Simulation Use in the Education of Perfusion Students: A Review

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Simulation in perfusion education in the United States is underutilized compared to other professions and disciplines which use simulation to train new professionals with success. The risk of death or serious injury during cardiopulmonary bypass (CPB) procedures is 1/2500 per procedure (1). Comparatively, the risk of death from anesthesia is 100 times greater than CPB procedures. This risk indicates the need for a high level of safety, not only in the perfusion profession but also for students beginning a career in the field.

With an emphasis to increase safety for perfusion students, some programs utilize high-fidelity simulation to help develop skills and effective communication in the operating room (OR). Simulation allows students to learn vocational skills in a lower stress environment, increasing comfort and familiarity with equipment and procedures that take place in the OR. Without simulation, students may only rely on exposure in the OR to increase expertise. Simulation also allows instructors to set the clinical agenda, helping each student achieve the same competencies and the program's educational goals and objectives.

Operating Room simulation is a common practice for assessment of cardiac perfusion students, but there are no validated clinical assessment rubrics in use. A group of researchers used a national survey in 2017 to identify the fundamental skills needed by perfusion students to perform adult CPB and the sub-elements that come with a perfusionists skill set (2).

Of the 261 respondents, all supported that there is variation between perfusion practices, but the data highlighted 20 core fundamental skills that are associated with adult CPB. The skills, listed from most important to least based on the results of the survey, included evaluation of patient data and calculations, component circuit selection, circuit assembly and priming, CPB checklist, anticoagulation, verification of arterial cannula placement, initiation of CPB, evaluation and troubleshooting technical aspects of CPB, myocardial protection, evaluation and troubleshooting physiological aspects of CPB, hemodynamic management, CPB circuit volume management, blood gas/electrolyte management during CPB, temperature management, ultrafiltration, weaning and termination of CPB, communication and team interactions, sterile technique, blood conservation, and standard precautions (2).

These skills could be highlighted in the curriculum and competency assessments of perfusion students throughout educational programs. This study emphasizes the lack of a validated clinical assessment rubric for perfusionists and perfusion students and recognizes common goals that perfusionists have. The standards and guidelines of the AC-PE include Intra-Aortic Balloon Pump (IABP), autotransfusion, and laboratory analysis, all of which were not items included in the survey but are expected to be performed by perfusionists and perfusion students (2).

A study in 2011 also noted that a competency assessment should be created to evaluate perfusionists on their communication skills (3). They concluded that without effective communication, harmful sentinel events could occur in the operating room. Four subjects were scored based on their communication during a variety of simulated cases. The researchers proposed that the mean scores could be utilized as the minimum score perfusion students should reach before entering clinical rotations. Per case,

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the mean scores were as follows: 96.3% for the CABGx4, 97.5% for the aortic valve repair, 97.8% for the CABGx3 with an aortic valve replacement and mitral valve repair, and 99.3% for the pediatric Norwood procedure (3). Overall, the study did offer a potentially usable rubric, but did not provide adequate data or procedural notes to be used.

In 2011, researchers performed a study at the Medical University of South Carolina (MUSC), who uses an Orpheus high-fidelity simulator to train their perfusion students (1). An OR-like environment is used and footage recorded from a cardiac surgery is displayed to simulate real-time procedures. Students were given case scenarios and acted in roles as the Perfusionist, Cardiac Surgeon, and Anesthesiologist. They were each given four case scenarios including an aortic dissection, poor venous return, heparin resistance, and inadequate cardioplegia delivery. Two versions of each of the four scenarios were performed. The first version consisted of poor communication, inter-professional knowledge and respect, and teamwork. The second version consisted of effective communication, inter-professional knowledge and respect, and teamwork. A peer review tool created by perfusion students at MUSC was utilized to quantify the team members performance in each scenario based on 8 factors: accountability, respect, excellence, adaptability, customer service, teamwork, communication and self-expression. Behavior was scored based on positive words (+1) or negative words (-1) (1).

The team totals, including the surgeon, perfusionist, and anesthesiologist, were -2.57 for negative descriptive words and 4.48 for positive descriptive words (1). The outcomes of this study demonstrated that poor communication and lack of inter-professional knowledge and respect can negatively affect patient outcomes. For perfusion students, this simulation can help promote accountability and communication used in the OR. Further research should focus on teamwork and surgical awareness (1).

