ORIGINAL ARTICLE

Simulation versus reality: what can interprofessional simulation teach us about team dynamics in the trauma bay?

Douglas J. Cassidy[1] · Kristen Jogerst[2] · Taylor Coe[1] · Derek Monette[3] · Naomi Sell[1] · Chalerm Eurboonyanum[1] · Isra Hamdi[1] · Michael Sampson[1] · Emil Petrusa[1] · Dana Stearns[3] · Denise W. Gee[1] · Angela Chyn[3] · Noelle Saillant[1] · James K. Takayesu[3]

Abstract

Purpose Surgical consultation and the joint management of trauma patients is a common scenario in the emergency department. The goal of this study was to utilize interprofessional trauma team training to understand the role of simulation and its impact on the overall culture of trauma-related care.

Methods Interdisciplinary trauma simulation scenarios were completed by 12 groups of emergency medicine residents, general surgery residents, and emergency medicine nurses across two academic years. Following each simulation, a debriefing session was held to reflect on the scenario, focusing on team interactions. Debriefing sessions were audio-recorded, transcribed, deidentified, and independently, inductively coded by two members of the research team. Using the constant comparative method, a codebook was developed and refined until interrater reliability was confirmed with a kappa of > 0.9. Codes were organized into higher level themes.

Results There were 72 participants, including 23 general surgery residents, 19 emergency medicine residents, and 30 emergency medicine nurses. 214 primary codes were collapsed into 29 coding categories, with 6 emerging themes. Pre-trauma bay impact describes how interactions prior to the trauma scenario can impact how team members communicate, trust one another, and ultimately care for the patient. Role and team identity explores the importance of one knowing their individual role in the trauma bay and how it impacts overall team identity. Resource allocation describes the balance of having appropriate resources to efficiently care for patients while not negatively impacting crowd control or role identity. Impact of the simulation experience highlights the impact of the lower stakes simulation scenario on learning and reflection as well as concerns with simulation fidelity. Trauma leader traits and actions outlines inherent traits and learned actions of trauma leaders that impact how the trauma scenario unfolds. Interprofessional team performance describes the overall performance of the trauma team, including but not limited to the type of communication used, teamwork behaviors, and transition of care of the patient.

Conclusions Interdisciplinary trauma simulations and structured debriefing sessions provide insights into team dynamics and interprofessional relationships. Simulations and debriefing sessions can promote understanding, respect, and familiarity of team members' roles; recognition of key characteristics of high functioning leaders and teams; and discovery of conflict mitigating strategies for future interdisciplinary team improvement. Simulation sessions allow implementation of quality improvement measures and communication and leadership strategy practice in a safe, collaborative learning environment. The lessons learned from these sessions can encourage participants to reexamine how they interact and function as a team within the real-life trauma bay.

Keywords Trauma team training · Interprofessional education · In situ simulation

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Douglas J. Cassidy and Kristen Jogerst co-first authors.

✉ Douglas J. Cassidy
d.j.cassidy30@gmail.com

Extended author information available on the last page of the article

Introduction

In most academic emergency departments (ED), trauma patients are jointly managed by trauma surgeons and the emergency medicine (EM) team. These interactions can

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be a source of frustration between the two specialties due to complex training paradigms, ED overcrowding, and institutional factors [1]. The scarcity and distribution of bedside procedures and interventions creates an additional source of conflict between surgery and EM residents. Working in interprofessional teams to enhance patient safety is a core principle and competency of the Accreditation Council for Graduate Medical Education (ACGME); however, this is often challenged during the acute management of trauma patients [2].

Trauma team training has been utilized to improve technical and non-technical skills, including leadership, teamwork, and communication, as well as improved patient outcomes and overall trauma team efficiency [3–6]. Additional benefits of trauma team training include improved task completion and patient disposition times as well as quality improvement measures, such as identification of latent safety threats [7–11]. While team training simulation has been used to focus on the clinical conditions to improve trauma care and patient outcomes, less is known about how simulation can impact interprofessional work culture. Qualitative explorations into the ED consultation process have elucidated that the conflict-mitigating themes of trust and familiarity as well as key conflict-producing themes such as doubt in the other party's competence, self-serving behaviors, and failing to collaborate all impact interprofessional interactions during the ED consultation process [12, 13]. However, it is unclear if there are similar conflict producing and mitigating themes that contribute to interprofessional culture within the trauma bay. Interprofessional team training naturally presents itself as a potential solution to closely examine the interprofessional dynamics within the trauma bay and to focus on improvements in teamwork, perceptions, attitudes, and behaviors of teams [14]. While simulation has been shown to improve trauma team performance temporarily, it is unclear if collaborative skills and team training can have longer lasting change on the interprofessional relationships, team dynamics, and culture that contribute to the workplace and to trauma patient care.

Therefore, the purpose of this study was multifaceted: (1) to characterize the current state of interprofessional relationships in our institution's ED that may impact the management of trauma patients, (2) to establish a novel collaborative skills curriculum and interprofessional trauma training program with associated team debriefing sessions, and (3) to utilize the debriefing sessions to further explore the relationships established in the management of trauma patients and participant perceptions of these relationships, the factors that impact these relationships, and the role of simulation on the overall culture of trauma-related care.

Materials and methods

Study setting and participants

Our institution's ED trauma team consists of a dedicated surgery consult team (PGY2 and PGY3) and a trauma senior (PGY4) who interact daily with the EM team (PGY 2–4) and ED nursing staff. The surgical ED consult teams change monthly, and our institution's EM residents rotate between two large academic medical centers. Trauma activations at our institution are run by alternating the leadership and procedure roles between the EM and surgical teams for each trauma scenario.

