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Strategically Leapfrogging Education in Prehospital Trauma Management: Four-Tiered Training Protocols

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Abstract

Trauma-related injury in fast developing countries are linked to 90% of international mortality rates, which can be greatly reduced by improvements in often non-existent or non-centralized emergency medical systems (EMS)—particularly in the pre-hospital care phase. Traditional trauma training protocols—such as Advanced Trauma Life Support (ATLS), International Trauma Life Support (ITLS), and Basic Life Support (BLS)—have failed to produce an effective pre-hospital ground force of medical first responders. To overcome these barriers, we propose a new four-tiered set of trauma training protocols: Massive Open Online Course (MOOC) Trauma Training, Acute Trauma Training (ATT), Broad Trauma Training (BTT), and Cardiac and Trauma Training (CTT). These standards are specifically differentiated to accommodate the educational and socioeconomic diversity found in fast developing settings, where each free course is taught in native, lay language while ensuring the education standards are maintained by fully incorporating high-fidelity simulation, video-recorded debriefing, and retraining. The innovative pedagogy of this trauma education program utilizes MOOC for global scalability and a “train-the-trainer” approach for exponential growth—both components help fast developing countries reach a critical mass of first responders needed for the base of an evolving EMS.

Keywords

Trauma; Global Surgery; Surgical Education; First Responders; MOOC; EMS

OVERVIEW OF THE GLOBAL NEED

Virtually non-existent emergency medical systems (EMS) in fast developing countries lead to predictable and preventable injuries and death. Understandably, most developing countries are not in an economic position to implement state-of-the-art EMS; thus, it is especially important to prioritize components that are immediately life-saving. Improved pre-hospital

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emergency care offers the greatest potential for decreased international mortality rates, of which over 90% are attributed to trauma-related injury.^{1–3} Even in developed countries like the US, trauma accounts for up to 10% of medical expenditures.⁴ The economic burden placed on fast developing countries is even greater due to the opportunity cost of healthy, working individuals.

Historically, the following training protocols have failed to address the unique trauma burdens of fast developing countries: Advanced Trauma Life Support (ATLS), International Trauma Life Support (ITLS), and Basic Life Support (BLS). The ATLS course has been heralded as the preeminent global solution in clinician trauma training, with positive reviews since its creation in 1978.^{5,6} However, non-US ATLS courses are not easy to set up or to attend, and they are certainly not cost-effective; this problem is exacerbated in under-resourced, fast developing countries.⁷ Furthermore, ATLS is designed to supplement graduate medical education, well beyond the education status of many of pre-hospital providers—including paramedics, firemen, police officials, and layperson first responders. Trauma models like ITLS, derived from developed countries, will not necessarily work in fast developing countries, particularly because these economies first need to mimic the evolutionary processes that allowed such mature EMS infrastructures to flourish initially.⁸ Entry-level protocols like BLS are more appropriate for laypersons; but education setup, contextual issues, and language barriers prevent success. Instead, contextually differentiated protocols must begin at the most basic levels,⁹ which then sustainably advance to higher levels of clinical competence through grassroots expansion.

Properly trained medical first responders—offering the quickest care in both urban and rural settings—have demonstrated significant trauma outcome improvement in countries with poorly developed EMS.¹⁰ On-site stabilization of patients, rapid and safe transportation, and enhanced care instruction are all first responder services that can dramatically transform pre-hospital trauma care management capacity.^{11,12} The authors are involved in a successful first responder training program targeted towards these global outcomes, with India as a test case.¹³

The complete scope of first responder training can be addressed through the tiered nature of our new program. Similarly, these tiered levels are designed with differentiation in mind to establish a common baseline and then accelerate to higher levels of clinical competency in first responders, regardless of socioeconomic strata. Finally, simulation has been demonstrated as key to emergency medical training,¹⁴ while newer educational pedagogy has even incorporated virtual reality in cost-effective simulation learning.¹⁵ Our program incorporates key elements of simulation education, coupled with massively open online course (MOOC) methods in order to expand the scalability of our training.

Educational Strategies for First Responders

Introduction—We have developed an intensive first responder training program that provides the knowledge and skills needed to address pre-hospital trauma situations in India.⁹ Adapted from existing United States trauma protocols, this multicenter initiative revolutionized the educational approach by offering high-fidelity simulation and audiovisual programming, while successfully differentiating content for local context. Components of

this program, illustrated in Figure 1, designed to be internationally scalable, are described in sections below.

