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Patient Simulation as an Active Learning Tool in Medical Education

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ABSTRACT

Active learning techniques encourage students to participate in acquiring skills and knowledge. One technique that encourages active learning is patient simulation. Patient simulation tools can range from simple part-task trainers to complex high-fidelity simulators. A variety of human simulators can be used to teach basic patient care skills or more complex skills such as trauma management. Simulation research has demonstrated students can improve scores on standardized tests as well as improve their confidence. Research is still needed to address the long-term impact of patient simulation training. Although simulations have gained popularity, researchers caution that they should always be used as part of clinical education and not as a substitute.

RÉSUMÉ

Les techniques d'apprentissage actif encouragent les étudiants à participer à l'acquisition de connaissances et de compétences. Une des techniques pratiquées à cet égard est la simulation de patient. Les outils de simulation de patient vont d'un simple outil de formation partielle aux simulateurs de haute fidélité complexes. L'utilisation de simulateurs humains peut servir à l'enseignement des soins de base au patient ou de compétences plus complexes comme la gestion des traumas. Les études sur la simulation ont démontré que les étudiants peuvent augmenter leurs résultats aux tests normalisés et aussi leur confiance.

La recherche doit cependant se poursuivre sur les effets à long terme de la formation au moyen de la simulation de patient. Bien que la simulation gagne en popularité, les chercheurs mettent en garde contre son utilisation complète et ils maintiennent qu'elle ne doit constituer qu'une approche clinique parmi d'autres.

Introduction

Active learning is a teaching method that offers an alternative to the traditional lecture format for presenting material to students. The belief is that active learning techniques encourage students to participate in acquiring skills and knowledge [1]. Examples of active learning techniques used in medical education include problem-based learning [2], interactive lecture activities [1] and simulation-based learning [3]. These techniques are being used in medical education because of the belief that students' critical thinking skills improve when students are engaged in content. Medical councils have recommended that medical programs work to develop students' critical thinking skills to prepare them more effectively for the transition to the clinical setting [2]. This literature review focuses on the use of simulation-based learning as an active learning tool in medical education. The use of various simulation techniques in medical education and the impact these simulations have on student learning outcomes will be examined. A discussion on future research using simulations will also be addressed.

Methods

The research for this paper was completed using electronic database searches using EBSCOHOST (Ipswich, MA) through the Furman University and Midwestern State University websites. Academic Search Premier, MEDLINE, ERIC, CINAHL Plus with full text, PsychINFO, Health Source: Nursing/Academic Edition, and Psychology and Behavioral Science Collection databases were used. The first search was done using the terms "Active Learning" AND "Clinical" AND "Education." This search identified 71 articles. A second search was completed using the same databases with the terms "Active Learning" AND "Medical" AND "Education." This search identified 185 articles. Many articles were duplicated from the first search. A third search was completed using the same databases with the terms "Medical" AND "Education" AND "Simulation" AND "High Fidelity." This search identified 29 articles. Not all articles pertained to medical education, and several were simply short notes in research journals. Some articles also were editorial reports. Articles had to contain quantitative research to be included in this review. One report on emerging technologies in radiologic science was accepted for this review. The report was the only literature that specifically addressed radiologic science education. A total of 29 articles were accepted

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for this literature review. The articles refer to use of simulation in medical education and any impact the use of simulations have had on learning outcomes for students.