Needs assessment

A needs assessment survey to determine the current state of interprofessional relationships between EM residents, general surgery residents, and other ED staff, including nurses, was conducted at the end of the 2018–2019 academic year. Active clinical residents and nursing staff who had spent time in our institution's ED caring for trauma patients over the academic year were recruited via email. A modified Multiple Group Measurement Scale (MGMS) for Interprofessional Collaboration (IPC) was used to assess collaborative relationships, as each target group can be assessed by multiple rater groups, forming unique interprofessional dyads [15]. Participants also provided qualitative feedback about their relationships in the ED with the other two study cohorts. The transcripts were inductively analyzed for prominent themes. Responses to each open-ended question were openly coded by a single author without a predefined framework (D.C.). These codes were then organized into broader themes, with a definition of each theme generated based on the associated codes. These themes were iteratively refined with input from a multidisciplinary team including an education psychologist (E.P.), medical educators (D.M., N.S., J.T.), and a surgical resident with formal training in qualitative analysis (K.J.). Compensation for participation consisted of a $5 gift card. This study protocol was reviewed and approved by the Partners Institutional Review Board (Protocol#: 2019P001069).

Interprofessional trauma team training

Our institution's Bay 13 Project is an interdisciplinary project designed to improve the quality of trauma care and interprofessional relationships through simulation exercises that emphasize the development of non-technical skills. The monthly simulations initially took place in situ within our institution's ED and then were relocated to a mock trauma

resuscitation room in a skills laboratory during the COVID-19 pandemic. Each simulation room was equipped with a high-fidelity mannequin (SimMan® Essential, Laerdal Medical), advanced audio-visual streaming, capture, and playback systems, as well as direct observation one-way mirrors.

Trauma simulations occurred monthly or bimonthly. Participants included the dedicated surgery consult team (PGY2 and PGY3), two EM residents (PGY2–PGY4), and 1–3 ED nurses who routinely manage trauma patients. Scenarios were adapted from material graciously provided by Dr. Victoria Brazil and the group at Gold Coast University Hospital in Australia. These scenarios were then modified to mirror common trauma presentations treated at our institution. (See Supplemental 1, for example, trauma simulation scenarios). Simulations were conducted during the 2019–2020 and 2020–2021 academic years with a hiatus during the peak of the COVID-19 pandemic. Some residents and nurses participated in more than one scenario; however, no participant was involved in the same scenario twice. Three facilitators from trauma and acute care surgery, EM, and EM nursing conducted the scenarios with dedicated assistance from education researchers and simulation specialists.

Each simulation began with a 5–10 min pre-briefing, during which all participants were introduced to the simulation environment and the goals of the simulation. This was followed by a 30-min trauma scenario and a subsequent 45-min debriefing session held in a separate conference room to allow learners to reflect on the scenario and how it compared or contrasted with prior real-life trauma resuscitations and trauma team interactions. The debrief was led by two members of the research team with formal simulation debriefing training (D.C., K.J.), utilizing a three-phase debriefing technique composed of reaction, analysis, and summary with an advocacy-inquiry approach to unveil learner's frames and facilitate reflective discussion [16, 17]. After the debrief, all participants were invited to complete a voluntary, anonymous post-simulation survey that collected demographic information and feedback on the simulation experience.

Data collection and analysis

A semi-structured debriefing guide for the 45-min debriefing sessions was developed by four members of the research team: two surgical residents (D.C., K.J.) and an EM attending physician (D.M.), all with formal debriefing training, along with an educational psychologist (E.P.). This guide consisted of open-ended questions focused on simulation feedback, interdisciplinary teamwork, and communication. It was refined by the research team following the first simulation and non-recorded debriefing session (See Supplemental 2 for final iteration of the debriefing interview guide).

All but the first debriefing session were recorded. Before each debriefing session, participants were informed of the purpose of the study and that their recorded responses would remain confidential. After verbal consent was obtained, debriefing sessions were audio recorded using a digital voice recorder and transcribed verbatim using institutional IRB-approved online software (www.transcribeme.com; TranscribeMe Inc.). Debriefing transcripts served as the primary data for analysis.

Debriefing transcripts were analyzed using an iterative, inductive approach to establish primary and secondary codes. Transcripts were initially openly coded by a single author (D.C.). Primary codes were then consolidated into secondary and tertiary codes by the primary author (D.C.) and then reviewed by a subset of the research team (D.C., K.J., T.C., E.P.). All transcripts were reviewed by the research team who met multiple times to iteratively refine the codes until a consensus codebook was established prior to complete, independent coding. Two independent coders, one male and one female (D.C., K.J.), both general surgery residents and former surgical education research fellows, used a constant comparative method to refine the consensus codebook and establish consistency. After finalizing and refining the codebook, the two coders independently coded the 11 transcribed debriefing sessions. Interrater alignment was established by calculating kappa coefficient and through discussion and review of codes after independent coding.

In a second phase of analysis, codes were grouped into broader themes, with a definition of each theme generated based on associated codes. The two primary coders (D.C., K.J.) processed these themes iteratively, through which themes and subthemes were collapsed and expanded, to ensure thematic categories accurately represented the transcribed data. The resulting themes were also iteratively reviewed by the multidisciplinary research team. All qualitative data, including transcripts, codes, and the final codebook, were organized using Dedoose (version 8.3.41, Socio-Cultural Research Consultants, LLC, Los Angeles, CA).

Results

Interprofessional collaboration survey

A total of 14 (48.2%) EM residents, 17 (70.8%) GS residents, and 47 (42.7%) EM nurses eligible to participate completed the survey following the 2018–2019 academic year. Four unique themes were identified when evaluating the relationships amongst general surgery residents, EM residents, and EM nurses in each unique dyad (Table 1). Between general surgery residents and EM residents, three main themes were identified, including issues with mutual respect and professionalism, competing priorities, and a perceived differences in patient care. Between general surgery residents and EM nurses, two themes were identified, including issues with

Table 1 Unique themes and representative quotes characterizing the relationships between general surgery residents, emergency medicine residents, and emergency medicine nurses

Unique provider relationship	Themes	Representative quotes
General surgery resident—emergency medicine resident dyad	Mutual respect and professionalism	*"There are many instances where they put themselves on a level higher than their EM resident colleagues and can be condescending and difficult to work with." -EM Resident*
	Competing priorities	*"The two groups often have different priorities which can cause friction." -GS Resident*
	Perceived Differences in Patient Care	*"I think most of the frustration stems not from the interactions in traumas but rather other interactions (unreasonable consults, not completing a workup/evaluation prior to a consult, etc.) that can lead to poor relationships." -GS Resident*
General surgery resident—emergency medicine nurse dyad	Communication	*"In general, communication is very poor from surgery to EM. Gen Surg residents often do not loop us in on important plans, like taking the patient to the OR. I almost never get a call." -EM Nurse*
	Mutual respect and professionalism	*"I find many surgical residents to be disrespectful and dismissive to nursing staff. It is as if they have no use for us and we are a bother to them." -EM Nurse*
Emergency medicine resident—emergency medicine nurse dyad	Communication	*"We as residents can be better communicators about the plans." -EM Resident*
	Mutual respect and professionalism	*"However, some residents act as if nursing is only in the way and have no regard for nurses in the ED at all." -EM Nurse*

communication and issues with mutual respect and professionalism. Similarly, between EM residents and EM nurses, the two themes were issues with communication and issues with mutual respect and professionalism.

