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Assessing the Impact of High Fidelity Human Patient Simulation on Teamwork among Nursing, Medicine and Pharmacy Undergraduate Students

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***Abstract*—**High fidelity human patient simulation has been used for many years by health sciences education programs to foster critical thinking, engage learners, improve confidence, improve communication, and enhance psychomotor skills. Unfortunately, there is a paucity of research on the use of high fidelity human patient simulation to foster teamwork among nursing, medicine and pharmacy undergraduate students. This study compared the impact of high fidelity and low fidelity simulation education on teamwork among nursing, medicine and pharmacy students. For the purpose of this study, two innovative teaching scenarios were developed based on the care of an adult patient experiencing acute anaphylaxis: one high fidelity using a human patient simulator and one low fidelity using case based discussions. A within subjects, pretest-posttest, repeated measures design was used with two-treatment levels and random assignment of individual subjects to teams of two or more professions. A convenience sample of twenty-four (n=24) undergraduate students participated, including: nursing (n=11), medicine (*n*=9), and pharmacy (*n*=4). The Interprofessional Teamwork Questionnaire was used to assess for changes in students' perception of their functionality within the team, importance of interprofessional collaboration, comprehension of roles, and confidence in communication and collaboration. Student satisfaction was also assessed. Students reported significant improvements in their understanding of the importance of interprofessional teamwork and of the roles of nursing and medicine on the team after participation in both the high fidelity and the low fidelity simulation. However, only participants in the high fidelity simulation reported a significant improvement in their ability to function effectively as a member of the team. All students reported that both simulations were a meaningful learning experience and all students would recommend both experiences to other students. These findings suggest there is merit in both high fidelity and low fidelity simulation as a teaching and learning approach to foster teamwork among undergraduate nursing, medicine and pharmacy students. However, participation in high fidelity simulation may provide a more realistic opportunity to practice and function as an effective member of the interprofessional health care team.

***Keywords*—**Acute anaphylaxis, high fidelity human patient simulation, low fidelity simulation, interprofessional education.

I. Introduction

UNDERGRADUATE health science students often enter the workforce with little or no experience in interprofessional teamwork, but teamwork is expected in the health care setting [1]-[3]. Teamwork is an important and requisite skill that must be taught, supported and nurtured in undergraduate programs. However, nursing, medicine and pharmacy students have limited opportunities during their undergraduate programs to learn how to collaborate with other members of the health care team. One effective way to promote teamwork is through interprofessional education [4]-[6], but undergraduate students continue to be educated in isolation [7]-[9]. Theoretically, if students from different health care professions learn together through interprofessional education (IPE), they are better prepared to practice more efficiently and effectively as a cohesive health care team. IPE is a collaborative approach to teaching and learning that fosters teamwork among students in health-related fields such as nursing, medicine and pharmacy [10]-[14]. IPE encourages students to use their varied educational backgrounds to learn together for a defined period of time during their education programs. Simulation is a particularly useful teaching and learning approach for IPE, including the use of high fidelity simulation (HF-IPE) to create realistic patient scenarios for active student engagement [15]-[17].

The problem of nursing, medicine and pharmacy students entering the workforce with little or no experience in interprofessional teamwork is further complicated by a lack of opportunities to practice teamwork in the educational or clinical setting. Concerns over patient safety in practice have led faculty to search for appropriate and safe simulated experiences to prepare students for real-life situations [18]. Simulated learning experiences can range from simple (low) to complex (high). HF-IPE involves the use of a life-sized human patient simulator that is programmed to respond to interventions by changing blood pressure, heart rate, breath sounds, and oxygenation. The human patient simulator can respond to medication administration and can talk to the team. Low fidelity simulation such as clinical case discussions, requires the student teams to discuss a clinical case but there is no actual intervention or response implemented.

