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ORIGINAL ARTICLE

Trauma team perceptions regarding in situ simulation

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Abstract

Background: In situ simulation provides an excellent tool for training, education, and quality improvement in trauma care. The benefits have been well described, but there is potential for harm or delay in patient care when running an unscheduled simulation with working staff members. The objective of this study is to assess trauma team member's perceptions regarding the value of in situ simulation relative to its perceived impact on patient care. **Methods:** A longitudinal survey was conducted between February 2019 and July 2020 and included all members of the multidisciplinary trauma team at a level 1 trauma centre in Nova Scotia, Canada. After each monthly in situ simulation, participants were given a 10-question survey with answers on a 5-point Likert scale. **Results:** One hundred and three surveys were completed. Survey respondents included physicians, trainees, and allied health staff. Simulations were found to infrequently compromise patient care, and minimal patient harm was described. The participants believed that in situ simulations improved many important aspects of trauma care, including communication and identification of latent safety issues. When the required time to complete an in situ simulation increased when COVID protocols were put into practice, the perceived major benefits of in situ simulation relative to its potential harm did not change. **Conclusion:** Trauma in situ training is perceived to be a good learning opportunity that identifies safety issues and improves patient care. It is not perceived to cause delays or compromise patient care, even when additional time is required for simulation training.

Keywords: *in situ simulation; trauma; medical education; interprofessional education*

Introduction

Trauma activations are random, unplanned events requiring rapid response by a complex system that is prone to error and adverse outcomes.[1] Technical skills are a vital component of trauma response and resuscitation, but non-technical aspects such as leadership, teamwork and communication are equally crucial for success.[2,3] Although simulation has been described as an important quality improvement tool, it is limited because individual and team performances in real trauma care are heavily influenced by their surrounding environment and extraneous stressors that cannot be recreated in the simulation laboratory. Furthermore, resource and system issues cannot be evaluated in a simulation laboratory. In situ simulation, as defined by simulation performed in the actual work environment, does not have such limitations because it utilizes the actual physical location, resources, equipment, and team members who would be involved in a real situation.[4] It has shown promise as an effective training method to improve technical, communication and teamwork skills.[5–9] In situ simulation programmes have also been shown to be effective at identifying latent safety threats in trauma systems, such as issues with resources, education, and organization of the work environment that would not be uncovered by scheduled simulations within a lab environment.[4,10] In situ simulation is generally well received, and its immersive nature improves learner buy-in and state-dependent learning, because it can be specifically tailored to a team's needs and goals.[11,12]

Although promising, a downside to the nature of in situ simulation is its potential for disruptiveness. In the case of a trauma simulation, the most high-fidelity scenario involves activation of an unannounced trauma code that assembles the trauma team in the emergency department trauma bay. At our centre, the trauma team is ad hoc, and all members of the trauma team also have other patient care duties that they are required to leave on activation of the trauma team. For example, the surgery and anaesthesia residents may have to leave the operating room in the middle of an operation, and allied health staff may have to prioritize trauma

care over an unwell patient in another department. The potential for impact on clinical activities, and a perception of disruption of patient care, presents a challenge to the implementation of a successful in situ training programme.[12]

There are several other institution-dependent barriers to in situ simulation that may influence its implementation and use. In addition to the use of clinical (and therefore potentially occupied) spaces, there is also the balance of realism versus cost regarding equipment use. Dedicated equipment in in situ labs may be re-used, whereas using real clinical equipment is more expensive, and may also affect patient care if not inventoried and replaced in a timely manner. The volume of clinical activity in in situ spaces may lead to cancellations of simulations, which not only has an impact on potential trainees but also the simulation staff who execute the simulation.[12]

Anecdotally, members of the trauma team at our institution had expressed frustration on having to leave patient care activities for a trauma team activation only to discover on arrival to the trauma bay that it was an in situ simulation. Although our in situ simulation programme had previously demonstrated its ability to identify and fix latent safety threats, there was concern raised by the Trauma Services Committee at the QEII Health Sciences Centre that the in situ simulation programme was causing more harm than benefit.[10] The accusation of harm or perceived harm caused by running an unannounced in situ trauma simulation has not been extensively addressed by the literature, beyond establishing the importance of no-go guidelines. Strict no-go guidelines generate trust in a simulation programme, but in our setting, these were only applicable to the emergency department because there was no way to simultaneously measure the activities of all other trauma team members in the hospital at the same time.[13,14]

Consequently, a more formal quality assessment was pursued to assess the ad hoc multidisciplinary trauma team members' perceptions on the impact of impromptu participation in of in situ simulation on patient care, relative to its perceived value.