Interprofessional in situ trauma team training

There was a total of 72 participants over 12 simulation sessions, including 23 general surgery residents, 19 EM residents, and 30 EM nurses. Simulation sessions were conducted over two academic years, between October 2019 and March 2021 with a hiatus from April to September 2020 due to the COVID-19 pandemic. Eleven of these 12 sessions were recorded with over 10 h of audio captured from the debriefing sessions. The final codebook consisted of 29 unique codes, all of which appeared in more than one debriefing session, suggestive of thematic saturation. For the 29 codes, the overall Kappa coefficient was 0.94 indicating substantial agreement between the two members of the research team. These codes were organized into six main themes (Table 2).

Theme 1: pre-trauma bay impact

Participants described how previous interactions between interprofessional team members impacted how team members communicate, trust each other, and ultimately deliver care for trauma patients. Resident participants from both specialties routinely cited specific colleagues they had previously established rapport with, leading to entrustment of one another and what they believed was improved patient care. Conversely, negative interactions from prior collaborative efforts in the ED, even outside of the trauma bay, such as with the surgical consultation process, were noted to be a deterrent to team building and entrustment. These strained interpersonal relationships could permeate throughout the residency program, with certain residents becoming universally known as "difficult to work with" or "confrontational."

From a nursing perspective, participants felt more familiar with the EM residents and more likely to have a preexisting relationship given the temporal nature of the surgical residents' time in the ED. This was echoed by surgical residents, who also noted that it is difficult to foster relationships with nursing due to the large number of nurses, frequent shift changes and staff turnover.

Participants acknowledged the importance of the pretrauma huddle during the simulations to focus the team on a common goal and allow for brief rapport building. Knowing the names of the trauma team members enhanced communication and helped orient the team. Even with the time pressure associated with trauma activations, all participants believed that the time sacrificed for a brief pre-trauma huddle before initiating care of the patient would be made up

Table 2 Unique themes and representative quotes from simulation debriefing sessions

Theme	Codes	Representative quotes
Pre-trauma bay impact	Familiarity and relationships	*"I think it just helps by introducing yourself and acknowledging everybody who's there and identifying roles if you've never worked with them." -EM Resident*
	Pre-trauma information and huddle	*"Having the leader say, 'Okay, let's take a 30 s pause and get our roles figured out and hear the story.' I think that is big. People realize that it's okay to take those 30 s and regroup because then it's only going to benefit the patient in the long run." -GS Resident*
	Competing priorities	*"I do think there is this attitude from the surgery trauma team for better or for worse because we get the final call, right? Because at the end of the day it's our patient but then that creates motions and conflict, right?" -GS Resident*
	Trust and respect	*"So, if you don't value your partner's input, you're certainly not treating the patient as well as you could be." -EM Resident*
	Creating common goals	*"Understanding that, even though we're different departments, we have to get along. We're in the trenches together for the patient's sake." -EM Resident*
Role and team identity	Clearly defined trauma roles	*"The ED residents would be like, 'Okay, so are you running this trauma?' And I'd be like, 'What does that mean to you?' We weren't even having the same language. Like, 'You mean, you want me to do the survey? Or just the foot of the bed thing? What does being the leader mean [to you]?'" -GS Resident*
	Microteam formation	*"You have totally different expertise than I have and it's super helpful to bounce things off each other." -EM Resident*
	Bird's eye view versus drawn in	*"I just found that if you're the Trauma Team Leader standing at the foot of the bed you are able to kind of synthesize that information and the other person can really focus on the survey itself." -GS Resident*
Resource allocation	Additional help versus crowd control	*There are already extra people anyways. So, to really alleviate who doesn't need to be there or have them sit outside the room, not be physically in the room at the bedside, so we can maneuver and do everything that we need to get done. -EM Nurse*
	Clear voice versus background noise	*"Sometimes it's so loud in there you can't really hear whoever is doing the primary and secondary survey, what they're saying. You have to ask other people like, 'Oh, what was that?' And we have to clarify things." -EM Nurse*
	Nursing supportive actions	*"I think I agree with the taking for granted the oxygenation in general because I feel like the nurses are so good that before you even realize usually the patient is desatting, they're on something. And it's very rarely that I will get a non-rebreather out myself just because they already have it." -EM Resident*
	Logistical barriers and external pressures	*"You could be gone for a long time. You're in the scanner, and then the OR, and you have to worry about your other patients. If you have enough unstable ones, it's stressful." -EM Nurse*
Impact of the simulation experience	Simulation versus reality	*"I would say that my level of sympathetic nervous system activation is much lower in simulation. So, I'm less likely to kind of get irritated or lose my cool, right? I have much more patience and less of an urgency about things." -GS Resident*
	Establishing a trauma system	*"For us, it's different because at the other hospital it is much more centralized so that the person who's at the foot of the bed does not touch the patient, and we have a designated procedure person, which is always on the right, the surgery person on the left. And then we switch between who does primary and secondary survey and then who's at the foot of the bed. It moves back and forth." -EM Resident*

Table 2 (continued)

