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Effects of a Simulation Educational Experience on Critical Care Staff's Recognition of Stressors Affecting Performance and Use of Teamwork Skills

Heidi K. Paradis
Rhode Island College, hparadis_8163@email.ric.edu

EFFECTS OF A SIMULATION EDUCATIONAL EXPERIENCE ON CRITICAL CARE STAFF'S RECOGNITION OF STRESSORS AFFECTING PERFORMANCE AND USE OF TEAMWORK SKILLS

A Major Paper Presented

by

Heidi K. Paradis

Approved:

Committee Chairperson	Cynthia Paderes	5/10/12 (Date)
Committee Members	Judy D Murphy	10/2/12 (Date)
	Lisa Cucca MSN, RN, NE-BC	5/2/12 (Date)
Director, Master's Program	Cynthia Paderes	5/10/12 (Date)
Dean, School of Nursing	Jane Williams	8/15/12

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Abstract

Background: Human limitations are sources of medical error that result in injuries, deaths and cost reaching millions. Preventing human errors from reaching patients is an imperative goal of a healthcare system that desires to reduce costs and produce quality outcomes. There is a mounting body of evidence that safety culture measurement and intervention can impact the safety and quality of healthcare.

Objective: To impact the safety culture attitudes of critical care professionals by providing a teamwork training that incorporated simulation.

Methods: The *purpose* of this study was to examine the effect of teamwork training on critical care staffs' safety culture and teamwork attitudes. A pre and post quasi-experimental *design* was employed. The *sample* included critical care professionals working in four critical care areas. The *intervention* was an 8 hour training involving teamwork didactic and simulation experiences. *Data* were collected via attitude surveys immediately before and after the training and two months following training.

Results: The difference in median values between individuals' pre and post attitude scores was significant ($p < .001$). Aggregate data showed three of the four critical care units and critical care as a whole, significantly improved key safety culture mean scores yet scores remained critically low.

Conclusions: The teamwork training with simulation was effective at impacting individuals' safety culture attitudes. The training had a positive impact on unit level safety culture; however, not enough for it to be considered a healthy climate, indicating the need for continued, broader intervention.

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The Effect of a Simulation Educational Experience on Critical Care Staff's Recognition of Stressors Affecting Performance and Use of Teamwork Skills

Background

Patients today have no guarantee of high quality care that is free from risk or harm. Although most patients receive treatment that improves their health and/or quality of life, an unacceptable number are harmed as a result of their encounter with the health care system (Carthey & Clark, 2009). Although it is the responsibility of all who work in healthcare to ensure safe, quality care, nurses are in an extraordinarily influential position to impact the safety and quality of care.

The patient safety movement was highly influenced by the release of the Institute of Medicine (IOM) report *To Err is Human: Building a Safer Health System* (Kohn, Corrigan, & Donaldson, 2000), which called for the health care industry to open its eyes and mouths on the subject of patient error. This report provided staggering figures on the number of deaths due to medical errors annually (44 to 98,000) and the associated cost, "estimated between $17 billion and $29 billion, of which health care costs represent over one-half" (p. 1). The harm caused to patients results in emotional stress for those who caused it and in a loss of faith in the system by the consumers who depend on it. The report urged the health care profession to build an organizational culture that encourages recognition of and learning from errors. A paradigm shift that challenged the health professions to recognize that human beings make errors and that it is crucial to learn from them and revise our systems to compensate for human limitations was urgently needed.

Subsequently, many organizations, such as the Agency for Healthcare Research and Quality (AHRQ), National Quality Forum (NQF), and The Joint Commission (TJC), sharpened their focus on patient safety as a requirement for quality. Many new organizations formed and legislation was passed to help ensure the safety of patients and to promote research to discover and share best practices to prevent error. There has also been a steady growth of research related to errors in health care, which include communication, physical environment, assessment, leadership, and human factors (TJC, 2011). James Reason (2000) focused on human factors or limitations that make us prone to errors, and proposed that it is rarely one factor that causes a sentinel event. It is usually a series of smaller, minor mistakes, when lined up together that lead to a larger event. A systems approach means recognizing these threats and embedding systems with barriers and defenses that mitigate for inevitable human error (Reason, 2000). A culture of safety is one in which all members of the healthcare team are aware of and on the lookout for these threats, and also one where best practices are used by all to prevent failures. Adding to the evidence supporting the importance of safety culture, TJC now requires hospital leadership to create and maintain a culture of safety. Leaders are expected to evaluate the safety culture using valid, reliable tools and then implement changes accordingly (TJC Accreditation Manual E-edition, 2010). Nurses, particularly in advanced practice roles, are uniquely positioned to help build a culture of safety and to incorporate research to promote practice and system changes that compensate for human limitations that lead to error. Safety culture assessment should be used to discover areas

of improvement that could lead to fewer adverse events, improved outcomes, and potentially decreased costs.

Definition of the Problem

At the Miriam Hospital (TMH), a 247 bed community hospital within the Lifespan Network, leadership continuously strives to maintain the safety culture through on-going assessment and planning for improvement. One validated assessment of multiple domains of the safety culture is the Safety Attitude Questionnaire (SAQ) (Sexton et al., 2006), which has six subscales: teamwork climate; safety climate; job satisfaction; stress recognition; working conditions; perceptions of hospital management; and perceptions of unit management. As part of a state-wide ICU Collaborative, TMH critical care units annually used the SAQ to evaluate the safety culture, and all units made significant improvements (greater than 10 percentage points) over the past four years in five of the six domains. In 2010, TMH participants scored among the highest in the state overall in the safety climate and working conditions domains. However, during the same time period, TMH respondents remained among the lowest (below the 'danger zone' of 60%) in the stress recognition subscale. This category measures the acknowledgement of how performance is influenced by stressors, an important skill in order to successfully discuss and learn from errors. In other words, staff respondents did not recognize, and may continually deny, the effect of stress and fatigue on their performance. In a healthy safety culture, recognition of these human limitations reduces the likelihood of error by increasing the use of threat and error management strategies (Sexton, Thomas & Helmreich, 2000).

This author, the critical care educator at TMH, questioned what could be done to improve staffs' awareness of their human limitations, explore strategies that might compensate for these factors, and also make them aware of how not doing so leads to error. A literature review was conducted to identify an evidence based approach that might involve simulation as a strategy. As a result, the author developed a simulation based educational intervention to potentially improve the SAQ scores. The purpose of this study was to evaluate the effect of such an educational experience on the staffs' ability to recognize how stressors affect their performance and lead to error and to learn strategies to counteract this human limitation.