Methods

Setting

The study was conducted at the QEII Health Sciences Centre in Halifax, Nova Scotia, Canada. It is the only level 1 trauma centre in Atlantic Canada, servicing approximately one million people and performs approximately 300–400 trauma team activations per year.[15] Members of the trauma team include the trauma team leader, resident trauma team leader (alternating between a senior general surgery and emergency medicine resident), junior general surgery resident, anaesthesia resident, respiratory therapist, orthopaedic surgery resident, paramedic, three emergency room nurses, and radiology resident and technicians. Team members are different each day depending on the time of day, availability, as well as call and rotation schedules. All members of the trauma team have other clinical duties that they must postpone when the trauma team is activated. The general and orthopaedic surgery residents cover the acute care surgery service and orthopaedic emergency service, respectively, and the anaesthesia residents are on-call for cardiac arrests and consults in addition to their operating room responsibilities. The trauma team nurses also cover patient care in the acute resuscitation pod of the emergency department, and respiratory therapists cover the emergency department and intermediate care units of the hospital. The staff trauma team leaders may be working in the emergency department, clinic, or operating room. To activate the trauma team, all members receive a distinct stat page directing them to report to the trauma bay immediately. Trauma team members are expected to prioritize activations and immediately leave the clinical duties they are engaged in to attend. There was no change in the activation page for the team members when there was a simulation as opposed to a real trauma; trauma team members only learned that the scenario was a simulation once they got to the trauma bay.

Study design

This was conducted as a longitudinal survey study with convenience sampling. Eleven simulations were performed between February 2019 and July 2020. The participants in the study were the members of the multidisciplinary trauma team at the QEII Health Sciences Centre. The number of simulations and duration of the study allowed for variability amongst rotating learners on the trauma team.

Dates for in situ simulations were booked in advance, but the trauma team members were not notified of the dates. An hour before to the simulation, discussion with the emergency charge physician and emergency room charge nurse was undertaken to assess if the emergency department was able to accommodate the simulation in the trauma bay. If it was perceived that definite harm to emergency room patients would occur on account of running the simulation, the simulation was postponed. This was established by assessing the number of working nurses, the number and acuity of patients in the waiting room, and current wait times. The workload of the other specialties involved was not assessed before initiating the simulation because it was impractical to determine the activities of five other

specialties scattered throughout the hospital. If it was deemed by the emergency charge nurse to be safe to proceed, a trauma code was activated in the same manner as for an actual trauma. The in situ simulations were organized in this unannounced manner to test the trauma team's ability to muster the personnel resources required to run a trauma as our model of care is an ad hoc team. Having the simulation reproduce the random temporal presentation of actual traumas provided the realism required to observe how the team functioned with team members arriving at different times, or in some circumstances, not at all. The resuscitation and evaluation were performed on a SimMan 3G mannequin (Laerdal Medical) utilizing the actual trauma bay resources as much as possible, with the scenario managed by one of the authors (S.M.) and a simulation technician. The scenarios were multisystem traumas designed to engage all members of the trauma team. Actual equipment, medications and personal protective equipment (PPE) were used during the simulations to allow for concurrent latent safety threat assessment.

Immediately after the simulation, participants were debriefed by S.M. then a short survey was administered to assess their perceptions of the exercise (Appendix 1). The simulations, including the associated debriefing, were designed to take less than 20 min to limit time away from other clinical duties. Surveys were collected immediately after each simulation, and results were compiled on completion of the study. Descriptive statistics were used to analyse the survey results.

