

High-Fidelity Simulation for Neonatal Nursing Education:
An Integrative Review of the Literature

Allyson Cooper

(Student Number: V00702442)

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Table of Contents

| | |
|--|----|
| Abstract | 3 |
| Background | 4 |
| High-Fidelity Simulation: The Process | 6 |
| Aim of the Project | 7 |
| Theoretical Perspective | 7 |
| Research Method | 9 |
| Step 1: Problem Formulation | 10 |
| Step 2: Literature Search | 11 |
| Database and search terms | 11 |
| Inclusion and exclusion criteria | 12 |
| Step 3: Data Evaluation | 12 |
| Step 4: Data Analysis | 14 |
| Presentation of the Literature Review (Step 5)..... | 14 |
| Yaeger et al. (2004) | 15 |
| Cates and Wilson (2011) | 17 |
| Lemoine and Daigle (2010) | 19 |
| Yaeger and Arafeh (2008) | 21 |
| Lindamood and Weinstock (2011) | 22 |
| Fawke and Cusack (2011) | 23 |
| Raines (2010) | 25 |
| LeFlore and Anderson (2008) | 27 |
| Synthesis of the Research | 29 |
| Theme 1: Benefits of High-Fidelity Simulation | 29 |
| Benefit (I): Communication and Teamwork | 29 |
| Benefit (II): Innovative Pedagogical Approach | 30 |
| Benefit (III): Skills Acquisition, Confidence and Satisfaction | 32 |
| Theme 2: Safety and Patient Care | 34 |
| Theme 3: Challenges of High-Fidelity Simulation..... | 35 |
| Cost and Technical Issues | 35 |
| Time and Faculty Requirements | 36 |
| Theme 4: Theoretical Frameworks | 37 |
| High-Fidelity Simulation and Constructivist Teaching | 39 |
| Theme 5: High-Fidelity Simulation and Traditional Education Compared | 41 |
| Theme 6: Debriefing | 42 |
| Implications for the Future | 44 |
| Additional Research | 44 |
| Innovative Future Uses | 45 |
| Limitations of the Literature Review | 48 |
| Conclusion | 49 |
| References | 51 |
| Appendix A | 56 |
| Appendix B | 58 |
| Appendix C | 59 |
| Appendix D | 64 |
| Appendix E | 67 |
| Appendix F | 68 |

Abstract

The lack of safe avenues to develop neonatal nursing competencies using human subjects leads to the notion that simulation education for neonatal nurses might be an ideal form of education. This integrative literature review compares traditional, teacher-centered education with high-fidelity simulation education for neonatal nurses. It examines the theoretical frameworks used in neonatal nursing education, and outlines the advantages of this type of training, including improving communication and teamwork; providing an innovative pedagogical approach; and aiding in skill acquisition, confidence, and participant satisfaction. The importance of debriefing is also examined. High-fidelity simulation is not without disadvantages, including its significant cost, the time associated with training, the need for very complex technical equipment, and increased faculty resource requirements. Innovative uses of high-fidelity simulation in neonatal nursing education are suggested. High-fidelity simulation has great potential but requires additional research to fully prove its efficacy.

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Background

When Captain “Sully” Sullenberger safely landed the US Airways airplane in the Hudson River after both of the jet’s engines failed, his prior experience with simulated flight training is partly to thank for the safe outcome (Newman, 2009). Training in simulated learning environments is not a new phenomenon. Historically, aviation and military training utilized simulated training opportunities to train in critical and mass casualty situations (Broussard, Meyers & Lemoine, 2009, Cates & Wilson, 2011), to promote effective teamwork, and improve communication among team members (Cates & Wilson, 2011; Lindamood & Weinstock, 2011; Yaeger & Arafah, 2008). Over the past decade high-fidelity simulation has been increasingly embraced as an educational tool in health professional education including nursing education (Broussard et al., 2009; Messmer, 2008).

High-fidelity simulation training in a healthcare setting involves the active participation of a student in realistic patient care scenarios (Yaeger et al., 2004). The types of simulation (Table 1) vary from low fidelity models or mannequins to high-fidelity simulation (Decker, Sportsman, Puetz & Billings, 2008). Whole-body, high-fidelity simulators are used to mimic real patients in an authentic clinical setting (Broussard et al., 2009, Cates & Wilson, 2011; Decker et al., 2008). High-fidelity whole body simulators are computerized and provide a realistic simulated experience for the student (Broussard et al., 2009; Decker et al., 2008). These simulators contain features such as movement, pulse, heart beat, lung sounds, visible respiration

rate, skin colour, voice, and have the ability to change these parameters based on the student's interventions (Broussard et al., 2009, Decker et al., 2008).