Literature Review

Impact/Etiology of Errors

The staggering financial and emotional cost of error was poignantly outlined in the 2001 IOM report that estimated that 1.3 million patients are injured each year due to medical error. One major recommendation was that the healthcare system needed to be redesigned in terms of processes and systems to compensate for the limits of human behavior. The patient safety movement began with an attempt to learn from errors by reporting and analyzing them.

Root cause analysis is a structured method for analyzing serious adverse events in order to learn what factors contributed to the event so that they can be eliminated or minimized by system redesign. Since 2004, TJC has kept and reported root cause analysis data, which has demonstrated that human factors are consistently among the leading causes of errors (TJC, 2011). Many articles cite the seminal works by Rasmussen

(1990) and Reason (1990), who described the performance of humans and those factors that impact limitations of human physical and cognitive performance. Human factors include fatigue, multitasking, distraction, illness, stress, workload, lack of knowledge and training, and inadequate communication, which have a negative impact on performance and make error more likely. When combined with "holes" or inconsistencies in systems and processes, these factors make the perfect storm for error. Such factors include the effect of stress and fatigue, both of which impair performance (Sexton, et al., 2000). These authors studied teams that worked in safety-critical environments and collected data on attitudes that could be used to design training, including simulation, as a systems approach to improve teamwork as an error prevention strategy. One of the authors, Robert Helmreich, had done extensive work in the aviation field, and found that attitudes toward stress, teamwork, and error are linked to performance and are susceptible to training. In their 2000 study, the authors surveyed 1033 medical personnel from the Intensive care and Operating Room areas as well as 30,000 airline cockpit crew members over three years to compare their attitudes toward error, stress and teamwork. The respondents included cockpit crew members from 40 different airlines in 25 countries over 15 years and medical staff from 12 urban hospitals in several countries. Surveys contained 23 core elements worded specifically for each environment and that measured attitudes toward stress, status hierarchies, leadership, and interpersonal interaction issues. Sixty to 70% of medical staff believed they performed effectively when fatigued or during critical events, as compared to 26% of aviation staff. Seventy percent of medical personnel agreed with statements that denied the effect of stress and fatigue on

performance. The authors concluded that this difference may be due to more extensive simulation and teamwork safety training, or crew resource management, in aviation.

In 2005, Rothschild and others conducted a prospective one year observational study to examine the incidence and nature of adverse events and serious errors in the critical care setting. A total of 120 adverse events occurred, of which 54 were preventable. There were also 223 serious errors identified, the most serious occurring during the ordering or execution of treatments. They also noted performance level failures were more often "slips and lapses rather than rule-based or knowledge-based mistakes" (p. 1697).

In a qualitative study, Wetzel et al. (2006) conducted 16 interviews with a purposive sample of London surgeons in order to explore surgical stressors, their impact on performance, and coping strategies used. Semi-structured interviews of individual surgeons were conducted. Findings identified that undue levels of stress impaired judgment, decision-making, and communication. Senior surgeons, in contrast to junior surgerons, were found to have developed strategies for controlling stressful situations, suggesting that such strategies could be learned.

West, Tan, Habermann, Sloan, and Shanafelt (2009) conducted a prospective longitudinal cohort study of 380 medical residents to determine the association of fatigue and distress with self-perceived major medical errors. The researchers used electronic surveys that included self-assessment of medical errors, and validated survey tools to measure fatigue, quality of life (QOL), burnout, and symptoms of depression. Errors were reported by 139 (39%) participants. Reports of error were associated with the Epworth Sleepiness Scale score ($p=.002$) and fatigue score ($p<.001$). Subsequent error

was also associated with burnout ($p<.001$) emotional exhaustion ($p<.001$); lower personal accomplishment ($p<.001$), a positive depression screen ($p<.001$), and overall quality of life (QOL) ($p<.001$). The authors concluded that higher levels of fatigue and distress among medicine residents were independently associated with self-perceived medical errors.

Nurses are not immune from the effects of fatigue. Rogers et al. (2004) conducted a study using logbooks completed by a nation-wide random sample of 393 staff nurses who were also ANA members. The purpose of this study was to determine if an association existed between occurrence of error and hours worked by nurses. Participants recorded information about hours worked and answered questions about errors and near errors they may have made. Nurses who worked more than 12.5 hours were three times more likely to make an error (odds ratio [OR] 3.29; $p=.001$) and those working more than 40 hours per week significantly increased the risk of making an error (OR 1.96; $p <.0001$). Scott, Rogers, Hwang and Zhang (2010) repeated this study with a random sample of 502 American Association of Critical Care Nurses (AACN) members. They also concluded that the risk of error nearly doubled for nurses working more than 12 hours (OR 1.94; $p=.03$), and noted that these findings support the IOM recommendations to minimize the use of 12 hour shifts and to limit shifts to no more than 12 hours.

An experimental within-subjects comparison study evaluated the impact of prolonged continuous wakefulness on resident performance during the management of a simulated patient deterioration (Sharpe et al., 2010). Performance was studied during 26 hours of wakefulness at four time points. The frequency of errors was assessed by scorers blinded

to the time interval, and overall performance was scored using a rating scale. An increase in the mean number of errors (p=.09) and a decrease in performance (p=.02) as hours of wakefulness increased over time was detected, and the authors concluded that fatigue adversely affected performance and led to errors. Landrigan (2010) noted that Sharpe's study adds to the "compelling body of evidence" (p.980), including more than 80 relevant studies, that led to the IOM call for the elimination of shifts exceeding 16 hours without sleep. Long shifts, however, continue to remain the norm at many hospitals. This fact, combined with the knowledge that health care workers deny the effects of stress and fatigue on performance, should cause concern amongst nurse leaders. Allowing controllable human factors such as these to be culturally accepted in the nursing profession leaves us vulnerable to error (Denham et al, 2007).

Safety Culture Interventions

In compliance with TJC recommendations, most hospitals assess safety culture to discover staffs' attitudes that might increase the risk of error, which then provides the opportunity to develop and implement action plans. The Safety Attitude Questionnaire (SAQ) (Sexton et al, 2006) provides specific information about staffs' recognition of the relationship between human factors such as stress and fatigue and performance. With information from this measurement tool, safety and quality improvement initiatives can be designed and implemented at the unit level to achieve sustainable results (Hudson, Berenholtz, Thomas, & Sexton, 2009).

