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Using Medical Simulation to Teach Crisis Resource Management and Decision-Making Skills to Otolaryngology Housestaff

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Abstract

Objectives. Develop a course to use in situ high-fidelity medical simulation (HFS) in an actual operating room (OR) to (1) teach teamwork and crisis resource management (CRM) skills simultaneously to otolaryngology and anesthesia trainees and OR nurses and (2) provide decision-making experience to ear, nose, and throat residents and OR teams in simulated high-risk, low-frequency airway emergencies.

Study Design. A simulation-based, in situ CRM course was developed to teach airway management and CRM in the OR. Upon completion of each course, the participants were surveyed using questions with (1-5) scale answers.

Setting. The simulated clinical scenarios took place in the intensive care unit and OR at Children's Hospital Boston.

Subjects and Methods. The participants consisted of pediatric otolaryngology fellows, otolaryngology residents, anesthesiology residents, fellows, and certified registered nurse anesthetists as well as OR nurses. Fifty-nine individuals participated in 9 simulation-based courses given between October 2008 and May 2010. The team members participated together in 3 simulated medical crises that centered on airway and anesthesia issues. Each simulated crisis was followed by a structured debriefing session conducted by trained debriefers. Embedded within the course were didactics on CRM principles.

Results. The participants' responses on the survey included General Course Organization, Realism, Debriefing, and Relevance to Future Practice. Ninety percent of the responses were favorable or very favorable.

Conclusion. Using a newly developed, in situ HFS-based course, clinical decision-making skills and teamwork can be effectively taught concurrently to members of an OR team.

Keywords

in situ high-fidelity simulation, crisis resource management, CRM, clinical decision making, simulation-based course, debriefing

Academic medicine has always been confronted with the dilemma of how to improve patient safety while providing excellent postgraduate medical education. The processes required to give optimal clinical care and offer surgical residents and fellows first-rate clinical experiences can at times be at cross-purposes. That is, learning surgery (a process inherently associated with errors) is difficult in an environment where the goal is to provide the best possible health care.

Over the past decade, it has become apparent that medical errors are pervasive in health care and that many of these errors occur in the operating room setting, especially during emergences.[1,2] Lapses often occur not only from technical skills or knowledge base but rather from breakdown in communication and collaboration among operating room (OR) team members. Lingard et al[3] showed that 30% of communications in the OR failed to convey the intended information properly. Thirty-six percent of these failures (approximately 10% of all OR communications) resulted in visible effects on system processes, including inefficiency, team tension, resource waste, workarounds, delay, patient inconvenience, and procedural error.

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Table 1. Principles of Crisis Resource Management (CRM)

Role clarity
Global assessment
Communication
Resources
Personnel support

The surgical environment has a number of factors that make it susceptible to communication and teamwork failure. These include

- Time pressure (both production/scheduling issues as well as the acute nature of surgical emergencies)
- Frequent rotation of OR personnel (both on a day-to-day basis as well as during the course of each day)
- The presence of multiple services (surgery, anesthesiology, and nursing)
- Participation by trainees
- A definite hierarchy

Despite the longstanding presence of each of these factors, multidisciplinary surgical teams in otolaryngology do not routinely receive formal training in how to function as a team.

During the 1960s, the Federal Aviation Agency determined that a significant number of airline mishaps were not due to mechanical malfunction but rather to "pilot error." These errors were secondary to inadequate teamwork, ineffective use of resources, and flawed communication.[4] At that time, the airline industry developed crisis resource management (CRM). CRM teaches individuals the principles of teamwork (**Table 1**). With the advent of CRM, the airline industry has improved its means of communication by altering its culture. Before this alteration, the pilot was the unquestioned leader of the aircraft and its operation. Now, that culture has transformed to a work environment where the pilot is a leader of team members who are empowered to work through problems in concert. Although not conclusively proven, evidence suggests that CRM training has significantly reduced the number of non-equipment-related aviation accidents.[5] The tool to teach CRM to airline personnel has been the flight simulator.