Self-directed learning videos and video debriefing—Both self-directed learning videos via MOOC and live instructor presentations were utilized to deliver content knowledge, which showed improved retention rates due to video-assisted debriefing. This method of pedagogical delivery accommodates many learning modalities and trainee backgrounds—it provides a centralized timeline while allowing for trainees to move at their own pace. Direct visualization and self-evaluation during video-assisted debriefing sessions also allows powerful learning outcomes, compared to verbal feedback alone.^{16–18}

High-fidelity simulation—An advanced *SimMan* health simulator provided high-fidelity simulation for trainees through a series of skills labs. This dynamic, yet approachable standardized patient experience simultaneously served as a hands-on learning opportunity and a performance assessment, which is an evidence-based measurement tool in medical education.¹⁹ Simulation is particularly important for first responders, who will be faced with high-stakes situations that require swift decision-making and effective communication skills. Therefore, simulation sessions allowed instructors to build upon trainees' theoretical content knowledge by developing clinical skills and necessary leadership mindsets.

Native language instruction—Finally, instruction was highly differentiated into lay, native language to provide the highest impact for the local context. Language barriers generally pose the largest barrier in global education initiatives, but they were overcome with less effort than expected. We utilized translation volunteers available at local medical school centers, in combination with their faculty, who are continuously able to disseminate this knowledge long after the program initiators are gone. In fact, the self-sustaining nature of our “train-the-trainer” approach leads to an exponential increase in the ground force of locally trained first responders.

MOOC FOR GLOBAL SCALABILITY

History of MOOC in Healthcare Education

In recent years, MOOCs have gained attention as a new pedagogical model for open and distributed learning with great potential for healthcare education. These courses offer free education, often developed by premier universities, to any student with Internet access.²⁰ Course enrollment is typically open beyond traditional start and stop dates, which allows students to work through series of online modules at their own pace. One disadvantage to this model is a low completion rate among enrolled students, which would be measured as a high failure rate if compared to traditional university education. However, the nature of open-access education allows for MOOCs to operate successfully in this manner, so long as the coursework itself is developed and administered by reliable sources like universities. Optimists have touted international MOOC education as a method that may have the disruptive technology potential needed to lift more people out of poverty.²¹

However, relatively few available MOOCs focus on healthcare, and even less are utilized by fast developing countries.²² Language barriers may contribute to this under-utilization, as English remains the dominant language of most MOOCs;^{23,24} though, language diversification continues as a growing trend since the global radiation of MOOCs from their North American origin.²⁰ Even sparser are MOOCs that offer multilingual content, designed for a truly global audience.²⁵ The European Commission and other academic bodies, however, are still pushing for the development of user-friendly, multilingual MOOCs that are usable even by vulnerable learners.^{13,26}

Rationale for Our First Responder MOOC

Our MOOC, specifically designed for training of medical first responders in fast developing settings, is a unique educational model that accordingly builds on lessons from previous MOOCs in the education literature. We seek to build trauma management capacity in a manner that is globally scalable in the native languages of under-resourced nations, many of which now have Internet access.²⁷ Thus, our MOOC design provides a no-cost, high-quality education, targeted for an expansive audience of laypersons. We then supplement MOOC learning with the live two-day workshop and interactive assessments to deliver a “dual-layer” MOOC,²⁸ which may serve as the ideal model to confer both clinical knowledge and interactional skills in a multinational force of first responders.

MOOC Curriculum Design for First Responder Training

In this paper, we present our MOOC “First Responder Trauma and Emergency Care Program,” which is featured on EdCast Health as the world’s first solution for scalable trauma education. EdCast is an open-source education platform for collaboration between world-class institutions, businesses, governments, non-profits, and the layperson audience who wishes to engage in specific learning topics. In addition to this global presence, SkillUpIndia.org has also featured this course for national recognition of excellence, alongside coursework developed by elite universities like Stanford and MIT. In the first run of this course, demonstrated in Figure 2 below, 78 participants registered from several countries to engage in a curriculum developed by nine researchers and co-taught by six faculty members from distributed United States medical institutions.

This MOOC is broken apart into a series of ten modules, which each focus on a core topic described above. These modules feature a self-directed learning video, narrated in native language instruction, along with a corresponding ten question multiple-choice assessment, as demonstrated in Figure 2. In addition to checking for understanding, these rigorous competency assessments utilize scaffolded questions that escalate critical thinking along the cognitive domain of Bloom’s taxonomy.²⁹ These questions were co-developed by US trauma surgeons, emergency medicine physicians, university professors, and education professionals.

As in the case with any MOOC, the massive number of potential students must not systemically burden instructors with course administration. We have accordingly utilized automatic grading with instantaneous feedback for correct and incorrect multiple-choice question (MCQ) attempts, as illustrated in Figure 2. In addition, we utilize a peer-instructor

social interaction system to allow more open-ended feedback, particularly by high-achieving students, who also remain more engaged in the course through this extra responsibility.

