The Use of Simulation Training to Improve Knowledge, Skills, and Confidence Among Healthcare Students: A Systematic Review

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Abstract

Purpose: The use of simulation has become a routine part of education and training for health professionals in many health education facilities. The increased awareness of patient safety and recent advances in technology are the main incentives to use simulation to teach and evaluate clinical competencies. The primary purpose of this study was to review the best available evidence (level and quality) for the use of simulation training to improve clinical skills, knowledge, and self-confidence among healthcare students. Method: A systematic review of qualitative and quantitative literature published between 2000 and 2016 was undertaken using databases including PubMed, CINAHL®, and PsycINFO® databases as well as three journal collections within ProQuest. In addition to the database search, the literature search for this study included two additional activities: search results were compared against the bibliographies of the reviewed studies, and Google Scholar was used to search the Internet for relevant publications. Data from studies meeting inclusion criteria was extracted and summarized. The level and strength of evidence was rated for each study. Results: Of 1412 studies identified via the search strategy, 30 met the inclusion criteria for this systematic review. A wide variety of study designs, interventions, measurements, and simulation types were represented. Data for study location, health profession, sample size, purpose, simulation type, intervention, and outcome measure are presented via evidence tables by authors. Statistically and/or clinically significant improvements in knowledge, skills, and/or self-confidence following simulation training were reported. Primary and secondary outcomes were identified and summarized. Conclusions: Evidence demonstrates that the use of simulation in student education significantly improves knowledge, skills, and self-confidence. A quality improvement framework of five best practice components for application in simulation research is proposed, generated from the findings of this review. Future research employing high quality research designs focusing on debriefing practices, interprofessional education applications, validation of outcome measures, student satisfaction, and long-term information retention will contribute to the growing body of literature supporting best practices for simulation training in healthcare.

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The Use of Simulation Training to Improve Knowledge, Skills, and Confidence Among Healthcare Students: A Systematic Review

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Abstract
Purpose: The use of simulation has become a routine part of education and training for health professionals in many health education facilities. The increased awareness of patient safety and recent advances in technology are the main incentives to use simulation to teach and evaluate clinical competencies. The primary purpose of this study was to review the best available evidence (level and quality) for the use of simulation training to improve clinical skills, knowledge, and self-confidence among healthcare students. Method: A systematic review of qualitative and quantitative literature published between 2000 and 2016 was undertaken using databases including PubMed, CINAHL®, and PsycINFO® databases as well as three journal collections within ProQuest. In addition to the database search, the literature search for this study included two additional activities: search results were compared against the bibliographies of the reviewed studies, and Google Scholar was used to search the Internet for relevant publications. Data from studies meeting inclusion criteria was extracted and summarized. The level and strength of evidence was rated for each study. Results: Of 1412 studies identified via the search strategy, 30 met the inclusion criteria for this systematic review. A wide variety of study designs, interventions, measurements, and simulation types were represented. Data for study location, health profession, sample size, purpose, simulation type, intervention, and outcome measure are presented via evidence tables by authors. Statistically and/or clinically significant improvements in knowledge, skills, and/or self-confidence following simulation training were reported. Primary and secondary outcomes were identified and summarized. Conclusions: Evidence demonstrates that the use of simulation in student education significantly improves knowledge, skills, and self-confidence. A quality improvement framework of five best practice components for application in simulation research is proposed, generated from the findings of this review. Future research employing high quality research designs focusing on debriefing practices, interprofessional education applications, validation of outcome measures, student satisfaction, and long-term information retention will contribute to the growing body of literature supporting best practices for simulation training in healthcare.

INTRODUCTION

Background
Simulation is an exercise that mimics realistic functions in a simulated environment.¹ The use of simulation in the healthcare field started more than a hundred year ago; however, advances in teaching technology have contributed to a recent resurgence of interest spanning the past two decades. Healthcare simulation is used by numerous healthcare specialties and serves multiple purposes.² Simulation has become a routine part of education and training for healthcare students and professionals in many academic health education facilities because of 1) the recent advances in simulator technology, 2) increased awareness of patient safety, and 3) emphasis on healthcare outcomes and accountability.³⁵

Simulation training offers a powerful learning experience, provides students with an opportunity to transfer theory to practice in an integrated learning environment, and serves as an efficient opportunity to practice skills, applying knowledge gained through lectures and/or reading assignments.⁶ Research suggests many benefits of simulation for learners in the development of clinical skills when used within the context of education for students enrolled in healthcare professional programs.⁷ Simulation training
provides clinical practice challenges and supports student practice while developing knowledge and skills in an environment with no fear of harming patients, thus, reducing error and anxiety.8-10

Simulation education in healthcare involves the use of low-, mid-, and/or high-fidelity simulation experiences. The level of simulation fidelity is based on the degree to which the simulation imitates reality.11,12 According to Neil and Wotton, “high-fidelity simulation, in which students engage in clinical scenarios replicating actual clinical situations, is now well integrated into nursing education.”13 There are various methods of simulation fidelity in teaching and learning.14 For example, teaching knowledge, skills, and self-confidence in simulated healthcare settings can be achieved through the use of manikins, part-task trainers, computer-based simulations, virtual reality, multimedia, and standardized patients (SPs).3,15-20 Numerous studies support the use of simulation for improved student outcomes in healthcare education to increase patient safety and reduce medical errors.5-10,21,22 There is a growing body of evidence focusing on improved outcomes specific to knowledge, skills, and confidence level of students in professional training programs.2,3,23-25

**Why it is important to do this Review**

Currently, there are no specific best practice models (or gold standards) in simulation training research. Simulation-based research is still a new area and requires additional study to reveal the nuances of best practice. For example, limited data is available on the benefits of using a combination of two or more simulation types in a single simulation experience. Furthermore, debriefing, a conversation between the facilitator and learners after the simulation experience is “the heart and soul” of simulation and still largely ignored in the simulation research process.6 Simulation studies do not use a specific framework for reporting the components and details of the simulation experiences such as briefing and debriefing practices and long-term retention of knowledge and skills after the simulation experience.13 Results of this study characterize the current state of evidence in simulation training across healthcare professions including medicine, nursing, pharmacy, and allied health professions. A quality improvement framework of five best practice components for application in simulation research is proposed, generated from the findings of this review.

**Objective**

The aim of this review was to systematically evaluate and analyze the best available evidence (level and quality) for the use of simulation training to improve knowledge, clinical skills, and self-confidence among healthcare students. The need to identify specific features as a framework for implementing simulation in health education exists. The rationale for including a variety of students from different health professions within the construct of a single study is that the benefits of simulation training extends to all healthcare professions students (medicine, nursing, pharmacy, and allied health) regardless of educational goals, objectives, and curricular differences in various programs.

**METHOD**

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) protocol.27 PRISMA is a guideline for authors to use for reporting systematic review methodology and results. This evidence-based approach is consistent with principles of high quality scientific research; providing enough details about the methodology for replication.