The communication and leadership problems that were occurring in the airline industry are comparable to those that are now being faced in medicine. One approach to solving this problem has been the use of medical simulation. Simulation has been in use for training medical personnel for some time. There are 2 types of simulators. One is the task trainer, which can be very effective in teaching procedural methods. Examples within otolaryngology are laryngoscopy and bronchoscopy trainers, temporal bone surgery simulators, and functional endoscopic sinus surgery simulators. The other type of simulator is high-fidelity medical simulation (HFS). HFS involves sophisticated whole-body manikins designed to provide realistic tactile, auditory, and visual stimuli. HFS has been shown to be a robust teaching tool uniquely suited to provide realistic encounters without risk of patient harm.[6] In this context, the emphasis is shifted. Instead of teaching specific technical skills, the participants receive instruction in human factors associated with optimal team performance in the delivery of efficient and safe patient care. Anesthesia has been using HFS to teach decision-making skills and CRM principles for the past 15 years.[7] Since then, many specialties, including critical care,[8,9] emergency medicine, OB/GYN, cardiology,[9] and cardiac surgery, have all used medical simulation to achieve these goals.

The Department of Otolaryngology and Communications Disorders (ORL) at Children's Hospital Boston (CHB) has been using HFS to teach CRM principles and decision making since 2002.[10] Initially, our HFS courses took place at an offsite simulation center. This had the advantage of isolating the participants away from the hospital and allowed them to concentrate on the simulation course without the distractions of clinical responsibilities on that day. However, it became evident that there were benefits to having the simulation courses occur at the hospital. In situ HFS takes place in the actual clinical setting at the point of care. It became apparent that this type of simulation program would have the advantages of less disruption of clinical schedules, scenarios that are more realistic, training with native teams and reduced costs.[7] Because of this, the Otolaryngology Department at CHB, in collaboration with the CHB Simulation Program, developed a course using HFS delivered in situ. This course uses the simulator at the point of clinical care as a tool to teach CRM and critical decision-making principles to otolaryngology housestaff within the context of native teams. The objective of this project is to develop a course to use in situ HFS in an actual OR to

1. Teach teamwork and CRM skills simultaneously to otolaryngology and anesthesia trainees and OR nurses
2. Provide decision-making experience to ORL residents and OR teams in simulated high-risk, low-frequency airway emergencies

Methods

Facilities and Materials

The simulated clinical scenarios took place in the intensive care unit (ICU) and ORs at Children's Hospital Boston. Equipment and supplies from both clinical settings were used. This included surgical instruments and equipment, disposables, anesthesia carts, and, if needed, code carts. The Department of Otolaryngology as well as the CHB Operating Room contributed operating room time.

The CHB Simulation Program provided manikins, control equipment, technical support, and expertise to administer the simulations. A Laerdal SimMan (Laerdal Medical Corporation, Wappingers Falls, New York) manikin was used in both the ICU and OR settings. A manikin voice was provided through an embedded speaker system, allowing the manikin to "speak" a history and respond to the questions. The technician, under the direction of 2 clinical facilitators (M.V., P.W.), manipulated the manikin's vital signs to simulate various clinical conditions.

Participants

The participants consisted of pediatric otolaryngology fellows (PGY-6), otolaryngology residents (PGY-3), anesthesiology residents, fellows, and certified registered nurse anesthetists (CRNAs) as well as OR nurses. All participants took part in their regular OR and floor activities on the morning of the simulation.

Institutional Review Board Exemption

This study does not require institutional review board approval as it meets the Children's Hospital Boston criteria establishing it as a quality improvement and educational/competency activity. The criteria may be found at www.childrenshospital.org/cfapps/research/data_admin/Site2206/Documents/cipp_081_014_qi_vs_rsrch.doc.

Course Design and Implementation

Each course started at 11:30 AM and finished at 4:30 PM (**Table 2**). Lunch and snacks were provided. Each course session comprised 3 scenarios and 1 embedded didactic session. Every simulation scenario was followed by a structured debriefing session that was facilitated by a trained debriefer. The debriefings took place in a conference room adjacent to the clinical areas. The scenarios were videotaped to review during the postscenario debriefings and for archiving.