Pronovost et al. (2008) studied the impact of a Comprehensive Unit based Safety Program (CUSP) of evidence based practices on the team climate scale of the SAQ in 72

intensive care units across Michigan. A total of 4,474 surveys (75% response) completed in 2004 were compared to 3,876 surveys (65% response) collected in 2005. One year post intervention, team climate scores on the SAQ improved significantly ($p < .005$), and adherence to some evidenced based measures improved. This study provides support that a unit-level improvement project involving education can impact the safety culture. Improvements in safety culture have been associated with positive patient outcomes. In a cohort study, Huang et al. (2010) combined safety culture survey data with the Project IMPACT Critical Care Medicine (PICCM) clinical database. The purpose of the study was to determine if ICU safety culture was independently associated with patient outcomes. A total of 2,103 SAQ surveys returned from 4,373 ICU personnel (47.9% response) comprised the culture survey data. A sample of 65,978 patients admitted to 30 participating multicenter ICUs from 2001-2005 was also included; outcomes examined included mortality and length of stay (LOS). For every 10% decrease in perceptions of management score, the increased odds of death were 1.24 ($p<0.0001$). Lower safety climate was significantly associated ($p<0.03$) with increased LOS. For every 10% decrease in score, LOS increased 15% ($p= 0.03$). This study adds evidence that interventions to improve safety culture may positively affect patient outcomes in the intensive care setting.

Simulation as Safety Culture Intervention

The IOM (2000) and AHRQ (2001) identified simulation as a best practice tool to engage and educate practitioners in health care in order to prevent and mitigate harm. Other organizations, including the American College of Surgeons, the American Council

for Graduate Medical Education and the National League for Nursing and AACN, also support the use of simulation to enhance learning (Cato & Murray, 2010).

A systematic review conducted by Cant and Cooper (2009) provided an extensive evaluation of the evidence behind simulation as an educational tool in nursing. The review included 12 quantitative studies that compared the effectiveness of medium and high fidelity simulations compared to other methods of education such as lecture, group interaction, case studies, debriefings, or tests. Only one study was a randomized controlled trial; most were pre and post-test quasi-experimental studies with a comparison group. Seven studies included a validated assessment measure. All 12 studies showed statistical improvements in knowledge, skill, critical thinking ability, and/or confidence after simulation education (p. 6), and over half showed simulation to be superior to other methods. What is lacking in the evidence is a standardized tool for measurement of the effect of simulation.

Many studies using simulation and team training were found in the emergency, labor and delivery, and OR arenas. Morey et al. (2002) conducted a prospective investigation using a quasi-experimental, untreated control group design. The Emergency Team Coordination Course™ (ETCC) served as the intervention and included elements of crew resource management. The experimental group (n=684 varied practitioners) participated in the ETCC and implemented formal teamwork structures and processes. Assessments occurred prior to training, and at four and eight months after. Trained observers rated ED staff team behaviors and made observations of clinical errors as a measure of ED performance. Staff and patients in the EDs completed surveys measuring attitudes and

opinions. Statistically significant ($p = .012$) improvements in the quality of team behaviors and reduction in clinical errors ($p = 0.39$) were among the results. ED staffs' attitudes toward teamwork increased ($p = .047$) and staffs' view of institutional support increased ($p = .040$).

Shapiro et al. (2004) tested an intervention involving a didactic training in ETCC, combined with simulation. The researchers used a single, crossover, prospective, blinded and controlled observational design. Outside-trained observers in the ED completed teamwork ratings using validated behaviorally anchored rating scales (BARS). Four ED teams were randomly assigned to two control groups (didactic training) and were compared with two experimental groups (simulation added). The experimental team showed an improvement in the quality of team behavior ($p = 0.07$), while the comparison group did not.

Miller, Riley, Davis and Hansen (2008) conducted a pilot study of 35 simulated obstetric emergencies involving 700 participants. The researchers designed the simulations to replicate stressful events that participants might encounter. Teamwork competencies based on the TeamSTEPPS® Curriculum (AHRQ and DoD, 2004) were evaluated. Participants evaluated their own performance and discussed failures and errors that occurred. Debriefing was emphasized, and debriefing and education occurred in a spacious conference room with food and drinks to enhance participants' comfort. Participants identified areas where they did not perform well and also participated in problem solving to find ways to improve their performance and identify systems issues that could be improved. The researchers analyzed videotapes, provided findings to unit

level leaders, and then developed process improvement initiatives and further team training. The authors compared SAQ scores two months before and six months after the 12 simulation trainings. Although the hospital aggregate data showed no improvement, the perinatal unit had significant improvement in six indices, including improvement at the unit level in teamwork (increased by 5.9%). Follow-up from participants was viewed as crucial because cognitive changes may occur several days after the simulation.

It is clear that safety culture is related to both error and patient outcomes. The safety culture can be measured and is amenable to intervention for improvement. Teamwork and simulation training as a combined intervention were supported as evidence based strategies that can be used to impact ICU staff attitudes, critical to the safety culture.

Theoretical Frameworks

Lazarus' theory of Stress Appraisal and Coping and Kolb's Experiential Learning Theory (1984) were used to guide development of the study intervention. Lazarus and Folkman (1984) defined stress as "a particular relationship between the person and the environment that is appraised by the person as taxing or endangering his or her well-being" (p21). Humans respond differently to the same stressors and each person evaluates the significance of a situation and reacts accordingly, described as cognitive appraisal. Three types exist: in primary appraisal, a person judges an encounter as irrelevant, benign, or stressful; during secondary appraisal, one considers what can be done; in re-appraisal, the individual changes his/her view of the experience based on new information (Lazarus & Folkman, 1984). Person factors influence cognitive appraisal, including commitments and beliefs, especially beliefs about personal control. Appraising

an outcome as controllable is stress reducing. When commitment is deep, motivation for ameliorative action is increased. Situation factors that influence cognitive appraisal include novelty, predictability, and uncertainty. New and unpredictable situations can cause increased stress; therefore practicing and preparing for events until they are familiar can reduce the stress response (Lazarus & Folkman, 1984). Providing strategies or resources can influence the secondary appraisal and affect a person's response to stress. Resources include health and energy (including positive beliefs), problem solving skills, social skills, and material resources. There are also constraints that influence a person's coping, including internalized cultural beliefs and values (Lazarus & Folkman). An intervention designed to stimulate individuals to appraise situations differently and provide resources to cope effectively may assist in managing stress.

David Kolb's Experiential Learning Theory was also considered in designing the intervention. Kolb's theory posits that learners construct new knowledge by adding what is learned from new experiences to what is already known (Billings & Hallstead, 2009). Kolb suggested (1984) that learning occurs in a continuous cyclical pattern. Learners interact in a real experience, then reflect on that experience, create meaning, and fit that into existing knowledge. That meaning is then applied to new experiences by thinking and acting differently. Learning is a process where ideas and concepts are formed and re-formed through application in experience. This theory can readily be applied to simulation as an educational tool in clinical practice (Billings & Hallstead, 2009). Simulation followed by didactic learning provides for immediate application of learning to a simulated realistic experience, and debriefing allows participants to reflect on their

performance to create change for improvement in attitude and behavior. Improvements in performance with use of teamwork skills during patient care events should translate into fewer errors and better patient outcomes.