Medicine, nursing and pharmacy undergraduate programs have been using high fidelity simulation for many years in their respective uniprofessional education activities to foster critical thinking, engage learners, improve confidence, and enhance psychomotor skills. Thus, it would be a natural progression in this field of experiential teaching and learning to move from uniprofessional high fidelity undergraduate education, to interprofessional high fidelity undergraduate education [19]-[24]. Although HF simulation has been used successfully for training teams at the post-licensure level, particularly in the area of advanced cardiac life support, there

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are few research studies that address the effectiveness of HF-IPE to foster teamwork with undergraduate students, or provide guidance on how HF-IPE can be integrated into undergraduate curricula [25].

The design of the anaphylaxis simulation scenarios developed for this study was based on Jeffries nursing simulation education framework [26]. The Jeffries Framework has five major components with associated variables: the teacher, the student, educational practices, simulation design (including high or low fidelity) and the learner outcomes (Fig. 1). The Kirkpatrick Model for measuring learning outcomes was also used to guide the measurement of the impact of the learning experience. The Kirkpatrick model identifies five outcomes for measuring the effectiveness of educational initiatives including: reaction – students' satisfaction; learning – knowledge and skills gained; behaviors – newly learned behaviors that are transferrable to practice; results – benefits, measurable results, and return on investment analysis [27]. This study focused on the outcomes of reaction, student satisfaction, learning and behaviors.

II. METHODS

A. Research Questions

1. Does participation in high fidelity simulation result in a higher level of understanding of team roles, than participation in low fidelity simulation?
2. Does participation in high fidelity simulation result in more improved confidence in communicating with the team to plan care as compared to participation in low fidelity simulation?
3. Does participation in high fidelity simulation result in improved confidence in collaborating with the team to plan care, as compared to participation in low fidelity simulation?
4. Are participants in the high fidelity simulation more satisfied with the teaching and learning approach, than participants in the low fidelity simulation?