Theme	Codes	Representative quotes
Trauma leader traits and actions	Trauma leader personality traits	*"I really think it depends on the provider. There was one surgeon, he was so super quiet in the back, at the head of the bed, that I just didn't even notice he was there. And then afterwards it was like, 'Oh, that was the person who was running it.'" -EM Nurse*
	Leadership actions	*"And also, when emotions start running high and then there's clearly some conflict, having somebody who's a voice to say, 'Hey, guys, let's just bring the tenor of the room down a little bit and focus on what our objectives are here and what are our priorities.' That, I think, would make me feel a lot better and make me feel like, okay, we have some chance of being organized and calm." -EM Nurse*
	Empowering team members	*"I think trauma, at least the ones I've seen that work the best, it's usually the trauma team leader has very much command of the room, and people can quietly, appropriately speak up when they see something notable and important." -EM Nurse*
	Contingency planning	*"I think the best-run traumas I've been in have always been the ones that are mostly wasteful it's also when you prepare for everything." -EM Resident*
Interprofessional team performance	Type of communication	*"I think one thing that went well was there was good closed-loop communication between me and Participant #7. So, any time I handed her a medication, she said, 'I have this med; I'm giving this med.'" -EM Nurse*
	Working in parallel	*"But I think in reality, things happen at the same time. And especially in a patient where you're doing things in the primary [survey] that matter like this. We had to do a lot of things for airway in this patient, but that led to doing assessments of other things." -EM Resident*
	Prioritizing key tasks	*"I felt a little unsettled by the feeling that everybody is just waiting for the airway to happen. And I'm the surgery senior in the room and kind of running the secondary, which is obviously comes second. We're just paused at that point." -GS Resident*
	Interprofessional teamwork	*"I feel like we worked well as a team and asked each other what we needed and what we think would be best for the patient." -EM Nurse*

throughout the scenario by less role confusion and more efficient patient care.

Finally, the presence of competing priorities between specialties and a lack of understanding of these priorities is a major driver of conflict between the three parties. For nursing, participants commented on the fact that they had multiple patients to care for in addition to the trauma patient. Potential conflict arises when residents are unaware that delays in patient disposition can cause unnecessary additional workload for nursing. For EM residents, priorities include patient disposition to reduce wait times and overcrowding in the ED. Potential conflict emerges when the other two groups, particularly surgical residents, disregard ED residents' need to care for other patients, many of them non-trauma patients. For general surgery residents, priorities include completeness of workup and a sense of "owning the patient" due to trauma patients ultimately being

admitted to the inpatient surgical team. The simulation sessions facilitated discussion of these competing priorities and helped to identify shared goals and remedies toward conflict resolution.

Theme 2: role and team identity

Participants described the importance of knowing individual roles and how understanding these roles can impact the overall team identity. This included the use of common trauma language and identifying who and what defines each role, particularly the team leader. These sessions, conducted over two academic years, led to an evolving definition of the trauma team leader. The EM residents at our institution rotate at another academic medical center, where the trauma team and personnel positioning are standardized, including the trauma leader standing at the foot of the bed, away from

the patient, with a "bird's eye view." Historically, traumas run at our institution are less standardized and often residents, particularly surgical residents, and nurses alike view the resident who is conducting the primary and secondary surveys and playing a "hands on" role as the team leader. Nursing participants identified that this variability was confusing, since the most vocal person was not necessarily the leader, especially if following a bird's eye view approach to overseeing the trauma. Nursing participants had to be aware of who to direct questions and clarifying statements to since the most frequently heard voice in the room was not necessarily the team leader. All in all, this created confusion across the three groups and identified a need for use of a universal trauma language to improve team identity.

The simulation sessions were often the first opportunity for participants to act as the team leader from the foot of the bed, referred to as the bird's eye view. In comparison with a hands-on approach, residents noted that this approach allowed for more global and spatial awareness of the events within the trauma bay, including an unobstructed view of the monitor and concurrent procedures and examinations. Residents noted an internal struggle as trauma leader of wanting to be more hands and being drawn into a specific procedure or aspect of the trauma and difficulty stepping back and maintaining a global perspective. Likewise, participants who were assigned to specific roles or tasks noted that they often felt hyperfocused on their task and less aware of the overall clinical appearance of the patient or the results of other parts of the trauma workup, including exam findings and E-FAST results. The term "siloed" was often used by participants, to describe how they were functioning within their role and were insulated from their surroundings.

Another key discussion about role identity was how to transition roles, especially regarding procedures. The trauma leader is the most senior member of each specialty in the trauma bay (PGY3 for general surgery and PGY4 for EM); however, when needed to assist or step in with a procedure, participants noted the aforementioned conflict with being drawn in and losing their global perspective. This also creates a conflict with nursing as far as who to turn to advance the trauma forward. Residents hypothesized what a role transition would look like, particularly utilizing their general surgery or EM counterpart to take over the role of the trauma leader and oversee the trauma. This fostered a sense of co-leadership and the formation of one of several "microteams" within the trauma bay.

The environment of the trauma bay and its team members can promote the formation of smaller dyads or microteams. This can occur within a specialty, such as with the general surgery trauma senior and junior who function as a team or between resident and attending of the same specialty. When within a specialty, this can often lead to a failure to collaborate and poor team identity. Alternatively, dyads can form between specialties, such as the ED senior and the surgical senior. This interdisciplinary dyad formation was facilitated by the simulations and by an absence of an attending physician in the simulations. Participants often used the terms "bouncing ideas off each other," "member-checking," "more collaborative," and "communal decision making" to describe this co-leadership dynamic between the interdisciplinary dyad. As co-learners and trainees, the success of the dyad relies on the two parties trusting one another and mutual respect. Similar to pre-trauma bay impact, respect and entrustment played a critical role in team identity.

Theme 3: resource allocation

Resource allocation describes the balance of having appropriate resources to efficiently care for patients while not negatively impacting crowd control measures or role identity. Participants discussed the delicate balance between having enough support during a trauma, such that all parallel tasks can be easily completed in a timely manner, but not too many people, such that it is difficult to hear the trauma team leader amidst loud background noise. While no consensus for an optimal number was reached, almost all participants discussed that having additional help available but outside of the room if needed was preferred to having extra bodies in the trauma bay. A source of conflict, particularly for nursing, was the balance between limiting the number of observers in the trauma bay with providing an educational opportunity through observation for students. Most nurses felt as though student observers were more likely to get in the way and have a negative impact on patient care, which took priority over trainee education. Residents were more likely to prioritize trainee education and a consensus was reached that students should either have assigned roles on the trauma team or a dedicated observation space that does not impact patient access.

