The Golden Opportunity: Multidisciplinary Simulation Training Improves Trauma Team Efficiency

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OBJECTIVE: Every trauma patient has a golden hour, and resuscitation efficiency within that hour has large implications for patients. We instituted simulation based trauma resuscitation training with the hypothesis that it would improve trauma team efficiency.

METHODS: Five simulation training sessions were conducted with immediate debriefing. Metrics collected in actual trauma resuscitations before and after simulation training included time of primary and secondary surveys and time to computed tomography (CT) scan. Study participants were from multidisciplinary specialties involved in trauma resuscitations as well as former trauma patients from the Trauma Survivors Network.

RESULTS: Seventy-three patients undergoing trauma resuscitations were screened and 67 patients were included. Time to CT scan and secondary survey completion were significantly reduced in actual trauma patient activations following implementation of the curriculum (reduction of 23 to 16 minutes for CT scan $p < 0.05$, and reduction from 14 to 6 minutes for secondary survey, $p < 0.05$). Time to primary survey completion did not change (5 minutes).

CONCLUSIONS: Multidisciplinary simulation training was associated with improved trauma team efficiency in the form of reduced assessment time. As emergency department length of stay is an independent predictor of hospital mortality following trauma activation, team-based simulation training has the potential to improve patient outcomes. Multidisciplinary involvement was a key factor, and Trauma Survivors Network involvement brought credibility from the patient perspective. (J Surg Ed 76:1116−1121. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: multidisciplinary, simulation, training, in situ, trauma surgery, emergency medicine

COMPETENCIES: Practice-Based Learning and Improvement, Interpersonal and Communication Skills

INTRODUCTION

The initial assessment and resuscitation of injured patients is a complex process that requires a systematic, multidisciplinary team approach. Advanced Trauma Life Support (ATLS) was first taught in 1978 with the goal of improving providers' assessment and management of injured patients with traumatic injuries.[1] Despite the considerable advancements of ATLS the trauma bay is an imperfect environment, hosting a clinical team comprised of individuals with variable experience and understanding. Inefficiencies in the initial care of a patient threaten the optimal care within the "golden hour," when identifying and treating injuries is critical to survival. Emergency department (ED) length of stay, as measured in minutes, is an independent predictor of hospital mortality in trauma resuscitation patients.[2] Since the

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function of the multidisciplinary trauma team determines the total time spent in the trauma bay, this construct is well-suited for assessment, formative feedback, and systematic education.

In an effort to build upon existing opportunities to improve trauma education, we developed a simulation training curriculum which incorporates surgical and nonsurgical specialties along with members of the Trauma Survivors Network (TSN). The hypothesis was that this curriculum would improve trauma team efficiency and reduce the time needed to complete critical steps in the initial assessment of trauma patients meeting activation criteria. The impact of this multidisciplinary simulation training was prospectively measured by time to completion of primary survey, secondary survey, and transport to computed tomography (CT) imaging in patients undergoing trauma resuscitations.

METHODS

Study Design

This study was conducted from July to December 2014 at a Level 1 trauma center verified by the American College of Surgeons with approximately 3000 trauma admissions per year. A needs assessment was done by identifying deficits during a trauma quality and performance improvement review. A multidisciplinary panel of trauma surgeons, orthopedic surgeons, neurosurgeons, emergency medicine physicians, ED nurses, and trauma program managers reviewed endemic data and identified trends demonstrating an opportunity for improvement. The 5 most common themes were identified and incorporated into the development of realistic patient scenarios. The scenarios were (1) a patient with spleen laceration and rib fractures following a motor vehicle collision (MVC), (2) a hypotensive patient with unstable pelvis fracture and intra-abdominal free fluid, (3) a patient with a penetrating stab wound to the chest, (4) a patient with facial fractures and a difficult airway, and (5) an elderly patient on anticoagulants with altered mental status after blunt head trauma.

Our trauma resuscitation algorithm was revised to clarify the roles, responsibilities, and timeline of trauma team members during the initial assessment of injured patients. The posted goals of this algorithm were to complete the secondary survey and to be ready for CT or operating room transport within 15 minutes of patient arrival. The algorithm was printed on a large poster board and displayed in the ED trauma bay and trauma carts (Fig. 1). Education regarding the new trauma algorithm was done at didactic conferences for the emergency medicine and general surgery attendings, residents, and fellows, as well as focused team huddles for all other involved specialties. The new algorithm was initiated in the month prior to starting simulation training.