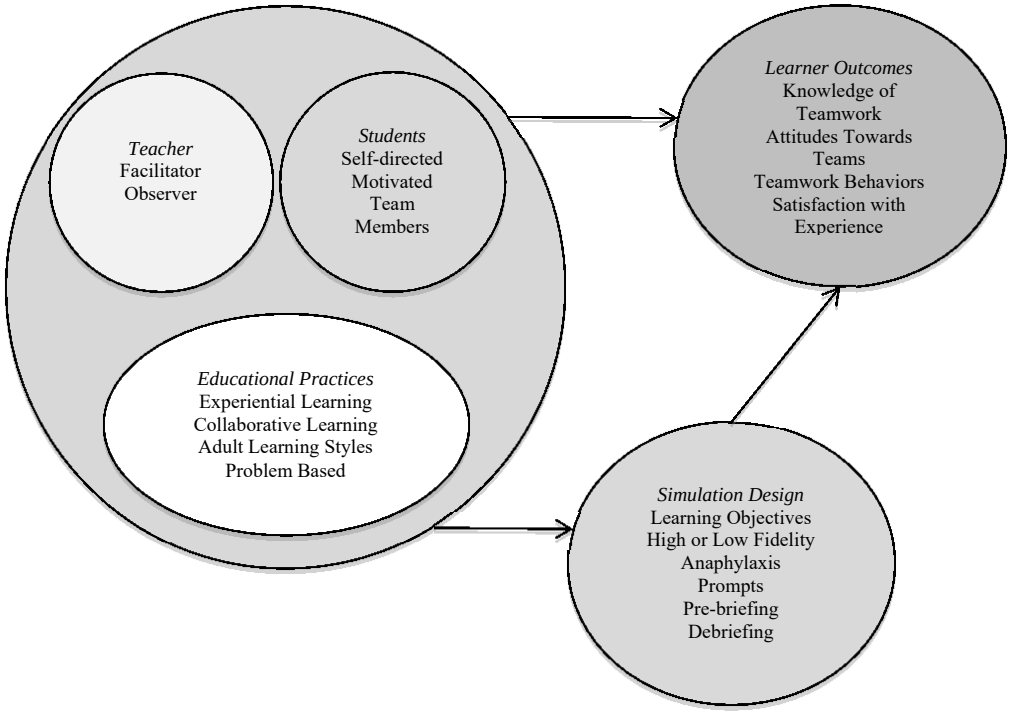


Fig. 1 Jeffries's framework applied to interprofessional simulation education

B. Research Design

A within subjects, pretest-posttest, repeated measures research design was used in this study. The design involved two interventions; one HF-IPE, and one low fidelity interprofessional education (LF-IPE). There was random assignment of individual subjects to interprofessional teams of two or more professions. The sequence of the simulations depended on students' schedule and availability of the simulation room. This research design eliminated the need for a separate control group, as participants served as their own control group.

C. Methods

The teams participated in two simulations: one HF-IPE and LF-IPE. Both simulations were based on the medical management of an adult patient experiencing acute anaphylaxis. The high fidelity case involved an acute allergic reaction to contrast medium and the low fidelity case involved an acute allergic reaction to antibiotics (Fig. 2). Patient history, presenting symptoms and the reason for the reaction were different for each simulation, but the treatment protocol for the medical management of acute anaphylaxis was exactly the same. The primary difference between the simulations was

the use of the adult human patient simulator in the high fidelity simulation and the paper based discussion in the low fidelity simulation.

During both the HF-IPE and the LF-IPE simulations, the students had access to a fictitious paper based chart with an admission history and physical, diagnostic reports, nursing notes, nursing care plan, physicians orders, policies and procedures, medication administration records and other charting documents as needed. In both simulations, students were expected to discuss, order and document care including prescribing, and transcribing medications and completing the required documentation. Each simulation session lasted approximately 60 to 90 minutes including a15-minute pre-briefing, and a 15-minute debriefing session. The pre-briefing session for the HF-IPE included an orientation to the human patient simulator. The debriefing session for both simulations focused on discussion questions related to the role of the interprofessional team, and whether the team provided good care and communicated and collaborated effectively.

Low Fidelity Case	High Fidelity Case
Mr. John Critch, 50 years old, 6 feet 2 inches, 185 pounds, has been admitted to the Special Care Unit from the Emergency Department with a diagnosis of bacterial pneumonia. He presented with shortness of breadth, and a productive cough that has become progressively worse over the past 24 hours. Intravenous fluid and oxygen were administered. Medications at home include Ramipril, Amlodipine, Metoprolol and Rosuvastatin. He is allergic to Sulfa Drugs. He states he took an antibiotic once before but developed a rash and stopped taking them. He cannot remember the name of the antibiotic.	Mrs. Carly Jones, 50 years old, 5 feet 8 inches, 154 pounds, was admitted last night to the Emergency Department with Undiagnosed Chest Pain. She presented to ER with acute right pleuritic chest pain after returning from an international flight. She is allergic to shellfish. Her medications at home are Ramipril, Amlodipine, Metoprolol, Rosuvastatin, and Metformin. She returned from a computed tomography of the pulmonary arteries about 5 minutes ago. Sub segmental pulmonary emboli were identified in right lower lobe. She is complaining of feeling "itchy" all over.

Fig. 2 Anaphylaxis Case for Low and High Fidelity Simulations

D. Sample

A convenience sample of twenty-four (n=24) undergraduate students participated, including: nursing (n=11), medicine (*n*=9), and pharmacy (*n*=4). One hundred and nine (n=109) students were recruited to participate in the study, but only 24 of those who expressed interest were able to find a common time to meet outside of their clinical and classroom schedules. All teams had nursing and medicine students. However due to scheduling issues, only five of those teams had pharmacy students. All students had completed courses containing the theoretical background on the medical management of anaphylaxis.