Results

High-fidelity Simulations

Bearnson and Wiker [4] define high-fidelity simulators as computerized medical mannequins capable of responding to treatments and medical interventions. The mannequins can be programmed to represent a variety of patients in various states of health. The advantages of high-fidelity simulators used in simulations include creating medical events that mimic real-life situations and provide practice for medical students in a safe environment [5]. These situations, or scenarios, can be simple to complex and can be common to rare experiences. Other benefits include a reduced need for practice on both animals and human bodies for basic skills training [6]. High-fidelity simulations (HFS) are useful in medical education because of the unique ability to demonstrate the effect a medical decision can have on a patient. The ability to demonstrate both positive and negative effects enhances the development of critical thinking skills through active learning [7]. Good [6] stated that 33% of all medical schools in the United States report using HFS. Nursing programs also use HFS [8]. Nehring and Lashley [8] conducted a survey of simulation centres that offer nurse training and nursing programs that had purchased a high-fidelity simulator to find out how programs are using the simulators and what the effects on learning have been. The results indicate that HFS are being used in multiple levels of nurse training, from technical colleges to graduate programs. Skills being taught also range broadly, from basic patient care skills to nurse anesthesia skills. There are also other simulators used in medical education besides the high-fidelity simulators. Well before HFS became common, there were part-task trainers as well as resuscitation simulators common to courses in cardiopulmonary resuscitation [6]. Standardized patients also have been used as simulation tools in medical training. These real ''live'' patients are trained to play the role of a patient and are generally knowledgeable regarding the disease or condition they are portraying [9].

Training Programs Using Patient Simulations

HFS are being used as training exercises for the US military. The US Army has used HFS to train and prepare staff for traumas resulting from combat injuries [10]. This study indicated that greater than 90% of army physicians who trained using the simulations rated the experience as excellent. The study also indicated that the Army is researching methods to make the training using HFS more effective [10]. In Norway, a group of researchers implemented a basic human simulator as a tool to provide trauma team training for hospitals [11]. The Norwegian medical community does not see the same number of trauma cases as seen in the United States, thus there is a need to maintain training in this area. The training program involved all levels of professionals responding to traumas: physicians, nurses, radiographers, laboratory technicians, and so on. This study was conducted over a 6-year period in 28 hospitals. The experience was reported as highly effective by 99% of participants. The project was so successful that 44 of a total of 50 hospitals in Norway have implemented the training program [11]. In another area of medical training, Kneebone et al. [12] proposed integrating HFS in parallel with actual surgery cases as teaching tools. Students participate in both simulated and actual surgery cases based on their skill level. With this model, students continually practice surgery skills. Students of various training levels participate; thus, the clinical and simulated training promote active learning as the students progress through various stages of learning [12]. A third area of training in which HFS are useful is in cardiology training, specifically the differentiation and identification of various conditions in a patient based on heart sounds [13]. The authors indicated that the percentages of students recognizing the cardiac auscultations were higher than expected for second-year medical students [13].

Specific Skill Training Using Simulations

Just as simulations have been applied to training programs, they have also been used to train students in specific skills. Seybert and Barton [14] used HFS to teach doctor of pharmacy students how to take accurate blood pressures. The authors found the skill difficult to assess when students practised on patients or actors because of variability among readings. The study demonstrated that high-fidelity simulators were effective in building this skill. After being trained on high-fidelity simulators, the students were able to determine blood pressures with 98% accuracy after three training sessions. By contrast, students determined blood pressures with only 22% accuracy during the first training session [14]. In a study by MacDowall [15], scenarios designed to give medical students practice at managing ''acutely ill'' patients allowed students to focus on basic skills in patient care. The students were able to work on gain intravenous access, begin appropriate fluids and use correct amounts of oxygen per patient condition using high-fidelity simulators. Other tasks performed included writing appropriate prescriptions and making correct chart entries. Students then completed surveys designed using a Likert scale. The students strongly agreed the simulations had provided valuable learning experiences. The students also strongly agreed the HFS improved their confidence in making decisions in patient care [15]. Bearnson and Wiker [4] also used HFS with nursing students to provide practice in medication administration. Students reported an increase in confidence in medication administration as a direct result of using HFS [4]. Issenberg et al. [16] reviewed uses of HFS and found that the use of this technology can be used effectively to develop new skills. However, the authors warn against using simulation alone; they argue that students do need to interact with patients in the clinical setting [16].