The effect of the training simulations was then measured in patients undergoing trauma resuscitations and compared to presimulation times for completion of primary and secondary survey as well as time to when patient was ready for transport to CT scan or operating room.

Study Setting and Population

Simulation training participants consisted of ED nurses, respiratory therapist, radiology technicians, and paramedics who volunteered alongside residents from general surgery, emergency medicine, anesthesiology, orthopedic surgery, and neurosurgery. Prior to each session, participants were given an initial briefing explaining expectations and roles. A different patient scenario was used for each session, and a total of 5 training sessions were conducted during the 10-week time period. Approximately 8 to 10 participants were involved in each scenario as well as 20 to 30 observers. Each scenario was led by a different team of senior general surgery and emergency medicine residents, who also observed their peers in the other simulation sessions. The residents who did not participate aided in the discussion and were required to complete evaluations after the scenario. The duration of each simulation session was 15 to 20 minutes followed by a 40 to 50 minutes debriefing. Debriefings were led by faculty previously trained in simulation debriefing with over 10 years of experience in multidisciplinary training, and conducted in a constructive, nonthreatening style to stimulate discussion. Visiting representatives from the TSN attended each session and contributed to the debriefing discussion. TSN participants were carefully desensitized and briefed prior to returning to the ED and witnessing a simulated trauma.

Each simulation was conducted in the ED trauma bay where actual trauma resuscitations occurred. In all scenarios a wireless, high-fidelity human patient simulator was used to manifest injuries in accordance with the goals of the simulation and programmed by simulation specialists during the scenario. This allowed for participant variability in identification and management of injuries. Aspects that involved human subject research were reviewed and approved by the institutional IRB.

Data Collection

Data from live trauma activations were collected on patients who met criteria for level 1 (highest level) and level 2 (intermediate level) trauma activation and whose resuscitations were observed by experienced trauma coordinators. The trauma coordinators did not participate in any aspect of the trauma activation and remained removed from the events in the trauma bay. This data