The physical limitations of the trauma bay can create conflict between team members for access to the trauma patient to fulfill their respective roles. Nurses commented that early access to both arms for IV placement, blood draws, and non-invasive monitoring was critical to their success and a priority. EM and surgical residents emphasized how early completion of the E-FAST was important and that if procedures needed to be performed, this would directly compete with extremity access by nursing. While no consensus solution was reached, all groups were able to use the simulation to acknowledge these difficult and conflict-driving situations and work toward troubleshooting potential solutions.

Barriers and external pressures that impact members of the trauma team and threaten trauma team identity were identified. Logistical barriers included trauma space issues, such as crowd control, noise level, access to the patient, equipment availability and room layout, as well as systemic

issues, such as delays in patient registration, access to the blood bank, and electronic medical record conflicts such as delays in placement and access of patient orders such as medications, labs, and imaging as well as different viewership and access of the EMR by the members of the trauma team. A universal external pressure felt by all members of the trauma team was the commitment to the care of other patients, dependent on how busy each group was at a given time.

Theme 4: impact of the simulated experience

Participants highlighted the impact of the lower stakes simulation scenario on learning and reflection as well as concerns with simulation fidelity. Participants described how the simulation environment was lower stakes than the actual trauma bay; therefore, it was less stressful and easier to work together as a cohesive unit. The low stakes simulation sessions also allowed for personal and team reflection with opportunities for growth and experimentations. The debriefings also allowed for a safe space to reflect and learn both clinical management of the trauma patient as well as non-technical skills. Participants from all three groups routinely described features of the simulated sessions or the ensuing debrief that they would bring back with them to the trauma bay in subsequent patient encounters.

The simulation sessions also offered an opportunity for quality improvement and identifying areas of need within the overall trauma system at our institution. These debriefing sessions, in addition to ongoing quality improvement work, led to the development of a trauma handbook for residents to standardize and unify the way in which traumas are run across the two departments. Other examples of areas of standardization that were discussed related to clearer role identifiers, such as nametags, pinnies, or standardizing role locations with outlined team position boxes in the trauma bay.

However, the simulation sessions were not without criticism. Participants questioned the fidelity of the simulation, particularly trying to simulate an exam and secondary survey with a mannequin. While procedures were not the focus of the simulation, participants also felt their absence reduced the realism, especially nursing tasks, such as obtaining intravenous access and labs. Likewise, while the lower stakes simulated environment allowed for learning in the absence of risk to patients, some participants noted the absence of the adrenaline or adrenergic response they would have in a real trauma, despite being performed in an in situ setting.

Theme 5: trauma leader traits and actions

Trauma leader traits and actions outlines inherent traits and learned actions of trauma leaders that impact how the trauma

scenario unfolds and the behavior of the trauma team. Participants discussed how some trauma team leaders have inherent traits that make leading a chaotic trauma simulation or real-life trauma scenario easier and more effective for the team. This included projecting confidence, being a calming presence, and appropriate tone of voice while leading the trauma. Consequently, certain personality traits or characteristics were described as potentially carrying negative connotation. Residents who are inherently quieter than their peers may have difficulty projecting the same level of confidence as their more vocal counterparts, even if equally skilled and knowledgeable. Participants also acknowledged gender differences in voice and height that can negatively impact female residents when projecting themselves as leaders in a trauma scenario.

Participants identified certain behaviors and actions in the trauma bay exhibited by team leaders that impacted the performance of the trauma team. Some actions described by participants in a positive manner included narrating one's thought process to align the room or taking a pause or timeout at times to gain control of the room. Team members also commented favorably on the team leader action of contingency planning. Participants noted that leaders who narrated their thought process, including the next potential steps and actions that would need to be taken, were more likely to have all members on the same page and able to work in parallel.

Finally, a key feature of an effective leader that was noted by all participants, especially nursing, was empowering all members of the trauma team and creating a safe, comfortable environment to speak up or voice opinions, thoughts, or concerns. Leaders who empowered team members were described as friendly, approachable, and inviting to conversation or discussion, whereas barriers to speaking up included a desire to not interrupt the team or worries that a team member's concerns or thoughts were wrong or not appreciated by the team. Team leaders discussed the balance they faced between allowing conversation and creating a culture of speaking up but also limiting excess noise in the room. All participants universally agreed that creating a culture of speaking up and validating each other's concerns is best for patient safety.

Theme 6: interprofessional team performance

Interprofessional team performance describes the overall performance of the trauma team, including but not limited to the type of communication used, teamwork behaviors, and transition of care of the patient. Communication in high performing teams was described as directed and closed loop, using team member names if able. Non-verbal communication was also noted, such as directed eye contact. Senior residents from both specialties commented on the benefits of an open dialogue between the two senior members, once

again emphasizing the concept of co-leadership. Summarization techniques to orient the group were appreciated by all parties and facilitated questions or clarifying statements. Alternatively, poor communication was described when participants spoke over one another or had side conversations. In addition, communication to the room, rather than directed to a team member or the trauma leader, runs the risk of critical information not being integrated into the care of the patient. This type of communication differs from that of the team leader speaking to the room in order one narrate one's thoughts or orient the room. When team members outside of the leader fail to use directed, closed loop communication, there is no feedback and patient care can be affected.

Within the simulation scenarios, participants identified certain team actions that resulted in high performance. These included completing tasks simultaneously, while the team leader was able to "conduct the orchestra" and move care forward. Alternatively, participants identified times when working in parallel was not possible and instead, the team needed to be focused on a single task. Critical steps, such as establishing an airway in a tenuous situation, required a transition from working in parallel to working in series. High functioning teams were able to make these transitions and perform a "hard stop timeout" to prioritize a key task. To liken it to a race, high functioning teams are able to "go fast on the straightaways but slow on the turns," meaning they were able to transition between working in parallel and working in series when priorities arose.