**Database**

Electronic databases available through the University of Arkansas for Medical Sciences (UAMS) were searched in November, 2016, and included PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL®) Plus with Full Text, and Psychological Information (PsicINFO®). Three journal collections within the ProQuest system were also searched: Health and Medicine, Psychology, and Social Science. In addition to the database search, the literature search for this study included two additional activities: 1) search results were compared against the bibliographies of recent literature reviews and current reviewed articles, and 2) Google Scholar was used to search for relevant publications. Relevant citations discovered were added to our search results. Search terms and strings are shown in Appendix A.

**Inclusion Criteria**

Research studies conducted for the purpose of undergraduate and/or graduate education employing the use of simulation types, such as manikins and/or SPs, regardless of the level of fidelity were included in this review. Simulation studies included in this review focused on knowledge, skills, and confidence level as outcome measures. Research designs eligible for inclusion were randomized controlled trials (RCTs), nonrandomized-controlled trials, quasi-experimental with one- or two- group pretest/posttest, observational-analytic, descriptive, and any type of qualitative or mixed-method design. Studies published in English in peer-reviewed journals after 2000 and available electronically were included (Table 1). Publications prior to 2000 were
excluded as a result of changes in simulation technology over the past two decades. Simulation education, a complex connection and interaction between individuals and technology, has advanced significantly, positively impacting teaching and learning practices in simulation education. Thus, the focus of this review was on the current best evidence for simulation training.

### Table 1. Inclusion and Exclusion Criteria

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
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</thead>
<tbody>
<tr>
<td>• Simulation studies conducted for the purpose of health education</td>
<td>• Research without a specified design or review not focused on topic</td>
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<tr>
<td>• Students of health occupations are the target population</td>
<td>• Studies published before 2000</td>
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<td>• Used simulation manikins and/or SPs</td>
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<td>• Outcomes related to knowledge, skills, and confidence levels</td>
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<tr>
<td>• All study designs</td>
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<tr>
<td>• Published in peer-reviewed journals</td>
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<tr>
<td>• Published in English</td>
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<tr>
<td>• Available electronically</td>
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</table>

### Procedure

Objectives, selection criteria, and a well-defined search strategy for this systematic review were set a priori. Following execution of the search strategy, the titles of articles were reviewed for relevancy, with those considered irrelevant being eliminated from further consideration. Abstracts of remaining studies were accessed electronically and reviewed for relevancy. Selected studies meeting inclusion criteria were downloaded and printed for full review. The simulation study review form developed for use in this study, shown in Appendix B, was attached to each of these research studies to aid in data extraction.

### Data extraction

First and second authors assessed the eligibility and methodological quality of each study twice, independently and together to ensure no bias when determining the inclusion or exclusion of any studies. When differences of opinion were encountered, the study was discussed until the discrepancy was resolved. Studies that examined variables that were not integral to the purpose of the study were eliminated. Data were extracted from the study onto the review form and each study was rated for level and strength (quality) of evidence.

### Evidence levels

Evidence levels proposed by authors of the Joanna Briggs Institute (JBI) Model of Evidence-based Healthcare were used for critical appraisal:28

- **Level 1:** Experimental Designs
  - Level 1.a – Systematic review of RCTs
  - Level 1.b – Systematic review of RCTs and other study designs
  - Level 1.c – RCT
  - Level 1.d – Pseudo-RCTs
- **Level 2:** Quasi-experimental Designs
  - Level 2.a– Systematic review of quasi-experimental studies
  - Level 2.b– Systematic review of quasi-experimental and other lower study designs
  - Level 2.c– Quasi-experimental prospectively controlled study
  - Level 2.d– Pre-test post-test or historic/retrospective control group study
- **Level 3:** Observational-Analytic Designs
  - Level 3.a– Systematic review of comparable cohort studies
  - Level 3.b– Systematic review of comparable cohort and other lower study designs
  - Level 3.c– Cohort study with control group
  - Level 3.d– Case controlled study
  - Level 3.e– Observational study without a control group (including qualitative research study designs)
- **Level 4:** Observational Descriptive Studies
- **Level 5:** Expert Opinion and Bench Research
Strength of evidence
Each of the studies meeting the inclusion criteria was also rated for quality (strength) of evidence and included three categories:
1. High – random assignment studies with low attrition of sample members and no reassignment of sample members after the original random assignments.
2. Moderate – random assignment studies that, because of flaws in the study design, execution, or analysis, do not meet all the criteria for the high rating; matched comparison group designs that establish baseline equivalence on selected measures; and single case and regression discontinuity designs.
3. Low – impact studies that do not meet the criteria for high or moderate.

RESULTS
The initial search strategy identified 1386 publications from four major databases and 26 studies from other sources, totaling 1412. Seven hundred and four duplicates were removed, leaving 708 publications for title review. The number of publications for each source after duplicate removal is shown in Table 2. Six hundred and fourteen publications were excluded due to irrelevancy on the basis of the title review. Ninety-four abstracts were reviewed with 40 deemed irrelevant. Full review was undertaken on the remaining 54 publications, identifying 30, which met the inclusion criteria and were subjected to data extraction and analysis of results. The PRISMA diagram was used to represent the study inclusion and exclusion process (Figure 1).

Primary outcomes were knowledge, skills and confidence. Secondary outcomes were anxiety reduction and satisfaction. Other secondary outcomes explored interprofessional education (IPE) and/or interprofessional practice (IPP) and preference and/or effectiveness of high fidelity and/or low fidelity simulations on students’ outcomes. The majority of studies reported use of more than one outcome measure, combining knowledge and skills, skills and confidence, confidence and satisfaction, etc. Overall, studies reported statistically and/or clinically significant improvements in knowledge (N= 14), skills (N= 20), self-confidence (N= 19) and satisfaction (N= 7). Two studies evaluated the long-term impact of the simulated learning.

Table 2. Number of hits for each database after the duplicate removal

<table>
<thead>
<tr>
<th>Database</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PubMed</td>
<td>394</td>
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<tr>
<td>CINAHL</td>
<td>149</td>
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<tr>
<td>PsycINFO</td>
<td>78</td>
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<tr>
<td>ProQuest- Social Science Journals</td>
<td>17</td>
</tr>
<tr>
<td>ProQuest- Psychological Journals</td>
<td>18</td>
</tr>
<tr>
<td>ProQuest- Career and Technical Education: Health &amp; Medicine</td>
<td>44</td>
</tr>
<tr>
<td>Additional Sources</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>708</td>
</tr>
</tbody>
</table>

Note. CINAHL= Cumulative Index to Nursing and Allied Health Literature; PsycINFO= Psychological Information.
The Use of Simulation Training to Improve Knowledge, Skills, and Confidence among Healthcare Students: A Systematic Review

Figure 1.
The search process consisted of identification, screening, eligibility checks, and inclusion in the study as shown on the study inclusion flow diagram. Numbers of studies excluded and the basis of the exclusion are detailed.

