Multidisciplinary Simulation Activity Effectively Prepares Residents for Participation in Patient Safety Activities

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PURPOSE: In 2017, The Accreditation Council for Graduate Medical Education (ACGME) issued Common Program Requirements that stipulated residents must participate in real or simulated interprofessional patient safety activities, such as root cause analyses (RCA). The requirements also stated that residents should have the opportunity to participate in the disclosure of patient safety events. Our institution supports a large graduate medical education (GME) cohort with approximately 1400 GME learners in more than 100 ACGME programs. Knowing that our university hospital system conducts approximately 15 RCA's per year, our GME leadership charged the Dean of Simulation with developing a pilot simulation activity that would satisfy these educational needs.

METHODS: Four departments (Anesthesia, Emergency Medicine, OB/GYN, and Surgery) assigned a total of 39 learners to participate in the pilot simulation. Learners were divided into groups of 5 to 8 participants representing at least 3 departments. Before the simulation, learners were asked to complete a preactivity questionnaire rating their comfort with the learning objectives and a 10-question multiple choice quiz assessing knowledge of RCA principles. The simulation was 1-hour long and consisted of 2 parts. First, learners participated in a high-fidelity, mannequin-based resuscitation scenario that was scripted to include systems barriers to effective resuscitation. Second, our University Hospital's Vice President of Quality and Safety led participants in a simulated RCA analyzing the systems issues encountered. Finally, all learners completed a postactivity questionnaire and quiz. Preactivity and postactivity data were compared with repeated measures *t*-tests with $p < 0.05$ considered significant.

RESULTS: Complete data were available for 38 learners. We observed significant improvements in quiz performance and learners' self-reported abilities to perform tasks related to patient safety and RCA. The simulation activity did not affect learners' anxiety regarding potential participation in an RCA.

CONCLUSIONS: Our data indicate that a 1-hour, introductory-level simulation improved residents' confidence and knowledge related patient safety activities. This training format is efficient, effective, and consistent with the expectations of the new ACGME Common Program Requirement. (J Surg Ed 76:e232–e237. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: simulation, patient safety, graduate medical education, root cause analysis

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

INTRODUCTION

Inpatient medical errors are the third leading cause of death in the United States[1] and lead to billions of dollars in healthcare expenses and income loss per year.[2] This has caused a major re-evaluation of the quality of patient safety in healthcare.[3] Over the past decade of healthcare reform in America, the Center for Medicare and Medicaid Services and the Department of Health and Human Services have continually striven to redesign our nation's healthcare systems to improve patient care quality.[4] In 2011, the Department of Health and Human Services published guidelines on redesigning a system of care to promote quality improvement, and one of the principal tools recommended in the guidelines was a standardized method for performing root cause analyses (RCAs) when analyzing patient safety events.[5]

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In 2017, recognizing the growing emphasis on patient safety in healthcare, the Accreditation Council for Graduate Medical Education (ACGME) issued Common Program Requirements that stipulated residents must participate in a real or simulated interprofessional patient safety activities, such as RCA. The requirements also stated that residents should have the opportunity to participate in the disclosure of patient safety events.[6] However, many academic medical centers perform less than 15 RCAs per year.[7,8] Our university includes a major university hospital system that implements around 15 RCAs,[9] and hosts approximately 1400 GME learners in more than 100 ACGME programs.[10]

Given the relatively low volume of RCAs compared to the large population of GME learners, our GME leadership realized that residents and fellows would need alternative resources to adequately expose them to this important educational content. With this in mind, the Designated Institutional Officer charged the Assistant Dean of Simulation with developing a simulation activity that could satisfy these educational needs. The purpose of this paper is to describe the results of a pilot, team-based simulation activity designed to educate residents on the core learning objectives put forth by the ACGME.