Methods

Purpose

The purpose of this study was to determine the effect of an eight hour teamwork training with didactic and simulation on critical care staffs' individual and unit level safety culture attitudes.

Design

A before and after quasi-experimental design was used for the study. The independent variable was the simulation intervention; the dependent variables were individual and unit level safety culture attitudes.

Site and Sample

The site was Rhode Island College (RIC) nursing simulation laboratory. The College generously allowed the use of the lab and the simulation faculty contributed their time. The potential sample consisted of multidisciplinary health professionals, including registered nurses, physicians (attending and fellows), physician assistants, and respiratory therapists employed at TMH. Inclusion criteria included all of these critical care professionals who provided direct patient care; there were no exclusion criteria.

Procedures

The proposal was approved by both the Lifespan and Rhode Island College Institutional Review Boards (IRB). Following IRB approval, participants were recruited

from all four critical care units. The researcher posted and emailed an IRB approved flyer (Appendix A) to eligible staff. The project purpose and overview was also announced at staff meetings. It was emphasized that critical care staff who agreed to participate would be required to attend one eight-hour simulation educational training day at the RIC Simulation lab between January and March 2011. Interested participants contacted the researcher directly, at which time an informational letter (Appendix B) was provided and participants identified a date to attend the intervention.

Measurement

Three distinct measurement instruments were used: the Safety Attitude Survey (SAS) (Appendix C); the Teamwork Attitudes Questionnaire (TAQ) (Baker, Krokos and Amodeo, 2008) (Appendix D); and the Safety Attitude Questionnaire (SAQ) (Appendix E). The SAS was used to measure acknowledgment of how performance is influenced by stressors. After discussion and advisement from the originator of the SAQ, J.B. Sexton (personal communication, March/April 2009) , 11 items comprising the stress recognition subscale of the SAQ ICU version were used and three items related to knowledge and use of error prevention strategies were added for purposes of this project. Responses use a Likert scale with scores ranging from 1-5 (1= strongly agree; 5 = strongly disagree). The TAQ was developed by the U.S. Department of Defense to be used with the TeamSTEPPS® program. Baker, Krokos, and Amodeo (2008) developed and pilot tested the tool. The 30 item TAQ measures six constructs: team structure; leadership; mutual support; situation monitoring; and communication. Responses on a Likert scale range from strongly agree to strongly disagree (1= strongly agree; 5 = strongly disagree).

Cronbach alphas range from .70 to .83. The SAQ was developed and refined from the medical translation of a questionnaire used extensively in the aviation industry (Sexton et al., 2000). Many organizations use this survey to measure their safety culture and benchmarking data is available (Sexton et al, 2006). The short form of the University of Texas SAQ was used to measure unit level safety culture attitudes since this is the version used historically at our institution. The authors reported reliability using Raykov's *p* coefficient of .90. Four items comprise the stress recognition scale in this version of the tool. The scores in this category were the target of interest for comparison.

Intervention

The intervention included an eight hour educational training incorporating didactics and simulation (Appendix F). On the day of training, the informational letter was reviewed and any questions answered. Participants completed the SAS (Appendix C) and the TAQ (Appendix D) pre-intervention. Participants then attended an eight-hour educational session, the TeamSTEPPS® Curriculum (AHRQ & DoD, 2004). This is an evidence-based training developed by the Department of Defense (DoD) and the AHRQ to optimize team performance to mitigate for the human limitations of individuals. The training includes four core competency areas: leadership; situation monitoring; mutual support; and communication, which contribute to improved team performance, safer practices, and change in culture. This interactive session included identifying sources of stress and fatigue, their effects on performance, techniques to mitigate these stressors, and other team based error management strategies. The curriculum used interactive group activities and video clips to illustrate concepts and role play to apply concepts and

strategies. After the didactic portion, participants received a brief orientation to the simulation center environment. Next, participants actively participated in a 10-15 minute simulation scenario using high fidelity equipment. The researcher, with the assistance of simulation center personnel, developed the simulation scenarios to replicate patients whose condition deteriorated. A confederate role player intentionally set up a medication error. Participants responded as a team to the situation as they normally would, but were asked to try to implement some of the concepts they learned about during the training. Videotaping was used to guide debriefing and enhance learning but participants were assured that it was not being used for evaluative purposes and would not be stored but erased immediately after debriefing. During a 20-30 minute debriefing, the participants were guided to discuss the scenario and whether they were able to implement any of the concepts learned. Any adverse events were discussed and contributing factors explored. Participants had another opportunity to apply concepts to a second simulated experience, and were encouraged to discuss how they could apply teamwork techniques to improve performance in order to prevent errors. In a second debriefing, participants again viewed their performance, discussed how stressors affected their performance, how they used strategies to prevent error, and how these strategies could be applied to future practice. At the conclusion of the program, participants again completed the SAS and the TAQ as well as a course evaluation. Pre and post surveys were linked with a de-identifiable code. A total of six sessions were offered.

All staff on the four critical care units (not just those who attended the training) then received an electronic link via email to complete the SAQ in May, two months after

training was completed, with a 50% response rate This optional, confidential, and anonymous survey was administered via survey monkey. SAQ scores completed October 2010 (response rate 75%) as part of the statewide ICU collaborative were compared to scores completed post intervention to measure effect of the training on the unit-level safety culture, specifically the stress recognition category.

Data Analysis

Data were analyzed using Sigma Stat. Descriptive statistics were performed on all data.

Results

Twenty seven participants completed both the program and the pre and post surveys, with no missing data. All items on both the TAQ and the SAS showed a difference between pre and post scores that indicated greater agreement with the items. A Mann-Whitney rank sum test showed that the difference in median values between the pre and post scores were significant for the TAQ ($p < .001$) and for the SAS ($p < .001$). Greater difference overall was seen in the SAS before and after scores, those indicating recognition of how stressors impact performance, than the TAQ before and after scores, those indicating agreement with teamwork concepts (Table 1). The differences in before and after mean scores of the stress recognition items (SAS) ranged from .111 to .926 (overall difference .545). The Teamwork concepts mean score differences ranged for Team Structure .148 to .593 (overall difference .371), Leadership .074 to .259 (overall difference .197), Situation Monitoring .260-.408 (overall mean difference .320), Mutual Support .185-.333 (overall difference .259) and Communication .37-.85 (overall

difference .545). The largest difference in concept means was seen in the communication subscale of the TAQ which includes items that acknowledge that poor communication among teams can lead to error and effective communication strategies can help prevent error.