Characteristics of the included studies
Studies varied in their study designs, simulation duration, preparing for simulation, intervention, and assessment measures. Several study designs were used: pretest posttest design (N=11), posttest design (N=10), pre/post test study design (N=4), qualitative study (N=3), and RCTs design (N=2). This review shows that the pre/post test study design and posttest study design were the most commonly used method for evaluating the effectiveness of simulation training. The duration of simulation training ranged from 30 minutes to a few weeks during the semester. Characteristics for each of the studies included in this review are shown in Table 3.

The reviewed studies were conducted in the following health disciplines: audiology, medicine, nursing, physical therapy, pharmacy, and physician assistants. The majority of studies reported outcomes from a single healthcare profession, while three studies reported IPE cohorts and queried students regarding IPP. The three IPE cohort studies included pharmacy and nursing, nursing and medicine, and pharmacy, medicine and nursing. Undergraduate and graduate students from the specified health professions participated in the simulation-based learning experiences. Of the 30 studies, 11 reported use of standardized

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patients or parents, 6,8,34,35,38,42,44,45,47,49,51,55 13 employed the use of manikins, 29,32,36,37,40,41,43,48,50,52,56 and 6 used a hybrid approach as teaching or intervention strategies, 3,33,39,46,53,54 Briefing before the simulation events was reported and included lectures, online and laboratory training, small learning groups, training on manikins, a problem based learning (PBL) case, and/or learning courses. Nine studies implemented debriefing or group discussion after the simulation experiences, 3,8,34,39,40,43,47,50,55 Students’ performance included peer, SP and/or faculty evaluation. The majority of studies used non-validated surveys and questionnaires developed by faculty or clinical personnel to measure the three main outcome categories knowledge, skills, and confidence, in addition to direct observation and written and practical examinations.

