Effective interdisciplinary teamwork is highly relevant to patient safety and care quality. An estimated 44,000 – 98,000 patients die annually due to preventable medical errors (Kohn, Corrigan & Donaldson, 2000). The highest error rates occur in the more complex and time-sensitive environments placing patients undergoing emergency care at highest risk. The importance of effective interdisciplinary teamwork to patient safety is one of the driving principles in the report from the Institute of Medicine (2001). Our study will address patient safety during emergency care by evaluating team effectiveness during a simulated patient crisis scenario following the implementation of an educational team-training program called Crisis Resource Management (CRM). CRM is a program of teamwork skills taught through lecture/discussion and simulation of patient crisis scenarios on the human patient simulator to facilitate participant’s successful use of team process variables of situation awareness, task management, and teamwork, to improve team effectiveness. Based on proven effectiveness in flight simulators, we have implemented CRM with patient simulators. In this study, 26 interdisciplinary teams will be randomized to a control or a treatment group. Each team will consist of three nursing students and three medical students. Teams will manage a simulated patient crisis for which resuscitation is indicated.

KEY WORDS: effectiveness, management, training program, CRM, team working

INTRODUCTION

Deaths resulting from preventable medical errors surpass the number of deaths due to the motor vehicle crashes, breast cancer, or AIDS (Kohn, Corrigan, & Donaldson, 2000). The highest error rates occur in the more complex and time-sensitive environments placing patients undergoing emergency care at highest risk (Kohn et al., 2000). Lack of interdisciplinary teamwork during emergent patient care is a major source of errors leading to poor patient outcomes (Finer & Rich, 2002; Marsch et al., 2004; Wears & Leape, 1999). In the landmark Institute of
Medicine report, *To Err is Human: Building a Safer Health System*, Kohn states, “people make fewer errors when they work in teams” (p. 173). Recommendations from this report include development of team training programs using evidence-based methods for effective teamwork.

In an American Heart Association publication, team training plus life support skills are identified as comprising the optimal curriculum for patient crisis preparedness training (Chamberlain & Hazinski, 2003). However, health care providers are rarely taught or have opportunity to practice teamwork (McCallin, 2001). To prepare for patient emergencies, health care providers renew basic and advanced life support certifications every two years. These required courses provide an individual-focused review of knowledge and technical skills for managing a crisis. Despite this technical expertise in basic and advanced life support skills, patient crises are frequently characterized by chaos and error, putting patient safety at risk (Frank, 1981; Maibach, Schieber, & Carroll, 1996; Hayes, Rhee, Detsky, Leblanc, & Wax, 2007; O’Brien, Haughton, & Flanagan, 2001). Therefore, the individual-focused technical skills of advanced and basic life support are not adequate to ensure effective and safe patient care in a crisis. Effective teamwork within the interdisciplinary team is a necessary complement to technical skill training to maximize quality and promote safe patient care.

Recent literature on patient safety provides evidence of the need for team training that is interdisciplinary in order to reduce error and improve patient safety (Baggs, et al., 1999; Boyle, 2004; Bumpus & al-Assaf, 2003; Corser, 2004; Higgins, 1999; Horak, Pauig, Keidan, & Kerns, 2004). Casto and Julio (1994) contend that interdisciplinary training may be most influential early in professional development when role socialization is evolving. However, education of health care providers occurs primarily in program silos.

The unusual characteristics of the health care team in a patient crisis include: team members without prior work relationship, heterogeneous roles of the team members, and high stake patient outcomes at risk. A team training curriculum called Crisis Resource Management (CRM) was borrowed and adapted from the aviation industry by the medical community. The aviation industry developed this curriculum following the unfortunate and avoidable crash of an airplane flown by expert pilots. The incident highlighted the inadequacy of pure technical skills in managing a crisis situation. That is, in addition to the relevant technical skills, team process variables such as task management, team-working, situation awareness and inter-professional attitude are necessary for team effectiveness. As in aviation, CRM for health care providers is a programmatic approach using simulation to teach non-technical skills or teamwork to manage a crisis. The program provides learners with a conceptual framework for the cognitive knowledge, behavioral skills and attitudes of team process plus a simulated opportunity using a human patient simulator for the learner to apply team process. In complex, dynamic environments such as aviation and health care, application of teamwork combined with the technical skills of basic life support are necessary to ensure safe and efficient management of a crisis (Howard, Gaba, Fish, Yang, & Sarnquist, 1992).