The course structure developed for this program consisted of 4 components—namely, an introduction, simulation scenarios, postscenario debriefings, and a final review and summation. These are described in the ensuing paragraphs.

Introduction

The purpose of the introductory session is to set the stage for a safe learning environment. This is often the participants' first encounter with simulation, and so it is important to put them at ease. The instructors and participants introduce themselves to each other, and the ground rules for the simulations are given. The simulations are not for assessment, so the nonevaluative nature of the course is emphasized. They are told that mistakes may occur. These are "puzzles to be solved, not crimes to be punished." A nondisclosure agreement and a video/photo/research consent are obtained per CHB Simulation Program protocol. During the introduction, the group participates in an educational game and watches 2 videos. These serve to introduce them to CRM principles. These didactics allow the participants to start to build a conceptual framework of these principles and of what it takes to perform as a good team.

Simulation Scenarios

To optimize realism as well as reinforce important clinical learning points, simulation scenarios are adapted from real patient cases. Scenarios take place within the CHB operating rooms during normal working hours and in the midst of normal clinical activities. Each scenario lasts from 15 to 45 minutes. Cases begin with the patient in a distressed state (ie, stridor, aphonia, respiratory distress, etc). The clinical condition of the "patient" will vary in direct response to participant/team interventions. Therefore, no 2 simulations are exactly alike, allowing the participants to experience (and later on experiment with) their performance as members of a team during a crisis (**Figure 1a**).

Debriefing

After each scenario, structured video-based multidisciplinary debriefings (**Figure 1b**) are held by trained facilitators. The debriefings are considered the most important component of the course, providing unique opportunities for team members to reflect on and discuss practice strategies within a safe and structured environment. Sessions follow 3 phases:

1. Participants are asked how it felt to be in the clinical situation, followed by a review of the medical facts of the case.
2. Using techniques adapted from industrial models of organizational learning, debriefers explore team performance. CRM principles (eg, leadership, communication, fixation, and failure to speak up) are discussed. Participants begin to learn that matters such as hierarchies, poor definition of roles, and lack of an event manager can all contribute to deficient team performance and inadequate care for the patient.
3. Key learning points identified during the debriefing are summarized.

At the end of the debriefing, the participants are given a short break, and the scenario/debrief cycle is repeated twice more.

Course Conclusion

At the end of the course, the instructors summarize the teaching points, and then the participants are given the last word. Each is given a chance to reflect about the simulation, the course, and his or her experiences. The course is concluded by having all participants complete postcourse questionnaires.

The Otolaryngology Department at CHB has 3 to 4 pediatric otolaryngology fellows per year as well as PGY-3 residents who rotate from each of the 3 otolaryngology programs in Boston (Boston University, Harvard, and Tufts). Each trainee attends the simulation course once during his or her CHB rotation.

Course Evaluation

At the conclusion of each course, each participant was asked to fill out a 25-question survey. Twenty-two of the questions were answered on a 1- to 5-point Likert scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, 5 = *strongly agree*). Three of the questions called for narrative answers.

Results

A total of 59 individuals participated in 9 simulation-based courses given between October 2008 and May 2010. The participants included 18 otolaryngology (PGY-3) residents, 7

Table 2. Schedule for Otolaryngology In Situ High-Fidelity Simulation Course

Children's Hospital Boston
SIMULATOR PROGRAM

OR CRM ORL Multidisciplinary Team Training
Facilitators: PW, MV, AN, JP
Course Outline