Table 3. Study characteristics

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Location</th>
<th>Design</th>
<th>Health Profession(s)</th>
<th>Study Sample</th>
<th>Study Purpose</th>
<th>Simulation Type</th>
<th>Intervention</th>
<th>Outcomes Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alanazi et al (2016)</td>
<td>United States</td>
<td>Pretest posttest</td>
<td>Audiology (2nd and 3rd year Doctor of Audiology students)</td>
<td>N=14</td>
<td>Assess the effect of the combined use of trained standardized parents and a baby simulator on students’ hearing screening and counseling knowledge and skills</td>
<td>SPs Manikin (Baby Isao, Intelligent Hearing Systems)</td>
<td>Clinical course and training on the baby simulator</td>
<td>Pre-post-self confidence questionnaire of knowledge and skills</td>
</tr>
<tr>
<td>Ander et al (2009)</td>
<td>United States</td>
<td>Pretest posttest</td>
<td>Medicine (3rd year students)</td>
<td>N=104</td>
<td>Evaluate lifesaving clinical skills and comfort level immediately after simulation training and after 1.5 years</td>
<td>Manikin and other medical equipment</td>
<td>30-minute lecture, small learning groups, and assessment at 5 skills stations</td>
<td>Pre/post performance checklist and level of comfort questionnaire</td>
</tr>
<tr>
<td>Baska et al (2015)</td>
<td>United States</td>
<td>Posttest</td>
<td>Nursing (1st and 4th semester pre-licensure students)</td>
<td>N=66</td>
<td>Assess the difference between the use of LFS and HFS on students’ outcomes and satisfaction</td>
<td>Manikins</td>
<td>Training on low and high fidelity manikins</td>
<td>Students’ satisfaction and self-confidence scale</td>
</tr>
<tr>
<td>Beamson &amp; Wiker, (2005)</td>
<td>United States</td>
<td>Qualitative</td>
<td>Nursing (1st year students)</td>
<td>N= not given</td>
<td>Explore the benefits and limitations of using SPs as a substitute for traditional clinical experience in medication administration</td>
<td>Manikin (HPS6, Medical Education Technology)</td>
<td>6 weeks of traditional clinical rotations</td>
<td>Students completed post simulation survey about what they had learned</td>
</tr>
<tr>
<td>Authors</td>
<td>Country</td>
<td>Design</td>
<td>Participants</td>
<td>Interventions</td>
<td>Outcomes</td>
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<tr>
<td>Bloomfield et al (2015)</td>
<td>United Kingdom</td>
<td>Mixed methods (Included pretest posttest design)</td>
<td>Nursing students N=51 Medical students N=24</td>
<td>Enhance students’ ability to communicate with dying patients and their families</td>
<td>SPs Focus groups Educational intervention Pre-post-simulation questionnaire</td>
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<tr>
<td>Brown &amp; Chronister (2009)</td>
<td>United States</td>
<td>Pretest posttest with control group</td>
<td>Nursing (Senior students) Intervention group N=70 Control group N=70</td>
<td>Determine the effect of simulation activity on critical thinking and self-confidence in ECG nursing course</td>
<td>Manikin (Laerdal’s SimMan) Experimental group received weekly lectures (350 minutes), and simulation training with debriefing (150 minutes) Control group received only lectures (400 minutes) Both groups were evaluated for critical thinking on the ECG SimTest computer exam Self-confidence form</td>
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<tr>
<td>Catling et al (2016)</td>
<td>Australia</td>
<td>Pretest posttest</td>
<td>Nursing (1st year midwifery students) N=71</td>
<td>Determine whether pre-clinical simulation workshops increase students’ knowledge, skills, and satisfaction</td>
<td>SPs Manikin (Sophie’s mum, Model-med International) 10-minute briefing 2-day workshop Online survey pre- and post-the simulation survey</td>
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<tr>
<td>Copper et al (2010)</td>
<td>Australia</td>
<td>Mixed methods (Included posttest design)</td>
<td>Nursing N=51</td>
<td>Examine the ability of students to respond to deteriorated or at risk of deterioration patients Assess the relationships between knowledge (situation awareness) and skill performance</td>
<td>Manikin (Laerdal’s Advanced Life Support computerized) 2 video recorded simulated scenarios 2 simulation exercises on the manikin followed by video-based debriefing Skills test on manikin Situation awareness yes/no questionnaire during simulation</td>
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<tr>
<td>Curtis et al (2016)</td>
<td>Australia</td>
<td>Posttest</td>
<td>Nursing N=509</td>
<td>Evaluate peer to peer facilitated student via the use of simulation experiences</td>
<td>Manikin (Sim Anne, Laerdal Medical) Three clinical courses Instructional videos A 16-item questionnaire Self-confidence in learning scale</td>
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<tr>
<td>Study Authors and Year</td>
<td>Country</td>
<td>Methodology (Design)</td>
<td>Field</td>
<td>Sample Size</td>
<td>Intervention</td>
<td>Outcome Measures</td>
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<td>Dearmon et al (2013)</td>
<td>United States</td>
<td>Mixed methods (Included pretest posttest design)</td>
<td>Nursing (Bachelor students)</td>
<td>N=50</td>
<td>Evaluate the effect of a 2-day simulated clinical nursing course of students' knowledge, anxiety, skills confidence, and satisfaction</td>
<td>SPs</td>
<td></td>
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<tr>
<td>Guvenc et al (2016)</td>
<td>Turkey</td>
<td>Mixed methods (Included posttest design)</td>
<td>Nursing (Senior students)</td>
<td>N=104</td>
<td>Evaluate students' communication experience with an English speaking patient</td>
<td>SP</td>
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<tr>
<td>Halm et al (2011)</td>
<td>United States</td>
<td>Pretest posttest</td>
<td>Medicine (2nd year students)</td>
<td>N=50</td>
<td>Determine if the use of a PBL case with a simulation training improve toxicology knowledge and confidence</td>
<td>Manikin (Laerdal SimMan)</td>
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<tr>
<td>Hoellein et al (2009)</td>
<td>United States</td>
<td>Posttest</td>
<td>Medicine (3rd year students)</td>
<td>N=92</td>
<td>Assess the impact of a CAM workshop using SPs on knowledge and skills</td>
<td>SPs</td>
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<tr>
<td>Hunag et al (2015)</td>
<td>Taiwan</td>
<td>Posttest</td>
<td>Medicine</td>
<td>N=253</td>
<td>Determine the influence of gender on communication skills</td>
<td>SPs</td>
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<tr>
<td>Study</td>
<td>Country</td>
<td>Design</td>
<td>Group 1</td>
<td>Group 2</td>
<td>Data Collection/Findings</td>
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<tr>
<td>Isenberg et al (2015)</td>
<td>United States</td>
<td>Posttest</td>
<td>Medicine (3rd year student)</td>
<td>N=195</td>
<td>Evaluate the validity of students' self-assessment of skills and confidence during working on manikin and encounter SPs</td>
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<td>Manikin (Rectal Examination Model, Fort Atkinson, WI; a Multi-venous IV Training Arm &amp; NG Tube and Trachestomy Care Simulator, Laerdal; Advanced Catheterization Trainer &amp; Suture Pad, Limbs and Things, United Kingdome)</td>
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<td>3 clinical simulated case scenarios on manikins and encounter SPs</td>
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<td>Checklists and rating scales of general skills and specific procedures were completed by students and SPs</td>
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<td>Kaplan &amp; Ura (2010)</td>
<td>United States</td>
<td>Pretest posttest</td>
<td>Nursing (Senior students)</td>
<td>N=97</td>
<td>Increase students' confidence and quality of care</td>
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<td>SPs</td>
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<td></td>
<td>4-hour simulation experience and IP training using SBAR method followed by SPs encounter and debriefing</td>
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<td></td>
<td>Faculty direct observation and self-rated confidence level pre/post simulation</td>
<td></td>
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<tr>
<td>Kim &amp; Kim (2015)</td>
<td>South Korea</td>
<td>Pretest posttest</td>
<td>Nursing</td>
<td>Intervention Group=48 Control group=46</td>
<td>Assess the effects of simulation experiences on students' knowledge, skills, and self-confidence</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>Manikins</td>
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<td>Baseline test Lectures for the control group 2-hour simulation training for the intervention group</td>
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<td></td>
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<td></td>
<td>A 10-item MCQ 4-phase rubric to test skills</td>
<td></td>
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<tr>
<td>Koo et al (2014)</td>
<td>United States</td>
<td>Qualitative</td>
<td>Pharmacy and Nursing*</td>
<td>Pharmacy students N=14 Nurse practitioner students N=32</td>
<td>Evaluate students' perception on IPE experience on improving communication skills and awareness of other team members' roles</td>
<td></td>
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<td></td>
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<td>SPs</td>
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<td></td>
<td>8-hour course followed by two 45-minute clinical scenarios to take case history, physical examination and communicate with other healthcare students</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Debriefing and focus groups discussion</td>
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<td></td>
<td>Semi-structured IP questionnaire with and without open-ended questions was completed by 30 volunteers</td>
<td></td>
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<tr>
<td>Study Authors (Year)</td>
<td>Country</td>
<td>Design</td>
<td>Stage</td>
<td>Profession</td>
<td>N</td>
<td>Description</td>
<td>Methodology</td>
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<tr>
<td>Langen et al (2011)</td>
<td>United States</td>
<td>Posttest</td>
<td>Physician assistant (2nd year students)</td>
<td>N=65</td>
<td>Expose students to more difficult case history taking scenarios to test their confidence level and counseling skills</td>
<td>Actor SPs, Students SPs</td>
<td>5 scenarios performed by 13 SPs</td>
<td></td>
</tr>
<tr>
<td>Mackey et al (2014)</td>
<td>Singapore</td>
<td>Qualitative</td>
<td>Nursing (3rd and final year students)</td>
<td>N=15</td>
<td>Determine the learning outcomes (knowledge and skills) of being SP</td>
<td>SPs, Three clinical roles were performed by trained students SPs</td>
<td>Audio-taped focus group interview guided by 4 open-ended questions with observation and evaluation of students SPs skills</td>
<td></td>
</tr>
<tr>
<td>Nimalkar et al (2015)</td>
<td>India</td>
<td>Randomized controlled trial</td>
<td>Medicine (Final year students)</td>
<td>HFS group N=50, LFS group N=51</td>
<td>Compare the acquisition of neonatal resuscitation skills and the retention of these skills after 3 months</td>
<td>Manikins (HFS: SimNew B; LFS: Resusci Baby Basic; Laerdal Medical), Lectures, Hands-on training</td>
<td>A 40-question written test, Megacode assessment (American Academy of Pediatrics)</td>
<td></td>
</tr>
<tr>
<td>Ohtake et al (2013)</td>
<td>United States</td>
<td>Pretest posttest</td>
<td>Physical therapy (1st year Doctor of Physical Therapy students)</td>
<td>N=43</td>
<td>Examine students' level of skills confidence and satisfaction after the exposure to an ICU SP</td>
<td>Manikin (Hal model S3101, Gaumard Scientific), 30-minute orientation session followed by the simulation event and a 40-minute debriefing session</td>
<td>Pre- and post-simulation skills, Satisfaction survey</td>
<td></td>
</tr>
<tr>
<td>Rickles et al (2009)</td>
<td>United States</td>
<td>Posttest</td>
<td>Pharmacy (2nd year Doctor of Pharmacy students)</td>
<td>N=127</td>
<td>Determine the impact of a lecture-laboratory course with SPs on students' communication skills during baseline, midpoint and final stages</td>
<td>SPs, Online, lectures, and laboratory learning, SPs cases related to lectures</td>
<td>Laboratory written exams, CSAF filled out by SPs, Two surveys to students/and SPs</td>
<td></td>
</tr>
<tr>
<td>Researcher(s)</td>
<td>Location</td>
<td>Year of Study</td>
<td>Control Group</td>
<td>Experimental Group</td>
<td>Methods/Interventions</td>
<td>Pre-post self-rated questionnaire</td>
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<tr>
<td>Roh et al (2014)</td>
<td>South Korea</td>
<td>2014</td>
<td>Nursing (2nd year students)</td>
<td>N=255</td>
<td>Evaluate the effectiveness of integrated simulation resuscitation training with clinical practice on students' knowledge, skills, and self-confidence</td>
<td>Pre- post-self-rated questionnaire</td>
<td></td>
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</tr>
<tr>
<td>Sarmasoglu et al (2016)</td>
<td>Turkey</td>
<td>2016</td>
<td>Nursing</td>
<td>Intervention group N=44</td>
<td>Examine the effect of SPs on students’ blood pressure measurement and administration of subcutaneous injections skills and self-confidence</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Siebeck et al (2011)</td>
<td>Germany</td>
<td>2011</td>
<td>Medicine (3rd and 4th year students)</td>
<td>Study 1: N=41 Study 2: N=188</td>
<td>Study 1: identify the effect of LFS and HFS on knowledge and inhibition on doing rectal examination. Study 2: explore the effect of different sequencing between LFS and HFS</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Stayt et al (2015)</td>
<td>United Kingdom</td>
<td>2015</td>
<td>Nursing</td>
<td>Intervention group N=48</td>
<td>Evaluate students' skills and confidence of recognize and manage an adult deteriorating patient</td>
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</tbody>
</table>
The Use of Simulation Training to Improve Knowledge, Skills, and Confidence among Healthcare Students: A Systematic Review

