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A simulation-based trauma education program: Does it improve trauma management?

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Abstract

Background: There is a growing literature base to support the use of human patient simulators in trauma education. The purpose of this study was to evaluate the impact of an 11-month simulation-based trauma education program (STEP) on the trauma management skills of senior medical residents in the simulation lab and the real trauma room.

Methods: Two cohorts of PGY-3 emergency medicine and general surgery residents participated in this study. The first cohort, the control group, consisted of 14 PGY-3 residents who only took part in the evaluation process. The second cohort, the intervention group, consisted of 28 PGY-3 residents who participated in the 11 month STEP and then took part in the same evaluation process. This process consisted of form-based evaluations (both self-evaluations, and staff evaluations), as well as an evaluation on a video-recorded standardized simulated trauma scenario.

Results: The crisis resource management (CRM) scores on the standardized simulated trauma scenario were not significantly different between the two groups. The intervention group scored higher on the staff evaluations across all categories: overall score (5.0 v 4.7), knowledge (5.1v 4.9), leadership (5.3 v 4.6), problem solving (5.2 v 4.7), situational awareness (5.3 v 4.7), resource utilization (5.4 v 4.7), and communication (5.4 v 4.8) but did not reach statistical significance. The intervention group scored higher on the self-evaluations in all categories but this difference was not statistically significant.

Conclusions: Our present study did not find any differences in the management of a standardized trauma scenario by PGY-3 residents following our 11-month simulation-based trauma education program. Secondary outcomes demonstrate a trend of increasing CRM scores and self-evaluation scores.

Keywords: Simulation

Article

Introduction

Simulation, in one form or another, has enhanced medical education for decades. Gaba, a pioneer in the field of simulation-based medical education, incorporated patient simulators into the anesthesiology training program at Stanford in the late 1980's (Gaba, 1988). As an educational tool, simulation allows for a controlled and reproducible setting that abrogates the risks of real patient encounters. It provides a safe and realistic 'hands-on' experience, and the opportunity to both learn and practice time-sensitive and uncommon clinical scenarios (Issenberg, 2005). Furthermore, simulation can be adjusted to suit the specific needs of the trainee (McFetrich, 2006). Scenarios can be repeated in a standardized fashion to allow focused practice of skills, knowledge, and judgement (Cherry, 2008). These are central concepts in competency-based education, and have led to the incorporation of simulation-based teaching into curricula across several medical specialties.

Trauma education is particularly well suited to the advantages afforded by simulation. There is a growing literature base to support the use of human patient simulators (HPS) in trauma education (Cook, 2011; Knudson, 2008). Studies have reported an improvement in knowledge-based written tests (Lee, 2003) and performance-based OSCE scores (Gilbart, 2000). Furthermore, simulation has been shown to improve teamwork skills (Cherry, 2008; Steinemann, 2011; Holcomb, 2002), which are central to the management of a trauma patient. Although there have been several short-term simulation-based trauma education studies described, to our knowledge there have been no studies evaluating a long-term simulation-based trauma educational intervention. This is significant, as previous meta-analyses (Issenberg, 2005; Cook, 2011) in the field of simulation based medical education have suggested that effective interventions include multiple learning sessions and repetitive practice over time. The purpose of this study was to evaluate the impact of an 11-month simulation-based trauma education program on the trauma management and leadership skills of senior medical residents in the simulation lab and the real trauma room.

Methods

This prospective cohort post-test only study involved third-year residents at an academic level 1 trauma centre. Approval from the research ethics board at our institution was obtained as well as written consent from all participants. Two cohorts of Trauma Team Captains (TTC) participated in this study. At our institution, third-year residents in the General Surgery and Emergency Medicine residency programs act as the TTC, under the supervision of a trauma team staff physician.

The first cohort acted as the control group, receiving the usual trauma educational sessions specific to their specialty over the academic year. This cohort was made up of 14 third-year residents (3 FRCPC Emergency Medicine, 3 FRCPC General Surgery, and 8 CCFP Emergency Medicine). The usual trauma education consisted of ATLS certification, a 15-minute orientation to the role of trauma team captain, clinical 24-hour supervised trauma call shifts two to three times per month over the academic year, as well as various didactic teaching sessions on trauma related topics. The didactic teaching sessions consisted of monthly 45-minute trauma rounds during which time a trauma team staff physician would present either a major topic in trauma or a review of our institution's trauma morbidity and mortality. Other than these monthly rounds there is no formal didactic trauma curriculum in the emergency medicine or general surgery residency programs.