Incorporating Simulations into Standardized Medical Exams

Another area of research found in the literature is the use of simulators, typically high-fidelity simulators, in standardized medical examinations. An example of this use is the objective structured clinical examination (OSCE) used by medical schools to evaluate students' clinical skills [17]. An example of research in this area is the comparison of traditional OSCE scores to scores on examinations using HFS. In the study by Gordon et al. [17], the OSCE used traditionally is the control, and the simulation-based exam is the experiment. The study included 23 medical students of various education levels who were asked to complete the two examinations. The scores were similar in each of the two examinations; however, there was no statistically significant difference between the two sets of scores. Students were asked their opinions on the experience and indicated that they felt the simulator testing and scoring was a true representation of their knowledge and skill level [17]. Another example of use in OSCEs is found in nursing. The question examined in this research is the impact of skills training using HFS versus a standard curriculum that does not incorporate HFS into skills training. Alinier et al. [18] added training using simulations to the standard curriculum for an experimental group. The control group learned from the standard curriculum. An OSCE was given to both groups initially, and then the experimental group received simulation training. Five to six months later, both groups were given a second OSCE. The experimental group shared significant improvement over the control group: the control group improved by 7.2% points, whereas the experimental group improved by 14.2% points. It is interesting to note that the experimental group did not show improvement in confidence when working with the simulation technology [18]. Another area in which HFS have been used in is training for advanced cardiac life support skills (ACLS). Morgan et al. [19] implemented HFS to improve student preparedness for upcoming ACLS testing. After the HFS sessions, evaluators debriefed students by reviewing video tapes of team performances. The simulations and debriefing had a positive effect on the ACLS scores. There was a statistically significant improvement in scores on written tests. Another area in which students demonstrated improvement was on team performance. Based on student satisfaction surveys, the students reported the simulation sessions beneficial as an educational experience [19]. Another study by Wayne et al. [20] demonstrated similar results. HFS were added before standardized clinical tests centred on ACLS. The study group was divided into two groups. A baseline test was given to all, and then only one group was given simulation sessions during the next three months. A second test was given to all study participants. The group that attended simulations had significantly higher scores (38% higher). Over the next three months, the second group was also provided with simulation training, and in the final and third test, showed improvement even beyond the first group. Thus both groups had improved scores significantly after simulations. It is important to note the significant improvement seen in test scores. Results should be interpreted cautiously given the small sample size (n = 38) in this study [20].

Using Simulation to Distinguish Level of Experience

In a study by Girzadas et al. [21], the authors examined the use of HFS as a testing tool for competency in patient care. The research must demonstrate construct validity in the use of simulation to test skill level. Girzadas et al. [21] found that using a simulation which required students to create a surgical airway was a good predictor of skill level. As expected, students with fewer years of training took significantly longer (534 seconds) compared with 442 seconds for more experienced students [21]. In a study by Boulet et al. [22], simulation scenarios were used to distinguish between levels of training. The study examined 37 participants through six scenarios. Each participant also had to indicate any specialized training he or she had received. For example, participants would indicate on an information sheet whether they had completed ACLS certification. The participants were scored based on performance using standardized scoring. The scores appeared to accurately reflect abilities in terms of years of training and current life support certifications. The scores therefore provided data to further suggest performance in simulation scenarios can reliably indicate level of training [22].

Simulation to Build Teamwork Skills

Simulations have also been used to build teamwork skills in medical education. Bligh and Bleakley [23] examined different uses of simulation in medical education and found that teamwork and communication skills are benefits to using simulation. Beaubien and Baker [5] also found that teamwork can be learned through effective use of HFS. The scenarios call on students to work under realistic time demands. Teamwork and effective communication become necessary to successful completion of HFS. One key to teamwork building is taking advantage to debriefing events to review scenarios [5]. Mention of this same benefit was made by Morgan et al. [19]. Students in the study conducted by Morgan et al. [19] also demonstrated improvement in teamwork skills as a result of HFS and debriefing sessions. In another study by Wallin et al. [24], teamwork skills and attitude were also examined. Junior medical students in a Swedish medical school participated in eight trauma simulations [24]. The scenario participants were carefully scored based on a patient safety rating. The simulations took place over several days. Scores were calculated and indicated a significant change in teamwork skills among the students. The greatest changes were seen in communication with other team members and in the students recognizing when to ask for help as the scenario reached a point that exceeded their training. No significant change in attitude toward safe teamwork was found, perhaps because less emphasis was placed on this subject in didactic course work [24].

