Using Simulation Education With Deliberate Practice to Teach Leadership and Resource Management Skills to Senior Resident Code Leaders

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Abstract

Background Cardiopulmonary arrests are rare, high-stakes events that benefit from using crisis resource management (CRM). Simulation-based education with deliberate practice can promote skill acquisition.

Objective We assessed whether using simulation-based education to teach CRM would lead to improved performance, compared to a lecture format.

Methods We tested third-year internal medicine residents in simulated code scenarios. Participants were randomly assigned to simulation-based education with deliberate practice (SIM) group or lecture (LEC) group. We created a checklist of CRM critical actions (which includes announcing the diagnosis, asking for help/suggestions, and assigning tasks), and reviewed videotaped performances, using a checklist of skills and communications patterns to identify CRM skills and communication efforts. Subjects were tested in simulated code scenarios 6 months after the initial assessment.

Results At baseline, all 52 subjects recognized distress, and 92% (48 of 52) called for help. Seventy-eight percent (41 of 52) did not succeed in resuscitating the simulated patient or demonstrate the CRM skills. After intervention, both groups (n = 26 per group) improved. All SIM subjects announced the diagnosis compared to 65% LEC subjects (17 of 26, $P = .01$); 77% (20 of 26) SIM and 19% (5 of 26) LEC subjects asked for suggestions ($P < .001$); and 100% (26 of 26) SIM and 27% (7 of 26) LEC subjects assigned tasks ($P < .001$).

Conclusions The SIM intervention resulted in significantly improved team communication and cardiopulmonary arrest management. During debriefing, participants acknowledged the benefit of the SIM sessions.

Introduction

Effective communication and coordinated teamwork are critical to the successful management of complex events such as cardiac arrests or "codes."[1–5] Delays in resuscitation can result in poor outcomes.[6–8] The essential "call for help" summons the emergency response personnel that the code leader must direct.[1] While crisis resource management (CRM) skills have been adapted from industry to medicine to enhance team performance,[3,9–15] these skills often are not explicitly taught during medical education.[3,9,12,13,16–19]

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Simulation-based education improves learner knowledge and skills, and allows practice in controlled, safe environments.[12,13,20] Deliberate practice, a feedback-based educational method, requires continued practice of challenging skills.[21,22] Simulation-based education combined with deliberate practice[8–26] promotes skill acquisition[27–32] and adherence to Advanced Cardiac Life Support (ACLS) algorithms.[25,26,32]

Senior internal medicine residents at Cooper University Hospital routinely act as code leaders. All receive medical education about codes, but not CRM skills required to manage resuscitation efforts. We hypothesized that using simulation with deliberate practice to teach CRM skills to code leaders would improve performance of targeted measures when compared with a lecture format.

What was known

Simulation-based education with deliberate practice can promote skill acquisition.

What is new

Study assesses internal medicine residents' skills after a simulation-based intervention compared to a traditional lecture format to learn team communication and crisis resource management (CRM).

Limitations

Single institution, and small sample size limit generalizability.

Bottom line

Residents exposed to simulation communicated and completed CRM skills more effectively than those taught in a lecture format.

Methods

For academic years 2006–2007 through 2008–2009, all senior postgraduate year (PGY)–3 internal medicine residents were invited to participate in the study. Participants within each year were randomly assigned to 2 groups: the lecture (LEC) group attended 2 lectures about team management, and the simulation (SIM) group engaged in simulation-based education with deliberate practice sessions (FIGURE).

All participants had 2 clinical months in the intensive care unit and had managed a minimum of 5 codes as leader. All participants were certified in Basic and Advanced Cardiac Life Support.

Scenario Development

Six arrest scenarios (TABLE 1) were created for testing purposes to assure that content was not shared among groups. Checklists of critical events that code leaders should perform were created and consensus was reached via a modified Delphi method.[33]

Preparing the Simulation Sessions and Briefing the Participants

Each resident was introduced to the functions and limitations of the high-fidelity simulator, SimMan (Laerdal Medical). A brief medical record outlining the simulated patient's history was placed in the room. Participants were required to recognize apnea and unresponsiveness, call for