The second cohort was the intervention group. These residents received the same baseline teaching as the control group, as described above, supplemented with the Simulation-based Trauma Education Program

(STEP). This cohort was comprised of 28 third-year residents (7 FRCPC Emergency Medicine, 6 FRCPC General Surgery, and 15 CCFP Emergency Medicine).

The educational intervention (STEP) consisted of eleven 2-hour sessions offered monthly over the course of the academic year. The curriculum was designed to provide repeated and deliberate practice of a structured approach to the trauma patient using the ATLS framework and fundamental crisis resource management skills. The STEP also provided exposure to unusual and time-sensitive trauma cases that the TTC may not have otherwise encountered in the real clinical setting. Sessions were attended by 5-8 TTCs and consisted of 2-3 simulated scenarios that illustrated a major topic in trauma (appendix 1). Each scenario lasted 15-20 minutes and TTCs took turns acting as the team leader, while others were assigned roles of members of the trauma team (general surgery, orthopedics, nursing, anesthesiology, etc). On average, an individual TTC would lead a trauma scenario every 2-3 sessions.

The STEP used a high-fidelity human patient simulator (Hal S3000 tetherless, Gaumard, Florida) and took place in our hospital's simulation lab, a 400sqft room that is set-up as a resuscitation bay with standard resuscitation equipment available (hemodynamic monitors, pressurized blood warmer, airway equipment, ultrasound machine, and a trauma locker). Our laboratory technician would moulage the mannequin according to the case script and would control voice, vital signs, and physical findings (ie breath sounds, pulses, cyanosis, pupils, etc) from the control room.

A staff trauma team physician led each session and would provide oversight of the simulated scenario followed by a structured debriefing session. During the simulated scenario the staff physician would instruct our laboratory technician with respect to adjustments of vital signs and physical findings in real time according to the actions of the TTC. Following each case there was a structured 20-minute debriefing session that involved an analysis of the learner's leadership, decision-making, communication, and situational awareness skills as well as a prepared didactic presentation that highlighted key concepts for that session.

Primary outcome measure:

The primary outcome for this study was performance on a standardized, simulated trauma scenario. The scenario involved an adult male pedestrian who had been struck by a car and had sustained a closed head injury, an intra-abdominal hemorrhage, and an open femur fracture. The scenario was developed by two of the authors (TC and DH) and was reviewed by two other experts in simulation and resuscitation. The initial vital signs were blood pressure of 92/50, heart rate 132, oxygen saturation 98% on a 100% non-rebreather face-mask, and a respiratory rate of 28. The patient is not responsive to crystalloid boluses and requires a massive transfusion. He has a decreased level of consciousness presumed to be from a closed head injury. He has free intra-abdominal fluid on a bedside FAST (focused assessment with sonography in trauma) exam and an obvious deformed and open fracture of his right femur. The initial resuscitation bay and vital signs were identical for all TTCs who individually participated as the trauma team leader in this scenario. The TTC was expected to manage the scenario for a 10-12 minute period in the resuscitation bay, during which time physiologic parameters were adjusted according to the case script as well as the management decisions of the TTC. Trained actors played the roles of the other trauma team members (anesthesia, general surgery, orthopedics, nursing). The actors were given role descriptions ahead of time, and the scenario was rehearsed in order to provide a standardized scenario for testing purposes. There were scripted cues that were given at specified time points if the TTC was not recognizing important clinical events (i.e. the anesthesiologist would provide the prompt "he isn't responding to pain and his respirations are now sonorous" at 6 minutes if an advanced airway hadn't been secured).

Audio-video performance of the standardized scenario was recorded using three ceiling mounted cameras that generate a single set of footage comprised of three views and the vital-signs monitor (KB-Port, ETC software, Pittsburgh). Three independent trauma experts from other academic centers evaluated the video-recorded scenarios. The expert assessors were not familiar with the study participants or the study design and were shown videos in a random order. They used a validated assessment tool: the Ottawa CRM Global Rating Scale (GRS) (Kim, 2009; Kim, 2006). This tool is a seven-point anchored scale for performance in six crisis resource management domains (leadership, resource utilization, communication, problem solving, situational awareness, and overall score). Our video assessors were trained in the use of the Ottawa GRS by reviewing a “below average”, “average”, and an “above average” performance on a simulated trauma scenario. This also was intended to provide a frame of reference for subsequent video assessment.