METHODS

Design of Simulation Activity

The Assistant Dean of Simulation formed a working group to design a brief simulation pilot that would satisfy the above learning objectives. The working group was composed of the Dean, the Vice President of Quality and Safety at an academic medical center, a faculty simulation expert in the department of anesthesiology, and a general surgery resident. Over the course of multiple meetings, the group put together a proposal for a 1-hour simulation activity that would include 2 main components. First, learners would participate in a high-fidelity, mannequin-based scenario wherein they would be tasked with caring for an unstable patient. The scenario was constructed to include multiple systems issues, which created barriers to timely and effective resuscitation of the simulated patient. Second, learners would participate in a simulated RCA during which they would discuss the challenges encountered in the mannequin-based scenario and develop action plans to deal with these systems issues.

Once this overall framework was established, the working group worked to further refine the activity. The group generated a course description with written learning objectives and minimum expectations for performance, as well as detailed scripts for both the high fidelity scenario and the simulated RCA. They also developed a pre-test and post-test to evaluate the effectiveness of the activity in achieving its educational objectives. This consisted of a 10 question multiple choice quiz based on the reading materials as well as several Likert scale items evaluating learners' self-rated comfort with participation in RCAs and related activities. Additionally, the group created and a simple assessment rubric to allow faculty members to document learners' achievement of expected behaviors or lack thereof during the activity. Finally, the team gathered relevant reading materials to distribute to learners in advance of the activity. The pretest, post-test, assessment rubric, and reading materials are all available in the Supplemental Materials.

Enrollment of Learners

Once the framework for the simulation activity was established, the working group presented the proposal to the GME Simulation Subcommittee, which is a committee of Program Directors, Associate Program Directors and simulation experts across all GME departments at our institution. Subcommittee members within the departments of Anesthesiology, Emergency Medicine, Obstetrics & Gynecology, and Surgery expressed interest in enrolling their residents in the proposed activity. After discussion, the departments agreed to launch the activity over 4 sessions on a single afternoon in late June 2018 so that trainees from multiple departments would be available to participate during GME orientation week. Following the successful launch of the activity in late June, the same 4 departments agreed to coordinate additional multidisciplinary sessions in October and November.

Details of the High-Fidelity, Mannequin-Based Scenario

Participants arrived at a designated small-group room where they met the facilitators. Once all learners had arrived, the faculty member leading the simulation gave a prebriefing on the scenario and explained the roles that participants would play. The simulated patient in the scenario was a middle-aged woman who was admitted to the floor postoperative day one from a laparoscopic hysterectomy. During the prebriefing, participants were informed that the patient had been transfused earlier in the day for symptomatic anemia, and a subsequent computed tomography scan had revealed a small intra-abdominal hematoma. It was now late at night, and the patient had developed lethargy and tachycardia, which prompted the nurse to page the cross-covering intern.

The learners from OB/GYN were informed that they would serve as the cross-covering team, and they would perform an initial assessment and call a rapid response for additional assistance if needed. The rapid response team would include the remaining learners with the expectation that anesthesiology residents would

manage the airway, surgery residents would perform vascular access procedures, and emergency medicine residents would serve as the rapid response team leaders. Once the learners were aware of their roles, the prebriefing concluded, and the team was escorted to the high-fidelity simulation room. When the learners arrived at the bedside, a member of the simulation team, serving as a nurse confederate, greeted the OB/GYN residents, explained the issues with the patient, and encouraged them to call a "rapid response" immediately.

When the rapid response team arrived the scenario played out to uncover multiple systems issues that hindered the ability of the team to effectively resuscitate the simulated patient. First, the nurse confederate informed the team that the patient had poor intravenous (IV) access as she was a "difficult stick." When the team requested a kit for central access, the nurse confederate would make sure to trip or bump into another learner and cause the kit to spill and become contaminated. The nurse confederate would then leave the room to obtain another kit but return to inform the team that the supply room was out of stock, and another kit would take 15 minutes to arrive from central supply.

Another systems issue encountered in the scenario was related to the availability of blood and vasopressors to support the patient's hemodynamics. If learners requested vasopressors from the crash cart, the nurse confederate informed them that the medications were expired. The scenario script allowed for limited medications to be obtained from the automated medication dispensing system on the ward, but most critical medications had to be tubed from the central pharmacy, which created a delay. If blood products were requested, the confederate nurse stated that blood was order but would take a few minutes to arrive from the blood bank since it was several floors away.

