

Incorporating high fidelity simulation into perfusion education

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Abstract

The new Perfusion Simulation Center at the Medical University of South Carolina provides a new level of high fidelity simulation training for perfusion students. A key component is the Orpheus Perfusion Simulator which is a computer-driven simulator integrated with the mechanical connections of the heart-lung machine to allow for real time operative procedures and perfusion incidents. Due to the ability to consistently reproduce cardiac surgical scenarios, it is possible to develop both basic perfusion skills as well as advanced emergency skills more effectively than with animal models. The purpose of this paper is to provide details about advanced simulation for perfusionists and to illustrate how simulation can be used to promote the assets of good communication, team work, and surgical awareness. Two sets of four cardiac surgical scenarios were recorded in the perfusion simulation operating room. Scenario team member roles included a cardiac surgeon, an anesthesiologist, a perfusionist and an operating room nurse. The scripted surgical scenarios were viewed by a focus group of students charged with identifying key personality traits of different members of the operating team and to characterize them using a list of descriptive words adapted from the Medical University of South Carolina's Peer Review Tool. In the first set of scenarios, initial scores were negative, with irresponsibility, impatience, and carelessness listed as the top behavioral characteristics leading to human error. In the second set of scenarios, logical, clear-thinking, and attentive were the most common personality traits observed of the effective team members. Simulation has become an invaluable tool for perfusion education and the goal of improving patient safety during cardiopulmonary bypass. The opportunities for advanced training in the perfusion simulation environment will certainly expand in the future.

Keywords

simulation; perfusion education; patient safety; cardiopulmonary bypass

Introduction

Cardiopulmonary bypass is an adjunctive technique that allows lifesaving surgical procedures, but it also has the potential to injure a patient due to equipment malfunction or operator error. Since its inception, the operation of the heart-lung machine has become progressively safer. This is due to many factors, such as improvements in technology, education and training. However, it is not completely safe. Currently, the risk of death or serious injury is 1/2500 procedures, which is 100 times greater than the risk of death or injury from anesthesia¹⁻⁴. In many professions, simulation training has been used to improve safety. Airline pilots, nuclear plant operators, nurses, and physicians use simulation to train and manage emergencies in a standardized manner⁵. The perfusion profession has a small number of practitioners, but because of the risks involved, the need for standardization and competency assessment is critical to reducing medical errors and improving patient outcomes^{6,7}.

The new Perfusion Simulation Center at the Medical University of South Carolina provides a new level of high

fidelity simulation safety training for perfusion students. A key component is the Orpheus Perfusion Simulator (Sim-Central Pty Ltd, Earlwood, New South Wales, Australia) which is a computer-driven simulation integrated with the mechanical connections of the heart-lung machine to allow for real time operative procedures and perfusion incidents. Also used is the EDAC Quantifier (Luna Innovations, Roanoke, Virginia, USA), a microemboli detection system to

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Figure 1. Perfusion Simulation Operating Room with video screens.

train the perfusionists to reduce the number of embolic events. There are two large video screens in the operating room so that a recorded operative procedure can be viewed simultaneously. Viewing the surgical procedure increases the fidelity of the simulation experience. The simulation room is used to train students from basic perfusion skills to advanced emergency procedures. The perfusion simulator has been utilized for practical examinations in place of animal models. This mode of testing perfusion students provided a much more comprehensive analysis of the student's performance while providing a definitive look at areas for improvement and achieving excellence in clinical practice⁸⁻¹⁰.

The purpose of this paper is to provide details about the advanced simulation center for perfusionists and to illustrate an example of how recorded scenarios in the simulation environment can be used to promote the assets of good communication, team work, and surgical awareness.

Methods

The perfusion simulation operating room at the Medical University of South Carolina (Figs 1 and 2) was used to

record four cardiac surgical case scenarios: an aortic dissection, poor venous return, heparin resistance, and inadequate cardioplegia delivery. The Orpheus cardio-pulmonary bypass simulator was used to generate real time hemodynamic and clinical blood gas changes that were observed by members of the operating team. The roles of the surgeon, anesthesiologist, perfusionist, and operating room nurse were played by the perfusion school faculty members. The four scenarios were scripted and filmed with two versions. The first version displayed poor communication, inter-professional knowledge and respect, and teamwork. The second version illustrated an atmosphere of the desired communication, inter-professional knowledge and respect, and teamwork to promote the optimal outcome for each scenario. The cardiac surgery scenarios were viewed by a focus group of perfusion students. Students were asked to identify key personality traits of the different members of the operating team from a list of descriptive words that were adapted from the Medical University of South Carolina's Peer Review Tool. This tool aims to quantify performance in eight key areas: accountability, respect, excellence, adaptability, customer



Figure 2. Perfusion Simulation Control Center.