Secondary outcome measures:

Secondary outcomes were trauma team staff evaluation, resident self-evaluation, and resident satisfaction with the STEP. Trauma team staff physician assessments and resident self-assessments took place following the management of clinical trauma cases in our emergency department over the last two months of the academic year, from April 1st -June 15th of 2010 for the first cohort and from April 1st -June 15th of 2011 and 2012 for the second cohort. Trauma team staff physicians used the same Ottawa CRM Global Rating Scale used in the simulation-based assessment. The resident self-evaluations consisted of 4 simple questions and used an anchored scale from 0 to 10 (i.e. “How comfortable were you leading the team”, “How confident in your knowledge were you as TTC”, etc). This was not a validated tool. A satisfaction survey was completed at the halfway point and conclusion of the STEP. General comments were also solicited to inform modifications in course design.

Statistical analysis:

Data was analyzed using SAS version 9.3 (SAS Inc. Cary, NC, USA). Continuous variables were described within group by means and standard deviations. Groups were formally compared by the Wilcoxon-Mann-Whitney test.

Results

The standardized simulated trauma scenario assessment was completed for 5 of 14 participants in the control group and 14 of 28 participants in the intervention group. The average assessment scores were not statistically different between the two cohorts in any of the CRM domains (figure 1).

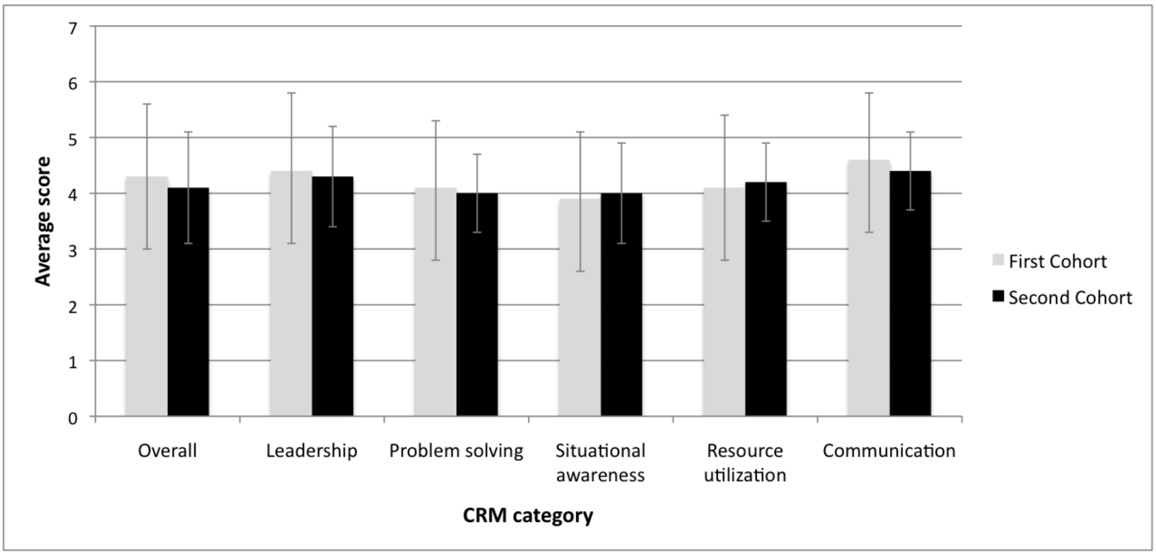

Figure 1. Average simulated scenario scores by cohort with standard deviation bars. There were no statistical differences in any CRM category between cohorts (overall 4.3 v 4.1, p=0.74; leadership 4.4 v 4.3, p=0.75; problem solving 4.1 v 4.0, p=0.69; situational awareness 3.9 v 4.0, p=1; resource utilization 4.1 v 4.2, p=0.81; communication 4.6 v 4.4, p=0.65)

During the first period of data collection (April 1st – June 15th 2010), there were a total of 34 trauma team activations at our institution that were managed by 3rd year TTCs. There were 30 completed trauma team staff evaluations, and 24 TTC self-evaluations. During the second period of data collection (April 1st - June 15th 2011 and 2012), there were 75 eligible trauma team activations. Forty-two trauma team staff evaluations and 40 TTC self-evaluations were completed.

The intervention group received higher marks on the trauma team staff evaluations across all CRM categories. However, none of these differences were statistically significant (figure 2).