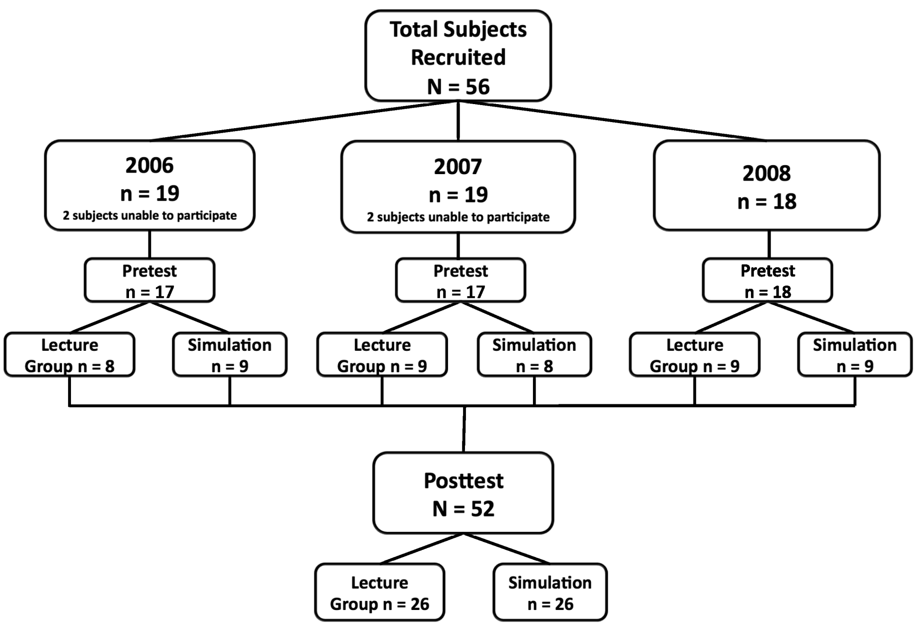

FIGURE **Study Design**

TABLE 1 **Scenario Events and Advanced Cardiac Life Support (ACLS) Algorithm**

Scenarios[a]	ACLS Algorithm
54-year-old man admitted with chest pain and shortness of breath, now in cardiac arrest	Ventricular fibrillation
68-year-old woman on postoperative day 2 after a right total knee replacement who is not ambulating and has a pulmonary embolism	Pulseless electrical activity
60-year-old man on postoperative day 1 following an anterior cervical discectomy now in respiratory arrest	Pulseless electrical activity
48-year-old woman with abdominal pain and a distended abdomen who is severely hypovolemic	Pulseless electrical activity
59-year-old man on postoperative day 1 following a left above-the-knee amputation	Pulseless ventricular tachycardia
55-year-old woman with dialysis-dependent end-stage renal disease, hypertension, and diabetes who is now hyperkalemic	Pulseless electrical activity

[a] Scenarios adapted from actual patient cases, developed by an anesthesiologist, anesthesiologist-intensivist, and 2 medical intensivists. Each scenario ran for 20 minutes; the subject was expected to recognize simulated patient distress, call for help, and lead the arriving emergency response team to manage the resuscitation. The resuscitation team would arrive 5 minutes after the subject called for help.

help, and lead the resuscitation team. This team consisted of 2 experienced anesthesiologists, 1 of whom was an intensivist, and a critical care nurse. Participants were told to verbalize all requests of the responding team. The team was instructed to provide requested information and assistance.

Debriefing and Intervention

Following the baseline simulation, each participant received an individual debriefing on his or her performance that identified areas for improvement. During debriefing, each participant's comfort during the scenario was assessed through questions. Participants were randomly assigned to 1 of 2 equal groups for teaching critical CRM skills (BOX 1). The SIM group engaged in 2 separate 2-hour simulation SIM sessions, the LEC group attended 2 separate 2-hour lectures. Both interventions taught the critical CRM skills (BOX 1). Lectures were taught by 2 anesthesiologists and a critical care nurse. All participants were individually tested 6 months after the educational interventions, 1 month before graduation.

BOX 1 **Critical Crisis Resource Management Actions**

- Identify distress
- Call for help
- Request name and role of arriving code team personnel
- Request readback of statements and requests (ie, the subject should ask the team to repeat all requests to administer medications, medication name, dose, route of administration, and completion of tasks)
- Attempt ventilation
- Successful ventilation
- Leader does not perform direct patient care and assigns all tasks to the appropriate team member (eg, assigns ventilation to an expert)
- Leader restates presumptive diagnosis and vital signs
- Leader asks team for suggestions

Video Review of Scenarios

All scenarios were videotaped and reviewed to assess performance of critical actions (BOX 1) and communication patterns (BOX 2).