Aggregate SAQ scores from November 2010 (pre-intervention) were compared to aggregrate SAQ scores completed post intervention. For purposes of this research, only scores on the stress recognition subscale, which is comprised of four items, will be reported. Scale scores (mean of all four items in this scale) were calculated for each of the four critical care units and compared to previous scores. A mean scale score for critical care as a whole was also calculated. According to Pascal Metrics Inc., a clinical risk management consulting team that administered the survey for the ICU collaborative, an improvement of 10% or more is considered meaningful and likely to be statistically and practically significant, while smaller differences are more likely due to random variation. Scores are reported as percent positive or the percent of those answering agree or strongly agree with a given item or scale. The goal is to reach 80% positive, indicating that four out of five agree that the climate is good. Scores below 60% ("danger zone") are considered in need of improvement.

As illustrated in Figure 1, three of the four critical care units improved their stress recognition scale scores by 10% or more (ICU 10%, CVTS 26%, CVTI 11%) while one unit decreased by 1% (CCU). The mean stress recognition scale score for critical care as a whole overall improved significantly from 36 to 47.5%. All scale scores remained under 60%. Three of the four individual items making up the scale showed small

improvements (less than 10%). For the item: "Fatigue impairs my performance during emergency situations," the mean scores for critical care showed significant improvement (from 35 to 63%), and three of the four units showed significant improvement (30%, 27%, & 14%) on this item. This one item lifted slightly above the 60% danger zone.

Summary and Conclusions

The inability of interdisciplinary critical care staff to recognize that stress and fatigue alter their performance is a serious risk factor that requires ongoing, intensive intervention. Teamwork training, guided by experiential learning theory, and combined with evidence based strategies and simulation experience contributed to a synergistic learning experience. Participants' evaluations of the program (Appendix G) indicated that all agreed that course objectives were met; participants were satisfied with the training, and most added comments that this training should be mandatory for all employees. Many commented on how valuable the debriefing aspect was to apply learning to practice.

The significant differences in pre and post survey scores demonstrated that the teamwork training with simulation was effective at impacting individuals' safety culture attitudes. This change in attitude was evident during the video debriefings. Also during the debriefing, the embedded medication error was revealed. Only one group caught the error during simulation. The other groups had to be shown the error they had made and were very surprised. This stimulated much discussion about how strategies could be used to prevent such errors. Other lapses in performance were noted by participants and again generated discussion on how the strategies learned could be used to improve

performance. Team strategies were more frequently used in the second scenario following this discussion. Staff acknowledged the important link between communication and error and the negative impact that stressors have on performance that can lead to error. Participants recognized that working and communicating as a team is a strategy that can help to mitigate for this risk and improve patient safety.

At the broader culture level, some significant improvement in scores was seen, possibly indicating that the training did have some impact on safety culture. However, the culture scores as a whole were still below what is desirable and remained in the danger zone, indicating the need for continued and broader intervention.

Limitations included the limited number of participants; since only 20% of critical care professionals participated, short and long term impact on the culture as a whole is expected to be limited. Likewise, the intervention was included in one limited time period; repeating the intervention, and also exploring alternative strategies, including intermittent 'booster' classes, is indicated. It is possible that other ongoing patient safety initiatives such as a communication improvement initiative in the ICU may have had some influence on participants' attitudes. Continued monitoring with the SAQ, administered two months after training, would be beneficial.

Results were shared with the Department of Nursing and hospital leadership, and funding for continued training has been provided. Continued refinement and on-going support of this training will ideally result in practitioners who can recognize and manage the effects of stress and fatigue on performance during clinical events. Improved individual and team performance could logically translate into reduced error, thus

potentially creating a safer environment. The institution has endeavored to create a safety culture where risks are reported and error is reduced. When errors do occur as a result of human limitations, there is tremendous ability to learn from those mistakes. This project has certainly contributed to that goal.

Implications for Practice

Consistent with the literature (Cant & Cooper, 2009), the video debriefing, where participants viewed and analyzed their performance and then discussed how the concepts learned could be implemented in practice, seemed to be the most crucial learning aspect. During debriefing, participants were able to recognize factors that influenced their performance and discuss specific strategies that could be used to compensate for impaired performance. Simulation is a highly effective tool for nurse educators to use to illustrate clinical issues that cannot readily be taught in practice.

The significant, positive effect of this training on individual attitudes should interest nursing leaders who are responsible and accountable for the safety culture in their practice environments. The improvement in the recognition that fatigue impairs performance is also an important finding in light of the Patient Safety Advisory Group's recent 2011 Joint Commission Sentinel Event Alert on health care worker fatigue and patient safety. The alert calls attention to the impact of fatigue, contributing factors to fatigue, and risks to patients. Actions suggested as part of safety culture include encouraging "teamwork as a strategy to support staff who work extended work shifts or hours and to protect patients from potential harm" (p. 2).

The cost of simulation and the skill required to develop and fully implement simulation scenarios are potential barriers to simulation intervention and research. Despite these constraints, simulation provides such a rich, valuable experience that the investment is worthwhile. Hospitals would be wise to invest in simulation equipment and training for educators so that this innovative, evidence-based strategy can be used as an effective means to impact employee's performance. Improvements in safety culture have been associated with sustained improvements in medication errors, length of stay, nursing turnover rates, and bloodstream infection rates (Hudson et al, 2009). Future studies might continue to explore and expand the impact of various types of improvements in safety culture on patient outcomes such as these. A critical question that remains is whether simulation training that results in improvements in safety culture translates to improved and sustained patient outcomes.