With the emergence of the COVID-19 pandemic in early 2020, many new protocols were set in place to manage COVID-positive trauma patients. The aim of the new protocols was to optimize patient care while minimizing staff exposure and hospital contamination. From May to July 2020, four simulations (of the total of 11) were carried out to practice and test these new protocols. These simulations were planned and executed as described above, however they often took up to 1 h to allow for practice transporting the mannequin to the computed tomography scanner and intensive care unit. As the time away from clinical duties was so much longer for these simulations, it was hypothesized that these COVID in situ simulations would be more likely to be perceived as causing patient harm than the shorter in situ simulations. As a natural sensitivity analysis, a separate analysis comparing pre-COVID in situ simulations with the longer COVID in situ simulations was performed to explore this theory. Responses to all questions were compared to assess the perceived value and disruption of the pre-COVID simulations with the COVID simulations using Fisher's exact test. All analyses were performed in Stata, version 14 (College Station, TX). This study was submitted to and approved by the Nova Scotia Health Authority Research Ethics Board (ROMEO File Number: 1024209).

Results

Overall, 103 surveys were distributed (61 pre-COVID, 42 during COVID) over 11 in situ simulations with a response rate of 100%. The results of two surveys were discarded because they were incomplete or there was discordance between comments and scale interpretation. The largest group of respondents comprised residents (41%). Other respondents included nurses (23%), attending staff physicians (5%), paramedics (6%), respiratory therapists (10%), medical students (4%), and clinical associates (1%). Of 12 planned simulations, only one needed to be postponed because the emergency department was unable to accommodate a simulation secondary to workload.

In terms of the primary question of the perceived negative impact of running an unannounced in situ simulation, 27% of participants believed that in situ simulations delayed patient care, 3% perceived that patient care was compromised and no one indicated that patient harm occurred because of their response to the trauma activation and participation in the simulation. The opinion that simulation should be performed as a scheduled session in the simulation lab, rather than as in situ in the trauma bay, was expressed by 8% of participants.

With regards to the perceived benefit of in situ trauma simulations, 76% of respondents believed that in situ simulation identified important safety issues, and $>80\%$ believed that it could improve trauma team communication and care for trauma patients. Participants stated that simulation was enjoyable (84%) and 87% identified it as a good educational experience that should continue to be practiced. There were no significant differences in opinion between attending staff, residents and allied health members for questions pertaining to patient safety and trauma care (Fig. 1).

Additional comments were provided by 75% of respondents. The most common theme described delays in patient care, and most of these responses came from residents. There was one incident described by an unspecified health care worker (i.e. did not identify their role) who identified delay in examining a patient with concerning ECG changes, however they did note that the patient was hemodynamically stable and asymptomatic. From the qualitative responses that were reviewed, 16% of participants reported leaving the operating room to participate in simulation; 28% of participants had been involved in some other form of patient interaction

