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Interdisciplinary Simulation Using the Cardiopulmonary Bypass Simulator (CPBS)©

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Abstract: Interdisciplinary education offerings between students of cardiovascular science and nurse anesthesia are uncommon despite the collaborative nature of these disciplines. The dual purpose of this article is to describe a method for interdisciplinary simulation and to report survey responses provided by participants. An interdisciplinary simulation session using concurrent use of the cardiopulmonary bypass simulator and the emergency care simulator is described. Interdisciplinary perceptions before and after the event were surveyed using the revised Interdisciplinary Education Perception Scale. Statistically significant differences between baseline and final survey responses were observed in the total score and within the areas of competency and perception of cooperation. Emerging simulation technologies and novel combinations of existing devices can facilitate meaningful interdisciplinary educational opportunities for health science students. **Keywords:** cardiopulmonary bypass simulator, interdisciplinary, simulation, interprofessional. *JECT. 2014;46:300–304*

Educational objectives for simulation offerings commonly include improvements in hands-on skill performance, knowledge acquisition, or nontechnical behavioral processes such as teamwork and communication (1,2). Effective teamwork is a critical skill in the operating room, which is somewhat predicated on positive perceptions of oneself and others within the collaborative effort. Preexisting perceptions regarding the potential or actual contributions of each profession are carried into any interaction (3) along with the technical skills offered by each member of the team.

Ineffective teamwork and poor communication can contribute to adverse patient events in the cardiac surgical population (4). Conversely, team training can positively influence the actions and behaviors of team participants (5), which may ultimately link to improvements in patient safety. Simulation has been suggested as an effective method of team training (5) and suggested as a useful means of integrating an interdisciplinary component into perfusion education (2).

Didactic interdisciplinary education between perfusion students and nurse anesthesia students is especially relevant to subsequent clinical education and practice because these specialties are uniquely collaborative. The event described in this report combined faculty, students, and high-fidelity simulators used in one cardiovascular science program and one nurse anesthesia program.

Diverse approaches to simulation in perfusion education range in fidelity from audiovisual learning modules to modifications of existing equipment or devices manufactured for the purpose of high-fidelity perfusion simulation (6–10). High-fidelity simulators used in many specialties provide physiologically accurate feedback to the learners in real time, which can be an excellent educational tool. Instructors can control these devices to provide accurate situations for students to manage (11).

The interdisciplinary component of the event described is important because scenarios where other members of the healthcare team such as the surgeon, anesthesia provider, surgical technologist, or circulating nurse are simulated by faculty or students role-playing as other professionals are common (2). These situations can arise from an array of logistical challenges and resource constraints. Although this role-play method may foster an awareness of teamwork and improve communication, it does not allow for assessment of authentic interdisciplinary perceptions. This article contributes an assessment of interdisciplinary perceptions among perfusion students and nurse anesthesia students surrounding a single interdisciplinary event that used a new method of using a projector to facilitate simultaneous use of two pieces of simulation technology. The two purposes of this article are to share the method for combining these technologies

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and describe the perceptions of the student participants as measured by survey response.

METHODS

This research project was approved by the Institutional Review Board of the University. A thorough explanation of the research project was sent by e-mail to all potential participants. Attendance to the weekend event was optional. The opportunity to participate in the research was also optional. Completion of the anonymous research surveys served as implied consent for research participation. All survey responses were collected on the day of the event.

Response sheets were printed on different colored paper according to specialty for the purpose of distinguishing between nurse anesthesia and perfusion student responses without the need to identify individuals. The revised Interdisciplinary Education Perception Scale (IEPS)was used with permission. Fifteen nurse anesthesia students and 22 cardiovascular science students elected to participate.

Nurse anesthesia students must have prior professional experience as registered nurses. All nurse anesthesia student attendees in this study had 2 or more years of critical care nursing experience. The specific prior work environment was not surveyed. The most common forms of prior nursing work experience are intensive care, postanesthesia care, and emergency care. Prior operating room nursing experience is uncommon.