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Table 1

Pre and Post Mean Scores on the TAQ and SAS Surveys (N = 27)

TAQ				SAS			
Item	**Pre**	**Post**	**Change**	**Item**	**Pre**	**Post**	Change
Team Structure	**1.636**	**1.265**	**-0.371**	**Stress Recognition**	**2.513**	**1.968**	**-0.545**
TS1	1.296	1.111	-0.185	SA1	1.926	1.259	-0.667
TS2	1.185	1.037	-0.148	SA2	1.963	1.63	-0.333
TS3	1.815	1.444	-0.371	SA3	1.63	1.185	-0.445
TS4	2	1.519	-0.481	SA4	3.222	2.296	-0.926
TS5	1.667	1.222	-0.445	SA5	2.593	1.741	-0.852
TS6	1.852	1.259	-0.593	SA6	2.148	1.37	-0.778
Leadership	**1.296**	**1.099**	**-0.197**	SA7	2.259	1.407	-0.852
TS7	1.148	1.074	-0.074	SA8	3.185	3.296	0.111
TS8	1.296	1.037	-0.259	SA9	3.852	3.519	-0.333
TS9	1.333	1.148	-0.185	SA10	3.259	2.704	-0.555
TS10	1.37	1.148	-0.222	Sa11	4.148	3.556	-0.592
TS11	1.37	1.111	-0.259	SA12	1.556	1.074	-0.482
TS12	1.259	1.074	-0.185	SA13	1.889	1.259	-0.63
Situation Monitor	**1.525**	**1.204**	**-0.320**	SA14	1.556	1.259	-0.297
TS13	1.519	1.259	-0.26				
TS14	1.444	1.111	-0.333				
TS15	1.667	1.259	-0.408				
TS16	1.593	1.222	-0.371				
TS17	1.407	1.111	-0.296				
TS18	1.519	1.259	-0.26				
Mutual Support	**1.475**	**1.216**	**-0.259**				
TS19	1.481	1.148	-0.333				
TS20	1.481	1.259	-0.222				
TS21	1.296	1.111	-0.185				
TS22	1.556	1.259	-0.297				
TS23	1.37	1.074	-0.296				
TS24	1.667	1.444	-0.223				
Communication	**1.747**	**1.185**	**-0.562**				
TS25	1.704	1.111	-0.593				
TS26	2	1.148	-0.852				
TS27	1.556	1.148	-0.408				
TS28	1.815	1.148	-0.667				
TS29	1.481	1.111	-0.37				
TS30	1.926	1.444	-0.482				

Note. Smaller pre post score values indicate greater agreement with concept

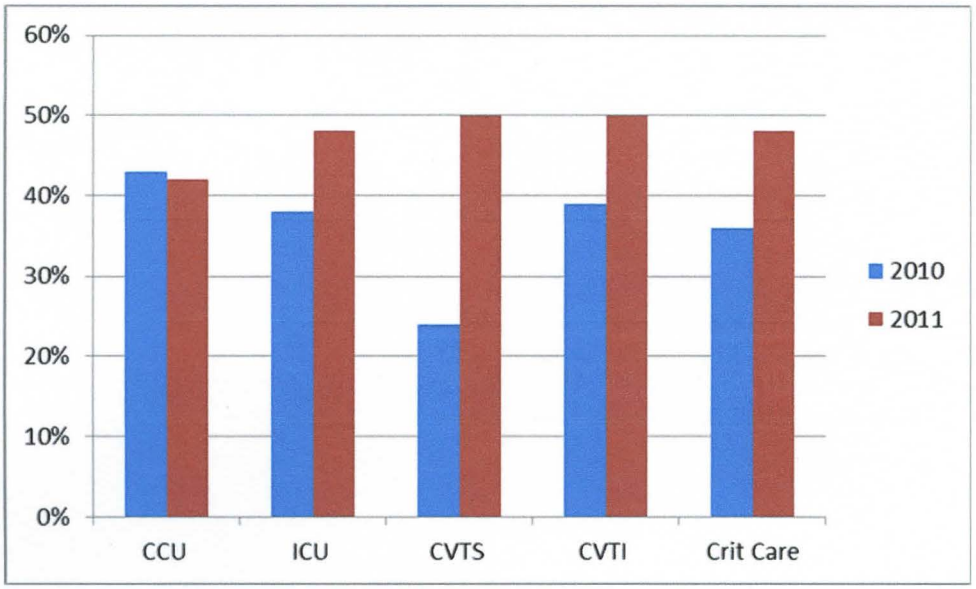


Figure 1

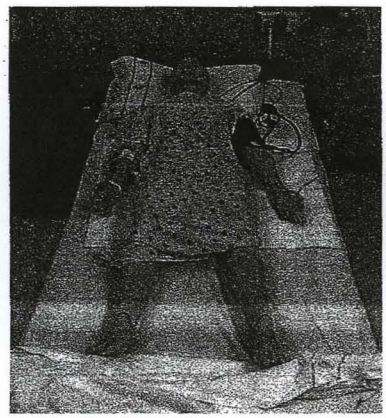
SAQ Stress Recognition Scale scores expressed as % positive (those answering slightly or strongly agree) for each unit and critical care as a whole. Comparison of 2011 scores (after training) to 2010 scores (prior to training).

Appendix A
Recruitment Flyer

Simulation Research Project

Interested in participating in a medical simulation experience at the

Rhode Island College SON simulation lab?



We are conducting a research study to determine the effect of a simulation educational experience on critical care staff's attitudes toward aspects of safety culture.

All Miriam Hospital critical care professionals who provide direct patient care i.e. Physicians, Nurses, Physicians Assistants, Respiratory therapists are invited to participate. Participation is completely voluntary.

Participation would involve attending a one day educational session at Rhode Island College SON simulation lab which is part classroom and part high fidelity simulation. Participation would also involve answering some surveys. Six sessions will be offered. Each session can accommodate 8 participants. Dates will be posted as soon as sessions are scheduled and will take place in January 2011.

Six Continuing Education Credits will be offered. There is no charge for the educational experience. Refreshments will also be provided during breaks.

More information will be provided prior to the session so that you may make an informed decision whether or not to participate.

Please contact Heidi Paradis by email hparadis@lifespan.org or by phone at 401-793-3630 if you are interested in participating or for more information.

Appendix B
Informational Letter for Simulation Educational Session

The Miriam Hospital
IRB Approved
11/23/16
Expiration Date 10/19/17

Research Informational Sheet

We would like to ask you to take part in a research study called " Effects of a simulation educational experience on critical care staff's recognition of stressors affecting performance and use of teamwork skills" that will measure changes in your attitudes/opinions before and after this full day training session by your completion of three different surveys.

If you choose to participate you will be asked to answer two surveys prior to the training. One survey contains 15 questions and the other contains 30 questions. We would like you to show that you agree or disagree with the statement by checking the box. The day of training will include a four hour classroom educational experience where you will learn about causes of medical error and teamwork skills followed by a four hour high fidelity simulation experience to practice these skills. These experiences involve role playing with lifelike mannequins to practice care in a realistic setting. Simulations provide a safe setting where learning can take place without harming patients. Each of three simulations is followed by a debriefing where you will view a video of the simulation and discuss what you thought, felt and learned. If you would not like to be in the video you may choose not to participate in the simulation. No video is saved or stored; it is erased immediately after use during debriefing. No one will view the video except those present during the simulation. You would be asked at the end of the training day to answer the same two surveys. You would then be asked, several months after the training, to answer a third, electronic survey containing 31 questions. A link will be sent via lifespan email. Answering this survey is also voluntary. All of the surveys would ask questions about your attitudes and opinions related to medical error, patient safety and teamwork. There are no questions that are personal, sensitive or that should cause you any discomfort. The surveys should take about 15-30 minutes to complete.

