. 2).

Twenty-five of the 26 physicians participated in the OSCE with a pass rate of 76% (19 passed and 6 failed). Of the six that failed, four were new participants and two were repeat course participants. However, no statistical significance was found between the average OSCE scores of the repeaters and the new participants. It is important to mention that in the previous course only a MCQ was used for evaluation. OSCE was not used. For this course, both an MCQ and OSCE were used for evaluation.

The OSCE identified various strengths and deficiencies based on patient location and available resources.

Table 2 Multiple Questionnaire Test Topics

Topic	Pretest (%)	Post-test (%)	p
Airway	74	42	<0.0001
Head injury	90	95	0.368
Shock	73	90	0.0027
Hemorrhage	85	100	0.046
Thoracic trauma	61	67	0.2695
Abdominal trauma	94	72	<0.0001
Pelvic injury	92	100	0.490
Extremity injury	23	100	<0.0001
Burn	73	62	0.311
Mechanism of injury	85	96	0.091
Prehospital care	23	87	<0.0001
Patient evaluation adjuncts	31	100	<0.0001
Total test average	72	79	0.032

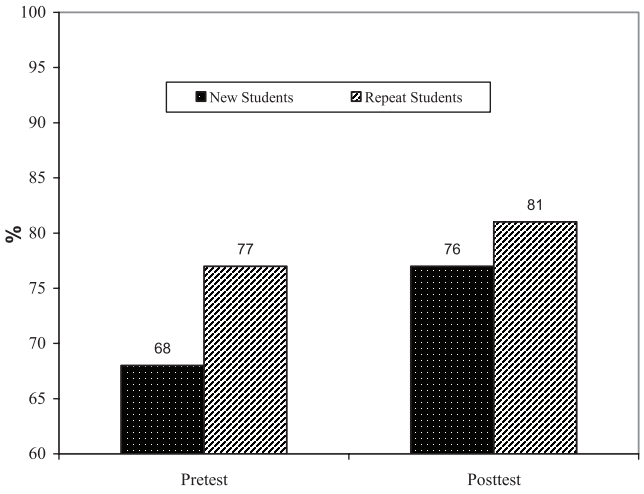

Fig. 1. *Repeat versus new test takers. Repeat test takers from a similar course in 2003 had improved pretest (76.8% vs. 68.4%) and post-test (81% vs. 76%) scores.*

Prehospital management in RHPs was adequate for hemorrhage control (65%), immobilization (77%), and early transfer to RHs (92%). Students failed to obtain the patient's medical history (15%) and to expose the patient during initial evaluation (31%). Prehospital communication was inadequate (54%). RH management was adequate for the initial evaluation (60%) and resuscitation (75%) but poor in secondary patient evaluation (31%), adjuncts (25%), and transfer to DRCs (11%) (Table 3). Six students were thought to possess instructor potential. OSCE scores differed from MCQ test results. Apart from airway, the majority of the OSCE scores were lower than the MCQ scores (Table 4).

All students participated in the course evaluation. The course's content and relevance to the management of trauma in the region were rated highly. More than 50% thought the course was too short. The training skills deemed most useful were tube thoracostomy, airway management, prehospital communication, and mechanisms.

DISCUSSION

During the development of this basic trauma course, reservations emerged regarding the ATLS model and whether it could be applied in the Ecuadorian jungle and rural setting. The 2004 7th edition of the ATLS course includes an optional lecture titled "Injury Care in Austere and Hostile Environments," intended specifically for rural areas and military applications. It became clear, however, that the specific requirements of the region would not be met because of a lack of local expertise and resources. Other courses, based on ATLS, for management of the injured patient have been described.[10]

The basic trauma course was therefore tailored to the region's needs, following the "patient pathway system" and optimizing resource utilization while maintaining universal principles taught in the American College of Surgeons ATLS course, the American College of Surgeons ATLS Subcom-