The Institute of Medicine (2001) identifies a failure to use innovative and proven teaching methods that can ensure translation of knowledge into practice as a factor in patient care quality. Several studies in health care have demonstrated positive outcomes from CRM education or similar team training programs; however, only a few studies have investigated interdisciplinary teams of health care providers and measured team effectiveness outcomes (DeVita, Schaeffer, Lutz, Wang, & Dongilli, 2005; Morey et al., 2002; Shapiro et al., 2004). Most studies used homogenous groups of resident physicians or medical students as the trainees for crisis management and/or non-experimental designs (Sica, Barron, Blum, Frenna, Raemer, 1999; Yee et al., 2005). Since crisis response is managed by an interdisciplinary team of nurses and physicians, it is important to study if training teams of nurses and physicians as a unit will improve outcomes during a crisis. To date, there have been no published results of a statistically powered experimental study of interdisciplinary healthcare teams evaluating the impact of CRM training. In addition, few studies have correlated important elements of team process variables such as task
management, teamwork, situation awareness, and inter-professional attitude to team effectiveness outcomes such as clinical response time and error rate. Such evaluation is required to build evidence that will target essential team process variables relevant to team effectiveness in a crisis. Correlation of team process variables to number of errors and to response time for standard interventions within a sufficiently powered experimental design will demonstrate the impact of CRM training on patient care which has valuable clinical relevance. Lastly, standardization of the CRM curriculum is critical to the application of a consistent independent variable across studies. Therefore, to ensure effective team training and to guide measures of effectiveness, the relevant variables that influence team process and team effectiveness must be grounded in a contextually relevant conceptual framework (Rosen et al., 2008).

The significance of this study is four-fold. First, successful team process is highly relevant to patient safety. That is, effective teams have improved patient outcomes, safer care and higher quality care. This study will test the efficacy of CRM training on team process variables and team effectiveness using a statistically powered, experimental design. Second, standardization of CRM training through theory-based content and learning methods is critical to clearly defining and evaluating an effective team training intervention. This study will outline the content and teaching methods of the CRM curriculum for team training educators and researchers. Therefore, clear identification of the independent variable and its effect will be demonstrated in this study for consistent implementation and future research. Third, empirical evidence correlating team process variables with pertinent team effectiveness outcomes in the health care setting is needed. Experimental design and advanced statistical analysis can test the hypothesized empirical links between these variables thus informing relevant theoretical propositions. Findings from this study may support an evidence-based CRM training curriculum to improve effectiveness of interdisciplinary health care teams and enhance patient safety. Kohn et al. (2000) states that effective health care teams provide safer and higher quality patient care. Fourth, patient safety and team effectiveness during sudden emergency care is applicable to all health care settings and all health care workers. Therefore, results from this study may provide valuable evidence for a team training curriculum that can lead to improved patient care at the bedside.

GOALS AND OBJECTIVE

The purpose of this study is to measure the effects of CRM training on team process variables of teamwork, task management, situation awareness and inter-professional attitude to evaluate the extent to which enhancing team process variables improves team performance by reducing team error rate and improving team response time. The interdisciplinary team will consist of student nurses and third year medical students. The findings from study will provide important foundational information to guide future CRM training that is empirically and theoretically grounded to improve patient safety and care quality. There are three primary aims of this study:

1. To test the efficacy of CRM training for improving team effectiveness through a reduction in response time for standard interventions and the reduction in number of medical errors during a simulated patient crisis.
2. To test the efficacy of CRM training for improving team process variables as measured by teamwork, task management, situation awareness and inter-professional attitude during a simulated patient crisis.
3. To evaluate the relationship between observed team process variables as measured by teamwork, task management, situation awareness, and inter-professional attitude and team effectiveness as measured by error rate and response time for standard interventions.