With these systems issues delaying the resuscitation of the patient, the mannequin became profoundly tachycardic and hypotensive for an extended period. Once sufficient time had passed to make the learners uncomfortable, the confederate nurse obtained saphenous vein access with a large bore IV, and informed the team that blood and vasopressors had arrived. Once blood and medications were administered, the patient's vital signs improved and the mannequin-based scenario ended. If the learners did not expeditiously request a central line kit, blood products, or vasopressors, the nurse confederate would gently suggest these items in order to move the scenario along and ensure that all systems issues were encountered by the team.

Details of the Simulated RCA

Following the mannequin-based, high-fidelity scenario, learners moved to a debriefing room. A simulation faculty held a short debriefing session to allow learners to reflect on the scenario in a safe environment and to reassure the participants that the scenario was frustrating by design and the challenges were not related to a lack of knowledge or skills among the team. At the conclusion of the debriefing session, the simulation faculty informed the team that due to the prolonged hypotensive episode, the simulated patient had suffered a disabling stroke in watershed areas of the brain. Learners were informed that they would now participate in a simulated RCA to analyze the event and determine how similar events could be avoided in the future.

The simulated RCA was facilitated by the Vice President of Quality and Safety at our institution's academic medical center. Additional simulation team members attended the RCA as confederates and played the roles of Director of Pharmacy and Nursing Unit Director. The confederate nurse also attended to provide details of the event. The learners were encouraged to engage in the discussion to recount their own memories of the issues encountered and identify the key challenges that limited their ability to provide effective care. As issues were identified, the facilitator and the confederate actors would provide background information to inform further discussion. For example, the Nursing Unit Director explained that the shortage of central line kits on the unit occurred because of a missed inventory related to miscommunications and staffing issues during a recent holiday weekend. The Director of Pharmacy explained that the failure to replace expired medications occurred because of recent changes to restocking protocols and deficits in knowledge among the pharmacy support staff.

Once the details of the systems issues were clarified, the learners' were encouraged to formulate action plans to address these issues. If learners' suggested weak actions such as educating personnel about existing policies, they were pushed to think of stronger interventions such as adding redundancy to key protocols, streamlining difficult tasks, or creating automated reminders for critical events. When the facilitator was satisfied that the learners had adequately addressed the issues, the simulated RCA was closed and the learners were informed that their action plans would be brought to hospital administration for implementation. The Vice President of Quality and Safety concluded the session with a brief PowerPoint talk that highlighted key elements of the RCA process.

Administration of Assessments

All learners were asked to fill out a pretest and post-test as part of their participation in the simulation activity. Both were administered electronically using Survey Gizmo. Both the pretest and post-test included Likert

TABLE 1. Participants' Self-ratings of Preparedness Before and After Participation in the Activity

	Preactivity	Postactivity	p Value
Quiz Score	53% ± 12%	66% ± 14%	<0.0001
How prepared do you feel to participate in an RCA? (1 = not at all prepared, 3 = somewhat prepared, 5 = very well prepared)	1.8 ± 0.8	3.6 ± 0.7	<0.0001
How prepared do you feel to disclose a patient safety event to peers? (1 = not at all prepared, 3 = somewhat prepared, 5 = very well prepared)	2.3 ± 1.2	3.3 ± 0.9	<0.0001
How prepared do you feel to formulate and implement action plans for patient safety events? (1 = not at all prepared, 3 = somewhat prepared, 5 = very well prepared)	1.8 ± 0.8	3.3 ± 0.7	<0.0001
How anxious would you be if asked to participate in an RCA? (1 = not at all anxious, 3 = somewhat anxious, 5 = very anxious)	2.8 ± 0.9	2.6 ± 1.1	0.10

ratings of participants knowledge and comfort as well as the 10-question quiz already described. Participants received the pretest via email 7 days in advance of the activity and asked to complete in within 4 days. Any participant who did not complete the pretest within 4 days received a reminder email. Upon completion of the pretest, learners automatically received an email with a link to the reading materials to review before arriving at the activity. All participants completed the post-test immediately following the activity on a smart tablet provided by the simulation center. Thus, all participants completed a pretest 1 to 7 days before the simulation and a post-test as soon as the simulated RCA ended.