All surveys will be kept confidential and viewed only by the researcher. None of the information provided by you will have your name or any identifiable number on it. You will make up a code of your choosing to link the before and after surveys but the code cannot be linked directly to you. Results as a whole may be shared with others but no individual information can be linked directly to you.

Participation is completely voluntary. You will not be evaluated and there will be no consequence to your employment status as a result of participating or not participating. It is expected of all those who participate that no discussion outside of the training will take place about the performance of others during simulations. The classroom and simulation activities are for educational purposes only and should be informational and enjoyable. There will be several short breaks and one longer break during the day. Refreshments will be provided. You may choose to withdraw from the study at any time by notifying the researcher (Heidi Paradis) or assistants.

There may be no direct benefit to you for participating or for answering the surveys however, you may keep all materials provided in the class. If you choose to complete the entire training, you will receive 6 contact hours of continuing education approved by the Rhode Island State Nurses Association. We are hoping that the education will enhance your practice and the information you provide will help to ensure safer patient care.

The risks of participating in this study are minimal meaning they are about the same as you would experience in your normal work activities. You will be given an orientation to the simulation environment and mannequins so that you will know what to expect. You may ask questions at any time if you are unsure of what to do. If you decide you do not wish to continue at any time you may stop by notifying the researcher, one of the assistants or any of the simulation lab personnel.

If you have any questions about the research study or about the surveys or the educational sessions please feel free to ask the researcher and/or assistants before we begin or you can call the researcher, Heidi Paradis, at any time at 401-793-3630.

If you cannot reach the researcher or if you have any questions about your rights as a research subject, or any concerns about your participation, please feel free to call the Lifespan Office of Research Administration manager Patricia Houser at 401-444-6246 or the Chair of the Rhode Island College Institutional Review Board at IRB@ric.edu or by phone at 401-456-8228.

Thank you for your time.

Heidi Paradis RN
Rhode Island College graduate nursing student
Critical Care Educator Miriam Hospital

Appendix C
Safety Attitudes Survey
(Subscale of University of Texas SAQ ICU version 2004)

The success of the survey depends on your contribution, so it is important that you answer questions as honestly as you can. There are no right or wrong answers, and often the first answer that comes to mind is best. All data are **strictly confidential**. No individual feedback will be given to your supervisors or colleagues, so feel free to express your opinion. Your participation in the study is valued and appreciated. Please place a checkmark in the box that matches your level of agreement with the statement.

Statement	***Disagree Strongly***	***Disagree Slightly***	***Neutral***	***Agree Slightly***	***Agree Strongly***
We should be aware of and sensitive to the personal problems of other ICU team members.					
I am less effective when stressed or fatigued					
Team members should monitor each other for signs of stress or fatigue.					
Team members should feel obligated to mention their own psychological stress or physical problems to other ICU personnel.					
Personal problems can adversely affect my performance.					
Effective ICU team coordination requires members to take into account the personalities of other team members.					
When my workload becomes excessive, my ability to concentrate is impaired.					
Even when fatigued, I perform effectively during critical phases of patient care.					
My decision-making ability is as good in medical emergencies as in routine situations.					
My performance is not affected by working with an inexperienced or less capable team member.					
A truly professional team member can leave personal problems behind when working in the ICU.					
There are strategies that can be employed to help prevent errors.					
I am not aware of any strategies that help prevent errors.					
I frequently use strategies to help prevent errors.					

Note: The SAQ is available online at:
http://www.uth.tmc.edu/schools/med/imed/patient_safety/questionnaires/SAQBibliography.html
Citation for the full survey is: Sexton JB, Helmreich RL, Neilands TB, Rowan K, Vella K, Boyden J, Roberts PR, Thomas EJ. The Safety Attitudes Questionnaire: Psychometric Properties, Benchmarking Data, and Emerging Research. BMC Health Services Research 2006; 6:44

Appendix D
TAQ Survey

TeamSTEPPS

TeamSTEPPS™ Teamwork Attitudes Questionnaire

The purpose of this survey is to measure your impressions of various components of teamwork as it relates to patient care and safety.

Instructions: Please respond to the questions below by placing a check mark (√) in the box that corresponds to your level of agreement from *Strongly Disagree* to *Strongly Agree*. Please select only one response for each question.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Team Structure						
1.	It is important to ask patients and their families for feedback regarding patient care.					
2.	Patients are a critical component of the care team.					
3.	This facility's administration influences the success of direct care teams.					
4.	A team's mission is of greater value than the goals of individual team members.					
5.	Effective team members can anticipate the needs of other team members.					
6.	High-performing teams in health care share common characteristics with high-performing teams in other industries.					
Leadership						
7.	It is important for leaders to share information with team members.					
8.	Leaders should create informal opportunities for team members to share information.					
9.	Effective leaders view honest mistakes as meaningful learning opportunities.					
10.	It is a leader's responsibility to model appropriate team behavior.					
11.	It is important for leaders to take time to discuss with their team members plans for each patient.					
12.	Team leaders should ensure that team members help each other out when necessary.					

PLEASE CONTINUE TO THE NEXT PAGE

TeamSTEPPS

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Situation Monitoring						
13.	Individuals can be taught how to scan the environment for important situational cues.					
14.	Monitoring patients provides an important contribution to effective team performance.					
15.	Even individuals who are not part of the direct care team should be encouraged to scan for and report changes in patient status.					
16.	It is important to monitor the emotional and physical status of other team members.					
17.	It is appropriate for one team member to offer assistance to another who may be too tired or stressed to perform a task.					
18.	Team members who monitor their emotional and physical status on the job are more effective.					
Mutual Support						
19.	To be effective, team members should understand the work of their fellow team members.					
20.	Asking for assistance from a team member is a sign that an individual does not know how to do his/her job effectively.					
21.	Providing assistance to team members is a sign that an individual does not have enough work to do.					
22.	Offering to help a fellow team member with his/her individual work tasks is an effective tool for improving team performance.					
23.	It is appropriate to continue to assert a patient safety concern until you are certain that it has been heard.					
24.	Personal conflicts between team members do not affect patient safety.					