Discussion

This study describes and suggests that an interprofessional trauma simulation program can impact the culture of an institution and provide insight into trauma bay workflow, team dynamics and institutional systems. Through organized, structured debriefing sessions, members of the trauma team were able to explore their own interprofessional relationships as well as comment on characteristics of high performing leaders and trauma teams with a goal of initiating collaborative institutional change. Most in situ simulation is focused on the clinical conditions and how trauma care and patient outcomes can be improved through simulation. However, our goal was to investigate how simulation could be used as a vessel for cultural change given the strained interprofessional relationships highlighted by our needs assessment. Relational coordination theory has been previously used as a framework to demonstrate how a simulation program can impact the relational aspects of care and development of a collaborative culture [18]. A properly designed and organized simulation program has the ability to highlight and target the domains of high-performing teams, specifically focused on shared goals, shared knowledge,

mutual respect and high-quality communication [18]. Our debriefing sessions explored many of these same themes, as participants identified the traits and behaviors of model leaders as well as the features of high performing interprofessional teams that they sought to emulate outside of simulation sessions.

The environment of the trauma bay facilitates the development and formation of microteams. Initially, microteams were formed within specialties, often as a result of familiarity with one another. The downside of these within-specialty dyads is a failure to collaborate in an interprofessional setting. However, by the end of the project, microteams were more often formed between EM and general surgery senior residents, promoting co-leadership in the trauma bay. Both within healthcare and across other professional sectors, shared leadership predicts team effectiveness and performance outcomes compared to traditional vertical leadership structures [19]. This intentional partnering is often driven by the alignment of professional agendas through the construction of a shared responsibility and acceptance of a mutual necessity [20]. Debriefing sessions highlighted the benefits of co-leadership across specialties, including the unique input and expertise brought by surgery and EM, respectively. Within this microteam, being credible, earning trust, and safeguarding mutual respect are paramount to successful co-leadership [20]. While it is possible that other social initiatives, external factors, or individual participant characteristics influenced the willingness to co-lead across specialties, debriefing sessions played a critical role in participants acknowledging the differences in priorities across the different specialties to help minimize conflict and promote collaborative efforts.

A pre-trauma huddle can be used to focus and orient the team on a common goal and allow for brief rapport building, especially when team members are unfamiliar with one another. Prior work in the interdisciplinary EM and surgery literature shows that the ED consultation experience produces less conflict between EM and general surgery if there is trust and familiarity between the two parties [13]. In addition, time-out protocols and pre-briefing are well established tools in both the trauma bay and operating room alike to improve team dynamics and patient outcomes [21]. Pre-briefing includes verbalizing what is known to the team, what can be expected, discussion of contingency plans, and assigning roles [22, 23]. Simulation sessions provide an opportunity to reinforce the benefits of pre-briefing sessions and team huddles so they could be regularly incorporated into practice. Participants routinely appreciated the 3–5-min pre-brief before each simulation, stating this was enough to gain some familiarity and thus trust of the other team members. This helped with creating a positive team identity which was magnified if participants had never met the other trauma team members.

The need for clear role definitions and identification was critical in unveiling prior confusion existent in our trauma bay regarding the interpretation of the trauma team leader. The trauma leader definition evolved over the course of this project; initially nurses and surgical residents viewed the resident conducting the primary and secondary survey as the trauma leader, whereas EM residents preferred the foot of the bed "bird's eye view" approach. Eventually all participants embraced the latter strategy as the definition of the trauma leader, so that a global perspective could be maintained, thus reducing the likelihood of fixation errors [24]. This highlighted the need for a universal trauma language and clear roles to improve team identity, which, in conjunction with ongoing simulation efforts, can improve team efficiency during real life trauma activations [3]. In addition, debriefing sessions and subsequent discussions were instrumental in identifying areas of improvement, outside of universal trauma language, within the trauma system at our institution. Simulation and debriefing sessions have been previously utilized to identify latent safety threats, promote quality improvement, as well as test and evaluate new trauma infrastructure [9, 10, 25]. Our simulation sessions led to multidisciplinary efforts to create a trauma handbook for residents to standardize traumas, including but not limited to role clarification, personnel identification, and trauma team positioning. While the initial scope of this study was to evaluate and improve the interprofessional relationships within our trauma bay through simulation further investigations will be needed to evaluate how continuation of this collaborative curriculum translates to improved outcomes or quality improvement measures in management of trauma patients in our ED.

Participants' descriptions of trauma team leader traits, behaviors, and actions is consistent with prior qualitative work examining effective senior surgical residents as well as the attributes most valued in trauma team leaders [26, 27]. Inherent personality traits, high levels of emotional intelligence, and the ability to manage stress were all identified as positive traits of effective senior residents as well as trauma leaders in our simulation sessions [26]. Likewise, the attributes of trauma leaders valued by their own team members, including communication skills, role clarification, prior experience, anticipation, management ability, and decisiveness were all discussed in our debriefing sessions [27]. A final attribute of effective leadership, emphasized by all parties but particularly nursing, was the creation of an environment in which all team members feel empowered to voice their opinions while still maintaining a decisive leadership role and position [27]. This further solidifies the importance of the development of these nontechnical skills within surgical and EM residencies and how they translate and are valued across disciplines. By identifying the behaviors and actions consistent with strong leadership skills, trainees can participate in targeted leadership simulation-based training to not only improve their own performance but also patient care [28]. The interdisciplinary simulation setting provides a unique environment for EM and surgical trainees to practice these skills and receive feedback from peers and interprofessional colleagues on their performance.

Overall, interprofessional team performance was most often positively characterized by closed loop communication, collaboration, teamwork behaviors, and parallel processing with identification of critical steps and tasks. Similar to prior investigations, the willingness to collaborate and respect the team leader and other team members was a critical attribute of high functioning teams [27]. To respect one another, interprofessional teams must have an understanding of the other professions, the roles they play on the trauma team, and the barriers, conflicts, and competing priorities they face in participating on the team. The nurse–physician relationship is an especially important prior source of conflict, as the historical, hierarchical relationship has now transitioned to include more collaboration and coordination of quality care with resultant improved patient outcomes [29]. One of the biggest barriers for the establishment of good relations between these professions is lack of recognition of each member's professional role, particularly that of nursing [30]. For example, many residents did not realize certain nursing workflows, and many nurses found it eye-opening to learn about the surgery residents' many competing interests. In turn, many of the participants discussed how they would approach future interprofessional interactions in the trauma bay, with these competing interests in mind. Even participants with more experience, and perhaps more rigid in their workflow, expressed a willingness to care for trauma patients in a more collaborative manner. Interprofessional simulation can be utilized to teach and improve attitudes toward physician–nurse collaboration and ultimately improve patient care [31, 32].