The nurse anesthesia students were in the fourth quarter of the first year of didactic education. The perfusion students were in the third quarter of the first year of didactic education. None of the students surveyed had any clinical rotation experience in the specialties of nurse anesthesia or perfusion.

This convenience sample represented a significant portion of those invited. One attendee in the perfusion group who completed the baseline survey did not complete the follow-up survey. As a result, 37 baseline perfusion surveys and 36 follow-up perfusion surveys were collected. All available responses were included in the analysis. The only discriminator was the color coding of the paper surveys according to educational program.

Members of the faculty from the nurse anesthesia program and the cardiovascular science program jointly developed an uncomplicated coronary revascularization case study for use in this simulation. The primary equipment included one Cardiopulmonary Bypass Simulator (CPBS) manufactured by BioMed Simulation Incorporated© (Poway, CA) and one Emergency Care Simulator (ECS) manufactured by CAE Healthcare© (Montreal, Quebec, Canada). The CPBS is used to provide high-fidelity simulation of cardiopulmonary bypass. The ECS is a full-body simulation mannequin used to provide high-fidelity simulation of various disease states and patient responses to interventions.

The output from one of these simulators is typically routed to a standard computer monitor on either the anesthesia machine or cardiopulmonary bypass pump, respectively. During this simulation, the output of each device was instead routed through an input toggle and then into a projector. This allowed either of the simulated monitors to be projected onto the wall for clear viewing by a large group. One of the faculty operators was able to toggle between the CPBS and ECS outputs as needed. During the portions of the simulation when anesthesia-related processes were primary such as induction of anesthesia and laryngoscopy, the ECS output was projected. During portions of the simulation when perfusion-related processes were primary such as transition to and weaning from cardiopulmonary bypass, the CPBS output was projected. The process of switching the projector output back and forth at key points effectively simulated one patient monitor used continuously throughout one procedure. One complete coronary revascularization procedure was simulated in a single 2-hour session. A short debriefing of the case was included.

Projection of the simulated monitor on a large scale was necessary because space and resource issues limited the offering to one simulated operating room. Two nurse anesthesia students along with one member of the nurse anesthesia faculty were assigned the role of nurse anesthetist. This group was stationed at the head of the ECS. Two perfusion students were assigned with one member of the perfusion faculty to the role of perfusionist. This group was stationed at the CPBS. The remaining students were seated in a half-circle arrangement behind the perfusionists with a clear view of both simulators, the projection of the simulated patient monitor, and a second projection used to display slides of equipment, procedures, and other information relevant to the topic. The seated group of students also included several members of the faculty from each discipline. All were encouraged to discuss what was being observed with students and faculty members of the other discipline throughout the event.

Student attendees were surveyed immediately before and after this event using the revised IEPS. The IEPS is a common and reliable tool for measuring student perceptions of interdisciplinary education. The 2007 revision of the IEPS by McFadyen et al. is a 12-item survey. Respondents are asked to identify increasing levels of agreement to each item from "strongly disagree" as 1 to "strongly agree" as 6. The range of the instrument is 12–72; higher scores indicate increasing agreement with the positively worded items and correspondingly more positive perceptions of interdisciplinary education (12). An example of the type of statement provided is: "Individuals in my

profession are extremely competent" (12, p. 434). The full revised IEPS is included as Appendix 1.

The revised IEPS measures participant perceptions of "Competency & Autonomy" among those in their chosen specialty, "Perceived Need for Cooperation" between disciplines, and perceptions of cooperative efforts between disciplines as "Perception of Actual Cooperation" (12, p. 440). Reliability estimates for these three subscales and the aggregate are reported between .38 and .86 in groups of students that were demographically and professionally similar to the volunteers described here (12,13).

STATISTICAL METHODS

The Mann-Whitney *U* test was used to compare pre-event survey responses to postevent survey responses. Nonparametric comparison was chosen because anonymity of responses prevented the use of matched pairs. Baseline scores were high in the aggregate cohort as seen in Table 1. Baseline responses were also high in both the perfusion and nurse anesthesia subsets as seen in Table 2. These data were not normally distributed. The first comparison included all participants, whereas the second compared the responses provided by perfusion students only. A third comparison of pre-event to postevent responses provided by the nurse anesthesia students was also included. Comparison of baseline to postevent responses according to group can be seen in Table 3.