PLEASE CONTINUE TO THE NEXT PAGE

Appendix E
SAQ Survey

Safety Attitude Questionnaire Items

Teamwork Climate
It is easy for personnel in this ICU to ask questions when there is something that they do not understand.
I have the support I need from other personnel to care for patients.
Nurse input is well received in this ICU.
In this ICU, it is difficult to speak up if I perceive a problem with patient care.
Disagreements in this ICU are resolved appropriately (i.e., not who is right, but what is best for the patient)
The physicians and nurses here work together as a well-coordinated team.

Safety Climate
The culture in this ICU makes it easy to learn from the errors of others.
Medical errors are handled appropriately in this ICU.
I know the proper channels to direct questions regarding patient safety in this ICU.
I am encouraged by my colleagues to report any patient safety concerns I may have
I receive appropriate feedback about my performance.
I would feel safe being treated here as a patient.
In this ICU, it is difficult to discuss errors.

Job Satisfaction
This hospital is a good place to work.
I am proud to work at this hospital.
Working in this hospital is like being part of a large family.
Moral in this ICU area is high.
I like my job.

Stress Recognition
When my workload becomes excessive, my performance is impaired.
I am more likely to make errors in tense or hostile situations.
Fatigue impairs my performance during emergency situations (e.g., emergency resuscitation, seizure).
I am less effective at work when fatigued.

Perceptions of Management
Hospital management does not knowingly compromise the safety of patients.
Hospital administration supports my daily efforts.
I am provided with adequate, timely information about events in the hospital that might affect my work.
The levels of staffing in this clinical area are sufficient to handle the number of patients

Working Conditions

All the necessary information for diagnostic and therapeutic decisions is routinely available to me.
This hospital constructively deals with problem physicians and employees.
Trainees in my discipline are adequately supervised.
This hospital does a good job of training new personnel.

Note: The SAQ is available online at:
http://www.uth.tmc.edu/schools/med/imed/patient_safety/questionnaires/SAQBibliography.html
Citation for the full survey is: Sexton JB, Helmreich RL, Neilands TB, Rowan K, Vella K, Boyden J, Roberts PR, Thomas EJ. The Safety Attitudes Questionnaire: Psychometric Properties, Benchmarking Data, and Emerging Research. BMC Health Services Research 2006; 6:44.
Participants indicated their level of agreement with these statements by choosing 1=Disagree Strongly, 2=Disagree Slightly, 3=Neutral, 4=Agree Slightly, 5=Agree Strongly.
This survey was administered in electronic format and also asked participants what type of unit they work on and how many years of experience they had. Results were viewed in aggregate per clinical unit; no data was linked to individuals.

Appendix F
Course Agenda

TeamSTEPPS® Fundamentals Course Agenda

Time	**Topic**	**Time allotted**
8:00 am-8:40am	Welcome/Informed Consent Surveys	40 Minutes
8:40-9:10	Introduction: Error Factors affecting Performance Teamwork as a strategy	30 Minutes
9:10-9:40	Team Structure	30 minutes
9:40-9:50	Break	10 minutes
9:50-10:20	Leadership	30 minutes
10:20-10:50	Situation Monitoring	30 minutes
10:50-11:20	Mutual Support	30 minutes
11:20-11:30	Break	10 minutes
11:30-12:00	Communication	30 minutes
12:00-12:20pm	Putting it All Together	20 minutes
12:20-1:00pm	Lunch	40 minutes
1:00-1:25pm	Orientation to Simulation Environment	25 minutes
1:25-2:10pm	Simulation 1 Debriefing	15 minutes 30 minutes
2:10-2:20pm	Break	10 minutes
2:20-3:05pm	Simulation 2 Debriefing	15 minutes 30 minutes
3:05-3:15pm	Break	10 minutes
3:15-4:00pm	Wrap Up: Take Aways Post surveys Evaluations CEU Presentation	45 minutes

Appendix G
Program Evaluations Summary

RISNA Continuing Education
Program Evaluation Summary
TeamSTEPPS®

Each participant must complete an evaluation to receive a Contact hour certificate for this educational activity. Please be as honest and objective as possible.

1. Rate the extent to which the objectives were met by circling the appropriate number.

Learner's achievement of each objective (list each objective below)	Met 1	Partially met 2	Not met 3
Describe the TeamSTEPPS ® program	23	0	0
Describe the impact of errors and why they occur.	23	0	0
Identify characteristics of high performing teams.	23	0	0
Describe benefits of teamwork.	23	0	0
Describe the role of a team leader.	23	0	0
Describe strategies used by effective team leaders.	23	0	0
Define situational awareness and how it can prevent error.	23	0	0
Define how the STEP process helps to monitor the environment.	23	0	0
Define Mutual Support & Discuss barrier tools, strategies, and outcomes of mutual support.	23	0	0
Recognize connection between communication and medical error.	23	0	0
Identify and discuss barriers, tools, strategies and outcomes to communication.	23	0	0
Discuss how to apply the tools and strategies presented and how to overcome barriers.	23	0	0
Demonstrate use of tools and strategies presented above during simulated scenarios.	23	0	0
States take-aways from experience & Discuss how learning can be applied to future practice.	23	0	0

2. Rate the relevance of the objectives to overall purpose/goals.

	1 Related	2 Partially	3 Not related
Relevance of the objectives to overall purpose/goals of the educational activity.	23	0	0

3. Rate the teaching expertise of the presenter.

Evaluation of presenter: Heidi Paradis	Met 1	Partially met 2	Not met 3
Speaker's expertise enhanced the activity.	23	0	0
Teaching strategies were appropriate for the objectives and content.	23	0	0
Evaluation of presenter: Lois Ginsberg (taught one less class)	Met	Partially met	Not met
Speaker's expertise enhanced the activity.	20	0	0
Teaching strategies were appropriate for the objectives and content.	20	0	0

4. Rate the appropriateness of physical facilities.

	Appropriate 1	Somewhat appropriate 2	Not appropriate 3
Appropriateness of physical facilities	22	1	0

5. Conflict of interest disclosure

	Met 1	Not met 2	N/A 3
Conflict of Interest disclosed	23	0	0

Participant Comments:

Great Job as always!

Heidi made class fun and informative and gave something to take back to clinical environment.

Very helpful. Should be mandatory for all personnel involved in patient care to take course to improve care and patient safety.

Important that included actual leaders to be one of presenters and share barriers.

Manikins very helpful. Being able to listen to lung sounds and feel pulse made situation more realistic and fun.

Suggest: More time with manikins to be able to function in more familiar environment. Allow participants to "play" with manikins, lead placement and how to use monitors before actual simulation.

Recommendations for future programs:

Make program mandatory for all hospital employees, helps focus on importance of team work which is a daily requirement for a facility to run effectively.

Talk about conflict during a situation when something has to be addressed right then and how to do it.

Include more simulated scenarios for more practice. More heat in room.