For each activity, a member of the simulation team also directly observed the participants during the high-fidelity, mannequin-based scenario and the simulated RCA. The simulation team member completed a simple evaluation documenting each learners' performance level on a set of expected behaviors. All learners also had the opportunity to evaluate the activity and faculty by filling out Likert scale items at the end of the post-test.

Data Analysis

Pretest and post-test scores for the multiple choice quiz and the Likert scale items were compared using independent samples *t*-tests with $p < 0.05$ considered significant. Scores are reported as mean ± SD unless otherwise noted. All statistical analyses were performed using Microsoft Excel 2018 with the Data Analysis ToolPak. This data collected for this pilot project was deemed part of usual educational practices (all simulation activities at our institution utilize a pretest and post-test) and was therefore exempt from institutional review board review.

RESULTS

Overall, 53 learners participated in the simulation activity. One learner did not complete the pretest and was excluded from analysis. Of the remaining 52 learners, 12 were Anesthesiology PGY 2 residents, 7 were Emergency Medicine PGY 2 or PGY 3 residents, 18 were Obstetrics & Gynecology interns, and 15 were Surgery interns. Learners were scheduled into 9 1-hour time slots based on their availability. Each time slot hosted 4 to 8 learners from at least 3 different specialties.

Table 1 summarizes the pretest and post-test scores on the multiple choice quiz and Likert scale items. Learners showed significant improvements in multiple choice quiz scores upon completing the simulation. After the activity, learners also demonstrated significant improvements in Likert ratings of their preparedness to participate in an RCA, disclose a patient safety event to peers, and formulate and implement action plans related to patient safety events. Participation in the activity did not affect learners' self-reported anxiety related to potentially participating in future, real-life RCAs.

Table 2 summarizes the course evaluation data that learners provided on their post-tests. Learners had overall positive reviews of the course and felt that the faculty were knowledgeable and helpful. Learners indicated that the activity was neither too easy nor too difficult, but rather, was reasonable for their skill level and familiarity with the material. In terms of effectiveness of various elements of the activity, learners gave the highest ratings to the mannequin-based scenario, followed by the simulated RCA, and finally the reading materials.

DISCUSSION

The aim of this study was to develop and implement a brief simulation activity that would achieve the educational objectives set forth in the new ACGME Core Program requirements. Our data indicate that the activity effectively improved residents' knowledge of and comfort with the target learning objectives. Additionally, although we would not expect most residents to be excited about a 1-hour patient safety exercise, we found that participants were very engaged in the process and

TABLE 2. Participants' Ratings of the Course Quality

Evaluation Item	Likert Rating
Please rate the overall quality of the activity (1 = poor, 3 = satisfactory, 5 = excellent)	3.9 ± 0.9
Please rate the difficulty level of this course (1 = too easy, 3 = reasonable, 5 = too hard)	2.9 ± 0.4
The resources (materials, videos, lectures, simulators, etc.) were adequate (1 = strongly disagree, 3 = neutral, 5 = strongly agree)	4.2 ± 0.7
The facilitators (faculty and proctors) were knowledgeable and helpful (1 = strongly disagree, 3 = neutral, 5 = strongly agree)	4.8 ± 0.4
How effective were the reading materials (1 = not at all, 3 = somewhat, 5 = extremely effective)	3.4 ± 0.8
How effective was the high-fidelity simulated patient encounter (1 = not at all, 3 = somewhat, 5 = extremely effective)	4.3 ± 0.8
How effective was the simulated RCA (1 = not at all, 3 = somewhat, 5 = extremely effective)	4.2 ± 0.7

gave the activity high marks on their evaluations. Finally, this simulation activity fulfilled an important area of need at our institution as there is a low volume of RCA's relative to the high volume of GME learners.