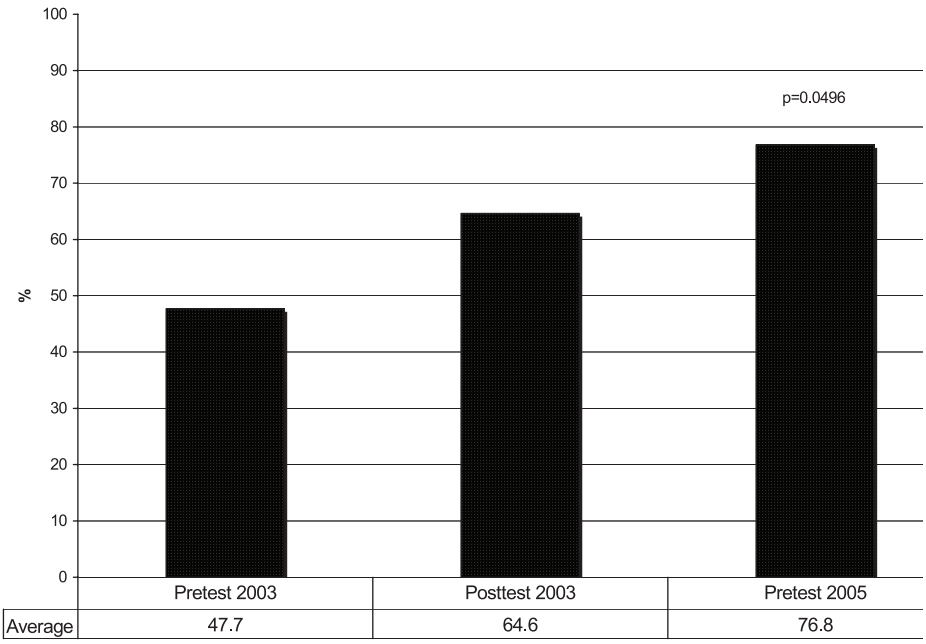

Fig. 2. *Trauma continuing education course. The highest 2003 pretest and post-test scores are averaged (68.5%) and compared with the average current pretest scores (76.8%).*

mittee TEAM (Trauma Evaluation And Management) course, and wilderness medicine courses.[11–13] The course content as shown in Table 1 not only included the major lectures in trauma, but also emphasized mechanism and identification of injuries, resuscitation, stabilization, prioritization, triage, and early transfer based on adequate communication to the next level of care. The inclusion of snakebites was because of its wide prevalence in the Amazon region and its evidence-based management was established on the local expertise present.[14] Additionally, the skill sessions trained participants with the necessary skills for adequate care of injured patients at the different levels in the patient pathway.

The testing of participants during a rural trauma course was the subject of much controversy during the recent 2005 American College of Surgeons Rural Trauma Team Development Course meeting. Various rural and international trauma course directors feared testing may drive rural physicians, both in the United States and in other nations, away

Table 3 OSCE Categories and Results

OSCE Categories*	Subcategories	Student Subcategories (n)†	Subcategories Addressed (n)	% Addressed
Mechanism of injury	Blunt vs. penetrating	169	106	63
Rudimentary health post	Rural management	260	178	68
	History	26	4	16
	Evaluation	130	94	72
	Hemorrhage control	26	17	65
	Immobilization	26	20	77
	Transfer to rural hospital	26	24	92
Prehospital communication	Mechanism, injury, vitals, transport	26	14	54
Rural hospital	Evaluation	260	147	57
	Primary	234	139	59
	Secondary	26	8	31
	Adjunct exams	156	39	25
	Primary	104	33	32
	Secondary	52	6	12
	Resuscitation	65	49	75
	Immobilization	13	6	46
	Transfer to definitive referral center	54	6	11

* Objective structured clinical examination (OSCE) grading system is based on the specific categories and subcategories that each student is required to address during the scenario.

† Total number of student subcategories refers to the total combined number of subcategories that should be addressed by the students as a group.

Table 4 MCQ Versus OSCE

Topic	MCQ Pretest (%)	MCQ Post-test (%)	OSCE Categories (%)
Mechanism of injury	85	96	63
Prehospital care	23	87	68
Patient evaluation	75	73	57
Evaluation adjuncts	31	100	25
Airway	74	42	81
Shock and resuscitation	73	90	75
Hemorrhage control	85	100	65

MCQ, multiple choice questionnaire; OSCE, objective structured clinical examination.

from these types of courses. We have shown that measuring the students' performance is imperative, not only to assess their level of knowledge before the course and to determine their areas of weakness, but to also establish knowledge retention and course effectiveness. Both MCQ and OSCE results have revealed areas that need further emphasis and will be utilized for future course improvement. Ali et al.[15] showed that the addition of the OSCE, as described by Harden,[16] to the MCQ could be effectively used to test students and evaluate the improvement in the post-course period. Others[17,18] have substantiated this method as reliable to assess clinical performance.