E. Setting

This study took place at the Cahill Simulation Room (CSR) at the School of Nursing, located in the Health Sciences Center in close proximity to the School of Nursing, Faculty of Medicine and the School of Pharmacy. In the HF-IPE the CSR was set up to resemble a standard patient room in an emergency room setting and in the LF-IPE the students sat around a table to discuss the case in a classroom setting. The pre-briefing and debriefing sessions for both simulations occurred in the classroom setting.

F. Instrument

The Interprofessional Teamwork Questionnaire (ITQ) was used as a pretest and posttest for both simulations [4]. That tool was modified with permission for use in this study. The ITQ extracts ordinal level data and includes seven statements that are rated by the participant on a five-point Likert scale from "Strongly agree" to "Strongly disagree." Those statements focus on areas of individual functionality within an interprofessional team, the significance of interprofessional collaboration in the simulation, comprehension of the role of each profession involved, confidence in effectively communicating with the interprofessional team, and confidence in effective collaboration for care planning. In addition to these initial statements, the post-test version of the ITQ included nine items that assessed the participant's level of satisfaction with the teaching and learning approach. Items included the level of clarity of the learning objectives, the fairness of the workload, the organization of the experience, utility of each component in the simulation experience, (pre-briefing, orientation to the simulator and debriefing), whether they would recommend the scenario to others, and whether the experience was meaningful. The ITQ measured three outcomes from Kirkpatrick's model for simulation education: the students' immediate reaction, including satisfaction with the experience; and the students' perception of the learning that occurred, including changes in knowledge of the importance of interprofessional teamwork, and confidence in communicating and collaborating with the team.

III. Findings and Discussion

A. Comprehension of the Team Roles and Importance of Teamwork

Participation in both the HF-IPE and the LF-IPE resulted in statistically significant improvements in students' understanding of the importance of the role of the interprofessional team and in participants' understanding of the roles of nursing and medicine. However, only the LF-IPE resulted in a significant change in the understanding of the pharmacy role (Table I). These findings may be due to the fact that not all teams had a pharmacy student present during the HF-IPE simulation. In those teams without a pharmacy student, the Research Assistant played the role of the pharmacist and consulted with the team via telephone, so this may have impacted on the understanding of the role of the pharmacist on the team. These findings may also reflect the importance of students meeting face to face during interprofessional simulations in order to foster an increased

understanding of their roles on the interprofessional team. These findings are in keeping with current research, which identifies simulation as useful teaching and learning approach for IPE, especially HF-IPE because it creates realistic patient scenarios for active student engagement [15]-[17].

B. Individual Functionality Within an Interprofessional Team

Participation in the HF-IPE resulted in a significant improvement in students' understanding of the importance of the interprofessional team (Table II). However, participation in the LF-IPE did not produce a similar change. This may be due to the fact that prior to participating in the LF-IPE the understanding of the importance of the interprofessional team was already high and this did not significantly change after participation. The same may be true of the lack of change in students' perception of whether they functioned effectively as a member of the team after participation in the LF-IPE. These findings would indicate that HF-IPE was more effective in enhancing students' ability to function as a member of the team whereas LF-IPE was more effective in enhancing the understanding of the team. These findings are similar to current research which shows that participation in HF-IPE results in significantly more positive attitudes about team work and collaboration, and undergraduate students are ready to engage in interprofessional education through exposure to an experiential format such as high-fidelity human patient simulation [15].

TABLE I
UNDERSTANDING OF NURSING MEDICINE AND PHARMACY ROLES ON THE TEAM

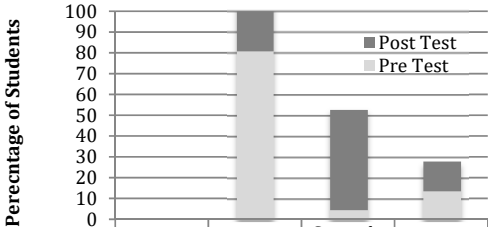
Profession	Low Fidelity *N*=21		*p* [a]	High Fidelity *N*=24		*p* [a]
	Pre	Post		Pre	Post	
Nursing	4.14±0.85	4.67±0.48	0.008	4.17±0.70	4.58±0.50	0.008
Medicine	3.90±1.00	4.52±0.51	0.004	3.75±0.99	4.33±0.76	0.001
Pharmacy [b.]	3.25±1.12	4.40±0.60	0.001	3.25±1.12	3.50±1.02	0.052