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Table 4. Level of evidence, strength of evidence, and outcomes

<table>
<thead>
<tr>
<th>Reference</th>
<th>Level of Evidence</th>
<th>Strength of Evidence</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Self-Confidence</th>
<th>Anxiety</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas &amp; Mackey (2012)</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. N= sample size; SPs= standardized patients; HFS= high fidelity simulation; LFS= low fidelity simulation; KA= knowledge assessment; SCA= self-confidence assessment; IPE= interprofessional education; PBL= problem-based learning; CAM= complementary and alternative medicine; PSS= Perceived Stress Scale; STAI= State-trait anxiety inventory for adults; CSAF= communication skills assessment form; SBAR= situation, background, assessment, and recommendation; MCQ= multiple-choice questionnaire; ECG= electrocardiograph; IV= intravenous, NG= nasogastric; OSCE= objective structured clinical examination. *IPE/IPP components were included.

Level of evidence, strength of evidence, and outcomes of the included studies

The level of evidence based on the JBI Model of Healthcare paradigm, strength of evidence ratings, and outcomes (i.e., knowledge, skills, self-confidence, anxiety, and satisfaction) are shown by study in Table 4. One study examined student preferences for high fidelity versus low-fidelity simulation.37 Two of the studies were rated as level 1.c with high strength of evidence,29,30 two studies were rated as level 2.c with moderate strength of evidence,31,32 three studies qualified as level 3.e with low strength of evidence,33-35 and the remaining studies met level 2.d design criteria with low or moderate strength of evidence. Six studies included control groups with traditional clinical training, lectures, or hands-on training in lieu of simulation training.30-32,48,53,56 Overall, statistical and/or clinical improvements in knowledge, skills, and self-confidence after the simulation training were reported.
<table>
<thead>
<tr>
<th>Study Reference</th>
<th>Methodology</th>
<th>Level of Evidence</th>
<th>Intervention</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Confidence</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ander et al (2009)</td>
<td>2.d</td>
<td>Moderate</td>
<td>Not reported</td>
<td>Increased</td>
<td>Increased</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Baska et al (2015)</td>
<td>2.d</td>
<td>Low</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Increased in HFSG more than LFSG</td>
<td>Not reported</td>
<td>Increased in HFSG more than LFSG</td>
</tr>
<tr>
<td>Bearmon &amp; Wiker (2005)</td>
<td>3.e</td>
<td>Low</td>
<td>Increased</td>
<td>Increased</td>
<td>Increased</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Bloomfield et al (2015)</td>
<td>2.d</td>
<td>Moderate</td>
<td>Not reported</td>
<td>Increased</td>
<td>Increased</td>
<td>Increased when talking with dying patients and families</td>
<td>Not reported</td>
</tr>
<tr>
<td>Brown &amp; Chronister (2009)</td>
<td>2.c</td>
<td>Moderate</td>
<td>Not reported</td>
<td>Equal for Critical thinking skills IG and CG</td>
<td>Increased in IG more than CG</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Catling et al (2016)</td>
<td>2.d</td>
<td>Moderate</td>
<td>Increased</td>
<td>Increased</td>
<td>Increased</td>
<td>Not reported</td>
<td>Increased</td>
</tr>
<tr>
<td>Copper et al (2010)</td>
<td>2.d</td>
<td>Moderate</td>
<td>Increased</td>
<td>Increased</td>
<td>Not reported</td>
<td>Decreased</td>
<td>Not reported</td>
</tr>
<tr>
<td>Curtis et al (2016)</td>
<td>2.d</td>
<td>Low</td>
<td>Not reported</td>
<td>Increased</td>
<td>Increased</td>
<td>Not reported</td>
<td>Increased</td>
</tr>
<tr>
<td>Dearmon et al (2013)</td>
<td>2.d</td>
<td>Moderate</td>
<td>Increased</td>
<td>Increased</td>
<td>Increased</td>
<td>Decreased</td>
<td>Increased</td>
</tr>
<tr>
<td>Guvenc et al (2016)</td>
<td>2.d</td>
<td>Low</td>
<td>Increased in terms of use another language</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Reported for participants before simulation</td>
<td>Not reported</td>
</tr>
<tr>
<td>Halm et al (2011)</td>
<td>2.d</td>
<td>Moderate</td>
<td>Increased</td>
<td>Not reported</td>
<td>Increased</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Hoellein et al (2009)</td>
<td>2.d</td>
<td>Low</td>
<td>Increased</td>
<td>Not reported</td>
<td>Increased</td>
<td>Not reported</td>
<td>Not reported</td>
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<tr>
<td>Hunag et al (2015)</td>
<td>2.d</td>
<td>Low</td>
<td>Not reported</td>
<td>The SPs gender influenced communicatio n skills</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Isenberg et al (2015)</td>
<td>2.d</td>
<td>Low</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Increased</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Kaplan &amp; Ura (2010)</td>
<td>2.d</td>
<td>Moderate</td>
<td>Not reported</td>
<td>Increased</td>
<td>Increased</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Kim &amp; Kim (2015)</td>
<td>2.d</td>
<td>Moderate</td>
<td>Increased in IG more than CG</td>
<td>Increased in IG more than CG</td>
<td>Equal for IG and CG</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Koo et al (2014)</td>
<td>3.e</td>
<td>Low</td>
<td>Not reported</td>
<td>Increased</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Langen et al (2011)</td>
<td>2.d</td>
<td>Low</td>
<td>Not reported</td>
<td>Increased</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Mackey et al (2014)</td>
<td>3.e</td>
<td>Low</td>
<td>Increased</td>
<td>Increased</td>
<td>Not reported</td>
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</tbody>
</table>
The Use of Simulation Training to Improve Knowledge, Skills, and Confidence among Healthcare Students: A Systematic Review

DISCUSSION AND SUMMARY

The use of simulation has become a routine part of education and training for health professionals in many health education facilities. Evidence supports simulation training for clinical knowledge and skills improvement as an educational methodology. The primary purpose of this study was to review the current best available evidence for the use of simulation in improving clinical skills, knowledge, and self-confidence among healthcare students and to rate the level and quality of research on simulation training.