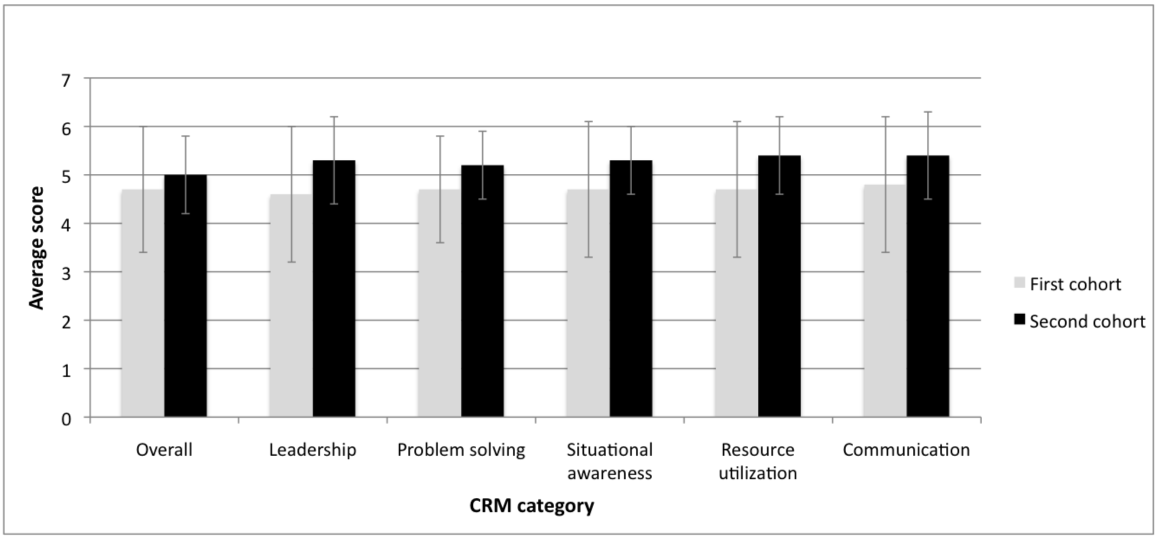

Figure 2. Average trauma team staff crisis resource management scores by cohort with standard deviation bars. Residents in the second had higher average scores in each CRM category but none of these were statistically significant (overall 4.7 v 5.0, p = 0.66; leadership 4.6 v 5.3, p= 0.47; problem solving 4.7 v 5.2, p= 0.13; situational awareness 4.7 v 5.3, p= 0.17; resource utilization 4.7 v 5.4, p= 0.05; communication 4.8 v 5.4 p = 0.09).

Participants uniformly rated the STEP as either 'helpful' or 'very helpful' for their current role as TTC and for their anticipated future practice. Course satisfaction was high (average of 4.2 out of 5).

Discussion

Despite the paucity of high quality evidence supporting the positive relationship between simulation based education and patient outcomes, it has been widely adopted as an educational modality. Simulation based education is particularly well suited to trauma education as it creates controlled, reproducible experiences that can be tailored to the needs of the trainee. It can provide exposure to rare or time-sensitive clinical situations, and it affords deliberate practice and assessment of knowledge, skills, and judgment as they pertain to decision-making in a crisis. These are central concepts in competency-based, learner-centered curricula that medical education is increasingly endorsing at both the undergraduate and postgraduate levels (The Future of Medical Education in Canada, Postgraduate Education Report; Hamstra, 2012).

The present study evaluated the management of a simulated trauma scenario by two independent cohorts of PGY-3 residents before and after the implementation of a simulation-based trauma education program. We attempted to adhere to the principles of effective simulation-based education as described by Issenberg et al (Issenberg, 2005): We provided a structured debriefing session that consisted of an initial 10 minute evaluation and discussion of the CRM skills employed in the scenario, followed by a 10 minute didactic presentation that re-iterated the key knowledge concepts for that session. The didactic debrief employed a second educational modality that emphasized the knowledge-based educational objectives for the session. Both components of our debriefing sessions (the CRM discussion and the didactic presentation) were consistently rated as 'very useful' by learners, this finding is consistent with previous studies that have found debriefing to encourage self-reflection on behaviour and to enhance the educational experience of simulation-based education (Berkenstadt, 2013; Rudolph, 2007). Secondly, a fundamental objective of our step was to provide focused and repetitive 'practice' of an ATLS-style approach to every trauma patient. This aligns with the educational principle of deliberate practice, as outlined in Ericsson's model of expert performance (Ericsson, 2004). Futhermore, we offered this practice over the course of an academic year (11 sessions) in an attempt to provide an effective educational intervention over time as opposed to a 'one-off' session. Thirdly, our STEP enabled active participation in scenarios that engaged the learner and challenged their medical knowledge and CRM skills. We exposed TTCs to a variety of clinical presentations in the field of trauma medicine that they would not have otherwise managed during their clinical training experience.