Table 1: Summary of Types of Simulation

| Simulation Modality | Description |
|---|---|
| Partial task trainer (low-tech simulators) | Models or mannequins used to learn, practice and gain competency in simple techniques and procedures |
| Peer-to-peer learning | Peer collaboration used to develop and master specific skills |
| Screen-based computer simulations | Computer programs used to acquire knowledge, to assess competency of knowledge attainment, and to provide feedback related to clinical knowledge and critical-thinking skills |
| Virtual reality | Combines a computer-generated environment with tactile, auditory, and visual sensory stimuli provided through sophisticated partial trainers to promote increased authenticity |
| Haptic systems | A simulator that combines real-world and virtual reality exercises into the environments |
| Standardized patients | Uses case studies and role playing in the simulated learning experience; individuals, volunteers, or paid actors are taught to portray patients in a realistic and consistent manner |
| Full-scale simulation (medium to high-fidelity) | Simulation that incorporates a computerized full-body mannequin that can be programmed to provide realistic physiologic responses to a practitioner's actions; these simulations require a realistic environment and the use of actual medical equipment and supplies |

Adapted from: Decker, S., Sportsman, S., Puetz, L. & Billings, L. (2008). The evolution of simulation and its contribution to competency. *Journal of Continuing Education in Nursing*, 39(2), 74-78.

Since high-fidelity simulation education in healthcare settings has become available, it has been used principally to train physicians in anesthesiology, and physicians and emergency technicians in critical and mass casualty situations (Broussard et al., 2009; Cates & Wilson, 2011). It is now becoming more common to see this pedagogical approach being used in nursing education (Broussard et al., 2009; Cant & Cooper, 2009; Stayt, 2012; Lindamood & Weinstock, 2011), and more recently in pediatric nursing education (Birkhoff & Donner, 2010). The

question arises as to whether high-fidelity simulation education could also be beneficial for use in teaching neonatal nurses.

High-fidelity Simulation: The Process

There is a recommended process for high-fidelity simulation education, which usually includes three major steps. In the first step students are introduced to the high-fidelity simulation experience, receiving an orientation to the physical space and high-fidelity mannequin, as well as a briefing on the video recording of the high-fidelity simulation sessions for use in the feedback process (Yaeger et al., 2004).

The second step in high-fidelity simulation is the simulated scenario itself, where the learners are asked to suspend their disbelief and engage with the high-fidelity mannequin as if it were a living patient. These full-scale simulations allow a dynamic learning opportunity and participants experience, among other things, the stress that accompanies real-life scenarios (Yaeger et al., 2004). High-fidelity simulation allows the trainee to practice their skills in communication, assessment, diagnosis, and treatment as well as teamwork (Cates & Wilson, 2011). Cates and Wilson (2011) put forward that “simulation improves outcomes that are difficult to teach or assess by conventional methods of education” (p. 322), although more research is needed to validate this claim.

The literature is clear that the third step is the most important stage from a pedagogical point of view (Cates & Wilson, 2011; Fawke & Cusack, 2011; LeFlore & Anderson, 2008; Lemoine & Daigle, 2010; Lindamood & Weinstock, 2011; Yaeger & Arafah, 2008; Yaeger et al., 2004). This step is the debriefing stage, which occurs after the high-fidelity simulated scenario has concluded. From a constructivist viewpoint most of the learning occurs during the debriefing session (Dreifuerst, 2009; Rudolph, Simon, Dufresne & Raemer, 2006). Debriefing

provides students the opportunity to reflect on their existing understanding and experience, coupled with the learning gained during the scenario, to form new knowledge and to reinforce the new concepts (Dreifuerst, 2009). This is consistent with constructivist theory, in that students integrate the new learning into their pre-existing knowledge to gain a new understanding (Young & Maxwell, 2007).

Aim of the Project

The aim of this project is to present an integrative review of peer-reviewed literature surrounding high-fidelity simulation education for neonatal nurses. Nurse educators will be informed by this review of the advantages and disadvantages as they appear in written texts. Recommendations will be offered, through a constructivist lens, incorporating a student centered teaching approach, creating a safe and effective learning environment. It is anticipated that this will influence the approach taken to nursing education in the future. It is also expected that the knowledge gained from this literature review might be extrapolated to answer whether high-fidelity simulation education might be beneficial to other subspecialties of nursing, specifically pediatric nursing.