Many healthcare disciplines use simulation for educational training throughout their prospective programs. Instead of students role-playing positions other than their own, different disciplines can simulate cardiac surgery together, each playing their own prospective role. A study in 2014 researched the effectiveness of combining simulation technologies and describing the perceptions of the student subjects (4).

Subjects for this study were CRNA students and Perfusion students who were in their first year of graduate school (4th quarter for CRNA and 3rd quarter for perfusion), and who had no clinical experience. Overall, there were 37 students: 22 perfusion students, and 15 CRNA students. Two students from each discipline, along with their faculty members for support, were chosen to perform the uncomplicated coronary revascularization case (4).

The researchers utilized a 12-item survey with possible score ranges from 12-72. The higher scores represent increased agreement with positively worded items and a more positive perception of interdisciplinary education. Subjects' perceptions were measured via the following: 1) competency and autonomy among those in their chosen specialty, 2) perceived need for cooperation between disciplines, and 3) cooperative effects between disciplines as perception of actual cooperation. The researchers found statistically significant differences between pre and post-event scores in the areas of "Competence and Autonomy" ($p= 0.002$) and "Perception of Actual Cooperation" ($p= 0.010$) for perfusion students. There were no statistically significant differences in any of the three subscales in the CRNA group (total $p= 0.115$) (4). This study demonstrated that combined simulation technologies facilitate interdisciplinary educational interactions that can improve interdisciplinary perceptions held by students from multiple professions. Healthcare disciplines that perform simulation scenarios together help promote effective communication, professional respect, and can increase the likelihood of good patient outcomes through mutual inter-professional respect (4).

Some studies have found that using a simulator to perform crisis drills in CPB improves proficiency of perfusionists and perfusion students in emergent situations. It is important for patient safety to have perfusionists and perfusion students become familiar with emergency protocols and frequently perform disaster drills. A study in 2003 (5), used a survey to collect information about morbidity and mortality incidents from practicing perfusionists. The survey collected information on the institutional use of emergency protocols and simulation crisis management drills to prepare perfusionists in the event that an emergency occurs (5).

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Results of the study showed that in 59 open-heart centers, with 312 perfusionists, and 47,227 cases annually, most departments (78%) manifested a written crisis management protocol for oxygenator failure and change-out. Only 10 (17%) of the subjects surveyed practiced emergency drills. Researchers also stated that the use of emergency drills in perfusion practice shortens reaction times in emergencies, allowing for the evaluation of protocols already used in practice, and allowing for the implementation of new procedures and techniques within the surgical team. The researchers concluded that perfusionists and perfusion students may incorporate wet labs into their practice to improve skills in emergency situations and increase patient safety (5).

A marked increase in advanced technology increases potential for equipment failure, and in cardiopulmonary bypass, failure of components can be lethal. Researchers in a study in 2012 noted that oxygenator failure in CPB is very rare with 50 cases in 2009, 101 cases in 2010, and 133 reported cases in 2011 in the United States (6). At the Royal Victoria Hospital in the United Kingdom, researchers developed an emergency oxygenator change-out algorithm to involve all members of a cardiovascular team in order to complete the task in expedient time. The staff were required to perform simulation drills weekly for the management of emergency situations. This practice facilitates an expedient emergency situation management and increases the confidence and skills of the perfusionist. Practice also promotes patient safety by maintaining current proficiency in perfusion skills (6). Perfusion students should be involved in practices similar to this in order to learn and maintain emergency scenario skills.

Various health care professions use simulators for education and to maintain skill proficiency. The use of high-fidelity simulation correlates to an increase in users' confidence, ability, and control of the equipment commonly used by CCP's. Authors have supported simulation use between healthcare disciplines, changing the modality of inter-professional practice. The resulting communication can help increase patient outcomes, solidifying how important inter-professional practice is.

It is important to utilize the newly developed and adopted technologies to train current and future professionals in emergency responses related to CPB. The CAAHEP and AC-PE note that students should be prepared and taught about possible crises and are required to pump a certain number of cases before graduation. However, the AC-PE and CAAHEP do not require any form of simulation to be completed by perfusion students prior to, during, or after clinical experience.

In future research, studies on the amount of simulation needed for perfusion students to become proficient in the skills outlined by Searles, et al. (2019) should be performed. There should also be further research on the use of simulation for emergency CPB pump maneuvers. Competency assessments also need to be developed to test perfusion student's proficiency in said skills.

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