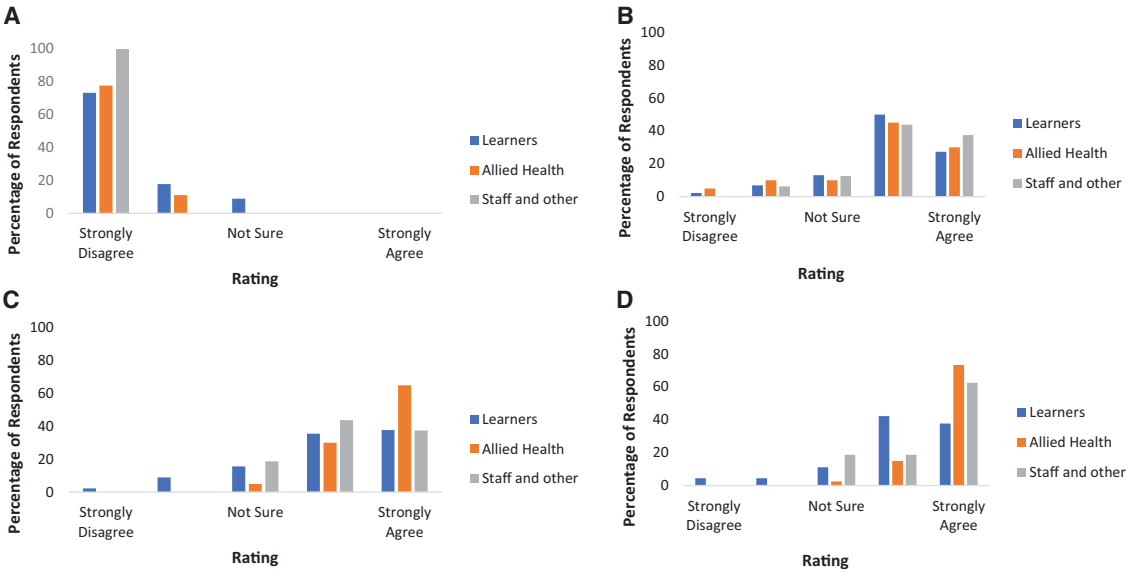

Figure 1. Ratings on a five-point Likert scale in response to the following statements: (A) "Participating in the simulation definitely resulted in harm to a patient"; (B) "The simulation identified important safety issues for trauma patients"; (C) "Simulation may improve care for trauma patients"; (D) "We should continue to do in situ simulation". Leaners consisted of medical students and residents; allied health included nurses, paramedics, and respiratory therapists. Staff were attending physicians, and other includes clinical associates and those who did not specify their role on the survey.

such as rounding, patient assessment or performing a procedure; 15% were performing consults; 28% were involved in some form of ward work such as reviewing bloodwork, discharge summaries, or calling consulting services; 5% identified that they had been doing administrative or office work; and 9% reported being on a break (Fig. 2).

There was no significant difference between the pre-COVID and COVID simulations with two exceptions; the COVID simulations were reported to be less enjoyable (72.5% vs 91.8%; P=0.011) and were less frequently considered a good educational experience (80% vs 95.1%; P=0.021) (Table 1).

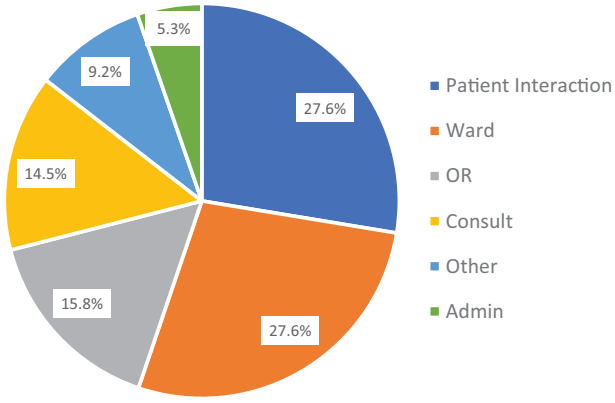

Figure 2. Distribution of task involvement deferred to participate in the in situ simulation. OR, operating room.

Discussion

Our study demonstrates that unannounced in situ simulations for an ad hoc multidisciplinary trauma team have a low rate of perceived negative impact on patient care. This parameter has not been described previously in the literature, but it is an important concern for centres with a similar ad hoc trauma team structure when considering the risks and benefits of creating their own in situ simulation programme. Although reaction is the lowest level of learning evaluation on the Kirkpatrick model, this is the first study to specifically address the safety concerns of unannounced in situ trauma simulations and will help inform and provide a basis for future work.

The positive aspects identified in the trauma in situ simulations are in line with findings from similar studies describing other longitudinal simulation programmes. Doumouras et al.[11] performed a review of simulation to teach crisis resource management to surgical trainees and demonstrated that most studies reported high resident satisfaction. Burke et al.[9] found that staff involved in paediatric trauma simulations valued the practice they received and supported an ongoing simulation programme. Katznelson et al.[16] implemented a longitudinal paediatric in situ simulation programme at rural hospitals that was universally accepted with 100% of participants endorsing ongoing training in

Table 1. Summary of percentage of respondents in agreement with the following survey questions.