Time	Topic	Roles	Location	Notes
12:00-12:15 PM	Course begins for ORL	Peter	7 South ICU Conference Room	ORL residents and fellows meet in the 7 ICU South Conference Room, Consent; sign out on ORL patient list. They will then be called to the 7S ICU Procedure Room to see a patient arriving to the "ED."
	Introduction to course/consent	Mark		
12:20-12:40 PM	Scenario I, Part I	Nurse: Liana (headset)	ICU Procedure Room	Scenario I, Part I: Todd Palich, Part I
		Control: Gavin		Residents may ask the nurse in the room to book the OR. Nurse will call ext. 5-9761 to speak to the control room.
		Director: Mark		
		OR voice: Peter (headset)		
12:45-1:00 PM	Course begins for OR RNs and anesthesia	Peter	Farley 318	At 12:45 PM, the course will begin for OR nursing and anesthesia in the Perioperative Conference Room. ORL will join the group. We will introduce the course and the facilitators and meet the participants.
	Introductions/lunch			
1:00-1:10 PM	Patient census	Andres	Farley 318	Participants will be given the OR schedule to create clinical context. The ORL will give sign-out to the OR team on the patient seen in ED.
	ORL sign-out	ORL team		
1:10-1:20 PM	Intro slides	Peter	Farley 318	Outline of the day's events
	Game play			Tennis ball game: hook into the principles of CRM
1:20-2:00 PM	Part I: CRM Didactic	Peter	Farley 318	Show second half of Sachs video
2:00-2:15 PM	Prepare OR	Participants	OR	Participants will have 15 minutes to prepare for the emergent OR case. The manikin will be off to the side. When the room is prepped and ready, the manikin will be transferred from the stretcher to the OR table.
2:15-2:45 PM	Scenario I, Part II	Confederate: Andres or Jen (headset)	OR	Scenario I, Part II: Todd Palitch, Part II
		Control: Gavin (headset)		
		Director: Mark		
		Camera: Liana		
		Observer: Peter (headset)		
2:45-3:15 PM	Debrief Scenario I	Lead debrief: Peter	Farley 318	Reactions
		Co-debrief: Jen		Understanding
				Summary
3:15-3:30 PM	Break			Refreshments will be provided.
3:30-3:35 PM	Patient update	Mark	Farley 318	Participants will be told who their next patient on the OR schedule is. The room will be already set up.
3:35-4:00 PM	Scenario II	Confederate: Amanda (headset)	OR	Scenario II: Bart Johnson
		Control: Gavin (headset)		
		Director: Andres		
		Camera: Liana		
		Observer: Peter (headset)		
4:00-4:30 PM	Debrief Scenario II	Lead debriefer and co-debriefer: Mark and Andres decide	Farley 318	Reactions
				Understanding
				Summary
4:30-4:45 PM	Closing		Farley 318	1. Summary
	Summary of day's learning			2. What you learned; go around room. No response from instructors.
	Evaluations			3. Fill out evaluations

Abbreviations: CRM, crisis resource management; ED, emergency department; ICU, intensive care unit; ORL, otolaryngology; OR, operating room; RN, registered nurse.

Figure 1. (A) Photo of in situ high-fidelity medical simulation in progress. (B) Screen shot of video taken during in situ high-fidelity medical simulation. Videos such as this, which show the manikin's vital signs superimposed on the image, are used during the debriefing session.

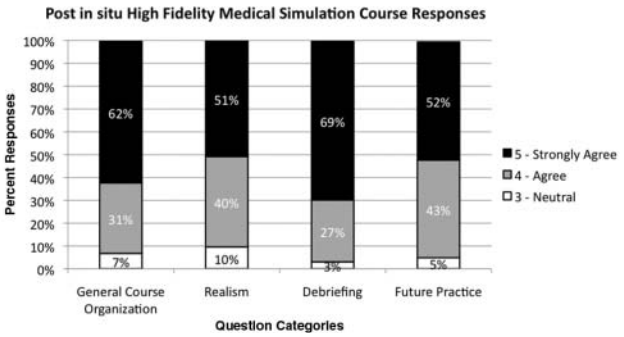

Figure 2. Responses to questionnaires administered to participants after taking the otolaryngology CRM course using in situ high-fidelity medical simulation.

pediatric otolaryngology fellows (PGY-6), 20 OR nurses, 4 CRNAs, 5 anesthesia residents, and 5 anesthesia fellows. All the participants completed a postcourse survey.