A few aspects of our results deserve further examination. First, although this exercise significantly improved learners' self-reported preparedness with participation in RCAs, disclosure of patient safety events, and formulation of action plans, some readers may argue that simulation should be improved since the observed effect size is relatively modest. Indeed, the average post-test Likert ratings for these skills hovered around 3.3 of 5 (3 = somewhat prepared). However, given that this subject matter is not routinely encountered in medical education, and most of our participants were very junior trainees (<6 months into training), we did not expect this population to exhibit a high-level of preparedness after our brief activity. Thus, we are satisfied with these results and feel comfortable with maintaining the current structure of the simulation for future sessions.

In contrast, even though our participants' quiz scores improved significantly, we do find the post-test average of 66% to be somewhat disappointing. The quiz was composed of 10 multiple choice questions based on information contained in the preactivity reading materials. Learners were exposed to some of this information in experiential fashion as they progressed through the simulation; however, we did not explicitly teach any of the information on the quiz nor did we have any method to verify that participants had completed the reading. Thus, we suspect that many participants neglected to review the reading materials in detail prior to the activity. With this in mind, we recognize that although we observed subjective and objective improvements in participants' knowledge, we have several opportunities for improving our delivery of the core learning objectives in this simulation.

In the future, we will consider bringing participants to the activity 15 minutes early in order to give them protected time to review the reading materials. We also plan to modify the quiz to focus on less on esoteric topics covered only in the reading materials and more on core learning objectives highlighted in the brief slide lecture given by the VP of Quality and Safety at the conclusion of the simulated RCA. This should not only improve quiz scores but may also improve learners' ability to retain the knowledge and apply it to patient care.

Our data also indicate that residents' found that both the high-fidelity, mannequin-based scenario and that simulated RCA were effective methods of exposure to core learning objectives with both components receiving nearly identical average Likert ratings (high-fidelity scenario = 4.3/5; simulated RCA = 4.2/5). Among our working group, we debated whether it was necessary to include the high-fidelity scenario, since this risked causing frustration among participants without contributing to their learning. Ultimately, the working group hypothesized that experiencing frustration related to systems issues (even simulated systems issues) would lead to increased engagement in and appreciation of the RCA process. Our data seem to validate this hypothesis, and as a result, we would advise others seeking to replicate our work to include a high-fidelity scenario in their activity if feasible.

Beyond inclusion of the high-fidelity scenario, we would offer several other pieces of advice to centers hoping to deploy similar activities. First, we note that a skilled nurse confederate is important to the success of the simulation since the scenario did not always progress in a predictable and uniform fashion. In our activity, this role was played by a senior (PGY5) surgical resident, but any team member with a strong background in postoperative surgical care (e.g., faculty, resident, advanced practice provider, nurse, etc.) would be similarly qualified. Nonmedical personnel without a strong medical background (e.g., simulation support staff, trained actor, etc.) may not have the same ability to ad lib effectively and create realistic challenges for participants as the simulation evolves. In contrast, prebriefing, staffing the

simulation control room, and debriefing can be effectively performed by simulation personnel with basic aptitude in these skills.

Regarding the simulated RCA, we strongly encourage other centers to engage the hospital's Department of Quality and Safety when planning this type of activity. The people in this department will have specific knowledge of the RCA process at your institution, and can help guide the design of the event to be realistic. In our experience, the Vice President of Quality and Safety served as a facilitator for the simulation and was very motivated to educate residents regarding the RCA process and invite them to participate in future real-life RCA's. At our institution, the Vice President of Quality and Safety has found that residents have extensive knowledge of how the hospital system works across multiple settings, (clinic, emergency room, inpatient ward, operating room, PACU, etc.) and therefore, trainees can be especially valuable contributors to the RCA process. Thus, we anticipate that exposing trainees to this simulation may improve resident participation in future RCAs and potentially enhance the quality of the process at our institution in a meaningful way.

Going forward, we plan to continue offering this simulation to trainees in the departments of Anesthesiology, Emergency Medicine, OB/GYN, and Surgery. We also plan to work with faculty in other departments to design multidisciplinary scenario for other GME learners (e.g., status epilepticus scenario for Internal Medicine, Neurology, and Pediatrics residents). The ultimate goal is to offer simulation training in patient safety and RCA to all GME learners on campus.

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SUPPLEMENTARY INFORMATION

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