METHODOLOGY
Design

This will be an experimental, pretest-posttest design. Each of the 26 teams will be formed using three baccalaureate senior-year nursing students and three third-year medical students recruited from Penn State University, Hershey Medical Center Campus during the spring semester 2009. Approval from curriculum directors from the College of Medicine and the School of Nursing to seek interested students at a regularly scheduled class has been obtained. Interested students will complete a subject inclusion form. Eligible students will be contacted by the principal investigator and enrolled in the study. Incentives to participate in the study will be practicing resuscitation skills in a realistic, yet safe learning environment and receiving a 20.00 gift card.

Sample size will be 13 interdisciplinary teams per control and treatment group for a total of 26 teams. This calculation is based on a desired power of 80 percent for a one-tailed study and alpha level of 0.05. Power calculation based on a one-tailed study is supported by significant results from prior studies as discussed in the literature review, the pilot study (Jankouskas, 2007) and is consistent with a directional hypothesis (McNeil, 1997).

Independent Variable

The CRM training serves as the independent variable or manipulated variable in our experiment. CRM is an educational program for health care providers focused on effective team process during emergency patient care. Due to the complexity of managing the unstable patient combined with overwhelming evidence of medical errors despite accomplished technical skills of physicians and nurses, CRM is a highly relevant educational program for health care providers (Howard et al., 1992). The purpose of CRM training is to teach a coordinated team response to a patient crisis. The focus of CRM is to complement the technical skills of patient resuscitation with cognitive knowledge, behavioral skills and attitudes of team process through didactic, simulation, and critical reflection learning methods. This is purported to improve team effectiveness during a crisis situation. Although the CRM program is taught in numerous medical institutions throughout the United States, Canada, and Europe, the content and teaching methods of the program are not standardized but are similar among institutions. The CRM program for this study includes three main segments: videotaped scenario practice using a human patient simulator that is programmed to exhibit an emergency event; a didactic presentation of team process variables, and an instructor-facilitated critical reflection of the videotaped team process of the simulated emergency event. Viewing videotaped performance of one’s own team process interactions during a simulated resuscitation with facilitated debriefing to stimulate critical reflection is an extremely powerful teaching tool.

Outcome Variables

The outcomes that will be measured in this experiment are team process variables (team work, task management, situation awareness and attitude) and team effectiveness variables (error rate and response time). The team outcome variables are based on a team theory called “A Dynamic Model of Team Effectiveness” (Kozlowski and Ilgen, 2006). The results of these outcome variables will reveal the impact of the CRM training.

Team Process Variables

The actions undertaken by the team or the team process are influenced by three primary competencies: behavioral skills, cognitive knowledge and attitude. These competencies are the primary variables of interest for impacting team effectiveness.

The skills competencies include teamwork and task management. The knowledge competency includes situation awareness. Situation awareness is the understanding of a patient situation and recognizing the relevant actions and priorities indicated. In this proposed study, the behavioral skills and knowledge competencies will be measured by blinded raters using the Anesthetists Non-Technical Skills (ANTS) observational rating system (Fletcher et al., 2003). This rating system was developed by a group of anesthetists and industrial psychologists which includes the elements of team-working, task management and situation awareness. These elements are
generic to any healthcare team. The ANTS system has evidence of content validity, internal consistency (Chronbach’s alpha 0.79-0.86) and inter-rater reliability (0.65 for task management; 0.65 for team working; 0.56 for situation awareness) which indicates that it is a sound rating system for measuring these team competencies.

The final competency is team attitude. In this proposed study, interprofessional attitude will be measured from participant completion of the University of West England Inter-professional Questionnaire. Three categories of questions were identified by an interdisciplinary team of healthcare experts following a review of relevant literature: communication and teamwork, inter-professional learning, and inter-professional interaction. A fourth category, inter-professional relationship, was identified in a second study (Pollard, Miers & Gilchrist, 2005). These two studies documented acceptable levels of test-retest reliability, internal consistency and concurrent validity (r = .71 -.86) which indicate it is a sound means for measuring team attitude.