Theoretical Perspective

In 450 B.C. Confucius is believed to have said, “Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand”. This sentiment continues to hold true for scholars and educators today. When teachers employ a constructivist teaching philosophy, students are able to develop learning skills that enhance knowledge acquisition and understanding (Peters, 2000). Jean Piaget influenced constructivist philosophy (Young & Maxwell, 2007) which, as an active form of knowledge acquisition (Peters, 2000), offers an alternative to traditional teacher-centered methods of education. The attributes of constructivist

theory include improving teaching practices to make them more effective (Young & Maxwell, 2007). This includes building on the students' prior knowledge and life experiences, developing meta-cognitive skills, creating a student-focused learning environment, enhancing learning and understanding, and employing self-directed learning (Peters, 2000). Constructivist pedagogy maintains that knowledge is not passively transmitted from teacher to student; instead knowledge is actively created by the learner by processing experiences and interactions with their environment (Parker & Myrick, 2009). According to Parker and Myrick (2009) "for new learning to occur, knowledge must be integrated into the learner's existing cognitive schema, which occurs largely as a result of conflict" (p. 326). Constructivist theory contends that there is conflict between the learner's existing knowledge and the new information, which raises questions within the learner. In the attempt to answer these questions, knowledge is gained (Parker & Myrick, 2009). The process of high-fidelity simulation is congruent with constructivist theory: the high-fidelity simulation scenario itself causes conflict within the learner. The debriefing session allows the learner to reflect on this conflict and associated questions, and to attempt to resolve these questions with the help of their peers and the high-fidelity simulation facilitator. This truly is knowledge creation, in accordance with constructivist theory.

Young and Maxwell (2007) contend that to be successful in constructivist teaching, it is not sufficient to introduce students to new knowledge, rather it is necessary to "[place] students in learning situations that raise a challenge to their current understanding" (p.9). It is in this respect that high-fidelity simulation education elegantly dovetails with constructivism.

High-fidelity simulation is an ideal tool which allows students to reason and practice difficult tasks without causing harm to a human patient (Birkhoff & Donner, 2010; Lambton,

2008). Parker and Myrick (2009) contend that constructivist-based clinical scenarios used in high-fidelity simulation are able to “direct students toward a specific learning objective, yet afford them the freedom to access information sources independently, think critically, and develop their own resolutions to the problem within” (p.327). Constructivist theory contends that when students are allowed to develop their own hypotheses and test these against their current understanding, knowledge is gained (Parker & Myrick, 2009). High-fidelity simulation allows the learner to actively create knowledge based on interaction with their environment during the learning session. As such, high-fidelity simulation can be viewed principally as a constructivist mechanism.

Research Method

To conduct the literature review of high-fidelity simulation education of neonatal nurses an integrative literature review method, as outlined by Whittemore and Knafl (2005), was selected. During the initial literature search it was noted that there was a variety of research questions and methods used to explore the topic of high-fidelity simulation education, including both qualitative and quantitative methods of data collection and analysis. An integrative literature review was chosen as it is an approach specifically designed to allow for the comparison of studies conducted under various research modalities, rather than restricting comparability to studies using only similar forms of research (Whittemore & Knafl, 2005). In addition, Whittemore and Knafl (2005) have created a comprehensive method for literature review that includes a five step framework. This has been used to increase the rigor, by ensuring that focus is maintained, the review is thorough, and the same methodology is used when analyzing each article during the literature review process. The five steps developed by

Whittemore and Knafl (2005) include “problem formulation, literature search, data evaluation, data analysis and presentation” (p.548).

Step 1: Problem Formulation

Whittemore and Knafl (2005) present that the first step in any review is the formulation of the problem. This entails making a clear identification of the problem that the review will address, creating a clear focus, and providing a description of the boundaries of the review.

