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Review

The effect of high-fidelity simulation on knowledge and confidence in critical care training: An integrative review

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ABSTRACT

Patient outcomes in critical care have long been linked to provider experience, but with older providers retiring, it is becoming difficult to maintain a high-level of experience among the ICU staff. Innovative training methods that improve providers' knowledge and confidence may be able to make up for deficiencies in clinical experience. High-fidelity simulation training mimics clinical experience and has been extensively studied in the training of procedural skills, but what is the effect of this type of training on knowledge and confidence? To answer this question, we conducted a review of the literature for studies examining the effect of simulation training on knowledge and confidence among critical care providers. Seventeen papers were identified that met the inclusion criteria and a systematic approach was used to review the papers and synthesize the data. All 17 studies demonstrated an improvement in knowledge and while only 13 of the included studies examined the effect on provider confidence, all found an improvement. We conclude that high-fidelity simulation is a useful tool for improving knowledge and confidence among critical care providers and merits consideration for inclusion in critical care training programs.

The care of the critically ill patient represents one of the most challenging tasks in modern healthcare. Patients in the intensive care unit (ICU) often have multiple simultaneous medical problems that may require widely divergent management strategies necessitating a fine balance between therapies. Data from monitors, laboratory tests, and other examinations must be synthesized to form a cohesive understanding of the problem so that clinical knowledge can be applied to address the issues. In addition, time is often of the essence and patient conditions may change rapidly, necessitating efficient diagnostic reasoning and evidence-based management.

Experience on the part of critical care providers (physicians, nurse practitioners (NP), physician assistants (PA), and nurses) in dealing with such patients and situations has been shown to improve patient outcomes (Morrison et al., 2001); however, with many older providers retiring and turnover of younger providers increasing, it has become difficult to maintain a high level of experience among ICU staff. Therefore, it is essential to ensure the highest quality training possible for ICU providers, both during the initial training period and continuing education. Even in the busiest ICUs, it is unlikely that trainees will be exposed to all possible clinical scenarios. Simulation in critical care training ensures that any given scenario may be encountered by the trainee, and may be carried out in a safe environment without putting patients at risk (Hovancsek, 2007).

The term “simulation” may be widely applied and includes the use of standardized patients, computerized manikins, and animations (Institute of Medicine (IOM), 2010). High-fidelity simulation is a specific form of simulation that utilizes lifelike manikins, which are able to faithfully reproduce physiological conditions of illness or injury and response to treatments and interventions (Decker et al., 2008). For the purposes of this paper, we will use the term “simulation” to refer exclusively to high-fidelity simulation unless otherwise specified.

A number of studies have shown simulation to be an effective tool for training in healthcare and it has been used in a variety of disciplines including critical care (Roche, 2010), trauma (Harvey et al., 2013), obstetrics (Gardner and Raemer, 2008), and surgery (Cumin et al., 2013). Its use has been shown to improve patient safety and operator skill in the performance of procedural skills including central venous catheterization, airway management, colonoscopy, peripheral venous cannulation, and bladder irrigation

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(Zendejas et al., 2013). In addition to technical skill training, simulation is being increasingly utilized as a tool for improving clinical knowledge and provider confidence/self-efficacy.

The review

Aim

The purpose of this integrative review is to examine the current research in order to answer the primary research question: "What is the effect of high-fidelity simulation on the knowledge and confidence/self-efficacy of critical care providers?" Although the conclusions of other authors reached through integrative and systematic reviews are no doubt beneficial, we chose to proceed with a review exclusively of original research. Based on this review, gaps in the current literature will be identified and areas for future research addressed.

Search methods

A comprehensive search for original, peer-reviewed research studies published in English within the past 10 years was performed using the following search string: (simulation) AND ("critical care" OR "intensive care"). An initial search employing the additional search term high fidelity demonstrated unreliable results, as a number of papers did not specify the precise modality in the abstract or keywords. The search was conducted using both the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and the Medical Literature Analysis and Retrieval System Online (Medline) databases.