The overall improvement between the participants' pretest and post-test scores was significant and could be attributed to the effectiveness of the course. More interestingly, however, is the analysis of the questions by topic. High marks on head injury, abdominal trauma, and pelvic trauma on the pretest could reflect commonly seen injuries in rural hospitals, and therefore more experience in their management. On the other hand, a major pretest deficiency in the management of extremity injuries may echo a true knowledge gap, lower exposure, or cultural difference in the local management of a prevalent problem. Currently, a trauma registry is under development in the region to confirm such a hypothesis. Low marks in prehospital care and adjuncts to physical examination reflect a lack of prehospital care and a systematic approach to trauma victims. However, significant improvements in these areas during the post-test support the benefit of this course.

The improvements on most post-test topics are testaments to the course's effectiveness (Table 2). However, the deficiencies in airway management, abdominal trauma, and burns will warrant a review of the lectures for improvement in future courses. Specific attention to examination questions in those areas is needed, especially since the above deficiencies were not present in the oral clinical examination. Nine random, repeated questions were included and confirmed the course's ability to teach the intended material.

Furthermore, significant improvement was seen in the scores of the 12 repeat test takers over time, demonstrating that knowledge retention after 2 years was not only sustained but improved. This finding is consistent with published reports addressing deterioration of cognitive knowledge and skill acquisition after successful completion of an ATLS course, which is 3.5 years for physicians.[19,20] The volume of trauma also has an influence on the preservation of the skills taught.[21] Therefore, courses should be taught periodically in areas of low volume to maintain an adequate level of care.

The OSCE evaluation exposed significant deficiencies that otherwise would have not been revealed with the MCQ alone (Table 3). The inclusion of specific subcategories in the evaluation was helpful for this process. Poor performance on the OSCE, when compared with the MCQ (Table 4), may be indicative of the lack of exposure rural physicians have had to this type of testing technique. These deficiencies stress the value of conducting more hands-on practice skill stations. It may also reflect our limited resources and ability to create more realistic clinical scenarios, such as the ATLS moulage. Lastly, the OSCE allowed identification of six participants with instructor potential who will eventually become instrumental in the continuity and sustainability of the course in this region. We think that the inclusion of OSCE with specific categories addressing various types of management required in the region is important to the development and future of a rural trauma course.

The objective of the MCQ and the OSCE was not to determine whether the students would pass or fail to grant them a certificate, but to evaluate the strengths and weaknesses of the participants and assess the effectiveness of the course. A certificate of participation was granted to all students at the end of the course regardless of their performance. We think a certificate of participation, not successful achievement, is important in the initial introduction and acceptability of a basic trauma course to rural physicians.

Some authors have demonstrated positive impacts of trauma education on patient care and outcomes.[22–24] Others, such as Shakiba et al.,[25] have argued that ATLS or similar training programs show improved knowledge in trauma care but do not impact the outcome of trauma victims. We agree with an observation by Ariyanayagam et al.,[26] who stated that "the potential benefits of the educational courses could be masked by weak links in the trauma care chain." The potential benefits of our course in the Morona Santiago province will most likely be masked by the lack of a trauma system and trauma registry in the region. Extensive effort in the development of a regional injury surveillance system in the southern provinces of Ecuador is currently underway. The influence on patient outcome will be determined when such a system is fully developed.[27] However, this course is an essential, initial component for the development of a trauma system.

CONCLUSION

Where there is no ATLS, a tailored trauma course and evaluation can be effective in educating local providers. A well-designed competency evaluation (MCQ and OSCE) is helpful in identifying deficient local aspects of trauma care.

In development of a rural trauma course, testing is not only feasible but necessary. This course design and evaluation method may serve as a model for continuing trauma care education in developing countries.

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