Reviewed studies

Results and analysis of the 30 studies included in this systematic review demonstrate and support the use of high and/or low fidelity simulation training as an educational methodology evidenced by enhanced scores on students’ knowledge, skills, self-confidence, and satisfaction. Moreover, simulation significantly decreased anxiety and inhibition levels in those studies where they were examined. The reviewed studies showed a great variability in terms of design, intervention, measurement, and simulation type and use. The majority of studies qualified as level 2 and only two studies qualified as level 1.29,30 The findings of the reviewed studies are highlighted by study location, health professions represented, level of evidence, sample size, sample characteristics, type of simulation, study purpose and intervention, and outcome measures and outcomes.

Study location

In this systematic review, the majority of studies were conducted in the United States (16 of 30 studies).29,31-34,36,37,43,44,46,47,49-51,55 This result is similar to the systematic reviews in the literature. Cant and Cooper found that most of the reviewed studies (11 of 12 studies) were conducted in the United States.57 Another systematic review by Gamble et al revealed that five of 15...
reviewed studies were conducted in the United States. The remaining studies in the current review were conducted in Australia, United Kingdom, Turkey, South Korea, Germany, Singapore, Taiwan, India, and China.

Health profession represented
Most of the reviewed studies (26 studies) were conducted in nursing and medicine, and only three studies included IPE/IPP with the use of SPs. The literature shows that internal medicine, family medicine, psychiatry, and other medical specialties use SPs to assess students’ clinical knowledge and skills in approximately 50% or more of the clinical rotations. The healthcare simulation literature includes numerous studies from nursing and medicine; however, the use of simulation in other healthcare professions, such as audiology, is scant.

Level of evidence (study design)
Validity and reliability of study results are two key features upon which decisions regarding the strength and quality of evidence are based. In general, validity is an assessment of the degree to which an evaluation tool measures what it is supposed to measure, whereas reliability refers to the concept that repeated measurement would result in similar findings. While the simulation literature has studies with several levels of evidence and designs, such as RCTs, quasi-experimental, and qualitative designs, the validity of studies included in this systematic review was threatened by several factors, such as choice of study design and psychometric properties of the assessment tools. The majority of the reviewed studies (76%) were designated as level 2.d (posttest or pre/post-test quasi-experimental design), which is the most commonly used design in the healthcare simulation studies. One reason may be the ethical quandary of having a control group with no benefits of the simulation training that could potentially reduce the students’ performance and achievement in the related courses.

Sample size
Sample size can affect the generalizability of outcomes. The sample size varies greatly across studies in the simulation literature. For example, Cant and Cooper reviewed 12 studies of which one study had 23 participants and another study had 798 participants. The range of the number of participants in reviewed nursing and medical studies was 18 to 146 participants. In the present systematic review, the range number of participants was 14 to 509 students. The small number of participating students in some studies may have occurred because of low numbers of students enrolled in the program or assigned for clinical practice simulation, the dropout rate, and/or technical issues with audio/video taping analysis. In one reviewed study, the number of included students was 115 in the initial training, but the completed data sets were available on only 104 students. In another study, 637 nursing students were invited to complete a 16-item 6-point Likert scale questionnaire after the simulation experience, but only 509 students responded. This loss of participants or data can threaten the internal validity and affect the efficacy of simulation research.

Sample characteristics
The sample characteristics were reported in the majority of reviewed studies, including gender, age and racial groups, and varied clinical experience. It is necessary to pay attention to the differences among student participants as internal validity may be threatened because of such differences. For example, one of the reviewed studies stated that females are more likely to underestimate their performance on technical skills compared to males, and male students tend to overestimate their communication and interpersonal skills. Moreover, students who achieved honors were more likely to overestimate their self-rated scores than students who just passed the course. IPE was identified as an emerging population sample variable.

Types of simulation
This review focused on two types of simulation: manikins and SPs for the following reasons. Manikins have advanced capabilities and outputs such as physiological changes, so they have greater effects on the learner. Manikins have been successfully used in both learning and assessment of clinical skills. The SPs assessment is one of the most common forms of physical examination and communication skills assessments in medical education. Evaluation of students via the use of SPs is more accurate and reliable in comparison to traditional testing formats. This review shows that SPs and manikins are the most common simulation types used in medical education. Use and outcomes of these simulation types was varied among studies in this systematic review. Two studies reported that the use of high fidelity simulation increased students’ knowledge, skills, self-confidence, and/or satisfaction compared to low fidelity simulation. Only six reviewed studies used hybrid simulation (i.e., the use of two or more simulation types at the same simulation experience). The combined use of different types of simulation could lead to better learning outcomes than the use of either alone. Nevertheless, no study in this review examined the effectiveness of using one type of simulation compared to two or more types.
Study purpose and intervention characteristics
The reviewed studies aimed to measure the effect of simulation on professional competencies including knowledge, skills, self-confidence, anxiety and comfort level, and the cooperation with and between healthcare students. The effect of using high fidelity simulation versus low fidelity simulation and the effect of the integration of simulation in the curriculum were identified as goals of the simulation training in some studies. Pre-simulation orientation to familiarize students with the simulation learning environment was reported. Lectures, online training, workshops, small learning groups, training on manikins, PBL cases, and a learning course were used in the pre-simulation orientation. The limited use of debriefing and carry-over effect of learned knowledge and skills was noticed among the reviewed studies. Only nine studies reported the implementation of debriefing or group discussion after the simulation experiences. The majority of these studies did not describe the debriefing session and how the session was conducted. Only two studies assessed the retention of the learned knowledge and skills three months and more than one year after the completion of simulation experience. These studies revealed that the retention or carry-over effect of learned skills decreased over time.