Neonatal nursing is a specialized form of pediatric nursing that takes care of the smallest and most fragile patients. Given the neonate’s specific and unique illnesses as well as their fragility, a generally trained nurse requires additional education and specialized learning, specific to this patient and family population, in order to practice safely and effectively. However, the fragility and vulnerability of this patient population, where a single touch can cause bradycardia or severe skin abrasions, precludes unprepared personnel from substantial hands-on experiential learning (Broussard et al., 2009; Cates & Wilson, 2011; Kassab & Kenner, 2011). The lack of safe avenues to develop neonatal nursing competencies using human subjects leads to the notion that high-fidelity simulation education for neonatal nurses might be an ideal form of education. “Simulator-based training embodies many of the strengths of traditional training programs while minimizing many of the intrinsic limitations” (Yaeger et al., 2004, p. 327). High-fidelity simulation education allows for the practice of skills and techniques, including teamwork and communication, in lifelike situations and in an environment that is safe for both patient and student and also allows for competence in clinical reasoning (Cates & Wilson, 2011). Cates and Wilson (2011) put forward that “simulation improves outcomes that are difficult to teach or assess by conventional methods of education” (p. 322). It is for these reasons that this literature review has focused on high-fidelity simulation. High-fidelity simulation education has been

found in medical education to be an effective, beneficial and innovative method of teaching (Broussard et al., 2009; Cant & Cooper, 2009; Messmer, 2008). The question remains whether high-fidelity simulation education could also be beneficial for use in teaching neonatal nurses.

Step 2: Literature Search

The second stage of an integrated literature review according to Whittemore and Knafl (2005) is a well-defined literature search. This stage is critical to the final outcome of the review, as an inadequate search can lead to inaccurate final results. Whittemore and Knafl (2005) state that the literature search process should be clearly documented including “search terms, the databases used, additional search strategies, and the inclusion and exclusion criteria” (p. 549).

Databases and search terms.

According to Whittemore and Knafl (2005), “computerized databases are efficient and effective” (p.548) for obtaining literature. Four electronic databases, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Summon, Medline (Ovid), and Google Scholar were used to conduct the literature search, based on consultations with and the recommendations of the University of Victoria librarians. The University of Victoria librarians also recommended the use of various combinations of the search words Simulation*, Neonat*, Nurs*, education, infant*, and NICU. A total of 142 articles were retrieved matching these criteria.

Whittemore and Knafl (2005) advise that a more thorough literature review requires that more than one search strategy be employed. With this in mind, in addition to the computerized database search, the ancestry method was also utilized to carry out the literature search. This method involves using references obtained from the main literature used to ensure a comprehensive overview of the subject. The ancestry search yielded an additional 20 articles. A

data collection tool was designed based on the works of Polit and Beck (2008) and Torraco (2005) (Appendix A) and an EXCEL spreadsheet for data collection, selection of articles, data analysis and critiques of each article was developed. Once duplicate records were removed and the records were screened, 115 articles remained.

Inclusion and exclusion criteria.

The inclusion criteria consisted of articles which: (a) were written in English, (b) were published in scholarly peer-reviewed journals between 2003-2013, (c) referred to simulation education using high-fidelity mannequins, and (d) referred to neonatal nursing. Articles referring to education of neonatal personnel other than nurses (e.g. medical students, residents, respiratory therapists) were not included. Other medical personnel have a role in patient care that is distinct from the nurse's role and their learning is inherently different. For this reason articles referring to the education of other medical personnel were excluded to ensure relevancy of the study to nursing. Unpublished manuscripts, poster abstracts, and dissertations were not included. Articles focusing primarily on simulation using virtual reality, standardized patients, and electronic simulation were also excluded. As high-fidelity simulation education is relatively new for nursing, only articles written within the last ten years (after 2003) were included. In total 22 full-text articles were screened for eligibility and 8 articles were included in the final review.

Step 3: Data Evaluation

The third stage of an integrative literature review according to Whitemore and Knafl (2005) is the data evaluation stage. In this stage extraction of specific methodological features is conducted and quality scores are given and incorporated into the next stage of data analysis.

To evaluate the most current and relevant literature a rating scale was devised and used, similar to the one outlined by Whitemore and Knafl (2005). Each article was evaluated using

two criteria: relevance to the topic of high-fidelity simulation education for neonatal nurses, and rigor of study methodology (Appendix B). Relevance was determined on a three point scale based on whether each article pertained to the parameters of nursing, high-fidelity simulation education, and neonatology. The article was given one point for each parameter. Articles that scored three points were deemed highly relevant, and were analyzed. Those scoring two points were considered moderately relevant; they were not included in this integrative review, but could be useful for further research. Those articles that scored one or zero were deemed to be of little relevance to the topic and were not analyzed.

Similarly, rigor was categorized based on whether the authors carried out an analysis of existing literature, added to the body of knowledge surrounding this topic, and provided provocative questions and possible directions for further research. Each parameter was given one point. Those scoring three points were considered to have high rigor and were further analyzed in this integrative review. Those scoring two points were deemed to have moderate rigor, and have potential for research in the future, but were not analyzed in this review and those scoring one or zero were judged to have low rigor and were not analyzed in the literature review.