The 22 survey questions were categorized into 4 groups: General Course Organization, Realism, Debriefing, and Relevance to Future Practice (see online appendix). No comparison could be made between the responses of the various types of practitioners (eg, nurses vs anesthesiologists) because the surveys were filled out anonymously. The percentage of responses to the questions in each category is shown in **Figure 2**. Ninety percent or more of the participants gave a response that either agreed or strongly agreed that the particular category was advantageous to his or her learning in the course. The participants had very favorable or favorable opinions regarding the course as a whole, the realism of the scenarios, the quality of the debriefings, and the impact that the course would have on their future practice. In addition, 3 questions asked for narrative responses. They were the following: (1) What were the most helpful aspects of the training program? (2) What were the least helpful aspects of the training program? and (3) Do you have any suggestions or recommendations for improving the quality and usefulness of the training program? The answers to these questions are shown in **Table 3**.

One notes from the responses that many of the participants were excited by their participation in the course. From the results of the questionnaire, it appears that the participants had a positive experience during the in situ HFS course.

Discussion

To increase realism and optimize the learning of CRM and critical decision-making skills, we were able to successfully modify our simulation course from a center-based simulation model to an in situ high-fidelity simulator within the ICUs and ORs at Children's Hospital Boston. From a search of the literature and from our knowledge, it does not appear that there are any other otolaryngology training programs using in situ HFS on an ongoing basis. The results of the postcourse surveys show that the simulations were well received.

We have tried to improve the course based on the participants' comments. We noted that they felt that the rooms in which the scenarios and debriefings took place were either too crowded or too small. From this feedback, we have attempted to have the course take place in larger rooms. Also, several participants voiced concerns about the lack of introduction to the manikin and the simulation environment. We have since expanded the introductory portion of the course and have given the participants a short hands-on introduction to the manikin prior to the first scenario.

The change from a simulation center-based course to an in situ HFS has brought about a number of improvements in how CRM is taught to the CHB otolaryngology housestaff. When the course was taught previously at the offsite simulation center, it required the residents to be away from the hospital for most of the working day. The offsite simulation center's hours of operation required the participants to arrive at 7:30 AM. By the time they returned to the hospital at 3 PM, they had missed most of the day's clinical work. In contrast, the in situ HFS was integrated into the residents' workday. It increased access by allowing the housestaff to see patients and operate at the hospital until almost noon on the day of the simulation. They completed the course by 4:30 PM, allowing them to participate in afternoon rounds/sign out.

Having the simulations take place within the actual ORs with actual nurses and anesthesiologists brought about a

Table 3. Narrative Responses to Final 3 Questions on Post–Simulation Course Questionnaire

What were the most helpful aspects of the training program?	Excellent course . . . great that this was in our environment!
	The simulator captures the spontaneous feel of a crisis i.e. bronch equipment not ready as is case with elective case
	Trying to think critically in high-stress environment
	Feedback, supportive environment, emphasis on leadership, great training for emergencies.
	Working as a team in the actual scenario.
	Knowing that speaking what you're thinking is a good thing
	Role clarity
	Reflection on what motivates one to react in certain situations
	Realistic environment
	It was helpful.
	Trying to think critically in high-stress environment
	Debriefing/discussions (8 comments)
	Communication process (3 comments)
	Multiple scenarios
	Introducing each other and establishing rules
	How important closed-loop communication is
	Everything!!
	Avoid fixation
	Doing simulations in the OR
	Going over situations where an immediate response is necessary
	Actual scenarios
What were the least helpful aspects of the training program?	Not knowing what we could actually do. i.e. calling people for help, calling for additional surgeon, etc.
	Perhaps incorporate actors for some roles
	Too many people involved
	In first scenario, clinical picture, having limitations (no drooling, no tracheal compression)
	Crowded rooms
	Some aspects of physical presentation of simulator. Need better introduction.
	Not seeing how an effectively run scenario would have played out—how should an event manager have acted in the scenarios given—who should be the EM? Anesthesia, surgeon, or RN?
	The lack of time to prepare for a stressful simulation situation (case 1)
	Debriefing sessions
	Wish we could practice more scenarios
Do you have any suggestions or recommendations for improving the quality and usefulness of the training program?	Summarize points that can actually be implemented from our experience.
	Do them (the courses) more often
	More scenarios
	Thanks for lunch
	Know some other things upfront like—don't draw up med-use saline with needles and labels that we can shout out for extra help other than team members involved.
	Concentrate on easily immitatable [*sic*] cases
	We never got a chance to review & critique the video and see what would have worked better.
	Thank you
	Ran smoothly. No suggestions
	Better introduction to SimMan and what to expect with SimMan
	Please, please, can we do more!
	Have another chance during the year to practice/other simulations
	More realistic cases like these
	Everyone should do this. Everyone!!