[a] Wilcoxon Signed Ranks Test, *CI 95%*
[b.] Pharmacy: low fidelity *n*= 20; high fidelity *n*= 21

TABLE II
IMPACT ON ATTITUDES TOWARDS INTERPROFESSIONAL TEAMS

Statement	Low Fidelity *M* ± SD			High Fidelity *M* ± SD		
	Pre	Post	*p*	Pre	Post	*p*
Function effectively as a member of the interprofessional team	*4.05±0.59*	*4.38±0.67*	*0.035*	3.63±1.01	4.29±0.69	0.003[a]
Understand the importance of interprofessional teamwork	4.48±0.51	4.86±0.36	0.005[a]	*4.75±0.52*	*4.83±0.38*	*0.317*
Confident can communicate effectively with the team	3.90±0.44	4.33±0.73	0.013[a]	3.79±0.78	4.25±0.85	0.036[a]
Confident can collaborate effectively with the team	4.10±0.54	4.43±0.68	0.020[a]	3.96±0.81	4.46±0.57	0.005[a]

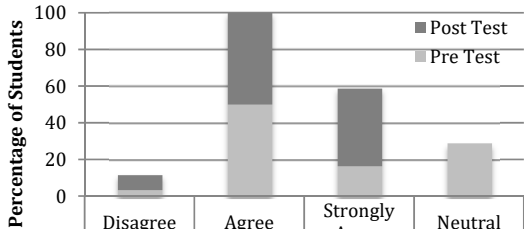
[a] Wilcoxon Signed Ranks Test, CI 95%



	Disagree	Agree	Strongly Agree	Neutral
Post Test	0	38	48	14
Pre Test	0	81	5	14

Fig. 3 Confidence in Communicating Effectively with the Team - Low Fidelity

Team Communication and Collaboration. Prior to participating in the LF-IPE, 81% agreed and 5% strongly agreed that they were confident they could communicate effectively with the interprofessional team to plan care for a patient experiencing acute anaphylaxis. After participation, 38% agreed and 48% strongly agreed they could communicate effectively with the interprofessional team (Fig. 3). Although there was no change in the percentage of students' who reported they were neutral on this item (14%), there was a positive shift towards strongly agreeing with this statement. This would further support the finding that participation in the LF-IPE resulted in a positive impact on students' perception of their ability to communicate effectively with the interprofessional team.



	Disagree	Agree	Strongly Agree	Neutral
Post Test	8	50	42	0
Pre Test	4	50	17	29

Fig. 4 Confidence in Communicating Effectively with the Team - High Fidelity

Prior to participating in the HF simulation, 29% of the

students were neutral about whether they were confident in communicating effectively with the interprofessional team (Fig. 4). This dramatically decreased to 0% post participation with a corresponding 25% positive shift in strongly agreeing they could communication effectively with the interprofessional team. This would further support the finding that participation in the high fidelity simulation resulted in a positive impact on students' perception of their ability to communicate effectively with the interprofessional team.

C. Satisfaction with Teaching and Learning Approach

The ITQ mean satisfaction scores for both the HF-IPE and LF-IPE showed that participants were satisfied with both experiences including satisfied with the workload, the organization of the experience and the debriefing sessions. Students also reported that both simulations were meaningful and they would recommend both experiences to others (Table III). However, participants in the LF-IPE reported they were significantly more satisfied with the learning objectives and pre-briefing session, than participants in the HF-IPE. The learning objectives for both sessions were the same, and students were not expected to review those objectives before participating in the simulations. Thus, it is possible that some students had not reviewed, or were not aware that the learning objectives for both sessions were exactly the same. The pre-briefing sessions for the HF-IPE included orientation to the human patient simulator and students may have perceived this orientation differently as this was the first time they had been exposed to the human patient simulator.