The study was approved by the Cooper Health System Institutional Review Board, and all participants gave consent.

Communication Pattern Review—Leader-Team Interaction Analysis of Preintervention and Postintervention Videos

To characterize and analyze team performance and decision-making processes between the participant and the team, we constructed a communication matrix and reviewed the simulation videos to evaluate the interaction between the code leaders and the team. The matrix, based on the military debriefing work of Entin et al,[34–36] captured time-based elements and information participants were considering to assess their decision making and actions.[23] While we evaluated medical technical skills (eg, successful ventilation), we were most interested in the performance of CRM skills (eg, calling for help, announcing the diagnosis, asking the team for suggestions; TABLE 2). A rating criterion for video analysis assessed the communication of

BOX 2 **Critical Communication Matrix Elements**

Information requests	Subject requests information from team
Information transfers	Subject acknowledges receipt of requested information
Action requests	Requests by the subject for the team to complete a critical action
Action transfers	The subject acknowledges that the action was completed

TABLE 2 **Critical Crisis Resource Management Actions Results**

Critical Action	Pretest SIM Practice, %	Pretest Lecture Only, %	Posttest SIM Practice, %	Posttest Lecture Only, %	*P*
Identify distress	100	100	100	100	.99
CFH	92	92	100	96	.84
Request role and name	31	35	92	39	< .001
Request readback	12	15	85	46	.008
Attempt ventilation	100	100	100	100	.99
Successful ventilation	36	27	39	27	.82
Leader assigns patient care tasks (eg, ventilation) to expert	0	0	100	27	< .001
Leader performs direct patient care	89	89	8	73	< .001
Leader restates presumptive diagnosis and vital signs	27	23	100	65	.001
Leader asks team for suggestions	0	0	77	19	< .001

Abbreviations: SIM, group engaged in simulation-based education with deliberate practice sessions; CFH, call for help.

critical information or actions categorized as "information" requests or transfers and "action" requests or transfers (BOX 2). All requests and transfers were tracked and summed for each 1-minute interval for the 10-minute time periods in the preintervention and postintervention assessments. Video analysis was performed by the principal author and cross-checked by 2 other examiners familiar with the simulation scenarios. Questionable ratings were marked and reviewed by the 3 examiners before final scoring. There were 2 questionable ratings for 52 reviews, and both were resolved easily.

Data were analyzed by using univariate and multivariate analysis of variance with repeated measures for pretest and posttest evaluations. Nominal data were analyzed by using Pearson χ^2 and Fisher exact tests. Statistical analyses were performed with SPSS version 20 (IBM Corp) with $P < .05$ considered statistically significant.

Results

Preintervention

Three groups of PGY-3 residents (19 in 2006, 19 in 2007, and 18 in 2008) were enrolled for a total of 56. Four participants (2 each in 2006 and 2007) were unavailable for the intervention, leaving 52 participants. The participants in each group were similar with respect to training level, age, and experience. All 52 attempted ventilation and 92% (48 of 52) did call for help. Seventy-eight percent (41 of 52) failed to successfully ventilate the patient, and all continued to attempt ventilation without asking for assistance from the arriving anesthesiologists. In all cases of failed ventilation, the simulated patient died (TABLE 2). Debriefing revealed that the participants recognized their inability to manage available resources. Sixty-four percent (27 of 41) of those who could not ventilate the patient were aware of their ineffective ventilation, and none requested help.

Postsimulation-Based Education With Deliberate Practice Intervention Results (SIM)

All participants recognized distress, called for help, and attempted to ventilate the simulated patient; however, 73% (19 of 26) failed in the latter task. All SIM participants, including those who could ventilate, assigned ventilation to an anesthesiologist in the response team. All announced the patient's vital signs and presumptive diagnosis aloud, and 77% (20 of 26) asked the team for suggestions (TABLE 2). The communication matrix revealed that these participants continued transfers of information and action requests with few gaps in communication.