	Pre-COVID simulations	COVID simulations	Combined data	*P* value
Participating in the simulation delayed patient care	27.9	25.0	26.1	0.468
Participating in the simulation compromised patient care	4.9	0	3.0	0.216
Participating in the simulation resulted in patient harm	0	0	0	1.000
The simulation identified important safety issues for trauma patients	68.9	87.5	76.2	0.993
Simulation may improve trauma team communication	88.5	80.0	85.1	0.186
Simulation may improve care for trauma patients	88.5	75.0	83.2	0.067
I enjoyed the simulation session	91.8	72.5	84.2	**0.011**
Simulation should be done in the lab and not the actual trauma bay	8.2	7.5	7.9	0.757
We should continue to do in situ simulation	88.5	85.0	87.1	0.410
Simulation was a good educational experience	95.1	80.0	89.1	**0.021**

Bold values indicate statistically significant results.

this fashion. These studies represent a spectrum of longitudinal in situ simulation programmes across different health care settings and demonstrate that they are consistently well received by participants. However, these studies do not specifically address concerns about the perceived impact of unscheduled in situ simulation on patient care. This is important for centres with non-dedicated trauma teams who choose to run in situ simulations in this manner. Although the high fidelity and subsequent insights into team resources and dynamics conferred by running trauma in situ simulations unannounced and unscheduled is important, the potential downside needs to be acknowledged and explored. Our study found that negative impact on patient care was rare, and that the overall majority of the participants believed that simulations should continue to be run in the same manner rather than in a simulation lab.

Although there was a low level of reported impact on patient care, the report of any negative impact on patient care is cause for concern. From the narrative feedback, there was one incidence reported of a participant leaving a patient with a concerning finding (ECG ST depression) to attend a simulation; however, this participant did not rank the situation as having led to patient harm. As expected, delays and compromises were linked to disruptions in patient care activities such as bedside procedures (reduction, sedation), consults, or having to leave the operating room. However, 25% of surveys did not have subjective responses to qualify perceptions, therefore future work could benefit from a more in-depth qualitative analysis. The survey in this study was intentionally concise to limit time away from work for busy clinicians. No morbidity and mortality conferences or patient safety incident management system submissions related to in situ activation were submitted over the course of the study.

Actual impact, or perception of impact on patient care, has not been extensively assessed in the literature, other than emphasizing the need for support of the training programme at a management level to minimize risk. Supervisors and leaders of those participating in the in situ programme must be willing to accept possible delays in work, or be willing to assume clinical responsibilities themselves when trainees are in simulation.[12] In addition, if there is any anticipated risk at all to real-life patients, there must be strong no-go criteria in place or extra staff provided to replace staff while they are in training.[17] In terms of how the perception of an impact on patient care may affect trainees, Møller et al.[18] commented that the distraction of performing in situ simulations during a workday, in the middle of an active patient care environment, poses a risk of trainees focussing on other things rather than the learning in front of them. However, this must be balanced with realism, because true crises will often take place in the context of distractions as well. Thus, it is important for the goals of the simulation to be clearly delineated before it takes place.

Any possible impact on patient care also comes with consideration of medical-legal implications. An example of this is the identification of latent safety threats, and this once again demonstrates the need for support at management level of in situ simulation programmes. Identified hazards and threats must be reviewed as part of quality assurance or quality improvement structures and appropriately addressed; otherwise, there is potential liability in simply knowing these threats exist. Before establishing an in situ

training programme, an institution must have mechanisms to identify and address systems and/or competency issues so that they can be corrected in a timely fashion.[14]

In situ simulation is a tool that can be used to improve health care processes, and indeed has been a useful tool in the rapidly changing landscape of the COVID pandemic.[19,20] At our centre, complex new trauma protocols were implemented, such as PPE safety checks, different transport ventilator usage patterns, and designated paths throughout the hospital to move patients from the trauma bay to the computed tomography scanner and then to the operating room or intensive care unit with the goal of minimizing potential contamination. In situ simulations run during this time required at least twice the amount of time to complete to review all these new protocols. Although not part of the original study design, these COVID simulations allowed us to introduce a natural sensitivity analysis, because the amount of time for an in situ simulation influences participant buy-in. Emergency department studies have demonstrated that 20–30 min for simulation plus debriefing allows for adequate training with minimal impact on workflow, and the COVID simulations typically stretched to close to 1 h in length.[21] Surprisingly, there remained minimal perception of patient harm or delay in care reported by participants (Table 1), and despite the increased time commitment, these simulations were not received less positively or identified as more disruptive. However, simulations during the pandemic were less enjoyable to the participants, which may reflect frustration with the testing of new protocols that were often problematic, such as trying to communicate clearly into an air-locked trauma bay, donning and doffing PPE, and minimizing contamination. Furthermore, the pandemic was associated with extensive hospital reorganization and uncertainty, which may have added to the participants' overall stress and anxiety levels, thus decreasing their enthusiasm for simulations. Despite this, 85% of participants still believed that these in situ simulations should continue.