Studies were included in this review if they were original research involving nurses and/or physicians in critical care and the use of high-fidelity simulation and its effect on knowledge and/or confidence. Studies using simulation modalities other than high-fidelity manikins, focusing on the training of procedural skills, and review papers were excluded from this review (see Table 1). Titles and abstracts of all search results were reviewed and inclusion and exclusion criteria applied. All references cited in extracted articles were further reviewed for potential relevancy. Each article selected was examined and graded according to the American Association of Critical Care Nurses (AACN) Levels of Evidence (Table 2, Armola et al., 2009). The selected articles are summarized in Table 3.

Results

The initial search returned 1453 papers (349 from CINAHL and 1104 from Medline). After duplicate papers were removed and inclusion criteria applied to a reading of titles and abstracts, 25 papers remained. Further review of the entire papers excluded an additional 8, leaving 17 papers for inclusion.

Of the 17 papers included, 6 were graded at a Level B and the remaining 11 at a Level C. Nine of the studies were conducted using physicians (either in training or practicing) as subjects, five used registered nurses, and three were either a mixed physician/nurse (n = 2) or NP/PA (n = 1) population. Sample sizes of the studies ranged from 3 to 102 with a mean sample size of 30 (SD = 26.7). The majority of studies were conducted in the United States (n = 12), with the remainder conducted in Canada (n = 2), Japan (n = 1), Sweden (n = 1), and Finland (n = 1). The majority of studies (n = 12) assessed the effect of simulation on knowledge as well as provider confidence. Four studies (Plante, 2006; Schroedl et al., 2012; Singer et al., 2013; Springer et al., 2013) only examined the effects on knowledge; one (Meurling et al., 2013) only examined the effect on confidence. Several studies examined variables other than knowledge and confidence; however, for the purposes of this review, we will focus only on the results in those two areas.

Effect on knowledge/competence

Sixteen studies measured the effect of simulation on the participants' knowledge and/or perceived clinical competence. The largest group of studies (n = 7) measured the effect of the simulation using a self-assessment on the part of the participant. In all seven studies (Abe et al., 2013; Figueroa et al., 2013; Kaddoura, 2010b; Kane et al., 2011; Lavoie et al., 2013; Nishisaki et al., 2009; Willett et al., 2011), participants rated their own perception of their knowledge as greater following the simulation intervention.

Six studies used some variation of objective testing with a control group for comparison. Of these, three studies (Jansson et al., 2014; Springer et al., 2013; Tofil et al., 2011) utilized a pre-test/post-test model for the intervention group and compared the results to the same test taken by the control group. In two studies (Jansson et al., 2014; Tofil et al., 2011), participants in the intervention group improved their scores following the simulation exercise. Further, scores in the intervention groups were consistently higher than those in the control groups who did not participate in the simulation exercise.

In a slight variation, both groups in one study (Springer et al., 2013) received simulation training; however, one group conducted all of their scenarios in one session while the other group split up the three scenarios over three days. Overall scores improved from 75% to 81%, but only the group with multiple sessions showed statistically significant improvement.

The remaining three studies (Pascual et al., 2011; Schroedl et al., 2012; Singer et al., 2013) did not include a pre-test, only a post-test following the intervention. Two studies (Schroedl et al., 2012; Singer et al., 2013) examined the use of simulation in training medical residents and found that objective test scores increased following the simulation. Interestingly, Singer et al. (2013) compared first-year residents with no ICU experience to experienced third-year residents and found that prior experience had less effect than the simulation. Prior to a month-long ICU rotation, the inexperienced group completed a simulation course while the experienced group did not. Following the rotation, both groups were tested on their clinical knowledge, with the inexperienced

Table 1
Inclusion and exclusion criteria.

Inclusion criteria
- Use of high-fidelity simulation
- Research study
- Effect on confidence and/or knowledge
- Nurses and/or physicians
Exclusion criteria
- Exclusive training of procedural skills
- Simulation modalities other than high-fidelity manikin
- Reviews