Overall, the students were satisfied with the teaching learning approaches used in both the HF-IPE and the LF-IPE and there were no significant differences between the HF-IPE and LF-IPE in relation to satisfaction with workload, organization and debriefing (Fig. 5). All students agreed or strongly agreed that they would recommend both learning experiences to others. These findings would indicate that participation in the HF-IPE did not result in a higher level of student satisfaction with the learning experience as compared to participation in the LF-IPE. However it was clear that students were satisfied with both the HF-IPE and the LF-IPE as a teaching and learning experience.

TABLE III
PRETEST AND POSTTEST SATISFACTION MEANS SCORES FOR LOW AND HIGH FIDELITY

Statement	Low Fidelity	High Fidelity	*Pearson's Coefficient*
Learning objectives were clear	4.43	4.21	0.661*
Workload was fair	4.62	4.29	0.295
Experience was organized	4.67	4.38	0.293
Pre-briefing was helpful	4.38	4.29	0.485*
Debriefing was helpful	4.42	4.48	0.342
Recommend experience to others	4.7	4.83	0.336
A meaningful experience	4.65	4.79	0.157

*Note: Significant at p = < 0.05, CI 95%

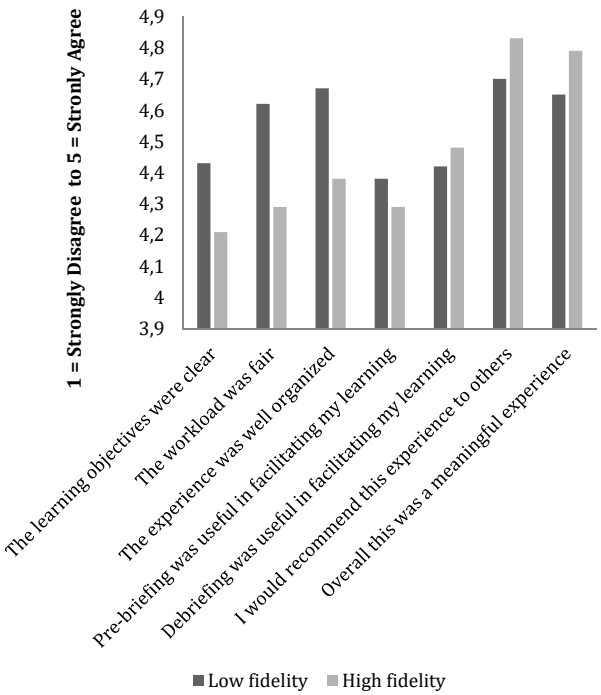


Fig. 5 Satisfaction with teaching and learning approach

IV. CONCLUSION

Participation in the HF-IPE and the LF-IPE developed for this study resulted in a significant increase in students' understanding of the importance of teamwork, and enhanced students' understanding of the role of nursing and medicine, in the interprofessional team when caring for patients experiencing acute anaphylaxis. The HF-IPE was more effective in enhancing students' ability to function as a member of the team, whereas the LF-IPE was more effective in enhancing the participants' understanding of the importance of interprofessional teamwork. Participation in both the HF-IPE and the LF-IPE resulted in a positive impact on students' perception of their ability to communicate and collaborate effectively with the interprofessional team to plan care. Students were equally satisfied with the educational practices and the simulation design of the HF-IPE and the LF-IPE as a teaching and learning approach. However, it is critical to ensure that when simulations are designed for a particular team (nursing, medicine and pharmacy) all members of the team are present during the simulation. HF-IPE and LF-IPE can be effective teaching and learning approaches to foster interprofessional teamwork in undergraduate nursing, medicine and pharmacy students and should be incorporated into the undergraduate curricula of nursing medicine and pharmacy education programs.

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