Table 3. Pre-event to postevent response comparison using the Mann-Whitney *U* test.

Scale	All (n = 37)	Perfusion (n = 22)	Nurse (n = 15)
Total	*p = .005**	*p = .014**	*p = .115*
"Competency & Autonomy"	*p = .002**	*p = .007**	*p = .113*
"Perceived Need for Cooperation"	*p = .374*	*p = .814*	*p = .217*
"Perception of Actual Cooperation"	*p = .010**	*p = .007**	*p = .339*

Scales as revised by McFadyen et al.

*Significance established at <.05.

Statistical analysis was completed using Predictive Analytics Software (PASW), Version 18 (14). Subscale titles and composition are presented in Tables 1–3 according to the revision of the IEPS presented by McFadyen in 2007 (12).

RESULTS

Statistically significant differences between pre-event and postevent responses were observed in the aggregate score along with the areas of "Competency & Autonomy" and "Perception of Actual Cooperation." Significant

Table 1. Pre-event and postevent revised Interdisciplinary Education Perception Scale responses.[1]*

Scale (number of Items)	No.[2]†	Range (possible)	Mean (standard deviation)
Pre-event total (12 items)	37	54–72 (72)	64.14 (4.57)
Pre-event "Competency & Autonomy" (5 items)	37	22–30 (30)	26.16 (2.33)
Pre-event "Perceived Need for Cooperation" (2 items)	37	7–12 (12)	11.35 (1.09)
Pre-event "Perception of Actual Cooperation" (5 items)	37	21–30 (30)	26.68 (2.45)
Postevent total (12 items)	36	59–72 (72)	67.61 (4.87)
Postevent "Competency & Autonomy" (5 items)	36	23–30 (30)	27.83 (2.38)
Postevent "Perceived Need for Cooperation" (2 items)	36	10–12 (12)	11.58 (.73)
Postevent "Perception of Actual Cooperation" (5 items)	36	24–30 (30)	28.19 (2.18)

Scales as revised by McFadyen et al.

*Each item is measured on a 6-point scale.
†One participant (perfusion) did not complete the postevent survey. Pre-event n = 37, postevent n = 36.

Table 2. Individual sample response characteristics.[1]*

Scale (possible)	Perfusion Pre-event Range (Mean)	Perfusion Postevent Range (mean)	Nursing Pre-event Range (mean)	Nursing Postevent Range (mean)
Total (72)	54–72 (62.95)	60–72 (67.1)	59–72 (65.87)	60–72 (68.33)
"Competency & Autonomy" (30)	22–30 (25.59)	23–30 (27.57)	24–30 (27)	23–30 (28.2)
"Perceived Need for Cooperation" (12)	7–12 (11.23)	10–12 (11.43)	10–12 (11.53)	10–12 (11.8)
"Perception of Actual Cooperation" (30)	23–30 (26.23)	25–30 (28.10)	21–30 (27.33)	24–30 (28.33)

Scales as revised by McFadyen et al.

*Perfusion n = 22. Nurse anesthesia n = 15.

results were observed in these areas using the entire response sample and after comparison of only perfusion survey responses. No statistically significant differences between pre-event and postevent survey responses were observed when only nurse anesthesia student responses were compared. This may be attributable to prerequisite nursing experience, previous participation in interdisciplinary education, or small sample size.

All students present were invited to complete the surveys. A small number of students actually participated in the activity while the remaining majority observed. All responses were included in the analysis. Responses provided by hands-on participants may have differed from responses provided by observers, which may have influenced the final results.

DISCUSSION

Many simulation courses emphasize application, but observation and discussion with others in a group as seen in this simulation are also effective means of learning (3). Ideally, future versions of this activity would serve as a demonstration to a large group, which would then be followed by opportunities for all participants to more actively embrace their professional roles in small teams with their peers (3).