Thus far, we have differentiated our core series of self-directed MOOC content into English and Hindi, with work underway to complete translation in Spanish and in several Asian languages. In addition, our innovative teaching model acknowledges that active learning best imparts procedural skills—such as those required by first responders—much more so than traditional didactic presentation can offer;³⁰ to this end, we offer to prioritize the expansion of two-day, hands-on training programs to interested regions with densely populated user bases.

Trauma Training Reform in Fast Developing Countries

To expand on the success of our program, we propose the adoption of a multinational system of trauma training protocols, specifically targeted to establish pre-hospital trauma management capacity in fast developing countries that lack a central EMS. Standard training protocols, such as Basic Life Support (BLS), Advanced Trauma Life Support (ATLS), and even International Trauma Life Support (ITLS), are not widely nor centrally implemented in developing settings; this failure is evidenced by the lack of trained medical staff and by the preventable mortality outcomes due to delayed healthcare responses. Thus, education reform is urgently required for pre-hospital trauma training protocols in fast developing countries.

Existing protocols fail to reproduce their expected standards of education because they were never designed for the level of differentiation required by various fast developing countries. In Western countries, ATLS training is beyond the scope of first responder training, since it is the default training standard for emergency medicine physicians and trauma surgeons; BLS training is more appropriately designed for first responders, emergency medical technicians (EMTs), and paramedics for non-invasive, pre-hospital care. However, even BLS training proves to be too steep of a learning curve for successful translation into fast developing countries, whose laypersons are often at lower educational statuses and medical literacy levels than those in Western countries.³¹ We accordingly propose a progressive, four-tiered system of trauma training protocols in order to establish a progressive, scaffolded educational experience in the native languages of fast developing countries: First Responder MOOC, Acute Trauma Training (ATT), Broad Trauma Training (BTT), and Cardiac and Trauma Training (CTT), as illustrated in Figure 3; these standards and their clinical topic coverage are outlined in Table I.

Four-Tiered Training Standards

ATT is designed as the most basic level needed by a first responder to gain baseline competency in trauma management. In comparison to the toolkit of educational strategies outlined in our previous education initiative,⁹ this protocol is more affordable and accessible to the greatest range of trainees. By substituting video-assisted debriefing and high-fidelity simulation with verbal debriefing and standard mannequins, we can train a larger force of first responders with the same amount of instructors in less time, as shown in Figure 4. The scope of this two-day trauma training program would cover the following core topics: airway management, chest injury, fracture stabilization, hemorrhage control, cervical spine

immobilization, vital signs and shock, scene management, and triage. ATT graduates would be eligible both to engage in the next level and to become self-sustaining trainers for the ATT level.

BTT represents the next level, which most closely resembles the educational standard of training administered in our previously implemented first responder education program.⁹ ATT graduates would return after six months for re-training with video-assisted debriefing and high-fidelity mannequins—offering a more rigorous learning experience through smaller class sizes, lower student-to-faculty ratio, and higher clinical confidence and competency expectations, as outlined in Table II. In addition, this two-day program will also train them in the additional topics of extrication, IV access, and mass casualty as new core topics. BTT graduates would similarly become self-sustaining trainers for the BTT level, as shown in Figure 5.

CTT offers accessible, advanced trauma training for healthcare professionals who wish to gain skills on a level similar to the US-based ATLS standard. Previous clinical skills will be reviewed and remediated, in addition to the teaching of acute trauma management and some invasive skills; therefore, cardiac and other specialized simulation mannequins are utilized, as in Figure 6. Since CTT graduates will have completed all previous levels of trauma training, they would serve as the ultimate trainers for any incoming trainees. This design mirrors the Western tertiary care structure of inpatient hospitals, and it produces the most equitable distribution of first responder development per geographical area in the shortest amount of time.

Long-Term Targets for First Responder Training

Our goal is to train a critical mass of 1% of the Indian national population at the BTT level. These 10 M individuals would then carry the clinical competency required to establish the bottom of the EMS pyramid structure. While an ambitious goal, this target is entirely attainable given the self-sustaining, exponential nature of the tiered program. To illustrate a timeline, the table below demonstrates how this 1% critical mass of BTT level first responders can be trained within just four to six years from the time of publication, as six training rounds occur per year.

The mathematical projection in Table III predicts worst case and best case scenarios, based on the following assumptions:

1. 33% or 50% of ATT/BTT graduates will contribute by training more individuals to their level,
2. 33% or 50% of all ATT graduates will continue to advance to BTT level, and
3. 33% or 50% of all CTT graduates will contribute back by training additional ATT individuals.