Discussion

Medical educators at all levels of education have been given the challenge of preparing students to be successful both academically and clinically. In this literature review, the use of simulation as an active leaning tool has been examined. Simulation tools vary from standardized patients to high-fidelity patient simulators that can appear lifelike. Simulation has been used for some time in medical education; this is not an entirely new concept. For example, Issenberg et al. [16] reviewed simulation literature from a 34-year time span. However, the tools used in simulation have changed over time as technology has improved. Good [6] notes that high-fidelity simulators have changed to the point that they are portable and could be used to train students outside of a laboratory setting. This portability may be an advantage to radiologic science programs. That simulators could be shared and transported to departments as needed may open up more possibilities for their use in radiologic in sciences. Although simulators have high-fidelity technology, they are still useful for teaching basic skills (Good [6], MacDowall [15], Kneebone et al. [25]). This also could be useful for radiologic science programs. Because students need to master basic patient care skills, high-fidelity simulators may provide an opportunity for students to practice patient care skills. Simulators such as high-fidelity simulator models are being used in a radiography program to train students in various medical emergencies [26]. McGaghie et al. [27] found through a literature review that students who had the most success in using simulators for training in a specific task also had the greatest amount of hands-on experience in working with simulators. The reasons for this success are believed to be repetitive practice throughout a curriculum. Also, the students were challenged at different skill levels, and debriefing sessions were included in training [27]. Knowing that training on simulators is an effective form of active learning will hopefully lead more radiography, computed tomography and even magnetic resonance imaging programs to consider the use of simulators throughout a curriculum to prepare students for medical emergencies they may encounter in clinical practice.

Although simulation appears to be highly effective as an education tool, the effectiveness of simulation in education programs from allied health through continuing medical education for physicians is still debated. Some literature reviews and research articles call for better quality research that will demonstrate clear advantages to using simulators [7, 16, 28]. Issenberg et al. [16] also caution against simulation being viewed as replacement for practice on live patients. The authors make the argument that simulation should be used in combination with live patients to gain the full benefit. Vozenilek et al. [9] also make this same plea and stress that mechanical simulators should not eliminate the use of standardized patients in some simulations. Bligh and Bleakley [23] also caution against overuse of simulators. They encourage simulators to be seen as a technique to "bridge the classroom and the workplace."

Although researchers appear to be cautious about fully embracing simulators and simulations as robust educational tools, many studies in this review do suggest that simulation has value as a training tool in medical education. More research is needed that examines the long-term impact of training using simulators. In the study by Issenberg et al. [13], a cardiology simulator was shown to be effective at improving students' scores on recognition of heart sounds and conditions. However, there are no long-term data on this effect. Another limitation of research in this area is small sample size. Several of the studies result from experiments with small sample sizes. Examples of these are the articles by MacDowall [15], Boulet et al. [22] and Wayne et al. [20]. All of the studies had 38 or fewer participants and were based on a single year. Studies should increase samples sizes and look at trends over a longer period than one academic year. Another area of research that has not been explored is the long-term impact of medical personnel that train with simulators and the continued effect of this training. This area will be difficult to measure, but it would bring validity to the use of simulators in medical education.

Although there are weaknesses in the research, there appear to be many promising advantages to the use of simulations in medical training. One of the greatest advantages is the ability of simulations to provide students examples of effects from poor patient care decisions. According to Ziv et al. [29], although simulators are not a replacement for clinical education, they will be an effective way to improve patient safety. In this regard, simulators also could help students in radiologic sciences gain more understanding of the impact mistakes can have on patients.

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