Postlecture Intervention Results (LEC)

All participants recognized distress; 96% (25 of 26) did call for help. Sixty-one percent (16 of 26) of participants failed to successfully ventilate, and 73% (19 of 26) continued to attempt ventilation regardless of difficulty. All participants who could not ventilate the patient were aware of their inadequate ventilation. Seventy-three percent (19 of 26) of participants continued direct patient care while attempting to manage the team (TABLE 2). Debriefing revealed that participants did not feel capable of managing resources effectively.

Communication Between Leader and Team

The communication matrix variables reflect the effectiveness of information exchange between the participants and team. These variables were measured across preintervention and postintervention periods between the SIM and LEC groups, and were quantified by summation of requests and transfers of information. All measures were significantly increased for each group during postintervention testing. The SIM participants demonstrated significantly higher ($P < .001$) communication skills, quantified as successful information and action transfers, than the LEC participants.

Debriefing Sessions

During the postscenario debriefing, participants reported difficulty in assessing the patient, communicating with the team, and prioritizing treatment steps. All participants said they behaved as if they were taking care of real patients and characterized the scenarios as realistic. The SIM participants reported that the opportunity to practice and debrief scenarios helped them learn to identify and treat the problem and manage the team. The SIM and LEC groups differed in their response to questions about performance, with a much higher percentage of the SIM group indicating comfort with CRM practices (eg, asking the team for help, asking for suggestions, assigning tasks to the team), comfort with managing the simulated emergency, and ability to manage the team. A higher percentage of SIM group participants also reported they incorporated lessons from the educational sessions, and the sessions made them more confident with real patients.

Discussion

Our study showed that simulation-based education with deliberate practice of CRM skills resulted in improved rare event and team management by senior internal medicine resident code leaders. While lecture format yielded some improvement in team and event management, the improvement was significantly greater for members of the simulation training group, especially for communication results. During debriefing sessions, participants disclosed difficulties they encountered while attempting to manage the event and team. While the LEC group demonstrated improved management, they reported that they did not feel comfortable asking the team for suggestions. In contrast, SIM participants reported that these sessions taught them to ask the team for help, resulting in greater comfort in both simulated and real code events.

Several studies suggest training deficits for residents functioning as leaders of code teams. Despite reporting that ACLS algorithm training seemed sufficient, many felt leadership training was insufficient.[15,16,37–40] Significant numbers of residents reported feeling unprepared for (78%), overwhelmed by (73%), and incompetent at (22%) managing cardiac arrests.[41] In the current study, the SIM participants reported increased comfort in managing real patient codes compared to the LEC group.

Simulation-based education with deliberate practice has been used to successfully teach procedural skills and adherence to algorithm steps.[25,26,32] While several studies identified that team behaviors correlate with timing and quality of cardiopulmonary resuscitation,[32,42] few studies have addressed leadership education and CRM skills.[43–47] A retrospective analysis of simulated scenarios found that residents who demonstrated good or subpar performance in 1 domain (technical or nontechnical skills) showed performance at a similar level on the other domain.[48] Yee et al[49] demonstrated that residents exposed to simulated CRM training demonstrated improved nontechnical skills in a repeated simulated arrest. While this study offered an additional simulation session, it did not allow participants to review and deliberately practice poorly performed skills.[49]

Few educational programs or guidelines exist for teaching residents to become code leaders, and we sought to identify a successful approach to teach the nontechnical elements of resuscitation team management. While there was some improvement in the residents' scores after a lecture program in leadership skills, the improvement in the group exposed to simulation-based education was significantly greater.

Limitations of our study include the small number of participants and that the study was conducted at a single institution. The SIM group members may have become more familiar with the simulated environment during their education sessions. Another limitation is that while a growing body of work supports the use of simulation, we cannot predict whether participants' actions would be similar during a real patient emergency, nor can we infer the effect on patient outcomes as a result of suboptimal performance in code events.

Neither group in our study demonstrated improved ventilation skills. We did not teach airway management or ventilation in this study, but advised participants to identify technical skills they did not perform well, and assign those tasks to the appropriate professional. We stressed that code leaders should not perform patient care while leading the team. The SIM group assigned patient care and led the team with greater success, and reported comfort with asking the team for help, while the LEC group reported they remained uncomfortable assigning tasks to other members of the team.

Conclusion

We demonstrated that simulation with deliberate practice to teach senior resident code leaders CRM skills improved performance in communication and leadership skills. Residents exposed to simulation communicated and completed CRM skills more effectively than those taught in a lecture format.

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