Team Effectiveness Variables

The team effectiveness variables are error rate and response time. Error rate is the number of observed cardiopulmonary resuscitation skills that are performed incorrectly according to the American Heart Association standards. Error rate will be counted by blinded raters. Response time is the elapsed time from the initiation of the simulated patient scenario until the following interventions are implemented on the patient simulator: administration of oxygen, call for help, assistance of breathing, and performance of compressions.

Procedure

FIRST, upon entering the simulation lab, each team will be introduced to the simulation environment, human patient simulator (HPS) capabilities and have an opportunity to feel the pulses and listen to the heart and breath sounds on the HPS. SECOND, the team will manage a patient crisis on the HPS while being videotaped. This first scenario experience will serve as the pretest which will be later analyzed for team process variables (team-working, task management and situation awareness), response time to critical interventions and error rate by blinded raters. THIRD, the control or treatment intervention will occur as follows:

Control Group

Interdisciplinary teams in the control group will experience a review of basic life support (BLS) skills or technical skills. The PI will facilitate group reflection on the videotaped crisis response from a technical skill or basic life support skill perspective.

Treatment Group

Interdisciplinary teams in the treatment group will experience basic life support skills plus a 45 minute discussion of team training or team skills. The team training is based on the principles of Crisis Resource Management training, a team training program originally developed for airline crews to improve safety of flight operations (Helmreich & Wilhelm, 1991; Helmreich, Chidester, Foushee, Gregorich & Wilhelm, 1990). The PI will facilitate reflection on the videotaped crisis response from a team skill perspective in addition to a technical, basic life support skill, perspective.

Following the control or treatment intervention, each team will return to the HPS to experience a second patient crisis scenario that is videotaped. This second scenario serves as the post test for the study which will be analyzed for team process variables (team-working, task management, and situation awareness), response time and error rate. Lastly, each participant will complete the University of West England Inter-professional Attitude Questionnaire following the second scenario.

Blinded and trained raters will score the scenarios for team process variables using the ANTS behavioral observation system. Two health care providers who are CRM and Basic Life Support instructors will be hired to review the videotaped crisis scenarios of each team. Reviewers will be blinded to the scenario order of pre and post presentation and to the treatment condition for each team. Inter-rater reliability will be assessed following the
initial rater training and intermittently throughout the study at rater review sessions for a minimum of 10 percent of the total number of videotapes. Previously rated scenarios will be re-rated intermittently during rater review sessions to maintain inter-rater reliability and prevent drift of scoring. The rater training and review sessions will be facilitated by the principal investigator.

Analysis
Analysis will include the following primary steps:
1. Examination of the distribution and shape of demographics, team process variables, and team effectiveness variables for the control and treatment groups.
2. Application of ANOVA to test the difference between groups on team process variables and team effectiveness variables.
3. Application of multiple regression analysis to evaluate mediator effects between team process variables (team working, task management, situation awareness, and inter-professional attitude) and team effectiveness variables (error rate and response time).

STRATEGIC EDUCATION GOALS
This study addresses most of the strategic education goals of the Woodward Endowment. First, the teaching method of simulation learning combined with video-recording and facilitated critical reflection provides an extremely powerful learning environment for participants. This learning method is highly valued by learners and is grounded in the learning theories of Self-efficacy (Bandura, 1977) and Transformative Learning (Cranton, 2006). Second, opportunities for interdisciplinary education between medical and nursing students or staff are desired to promote future collaborative relationships that enhance effective communication leading to safer patient care. Third, CRM training can be applied to any emergency in any practice setting to promote team effectiveness resulting in higher quality care. Fourth, this study is an excellent use of resources because use of the simulation lab for this training will occur during low usage time in the evening hours when students are most available to participate. Lastly, if CRM training is incorporated into a permanent curriculum for new staff, residents and/or medical students, then the uniqueness of this interdisciplinary team training using high fidelity simulation can be highlighted in future recruitment.

PLANS FOR PUBLICATION/DISSEMINATION OF RESULTS

Research findings will be presented at the Eastern Nurses Research Society within two years. I plan to publish my results in the multidisciplinary education journal, Simulation in Health Care. I have successfully published two prior papers in this journal in 2007, one as a lead author and principal investigator in a pilot study and one as a second author in a related scholarly paper (Bush et al., 2007; Jankouskas et al., 2007).

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