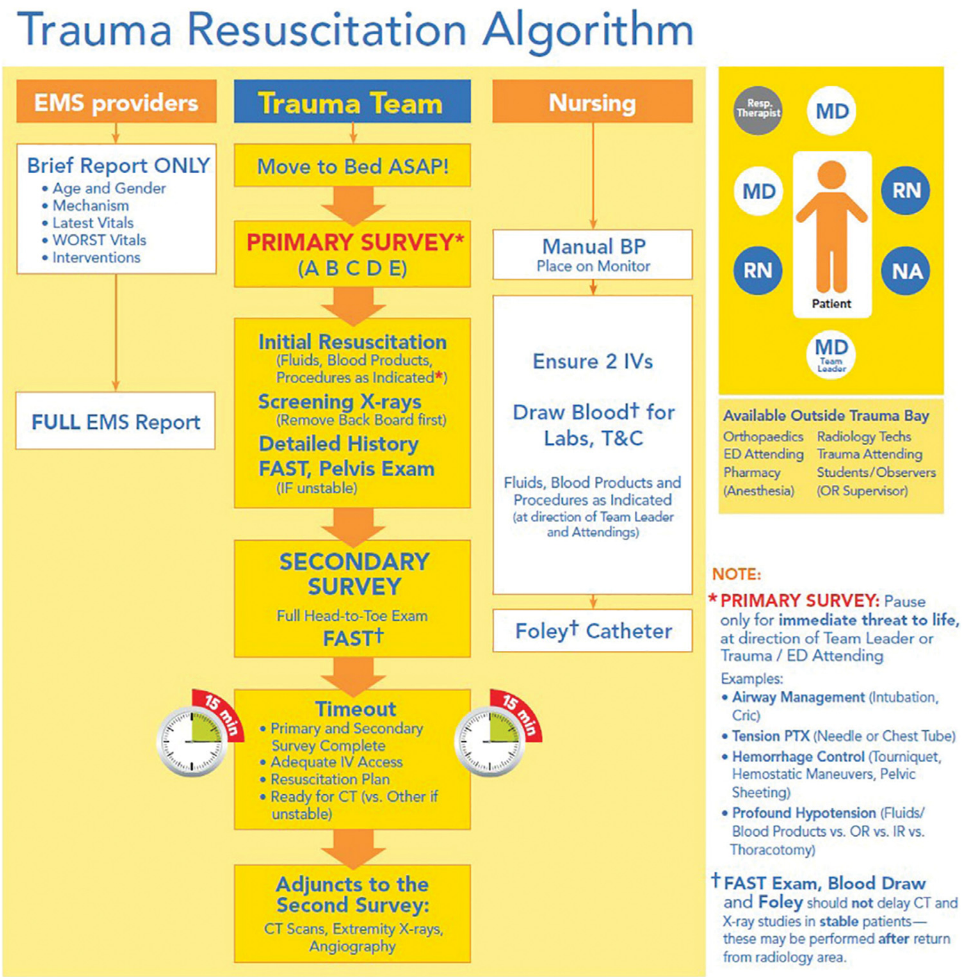

FIGURE 1. Trauma resuscitation algorithm.

collection was conducted 2 weeks prior to starting the simulation training, during the training interval, and continued 2 months after conclusion of the training program. Post simulation data was separated into 5 groups based on timing after each individual simulation session, e.g., post simulation 1 group were patients resuscitated in the time period between simulation sessions 1 and 2. This data collection was done prospectively as part of ongoing quality improvement process.

RESULTS

Data were collected on 73 trauma activations at our hospital, of which 67 were included in the project. Six patients were excluded from all analyses due to incomplete times or Cardiopulmonary resuscitation (CPR) in progress upon arrival. An additional 8 patients were excluded from primary survey analysis, 3 from secondary survey, and 14 patients from time-to-CT subsets due to procedures being done during the survey time period, incomplete times or unavailability of the CT scanner. Ten patients did not undergo CT scan and were excluded from the subset analysis (Fig. 2). We did not include patients undergoing beside procedures, as the curriculum at the time was not directed at improving this component of trauma activations.

Data analysis consisted of a Student's 2−tailed t test. The control group consisted of trauma resuscitations prior to simulation training. We divided the postsimulation data

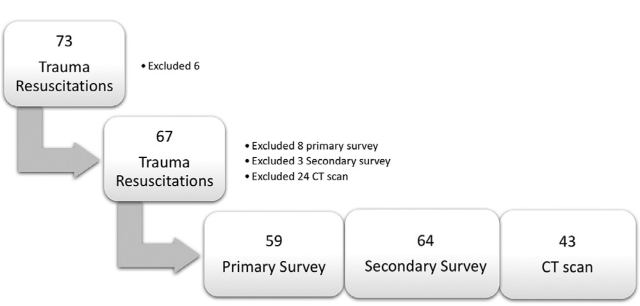

FIGURE 2. Exclusions from data analysis.

into 5 groups based on the timing after each simulation session. The completion time was an average in minutes.

There was no significant change in the time to completion of the primary survey, which was 5 minutes prior to simulation and 5 minutes post simulation training. There were incremental decreases in time to completion of secondary survey and time to CT scan after each training session, with an overall statistically significant decrease in both metrics after completion of all simulation sessions. The time to secondary survey decreased from 14 minutes prior to simulation, to 6 minutes after training sessions, with p value 0.004. The time to CT scan decreased from 23 minutes prior to training, to 16 minutes after simulation, with p value 0.01.

DISCUSSION

The benefits and applications of simulation training in healthcare have been widely described.[3-9] Methods of team training to improve efficiency specifically in trauma resuscitations have been evaluated but methodologies vary widely. Some have focused on improving efficiency within the simulation scenario alone.[10,11] Others have focused on training residents alone or in combination with faculty and nurses, but not other members of the healthcare team.[12-15] An integrative review by Murphy et al. in 2015 found only 11 research articles involving simulation-based multidisciplinary team training, 5 of which involved trauma settings.[16] The breadth of disciplines involved in these "multidisciplinary" teams was also widely variable. In a survey conducted of medical schools and teaching hospitals across the country, only 46% of medical schools and 56% of teaching hospitals used simulation training in multidisciplinary environments.[17] Few studies have involved training all the professional disciplines that are typically included in a trauma resuscitation team.[11] In our training we not only emphasized involvement of all team member specialties in the simulations, but also in the development of the scenarios in order to provide a more robust experience.

We believe that scenarios conducted in the actual environment where trauma resuscitations occur adds realism and contextual relevance to the learning experience. Previous in situ simulation training has demonstrated positive improvement in overall training assessments.[7,8,11,18] In situ training at our institution led to invaluable feedback from participants that helped us educate staff on previously overlooked aspects of care. Some examples include locating the optimal place for participants to stand in the trauma bay, and finding the location of clamps for pelvic sheeting. By combining practical skills and group discussion, participants were able to engage in self-reflection and share their observations about team performance.