There are several limitations to this study. The perception of events may differ from reality, and we did not have objective measurements of clinical disruption such as hospital-wide mortality rate or emergency room flow on days the in situ simulations occurred. The perceptions of the benefits of in situ simulation are similarly flawed and across a wide range of in situ simulation studies, it has been difficult to show direct correlation between the implementation of training programmes and improvements in patient outcomes.[4] The findings of this study may be specific to how our trauma team is set up and the overall low volume of trauma activations. Another limitation is participant self-selection, because the survey only included those who came to the simulations and the rate of non-participation was not measured. It is highly likely that team members who came to a trauma team activation while they had another emergency on the go, would not have stayed to participate in the simulation, although anecdotally this was uncommon. Furthermore, as the survey was filled out in the presence of other team members, including one author of the study, it may influence an individual's willingness to comment negatively on their experience.

This study describes that a trauma in situ trauma programme for an ad hoc trauma team is perceived to have a low amount of negative impact on other clinical care in the hospital. Conversely, it was described as a valued educational experience that improves team communication and identifies important safety issues. Future directions for study should focus on the measurement on objective patient care outcomes, such as emergency room waiting room times, patient flow through, morbidity and mortality rates on days in situ simulations are performed.

A trauma in situ simulation programme is perceived by members of an ad hoc multidisciplinary trauma team to have a minimal amount of negative impact on patient care and not cause patient harm. Despite its disruptiveness, the benefits were thought to outweigh the compromises.

Conflict of interest

There are no conflicts of interest to declare.

Acknowledgement

This work was accepted and presented at the following meetings: Trauma Association of Canada Scientific Meeting and Conference 2020 (accepted as a podium presentation; conference cancelled due to COVID-19); Trauma Association of Canada Scientific Meeting and Conference 2021 (poster presentation). The data regarding COVID-19 simulations were presented at Canadian Critical Care Forum 2020 (winner of the Allan Spanier Award for Best Education Study).

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Appendix 1. Study survey.

Impressions of the In-Situ Simulation Trauma Program

This aim of this study is to assess trauma team member's perceptions of the in-situ simulation trauma training program at the QEII Health Sciences Centre. Specifically, we are hoping to assess what your perceptions are with regards to the value of the training program, as well as perceived impact on patient care. This study is being conducted by Olga Bednarek (Resident, General Surgery), under the supervision of Dr. Sam Minor (General Surgery). The information gathered will allow for future refinement of trauma training at the QEII Health Sciences Centre. Surveys will not be reviewed until all responses are collected in order to limit identifiability of responders. Completion of the survey is voluntary, and participants may withdraw at any time. If you decide not to take part, or if you leave the study early, your employment will not be affected.

Consent for participation in this research study will be implied by completion and return of this survey

Role: Attending Staff/ Nurse/ RT/ Paramedic/ Medical Student/ Resident

For Staff/Residents, specialty (general surgery, emergency, anesthesia etc.):

	Strongly Disagree		**Not Sure**		**Strongly Agree**
1. My participating in the simulation today **delayed** other patients' care	1	2	3	4	5
2. Participating in the simulation today **compromised** other patients' care	1	2	3	4	5
3. My participation in the simulation today definitely resulted in **harm** to a patient	1	2	3	4	5
If you answered 4 or 5, please explain how harm occurred:					
4. The simulation today identified important **safety issues** for trauma patients	1	2	3	4	5
5. My participating in the simulation may improve trauma team **communication**	1	2	3	4	5
6. My participating in the simulation may result in **improved care** for trauma patients	1	2	3	4	5
7. I **enjoyed** the simulation session	1	2	3	4	5
8. This type of simulation would be better done in the **simulation lab** and not in the actual trauma bay	1	2	3	4	5
9. The QEII Trauma Program should **continue** to do in situ simulations	1	2	3	4	5
10. The simulation today was a good **educational** experience	1	2	3	4	5

11. What were you doing prior to the start of the simulation (ex/ consult, in OR)?:

12. Other comments (use back of page if necessary):