Outcome measures and outcomes
The use of non-validated outcome measures has been reported in the studies included in the current review. This may influence the outcomes and bias the results. Only seven reviewed studies used validated assessment instruments. This is not the only issue, as the validity of self-assessment as a measure of learning is also debatable. For instance, one study showed the self-assessment is valid and reliable in specific skills but not across all skills learned in the simulation training. Instrumentation can also be another threat to internal validity “in which changes in the calibration of a measuring instrument or changes in the observer or scores used may produce changes in the obtained measurements.” In one of the reviewed studies, Rickles et al. chose to remove 21 sets of the recorded SPs group training from analysis due to audiovisual difficulties. Cant and Copper reported that simulation outcomes using self-reported instruments are less reliable than the other objective simulation outcome assessments, such as examiners evaluation and interview. On the other hand, Gosen and Washbush demonstrated that objective measures are inadequate measures of learning. Therefore, student learning and performance in simulation experiences may not readily be assessed by objective measures. Regarding the outcomes, the healthcare simulation literature includes a great deal of studies that explore the effect of simulation on knowledge, skills, self-confidence, and other technical and non-technical skills. For example, self-assessment skills and behavior can improve with self-assessment practice. Thus, learning is the core outcome of simulation training. However, knowledge acquisition through simulation training alone has not previously been well established. Results of this systematic review revealed statistical and/or clinical improvements in knowledge, skills, self-confidence, and/or satisfaction after the simulation training.

Implications
The reviewed studies consisted of high, mid, and low strength (or quality) of evidence. A quality improvement framework of five best practice components for application in simulation research is proposed, generated from the findings of this review. These practices include 1) study design, 2) debriefing, 3) integration of IPE values, 4) outcome measures, and 5) student satisfaction and information retention.

Study Design
Reviewed studies included qualitative, quantitative, and/or mixed methods research designs. In general, the validity of simulation studies is often threatened by several factors, one of which is the study design. Campbell and Stanley identified several designs in the educational research that might affect both internal and external validity. Quantitative simulation research includes three common study designs: the posttest design, the one group pretest-posttest design, and the non-equivalent control group pretest/posttest design. The posttest design is the simplest and weakest quasi-experimental design, which is also known as “the one-shot case study.” In this design, a single group is observed one time after it has been exposed to the simulation. These studies do not have reference points for comparison (i.e., pretest scores or control group). Therefore, the effect of simulation cannot be evaluated because there is no basis for comparison of professional competency development (e.g., knowledge, skills, and/or confidence level). The other design observed is known as “one-group pretest-posttest design” in which a single group is pretested before the simulation and posttested after the simulation. This design is more commonly found in the simulation literature and shows some improvements over the posttest design. However, a threat to this design can appear if the pretest increased students’ ability to perform better on the posttest or if pretest and posttest are not equivalent, particularly when the outcome is measured by an observer (i.e., faculty members or SPs).

The third design is the non-equivalent control group pretest/posttest design. It is also called “nonequivalent control-group design” in which one group is pretested before the simulation training and posttested after, while the other group is pretested, not exposed to the simulation training, and posttested. This design is stronger than the previous designs because it includes a
control group. One of the threats to the internal validity of this design is the student-selection factor. This means that the selection of students in each group (i.e., the experimental group and control group) has been based on accessibility or convenience rather than on randomization. Therefore, without randomization, unknown confounders and unmeasured differences between groups can bias the results. The stronger and best study design would be to include three groups: an experimental group with (simulation training), an experimental group with (traditional training), and a control group with (no training).66 This design will provide high levels of evidence; however, it is hard to employ because having a group or two with no benefits of the simulation experience may hinder students from getting the benefits of the simulation training, so students’ performances on related academic courses could be affected.66 Therefore, the most common simulation study design, which is usually pretest, posttest design, does not include a control group. That said, when a simulation study design includes a control group, a traditional training can be provided firstly to this group and followed by simulation training after the completion of simulation event so learners in this group benefit of the simulation experience.66

Debriefing
This practice is universally accepted as an evidence-based process in 1) facilitating a high level of learning, 2) assisting the participants to clearly understand and integrate the simulation experience, and 3) connecting it with previous knowledge and future real practices.45 The role of debriefing in simulation education has been eloquently described by Phrampus and O’Donnell.71 The lack of the debriefing component has been reported in literature.13,72 This systematic review included nine studies that implemented debriefing or group discussion after the simulation experiences. Eight of these studies reported insufficient details about how the debriefing sessions were organized, how the debriefing methods were used, and how time was allocated to these debriefing sessions. Only one study provided sufficient details about debriefing and how it was used in the simulation experience.6 This study used the Promoting Excellence and Reflective Learning in Simulation (PEARLS) model. This model specifies four distinct phases of the debriefing process: 1) reactions, 2) description, 3) analysis, and 4) summary. This model focuses on identifying positive aspects of the experience (what went well), negative aspects (what could have gone better), and changes if learners were given another opportunity.73 There are several debriefing models to organize the structure of the debriefing session. Some authors divided the debriefing conversational structures into two types: “three-phase debriefing structure” and “multiphase debriefing structure.”74 The “Debriefing with Good Judgment” is an example of the three-phase debriefing structure type. It is an evidence-based framework of observation and reflection to change behaviors in the learning process.75 The PEARLS debriefing is an example of the multiphase debriefing structure type.73 Debriefing helps learners to clearly understand and integrate the simulation experience and connect it with previous knowledge. Students who engage in academic discussions with peers may benefit motivationally, academically, and socially.76 Students are expected to discuss and analyze the experience to enhance their learning.77 Cognitive theory supports this as evidence-based practice due to research presenting findings about multi-sensory input/output as a strategy for information retention.78 Also, debriefing time is critical. The reviewed studies support previously published literature about the length of time for debriefing. Debriefing time is estimated at 15 minutes for each objective or twice the time of the simulation activity.79

Interprofessional Education and Practice
The core goal of IPE is to prepare all health profession students to work together. Therefore, students can experience working with other professions and obtain knowledge and skills about other professions, in addition to their own profession, to enhance their effectiveness as professionals once they enter clinical practice.80 Consequently, healthcare quality and patient safety is achieved.80 IPE is more effective if used appropriately with consideration of context, goals, and approach.81 The Interprofessional Education Collaborative Expert Panel proposed four major interprofessional collaborative practice competencies: 1) values and ethics, 2) roles and responsibilities, 3) interprofessional communication, and 4) teams and teamwork.80 There are several tools used to assess IPE learners in the educational settings. For example, Thanhauser, Russell-Mayhew, and Scott identified 23 assessment tools.82 The Readiness for Interprofessional Learning Scale (RIPLS) and Interdisciplinary Education Perception Scale (IEPS) were the two primary measures reviewed of the 23 measures because both measures were easily accessible, commonly used, and validated, while limited information existed for the remaining measures.83 Simulation offers good opportunity for training students from different health professions, and it is associated with improving students’ IPP, teamwork and collaboration, and communication skills.84 To achieve professional competency and patient safety as a result, many practicing healthcare professionals need training to achieve these competencies. The researchers should implement and assess IPE. However, two main barriers to IPE include 1) healthcare professionals are not well trained in interprofessional environments, and 2) there is a lack of sufficient connection with other healthcare providers to build collaboration among healthcare teams.80,84

Outcome Measures
Knowledge and skills learned in simulation are usually connected to the cognitive domain levels of Bloom’s taxonomy and Kolb’s experiential learning cycle.78 These learned knowledge and skills acquired in the simulation training are built on prior knowledge
and skills. Therefore, the use of an appropriate scale to measure the impact of a simulation exercise on learning is important. Silvia suggested that the use of self-rating surveys to obtain the impact of the simulation on students’ learning is the most appropriate approach. Rating scales allow participants to rate their attitudes and perceptions. Issenberg et al warned that using pretest and immediate posttest is ineffective to investigate the retention (or carry-over) effect. Therefore, researchers should use valid and proper scales consistent with their learning objectives.