Table 1. Students' witnessed behavioral characteristics of members of the cardiac operative team after watching four video-based scenarios. All positive words were given a +1 and negative scores were given a -1. Scores are averages of all students' perceptions among all four scenarios. Scores are presented as mean \pm standard deviation. The five most commonly occurring descriptive words applying to each character are listed

Character	Initial Score	Most Commonly Occurring Descriptive Words	Score After Improvement	Most Commonly Occurring Descriptive Words
Surgeon	-5.44 ± 2.4	Impatient, abrasive, rude, irresponsible, inconsiderate, over-reactive	6.11 ± 2.5	Cooperative, clear-thinking, logical, dependable, attentive
Anesthetist	-2.11 ± 3.2	Irresponsible, careless, indifferent, inconsiderate, rude, impatient	3.22 ± 1.6	Proactive, dependable, capable, attentive, logical, honest
Perfusionist	0.39 ± 3.7	Careless, reactive, attentive, rude, over-excitable, undependable	4.11 ± 2.7	Logical, attentive, clear-thinking, dependable, proactive, cooperative
Team Totals	-2.57 ± 3.4	Irresponsible, impatient, careless, over-excitable, inconsiderate, over-reactive	4.48 ± 2.6	Logical, clear-thinking, attentive, dependable, cooperative, proactive

Table 2. Students' perception of the area where communication breakdown occurred in each scenario based on the Human Factor Analysis Classification System

Scenario	Most Commonly Occurring Errors
(1) Possible aortic dissection	Organizational Influence due to failure to have proper communication on new equipment
(2) Poor venous return	Precondition for Unsafe Acts due to substandard practice of operators (failure to effectively communicate)
(3) Possible heparin resistance	Unsafe Supervision due to inadequate supervision & failure to provide correct information
(4) Inadequate cardioplegia delivery	Unsafe Acts due to failure to do something that is routine/misperception

service, teamwork, communication and self-expression. The behavior was scored with a +1 for each positive descriptive word and -1 to each negative word. These scores were summed and averaged for each character.

The students engaged in a group discussion on barriers to communication and specific communication breakdowns in each scenario. Students were then asked to identify the key components that led to the adverse event, based on the human factor analysis classification system¹¹. The students recommend ways to improve communication in these situations. After critiquing the first version of the scenarios, the students were asked to view the second version of the scenarios. Students were again asked to circle descriptive words describing each character in the video-scenario. Students commented on the validity of the scenarios in terms of how well the simulation captured actual operating room events and behaviors.

Results

The students immediately identified unprofessional and aggressive behavior, and recognized the impact of poor communication and teamwork on patient outcomes. Initial scores were negative, with irresponsibility, impatience, and carelessness listed as the top behavioral characteristics leading to human error (Table 1). All scores improved in the revised scenario. Logical, clear-thinking, and attentive were the most common personality traits of the effective team members (Table 1). Surgeons' scores showed the greatest change (-5.44 ± 2.4 to 6.11 ± 2.5).

The perceived human errors in each scenario are listed in Table 2. Students commented that the scenarios were believable and were an effective representation of behaviors that they have witnessed in the operating room.

Discussion

The link between poor communication and medical errors is becoming more evident, yet specific courses on effective inter-professionalism, communication, and teamwork are slowly making their way into medical

professionals' curriculums¹²⁻¹⁴. Simulation is a logical step to incorporate this training, especially in high stress environments such as cardiac surgery. This study shows an innovative way of demonstrating, identifying and quantifying problems associated with poor communication and the lack of inter-professional knowledge, respect and teamwork. Simulated scenarios are effective in demonstrating the importance of teamwork, inter-professional knowledge and respect, and communication during the training of healthcare professionals. The benefits of simulation are becoming more apparent and should be incorporated into the curriculum of all healthcare professionals to promote effective communication and inter-professionalism to reduce the chance of human errors and improve patient outcomes.

In addition to the development of video scenarios, the role of simulation in perfusion education continues to grow. Traditional clinical perfusion training is solely dependent on hands-on experience in the operating room, with actual patient interaction. At the end of the case, the student is debriefed and critiqued, with little to no ability to demonstrate the proper technique or corrective action. Depending on the student's performance, this type of evaluation can be an undesirable situation which is not always conducive to a positive learning experience. The ability to expose a perfusion student to critical and/or catastrophic situations is also limited in technical training. When these situations do arise in the actual operating room, the instructor usually plays the primary role, with little to no interaction with the student. The instructor's first priority is patient care, which limits the educational experience. With simulation, the ability to develop critical skills is facilitated by discussions and demonstration in a less stressful environment. A high fidelity simulator allows for both coaching and debriefing, while allowing the student to take the primary role. The advantage for the student is that it promotes independence in their technical training while providing the ability to develop critical judgment skills. Video screens show recorded cardiac surgical procedures and help students develop their skills to anticipate commands from the surgical field. The debriefing

sessions of these scenarios can involve repetitive demonstrations of the correct action and promote an open discussion of how to improve the technique. This type of evaluation cultivates accountability and communication. The ability to expose the student to critical situations prior to them occurring in an actual surgical procedure will provide a more systematic approach to the situation while decreasing the stress level and promoting confidence in their actions⁵. As the students progress through their simulation training, other key components of the surgical environment can be focused on, such as communication, team work, and surgical awareness.

Simulation is being utilized to train professionals in many high-risk occupations to promote safe practices. It is evident that simulation has improved the critical training skills in these other professions. Utilization of simulation for training and continuing education sessions will promote the perfusionists' critical thinking skills and their ability to respond to critical and/or catastrophic events in a standardized manner that improves patient outcomes. At this time, simulation is at its very infancy in both perfusion training and promoting the advancement of perfusion techniques and technology. It has become an invaluable tool in perfusion education. The opportunities for advanced training in the perfusion simulation environment will certainly expand in the future.

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Conflict of Interest Statement

None Declared.

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