Overall, we wanted to focus on the active methods of team learning. The concept of the learning pyramid was developed in the 1960s and describes the retention rate one day after training exercises with both passive and active learning methods.[19] Methods of passive learning such as lecture and demonstration yielded only a 30% retention rate. Active methods such as group discussion, practice, and teaching others led to a 90% retention rate. In our training we conducted an immediate debriefing with group discussion. Our participants went on to immediately apply practical skills and implement team-based techniques during real trauma resuscitations, sometimes just a few hours after the simulation training. By collecting objective information from trauma resuscitations immediately following the intervention and over time, this study offers a unique glimpse into the impact of team training on key aspects of clinical care.

Few studies have focused on transferability of simulation based trauma training into the clinical context.[12,13] Knudson et al. showed that skills learned in simulation could be effectively transferred into real time patient care.[13] In other areas of healthcare, a method to assess the impact of medical team training on surgical mortality has been described.[6] A tool to measure teamwork performance during a training session has also been developed.[20]

Emphasis was placed on team communication in the scenarios as well as trauma resuscitations. This training provided a unique opportunity to execute, review, and improve communication of the actual team members involved in trauma care at our institution. Courses such as Advanced Trauma Operative Management and Advanced Surgical Skills for Exposure in Trauma help learners in acquiring the technical skills essential to trauma care, but do not focus on necessary communication skills.[21] ATLS courses do include more training on communication, but in situ training with home institution team members is not always possible. As Drs. Hirshberg and Mattox described in their book *Top Knife*, in order to succeed in trauma surgery one must become a 3−dimensional surgeon.[22] The "big picture" must be kept in mind with focused communication between team members as well as having knowledge of the training and ability of all personnel and resource availability. Practicing effective communication with emphasis on team−based practice and crew resource management skills can significantly impact patient care.[23]

The time to completion of primary survey did not change. This was not unexpected, as renewed focus was placed on the new trauma algorithm with an emphasis on the secondary survey and timing of adjunct imaging. The differences noted in time to completion of secondary survey and transfer to CT scan were likely the result of overall increased team efficiency. A general trend toward shorter times was demonstrated after each simulation training session.

Due to time constraints and the large sizes of the training programs involved, we did not have an opportunity to train every individual with the simulation scenarios. It is possible that by training key individuals in the team, we were able to garner a global effect and make positive institutional changes. One benefit to doing these monthly is that it allowed for a different surgery and emergency medicine resident to rotate onto the trauma service, and for each simulation to be led by a different learner. While the ED personnel would have more overlap between simulations, there were different team members involved in each session as both participants and observers. We found that this heterogeneity was a strength as it showed the simulation effect could be seen across different learners.

Clinical performance data was collected from real trauma resuscitations regardless of its team members' simulation training history, and still showed improvement. While one could argue that the changes in the algorithm explained the increased efficiency it would be impossible to separate the education from the material. The goal of the simulations was to rehearse the algorithm and to spur the heightened sense of urgency. Out data supports that both those goals were accomplished resulting in a more efficient trauma resuscitation. Further research is required to examine the durability of the training, secondary outcomes such as mortality, and the applicability of this methodology to other institutions.

LIMITATIONS

We had a small population and single center data may limit generalizability. The sample size prior to initiating simulation training was small, as we wanted to start training as early as possible. Data collection required trained observers to accurately document the times to completion of each step as well as list any possible outliers or conditions for exclusion of data. Trauma coordinators were trained for this study because they had considerable experience with the trauma algorithm and had no direct role in clinical care. Also, they were unknown to the residents and staff, thus reducing any Hawthorne effect. However, data collection was limited by their availability to respond to trauma resuscitations.

Although, some of our simulations included procedures in order to keep them realistic and allow feedback for participants, this was not the focus of the study. There was no way to standardize the flow and time of procedures or to control for the level and experience of resident doing procedure. Therefore, trauma resuscitations involving procedures were excluded from analysis. We have since implemented more simulation training with procedures and this will be a future focus of study.

CONCLUSIONS

A series of high-fidelity training simulations involving multiple surgical and medical specialties and staff was associated with a reduction in the duration of key phases of initial trauma care, including time to completion of secondary survey and time to CT imaging. The implementation of multidisciplinary simulation training improves the efficiency of team-based trauma care.

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SUPPLEMENTARY INFORMATION

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jsurg.2019.01.003.