CONCLUSION

Similar projections can be estimated to fast track EMS expansion for other developing economies of the world. MOOC learning shows great potential to leverage today's technology to convey clinical knowledge to motivated students. Supplemented by our live two-day workshops, the tiered ATT/BTT/CTT protocols can confer life-saving skills that can be sustainably and exponentially disseminated with the "train-the-trainer" approach. It is our hope that this innovative teaching model will also translate outside of trauma education, accelerating both the accessibility and efficacy in healthcare education across the globe.

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Figure 1.

Two-day training program design features a cyclical, “train-the-trainer” approach that allows self-sustaining, exponential expansion of medical first responders. Key program components allow for success in fast developing settings, transcending socioeconomic strata.

Figure 2.

“First responder trauma and emergency care program” MOOC featured: (A) EdCast health premiere course, with example trauma topic selected with associated self-directed learning video and instant feedback multiple-choice competency assessment; (B) SkillUpIndia.org provides national recognition of quality, alongside coursework from other premier U.S. universities.

Figure 3.

Four-Tiered progressive curriculum sequence with optional MOOC preparation before ATT, BTT, and CTT levels of trauma training. MOOC, ATT, and BTT are all designed for the layperson; BTT graduates who are healthcare professionals—such as paramedics, nurses, or physicians—may continue onward to the CTT level, which is most similar to the US-based ATLS standard.

Figure 4. Live action photographs of four-hour Acute Trauma Training (ATT) workshop. (A) 500+ police officers attending a didactic lecture-based training seminar; (B) This panel features Dr. Vyas demonstrating ATT level cervical spine immobilization techniques.

Figure 5.

Live action photographs of two-day Broad Trauma Training (BTT) workshop. (A) 30–50 ATT graduates learn from a didactic lecture-based training seminar in native, lay language; (B) This panel features a local physician faculty member leading a self-sustaining BTT workshop on intravenous (IV) access for drug administration.

Figure 6.
Increasingly specialized technological tools for four-tiered trauma protocols.

Table I

Curriculum scope comparison chart for clinical topics covered during progression through four-tiered trauma protocols.

Clinical topics	MOOC	Acute trauma training (ATT)	Broad trauma training (BTT)	Cardiac and trauma training (CTT)
Airway management	✓	✓+	✓++	✓++
Chest injury	✓	✓+	✓++	✓++
Fracture stabilization	✓	✓+	✓++	✓++
Hemorrhage control	✓	✓+	✓++	✓++
Cervical spine immobilization	✓	✓+	✓++	✓++
Vital signs and shock	✓	✓+	✓++	✓++
Scene management	✓	✓+	✓++	✓++
Triage	✓	✓+	✓++	✓++
Extrication	✓	✓+	✓++	✓++
IV access	✓	✓+	✓++	✓++
Mass casualty			✓++	✓++
Management of unconscious patients				✓++
AED and cardiac drug administration				✓++
Invasive airway management				✓++
Chest tube insertion				✓++

Legend: ✓ denotes no mannequin availability; ✓+ denotes optional mannequin simulation; ✓++ denotes mandatory mannequin simulation.

Table II

Curriculum training logistics comparison chart, detailing the scaffolded expectations for graduation and progression through each of the four-tiered trauma protocols.

Tier level	Participants per session	Student: faculty ratio	Hours per day within 2-day session	Minimum confidence pass criteria	Minimum competence pass criteria
MOOC	∞	∞:1	N/A	N/A	50% of 50 MCQ's
ATT	300–500	50:1	3–4	50% in 3 critical topics *	60% of 50 MCQ's
BTT	30–50	2:1	5	100% in 4 critical topics **	75% of 100 MCQ's
CTT	30–50	2:1	7	100% in 8/12 general topics	80% of 100 MCQ's

Legend:

* denotes hemorrhage control, fracture stabilization, airway management;

** denotes hemorrhage control, fracture stabilization, airway management, and communication.

Table III

Projected first responder training expansion rates, based on “worst case” and “best case” scenario assumptions, where graduates from progressive trauma levels engage in 33% or 50% continued participation, respectively. Highlighted in bold are values that exceed the 10 M target that represents 1% of the national population.

Year	ATT		BTT		CTT	
	Worst case	Best case	Worst case	Best case	Worst case	Best case
1	0	0	2,000	2,000	0	0
2	3,863	10,125	12,466	29,531	843	1,519
3	28,807	149,929	107,040	595,872	4,735	17,300
4	201,766	2,101,891	869,147	10,531,348	26,607	197,052
5	1,357,895	28,430,945	6,724,072	171,583,247	149,493	2,244,548
6	6,509,611	244,305,053	35,881,608	1,681,727,808	629,962	17,044,539