Abbreviations: EM, event manager; OR, operating room; RN, registered nurse.

significant improvement in realism and in interpersonal/team dynamics. This was evident in several of the conversations between participants during the postscenario debriefings. Many of them said that during the simulations, they felt the same emotions and thoughts that they felt during actual crises. The presence of native teams brought out the importance of using CRM principles during crises. For instance, the lack of communication during the scenarios was often very revealing to the participants during the debriefings. The group often finds out that different team members had a different concept of the patient's diagnosis and a completely different notion of what the management goals should be. This was particularly common between teams (ie, between nurses and surgeons). This lack of a shared mental model is often eye opening to the participants and emphasizes the need for good communication skills in a crisis. This type of interaction and the ensuing discussion during the debriefing could only happen with personnel who are native to the OR environment.

Another benefit of simulation occurring at the point of care is the ability of in situ HFS to identify systemic problems within the hospital environment itself. For instance, during 1 simulation, the participants wanted to call a code and were unable to locate either of the 2 code switches in the room. This was because of inadequate signage and the presence of more than the usual amount of equipment in that room. Afterward, this incident prompted the OR administration to improve the signs pointing to the code switches.

A number of limitations are apparent regarding this specific study and in situ simulation in general. One is that although it appears that the in situ simulation course has been well received, we relied on a survey that was not validated and lacked a control. We assumed that performing in situ simulation would increase realism and therefore improve the learning experience for the participants. However, we have not measured the ability of the participants to learn and retain CRM principles in this simulation environment.

A number of questions need to be answered going forward. One of the advantages of using in situ simulation is that not only do the targeted participants (in this case, otolaryngology housestaff) benefit from the course but so do the others who are also participating. In our hospital, the otolaryngology trainees rotate for periods varying from 3 to 12 months. However, the anesthesiologists and the nurses, in particular, tend to stay for years. In this situation, will the continued rotation of nurses and anesthesiologists through the course bring about an improvement in the culture of safety within the ORs at CHB? We intend to evaluate this with a validated longitudinal survey of the nurses' attitudes toward safety and CRM principles.

Conclusion

In addition to technical issues, poor communication ranks high in the causes of preventable errors within the operating room. Medical simulation offers a robust tool in teaching both technical and communication skills to health care professionals within a highly realistic environment, free from patient harm. Using in situ high-fidelity medical simulation, critical decision skills and CRM principles were taught to otolaryngology housestaff at the point of clinical care and among native OR teams at Children's Hospital Boston. The course was well received. We feel that this program not only has the capability to improve the crisis resource management skills of our rotating residents and fellows but also has the potential to improve the overall culture of safety in all our operating rooms.

Author Contributions

Mark S. Volk, design of curriculum, conduction of courses, writing manuscript; **Jessica Ward**, data collection and analysis, conduction of course; **Andres Navedo**, course design, manuscript writing; **Noel Irias**, data collection; **Jennifer Pollart**, design of course; **Peter H. Weinstock**, design of course, conduction of courses, manuscript writing.

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Supplemental Material

Additional supporting information may be found at http://oto.sagepub.com/content/by/supplemental-data

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