Our primary outcome was performance on a standardized simulated trauma scenario as assessed by the Ottawa Global Rating Scale (GRS) (Kim, 2009; Kim, 2006). This tool was designed and subsequently validated to assess crisis resource management skills in a simulated medical emergency. The tool is divided into 5 CRM categories (problem solving, situational awareness, communication, leadership, and resource utilization) and each category is assessed using a 7-point ordinal scale with descriptive anchors. It demonstrated construct validity, discriminatory ability, and inter-rater reliability for the assessment of CRM skills in a simulated medical emergency (Kim, 2006). As there is no gold standard for the assessment of CRM performance in a simulated trauma scenario, we believe that the Ottawa GRS was an acceptable assessment tool for the purposes of this study. Furthermore, the CRM skill set defines key non-medical skills that are required for the successful management of any crisis scenario. There is no reason to believe that the Ottawa GRS would be applicable to some medical emergencies, such as hypoxic respiratory failure as described in the Kim paper, and not to others, such as blunt thoracic trauma.

There are several limitations of this study. Firstly, participation in the standardized simulated trauma scenario was poor. Only 36% (5 of 14 TTC) of the first cohort and 50% (14 of 28 TTCs) of the second participated in the primary outcome measure. TTCs reported the timing of the standardized scenario during the academic year (mid June) as the major barrier to participation. This small sample size may have made the study underpowered to detect a moderate improvement in performance, or have biased the results. Secondly, attendance at monthly sessions averaged 82% (although there was large variation at the individual TTC level). Despite being designated as protected academic time by both the general surgery and emergency medicine residency programs, it was difficult for residents to attend regularly, most notably while on a general surgery service. To address this, we moved the sessions to coincide with one program's monthly academic days. The variation in attendance could result in a reduced impact of the intervention. Thirdly, we did not control for confounding exposures during the study period. Individual residents in either cohort may have participated in extra trauma education in the form of conferences, independent reading, or clinical experience while on elective. Fourthly, although we did show our expert reviewers example videos in order to provide a frame of reference when using the Ottawa GRS tool, we did not formally train our expert reviewers or staff trauma team physicians in the use of the tool. This training was described in the Kim paper (Kim, 2006) and a lack of training may have compromised the validity of the assessment tool. Lastly, although curricular alignment was found to be associated with effective simulation-based education (Issenberg, 2005), our STEP was not aligned with any curriculum and this may have decreased the effectiveness of the educational intervention. In fact, the lack of a formal curriculum in trauma education was the rationale for the STEP development.

This study did not find a measurable difference in the management of a standardized simulated trauma scenario by PGY-3 Trauma Team Captains following a simulation based trauma education program. We used a validated assessment tool and independent expert reviewers. The cohort of TTCs that participated in the STEP demonstrated a trend towards improved crisis resource management skills in the real clinical setting that failed to reach statistical significance.

As Gaba et al wrote in 2001 "As with other industries in which human lives depend on the skilled performance of responsible operators, we believe that health care will come to embrace these modalities fully and will not wait idly for unequivocal proof of its benefits" (Gaba, 2001). It may not be desirable for educational interventions to seek proof of benefit using the evidence based medicine methodology. Unlike a drug that is the same dose every time, even the most rigorously standardized educational intervention has variation due to environmental, educator and learner factors. Variations in attendance also change the effective 'dose' of the intervention. These factors break some of the fundamental assumptions of quantitative analysis, and while the goal of providing 'evidence based' support for educational interventions is admirable it may be flawed.

Our STEP has become a mandatory, highly valued and appreciated component of our training programs and simulation-based trauma education will undoubtedly play a central role in both formative and summative assessment in the training of future physicians. Future directions for study include the refinement of valid and reliable assessment methods for crisis resource management scenarios, the most effective timing and use of simulation-based education in a learner's educational trajectory, and ultimately the translation of competency from the simulated scenario to the resuscitation bay.

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Appendix 1.

STEP course curriculum

Topic	Date
Approach to trauma	August
Burns	September
Shock and fluids in the trauma patient.	October
Abdominal trauma	November
Head injury	December
Penetrating trauma	January
Thoracic trauma	February
Pediatric trauma	March
Musculoskeletal and pelvic trauma	April
Challenging Cases	May
Formative Assessment	June