Articles that have the categorization of “moderate” have been listed in Appendix C, and are available for future research. A high rating, with more points, indicates that the research is more pertinent to the purpose of this integrative literature review and has been included.

In this integrative review the initial database searches yielded 142 articles, and the ancestry method yielded an additional 20 articles. Once duplicates and those articles not meeting the eligibility criteria were removed, 39 articles remained to be screened. Of this group, 17 were found to not meet the inclusion criteria, leaving 22 full text articles which were assessed for eligibility. Of those, 14 were excluded or evaluated as moderate or low on the rigor or reliability

scales (Appendix D). Eight articles remained for inclusion in the review. A flow diagram based on the work of Moher, Liberati, Tetzlaff and Altman (2009) is included (Appendix E) to provide a visual representation of the numbers of records searched and screened for eligibility.

Step 4: Data Analysis

According to Whittmore and Knafl (2005) the fourth stage of an integrative review is data analysis, where the research is “ordered, coded, categorized, and summarized into a unified conclusion about the research problem” (p.550).

The process of analyzing all 115 articles began with a brief review of each article. This allowed for categorization based on the inclusion and exclusion criteria described previously, with the articles identified as being excluded being taken no further. After this initial review, 22 full-text articles were reviewed individually and in-depth. During this step the major points were extracted and noted using the research protocol developed (Appendix A). After this step the articles were reviewed again and categorized using the three point system for each of relevance and rigor. This resulted in eight full text articles being included in the integrative review. Another review of these eight articles resulted in common themes being identified, categorized and organized using the EXCEL spreadsheet that had been created. This step led to the identification of many common threads from which the six principle themes included in this literature review were drawn.

Presentation of the Literature Review (Step 5)

According to Whittmore and Knafl (2005), the final stage of a literature review is the presentation stage. This is where “explicit details from primary sources and evidence ... are provided to demonstrate a logical chain of evidence” (p.552).

In the literature review that was conducted there are a total of eight articles that met the highest standard (three points) of both relevance and rigor. A review of each individual article that met the highest criteria is provided and key themes that emerged from the review are discussed (Appendix F).

Although many of the articles are not research-based, they serve a purpose by highlighting the limited nature of the objective research available on the subject of high-fidelity simulation. Generally, the articles indicate that high-fidelity simulation has great potential to be an effective pedagogical approach, but more rigorous studies to objectively prove its effectiveness are required.

Despite the limitation identified above, the following eight articles contribute significantly to broadening our understanding of the benefits of high-fidelity simulation and also provide an impetus to subject high-fidelity simulation in neonatal nursing to rigorous quantitative analysis. The current inability to demonstrate a positive quantitative improvement does by no means diminish the importance of these articles or the future of high-fidelity simulation.

Yaeger, K.A., Halamek, L.P., Coyle, M., Murphy, A., Anderson, J., Boyle, K., ... Smith, B. (2004). High-fidelity simulation-based training in neonatal nursing. *Advances in Neonatal Care*, 4(6), 326-331. doi:10.1016/j.adnc.2004.09.009

In this opinion-type, review article the authors contend that high-fidelity simulation is a “powerful tool for gaining the experience and generating the self confidence needed to solve real life problems” (p. 327). Yaeger et al. (2004) describe primary research which relied on participants’ subjective evaluations of the training. The reported research noted that the

participants spent more time in active learning than occurs with traditional teacher-centered education.

Summary.

The authors provided a general overview of high-fidelity simulation and contrasted the inadequacy of traditional medical and nursing education with the superiority of high-fidelity simulation as an educational modality. The assumptions that are intrinsically made regarding the value of traditional methods of education include the view that clinical role models or preceptors are effective and skilled and that their behaviors are worthy of replication. In reality, preceptors are often inadequately equipped or prepared to teach, and often do not have a background in educational methodologies. The second assumption made by traditional education is that at the end of their training period medical/nursing personnel are skilled and competent for clinical practice. In fact competence continues to evolve, even after the completion of an education program, and education needs to be ongoing.

Theoretical perspectives.