Our study is not without limitations, as simulation programs are dependent on the local environment in which they are developed. As the needs assessment, interprofessional trauma simulations, and debriefs were held at a single, large academic hospital in an urban center, our findings may not be transferable to other multidisciplinary settings. While the recorded debrief sessions and subsequent transcripts provide a robust data set for analysis, they were obtained over a relatively short time period with limited resident turnover between the two specialties. As a result, familiarity with one another as well as prior participation in an earlier interprofessional simulation session may have played a role in enhanced communication and team dynamics. Likewise, it is possible that while the two debriefers had no evaluative role in the participants' academic training, the social pressure to participate and provide positive feedback, may have limited negative

themes, and partially explaining why the debriefing themes are more positive than the original needs assessment. However, the anonymous post-simulation surveys used for quality improvement contained few negative comments and overwhelming positive feedback despite their anonymity.

It is unclear how the COVID-19 pandemic may have impacted the findings within our study, particularly regarding team identity, familiarity, and interprofessional relationships. Healthcare providers encountered disruptions and changes in their professional roles, relationships, and identities during the pandemic with variable responses from institutions and individuals. Potential positive effects could include enhanced relationships due to the spirit of collaboration and camaraderie with aligned common goals, whereas potential negative effects could be secondary to provider burnout and mistreatment, fueling potential conflict and mistrust in individuals and institutions alike [33]. There did not appear to be a difference in themes and frequency of codes between the simulation sessions run pre- and post-pandemic; however, this potential confounding effect cannot be excluded.

Finally, as with any educational initiative, maintaining the sustainability of a program and producing durable effects is the ultimate goal. Implementation of an interprofessional education program, particularly a simulation-based program, is time intensive and requires continuous financial support, buy in, and commitment across department and at multiple organizational levels. The findings of our simulation program represent the themes discovered during debriefing discussions present over two academic years, but do not assess any long-term durable effects or any degradation of these effects over time. There is a paucity of data on long term organizational impact and sustainability, particularly with personnel change, as occurs constantly within residency programs. Because of the challenges in implementing meaningful and sustainable curricula and programs, it is important to draw upon best practices from successful, non-simulation-based IPE programing when designing and developing simulation programs. This includes aligning team training objectives with organizational goals, securing institutional support for initiatives, and encouraging real-time application with measured assessment of the effectiveness of a training program [34]. The early dividends of our work include quality improvement measures such as collaborative development of a trauma handbook and manual with interprofessional input from general surgery and emergency medicine nurses and physicians. Future work for continued assessment could include repeated measurement with the interprofessional relationship survey as well as semi-structured interviews to assess the current dynamic of our institution's emergency department.

Conclusions

Structured debriefing sessions provide an avenue for healthcare professionals to explore interprofessional relationships and team dynamics. This opportunity for guided discovery and reflection can promote mutual respect and understanding of each team member's role, knowledge, and ability as well as the barriers and conflicts each team member faces in providing high level, collaborative care to the trauma patient. Group recognition and understanding of the competing priorities and barriers faced by all team members is essential for inspiring quality improvement measures and improving patient care.

A structured interdisciplinary trauma simulation can be tailored to an individual's and organization's need based on the topics explored during debriefing sessions. Trauma team leaders can learn and practice the necessary leadership and communication skills for successfully navigating a trauma bay resuscitation. Organizations can create and practice standardized trauma protocols with role assignments and positioning as well as trial quality improvement measures, such as resource allocation, in a simulated setting. Finally, participants can ultimately develop familiarity with all members of the interprofessional team and work toward mitigating future conflict by aligning team goals and priorities.

Simulation experts and educators should be aware of their own institutional culture and the impact simulation and debriefing sessions may have on it. The lessons learned within the simulations can encourage participants to reexamine how they interact and function as a team within the real-life trauma bay and hopefully improve the interprofessional relationships within an institution and promote collaborative change.

Data availability The data sets (transcripts, coding) generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

References

1. Exadaktylos AK, Velmahos GC. Emergency medicine and acute care surgery: a modern "Hansel and Gretel" fairytale? Emerg Med J. 2008;25(6):321–2.

2. ACGME. Program director guide to the common program requirements. 2020.

3. Long AM, Lefebvre CM, Masneri DA, Mowery NT, Chang MC, Johnson JE, et al. The golden opportunity: multidisciplinary simulation training improves trauma team efficiency. J Surg Educ. 2019;76(4):1116–21.

4. Miller D, Crandall C, Washington C III, McLaughlin S. Improving teamwork and communication in trauma care through in situ simulations. Acad Emerg Med. 2012;19(5):608–12.

5. Roberts NK, Williams RG, Schwind CJ, Sutyak JA, McDowell C, Griffen D, et al. The impact of brief team communication, leadership and team behavior training on ad hoc team performance in trauma care settings. Am J Surg. 2014;207(2):170–8.

6. Steinemann S, Berg B, DiTullio A, Skinner A, Terada K, Anzelon K, et al. Assessing teamwork in the trauma bay: introduction of a modified "NOTECHS" scale for trauma. Am J Surg. 2012;203(1):69–75.

7. Capella J, Smith S, Philp A, Putnam T, Gilbert C, Fry W, et al. Teamwork training improves the clinical care of trauma patients. J Surg Educ. 2010;67(6):439–43.

8. Murphy M, Curtis K, Lam MK, Palmer CS, Hsu J, McCloughen A. Simulation-based multidisciplinary team training decreases time to critical operations for trauma patients. Injury. 2018;49(5):953–8.

9. Patterson MD, Geis GL, Falcone RA, LeMaster T, Wears RL. In situ simulation: detection of safety threats and teamwork training in a high risk emergency department. BMJ Qual Saf. 2013;22(6):468–77.