An unanticipated strength of the large-group approach used in this simulation was the opportunity for students to observe members of the faculty interacting in a pseudoclinical manner. Although this may have influenced the results, communication that combines assertiveness with professional respect is necessary in both nurse anesthesia and perfusion. This is a skill that can be positively modeled by instructors in the preclinical portion of the educational program.

Negative communication, interpersonal incivility, and lateral violence are unfortunately common and well documented in the nursing literature (15–17). Nontechnical failures, including communication, are implicated in poor patient outcomes and perioperative harm (4,15,18). Negative interpersonal and interdisciplinary perceptions can contribute to negative beliefs, negative communication, and behaviors that are antithetical to the surgical culture of safety. Addressing these perceptions during the preclinical portion of nurse anesthesia and cardiovascular science programs is an important part of the educational process. The high participation rate, both among students and instructors, seen during this event may indicate underlying interest in these important interdisciplinary issues.

A weakness of the observational technique used in this large-group simulation was the absence of risk in the role of observer. Effective simulation sometimes requires the opportunity to experience simulated misadventures that create very real impressions of potential or actual failure in the participant while removing the risk to an actual patient (3).

Risk is an important consideration in clinical practice that influences communication, decision-making, and teamwork. In the case described, the scenario was successful and the observers were not required to hazard any opinions as to proper management of the various events. The few participants selected to occupy their respective roles with the instructors had the opportunity to actively manage simulated patient events. Ideally, future repetitions of this simulation would offer this opportunity to more students of diverse specialties to accurately mimic clinical decision-making.

LIMITATIONS

A significant limitation of this study was the opportunity for only a few student participants to perform the actual interventions. "Active experimentation" (3, p. 2) is a unique feature of experiential learning, like simulation, in which learners directly attempt the activity at hand (3). Offering full participation to all students in this event was not reasonable in light of time and resource limitations. All surveys were used in the analysis, including the small number of participants. Participant responses may have differed from observer responses, which may have influenced the results considering the size of the sample.

Selection bias is a limitation of using volunteers. Baseline positivity regarding the "perceived need for cooperation" (12, p. 440) may have contributed to nonsignificant results in this area. Another limitation of this sample was that nurse anesthesia and perfusion were the only specialties represented. Many members of the surgical team (circulating nurse, surgical technologist, surgical assistant, and surgeon) were absent. Each team member makes a valuable contribution; every specialty not present diminishes the authenticity of the team and, consequently, the interdisciplinary component of the activity. Future research would benefit from including a more diverse array of specialties commonly represented on a cardiothoracic operating team.

This study examined an event that was unique in execution. Changes observed can be neither generalized to other programs nor assumed to represent lasting or clinically beneficial influence. All students in this study were in the didactic phase of their respective specialty programs, but nurse anesthesia students had previous nursing experience. Prior nursing experience in any setting can reasonably be assumed to have influenced participation and baseline perceptions of interdisciplinary practice.

CONCLUSIONS

This event was well received by students and faculty in attendance. Emerging simulation technologies like the CPBS and novel combinations of simulation technologies can facilitate meaningful interdisciplinary educational interactions. Interdisciplinary case-based simulation events may contribute to improved postevent interdisciplinary perceptions held by nurse anesthesia students and cardiovascular science students when compared with their own baseline. Interdisciplinary simulation activities combining students from cardiovascular science and nurse anesthesia programs present opportunities for innovative preclinical education.

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APPENDIX 1. Revised Interdisciplinary Education Perception Scale.

"1. Individuals in my profession are well trained.
2. Individuals in my profession are able to work closely with individuals in other professions.
3. Individuals in my profession are very positive about their goals and objectives.
4. Individuals in my profession need to cooperate with other professions.
5. Individuals in my profession are very positive about their contributions and accomplishments.
6. Individuals in my profession must depend on the work of people in other professions.
7. Individuals in my profession trust each other's professional judgment.
8. Individuals in my profession are extremely competent.
9. Individuals in my profession are willing to share information and resources with other professionals.
10. Individuals in my profession have good relations with people in other professions.
11. Individuals in my profession think highly of other related professions.
12. Individuals in my profession work well with each other." (12, p. 434)