**Satisfaction and Retention after Simulation**

The level of satisfaction among participants in simulation is critical in terms of repeating the training sessions. Participants’ satisfaction may have correlations with performance and may help to build self-confidence, which in turn helps students develop skills and acquire knowledge. Repetitive practice is one of the key features of simulation that best facilitates learning, and the level of satisfaction is also related to repeating the simulation training. The researchers should use valid and reliable instrument to measure satisfaction after the simulation experience, such as the Satisfaction with Simulation Experience (SSE). Besides the repetitive nature of simulation training, it is important to understand how long learning is sustained after the simulation experience. Little is known about the impact of the simulated learning over the long term. The test of retention is important to make sure that the learned knowledge and skills are generalized and continued after the simulation training. Therefore, the researchers should test the retention of learned knowledge and skills within 3 to 12 months after the simulation experience according to the type of the learned knowledge and skills in the simulation activity.

**LIMITATIONS**

Efforts were made to minimize study limitations, though some were unavoidable. Potentially useful databases for this project, such as EMBASE, were not searched as a result of a lack of access, so only four databases were searched for eligible studies. However, additional sources were searched to identify any papers that were missed by the original search strategy. Furthermore, reviewed studies were limited to those available electronically and to those published in English. The inclusion criteria were open to all JBI levels of evidence to include many studies for review. This may have been an advantage of the review; however, a great deal of the reviewed studies had weak designs. The other limitation was that the inclusion criteria for this study were restricted to student populations and it is possible that some studies were excluded because of the target population.

**FUTURE RESEARCH**

There is need for a quality improvement framework on how to design and implement simulation training in health education utilizing strong study designs. Further research is warranted to establish guidelines for designing and writing simulation studies. Students may benefit from serving as SPs; however, caution should be taken when recruiting students as SPs to train and evaluate their peers. There is ample evidence to support the use of reflection as a tool to support student learning and the development of critical thinking skills. The use of structured debriefing sessions should be included in all simulated training and learning experiences. The use of validated outcome measures, when appropriate, is important to avoid any potential bias. Simulation is a valuable teaching and learning methodology to accomplish IPE objectives and to prepare all healthcare students to work together in safe IPP environments, suggesting the need for additional IPE/IPP simulation research.

**References**


The Use of Simulation Training to Improve Knowledge, Skills, and Confidence among Healthcare Students: A Systematic Review


The Use of Simulation Training to Improve Knowledge, Skills, and Confidence among Healthcare Students: A Systematic Review


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## APPENDIX A
Search Terms, Databases, and Search Strings

<table>
<thead>
<tr>
<th>Search Terms</th>
<th>Database</th>
<th>Search Strings</th>
</tr>
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<tbody>
<tr>
<td>- Health occupation students:</td>
<td>The PubMed and CINAHL® database searches consisted of the MeSH term/CINAHL</td>
<td>Heading Students, Health Occupations as a major topic combined (OR) with the terms simulation OR &quot;standardized patient&quot; OR &quot;standardized patients&quot;. The citations retrieved from this search were further narrowed using the terms confidence OR skill OR skills OR knowledge combined with AND to the terms tool OR instrument OR survey OR questionnaire* OR &quot;student evaluation&quot; OR &quot;student evaluations&quot; OR &quot;student satisfaction&quot; OR (student*[tiab] AND (narrative OR reflect*)) OR educational measurement. The results were limited to English language; they were not limited by publication date.</td>
</tr>
<tr>
<td>- Simulation types: simulators/simulation, standardized patients, manikins</td>
<td>PsycINFO, ProQuest- Social Science Journals, ProQuest-Psychological journals, ProQuest- Career and Technical Education: Health &amp; Medicine</td>
<td>These databases were searched using only text words. As an example, the ProQuest collections were searched as shown below: all(simulation OR &quot;standardized patient&quot;<em>) AND all(confidence OR skill OR skills OR knowledge) AND all(tool OR instrument OR survey OR questionnaire</em> OR &quot;student evaluation&quot; OR &quot;student evaluations&quot; OR &quot;student satisfaction&quot; OR (student AND (narrative OR reflect*)) AND all(student? AND (medical OR nursing OR pharmacy OR psychology OR &quot;social work&quot;*))</td>
</tr>
<tr>
<td>- Outcomes: education, knowledge, skill, confidence, satisfaction</td>
<td></td>
<td>Note. CINAHL = Cumulative Index to Nursing and Allied Health Literature; PsychINFO= Psychological Information; MeSH= Medical Subject Headings; tiab= Title/abstract.</td>
</tr>
<tr>
<td>- Assessment tools: evaluation, educational measurement, questionnaire, survey</td>
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APPENDIX B

Simulation Studies Review Form

Study title: _____________________________________________________

Database: __________________Study Number______ Reviewer_________________

(1) Study Screen Details

<table>
<thead>
<tr>
<th>Screening Decision</th>
<th>Screening Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Passes Screens</td>
<td>Yes</td>
</tr>
</tbody>
</table>

(2) Study Design Details

Rating: High  Moderate  Low

Study Design: Randomized control trial  One group pretest posttest design

Pretest posttest design with a control group  Posttest design  Mixed Research

Qualitative  Other _____________________________

(3) Study Characteristics

Study Population  Graduate Students  Undergraduate Students

Participants' Profession  Audiology  Speech-language pathology  Physical Therapy  Nursing

Medical Students  Physician Assistant  Pharmacy  Optometry

Other______________________________

Demographics  Sample size_______ Gender: M  F

Year in the program______________________

Primary Outcome  Knowledge  Skills  Confidence  Satisfaction Other

______________________________

Secondary Outcome  Self-Efficacy  Stress  Anxiety  N/A

Other: ______________________________

Primary Outcome Measure  Direct Observation  Direct Assessment  Self-Reported Written Exam

Clinical Exam Other: ______________________________

Type of Simulation  Manikins  Standardized Patients  Virtual Patient

Other: ______________________________

Type of Standardized Patients  Real Actors  Students  Faculty  N/A

Other: ______________________________

Simulation Settings  Hospital  Simulation Center  University

Other: ______________________________

Interprofessional education/practice  Yes  No

Debriefing  Yes  No