10. Petrosoniak A, Fan M, Hicks CM, White K, McGowan M, Campbell D, et al. Trauma resuscitation using in situ simulation team training (TRUST) study: latent safety threat evaluation using framework analysis and video review. BMJ Qual Saf. 2021;30(9):739–46.

11. Steinemann S, Berg B, Skinner A, DiTulio A, Anzelon K, Terada K, et al. In situ, multidisciplinary, simulation-based teamwork training improves early trauma care. J Surg Educ. 2011;68(6):472–7.

12. Chan T, Bakewell F, Orlich D, Sherbino J. Conflict prevention, conflict mitigation, and manifestations of conflict during emergency department consultations. Acad Emerg Med. 2014;21(3):308–13.

13. Chan T, Sabir K, Sanhan S, Sherbino J. Understanding the impact of residents' interpersonal relationships during emergency department referrals and consultations. J Grad Med Educ. 2013;5(4):576–81.

14. Lapierre A, Bouferguene S, Gauvin-Lepage J, Lavoie P, Arbour C. Effectiveness of interprofessional manikin-based simulation training on teamwork among real teams during trauma resuscitation in adult emergency departments: a systematic review. Simul Healthc. 2020;15(6):409–21.

15. Kenaszchuk C, Reeves S, Nicholas D, Zwarenstein M. Validity and reliability of a multiple-group measurement scale for interprofessional collaboration. BMC Health Serv Res. 2010;10(1):1–15.

16. Abulebda K, Auerbach M, Limaiem F. Debriefing techniques utilized in medical simulation. 2019.

17. Rudolph JW, Simon R, Dufresne RL, Raemer DB. There's no such thing as "nonjudgmental" debriefing: a theory and method for debriefing with good judgment. Simul Healthc. 2006;1(1):49–55.

18. Brazil V, Purdy E, Alexander C, Matulich J. Improving the relational aspects of trauma care through translational simulation. Adv Simul. 2019;4(1):1–10.

19. De Brún A, O'Donovan R, McAuliffe E. Interventions to develop collectivistic leadership in healthcare settings: a systematic review. BMC Health Serv Res. 2019;19(1):1–22.

20. Clausen C, Lavoie-Tremblay M, Purden M, Lamothe L, Ezer H, McVey L. Intentional partnering: a grounded theory study on developing effective partnerships among nurse and physician managers as they co-lead in an evolving healthcare system. J Adv Nurs. 2017;73(9):2156–66.

21. Fitzgerald M, Reilly S, Smit DV, Kim Y, Mathew J, Boo E, et al. The World Health Organization trauma checklist versus trauma team time-out: a perspective. Emerg Med Australas. 2019;31(5):882–5.

22. Hicks C, Petrosoniak A. The human factor: optimizing trauma team performance in dynamic clinical environments. Emerg Med Clin. 2018;36(1):1–17.

23. Purdy E, Alexander C, Shaw R, Brazil V. The team briefing: setting up relational coordination for your resuscitation. Clin Exp Emerg Med. 2020;7(1):1.

24. Gillman LM, Brindley PG, Blaivas M, Widder S, Karakitsos D. Trauma team dynamics. J Crit Care. 2016;32:218–21.

25. Petrosoniak A, Hicks C, Barratt L, Gascon D, Kokoski C, Campbell D, et al. Design thinking–informed simulation: an innovative framework to test, evaluate, and modify new clinical infrastructure. Simul Healthc. 2020;15(3):205–13.

26. Coe TM, Jogerst KM, Petrusa E, Phitayakorn R, Lipman J. Effective senior surgical residents as defined by their peers: a qualitative content analysis of nontechnical skills development. Ann Surg. 2021. https://doi.org/10.1097/SLA.0000000000005106.

27. Kassam F, Cheong AR, Evans D, Singhal A. What attributes define excellence in a trauma team? a qualitative study. Can J Surg. 2019;62(6):450.

28. Fernandez R, Rosenman ED, Olenick J, Misisco A, Brolliar SM, Chipman AK, et al. Simulation-based team leadership training improves team leadership during actual trauma resuscitations: a randomized controlled trial. Crit Care Med. 2020;48(1):73–82.

29. House S, Havens D. Nurses' and physicians' perceptions of nurse-physician collaboration: a systematic review. JONA J Nurs Adm. 2017;47(3):165–71.

30. Matziou V, Vlahioti E, Perdikaris P, Matziou T, Megapanou E, Petsios K. Physician and nursing perceptions concerning interprofessional communication and collaboration. J Interprof Care. 2014;28(6):526–33.

31. Dillon PM, Noble KA, Kaplan L. Simulation as a means to foster collaborative interdisciplinary education. Nurs Educ Perspect. 2009;30(2):87–90.

32. Liaw SY, Siau C, Zhou WT, Lau TC. Interprofessional simulation-based education program: a promising approach for changing stereotypes and improving attitudes toward nurse–physician collaboration. Appl Nurs Res. 2014;27(4):258–60.

33. Butler CR, Wong SP, Vig EK, Neely CS, O'Hare AM. Professional roles and relationships during the COVID-19 pandemic: a qualitative study among US clinicians. BMJ Open. 2021;11(3): e047782.

34. Salas E, Almeida SA, Salisbury M, King H, Lazzara EH, Lyons R, et al. What are the critical success factors for team training in health care? Jt Comm J Qual Patient Saf. 2009;35(8):398–405.

Authors and Affiliations

Douglas J. Cassidy[1] ⊙ **· Kristen Jogerst[2] · Taylor Coe[1] · Derek Monette[3] · Naomi Sell[1] · Chalerm Eurboonyanum[1] · Isra Hamdi[1] · Michael Sampson[1] · Emil Petrusa[1] · Dana Stearns[3] · Denise W. Gee[1] · Angela Chyn[3] · Noelle Saillant[1] · James K. Takayesu[3]**

[1] Department of Surgery, Massachusetts General Hospital, Boston, MA, USA

[2] Department of Surgery, Mayo Clinic Hospital, Phoenix, AZ, USA

[3] Department of Emergency Medicine, Massachusetts General Hospital, Boston, MA, USA