To make parallels between traditional education and high-fidelity simulation education, Yaeger et al. (2004) use Bloom's Taxonomy of the Cognitive Domain, which categorizes learning into six levels evolving from the simplest to the most complex. They contend that traditional education using textbooks, lecture, and video uses the lowest, or simplest, level of the taxonomy, because students are not given the opportunity to analyze, synthesize, and evaluate during their training. High-fidelity simulation on the other hand, provides higher-order learning by providing hands-on practice, active learning, immediate feedback, and increased relevance to their practice.

Findings.

Yaeger et al. (2004) reported that students spent increased time in active learning when using high-fidelity simulation as compared with traditional forms of education and stated that 85% of students self-reported that high-fidelity simulation contributed to improving their technical skills. There was no objective measure of skill acquisition, however, in this article.

Yaeger et al. (2004) discuss the limitations and the many benefits of high-fidelity simulation education for neonatal nurses. This article is particularly useful as it makes recommendations for future practice, education and research, specifically evaluating the residual effect of high-fidelity simulation education on actual patient outcome.

Cates, L.A., & Wilson, D. (2011). Acquisition and maintenance of competencies through simulation for neonatal nurse practitioners. *Advances in Neonatal Care, 11(5), 321-327.* doi:10.1097/ANC.ob013e31822a34a0

In this opinion-type article, there is a focus on Neonatal Nurse Practitioners (NNP). This article demonstrates the use of simulation in the acquisition, maintenance and evaluation of competencies for NNP's (Cates & Wilson, 2011). Although these advanced practice nurses have a unique set of skills, this article in particular maintains its relevance for neonatal nurses that do not have the advanced practice skills and the higher education of NNP's.

Summary.

Based on the successful use of high-fidelity simulation by other healthcare professionals, Cates and Wilson (2011) contend that high-fidelity simulation is a superior adult education technique when combined with traditional teaching methods, and can help bridge the theory/practice gap. The authors believe that high-fidelity simulation is revolutionizing the

acquisition and maintenance of competencies for NNP's, and will change the way medical and nursing education is approached.

Theoretical perspectives.

Cates and Wilson (2011), use Miller's Evolution of Mastery of Knowledge and Skills as a philosophical model for high-fidelity simulation. Miller describes the need to evaluate students' knowledge, competence, proficiency, and mastery of skills. Cates and Wilson (2011) feel that high-fidelity simulation can provide the means to demonstrate and measure this evolution.

Findings.

Cates and Wilson (2011) quote studies that show the effectiveness of high-fidelity simulation on the achievement and maintenance of skill competency in surgical techniques, advanced cardiac life support, emergency medical airway management, trauma resuscitation, bronchoscopy, and carotid angiography and infer that high-fidelity simulation education will ultimately improve patient outcomes. Although this article demonstrates that skills are successfully acquired using high-fidelity simulation, it has not yet been proven that an educational initiative can improve patient care.

High-fidelity simulation is also being used beyond a pedagogical modality and is now regarded as a method of competency evaluation. Using high-fidelity simulation for assessment allows for the same conditions for all test takers, using real-life scenarios to demonstrate their competence and ability to actively perform. Although there are barriers to high-fidelity simulation, Cates and Wilson (2011) also note many benefits, and assert that although national nursing certification programs do not currently require high-fidelity simulation for certification testing, it will likely be a requirement in the future. There are already other certification boards,

such as the Medical Council of Canada, Professional Linguistic and Assessment Board, and United States Medical Licensing Examination that currently use high-fidelity simulation for testing.

Although the focus of the article is mainly on competency testing, Cates and Wilson (2011) do emphasize the requirement for debriefing during high-fidelity simulation, as it has been well documented that debriefing is “crucial to the learning process” (pg 323). The authors also put forward several areas for future research for high-fidelity simulation education.

Lemoine, J.B., & Daigle, S.C. (2010). Neonatal resuscitation simulation: Improving safety while enhancing confidence and competence. *Nursing for Women's Health, 14(2), 143-145.* doi:10.1111/j.1751-486X.2010.01528.x

Summary.

In this case report article, Lemoine and Daigle (2010). They assert that, as a result of nursing shortages, novice nurses are being employed in critical care areas. The novice nurses are provided with the same orientation that more experienced nurses receive and complete their orientation to the critical care area with “minimal experience and untested levels of clinical judgment, critical thinking and organizational skills” (p.144). This can lead to dangerous circumstances when critical situations arise that were not encountered in orientation and for which the novice nurse is unprepared. Lemoine and Daigle (2010) contend that although the current Neonatal Resuscitation Program (NRP) teaches the skills and knowledge for successful resuscitation, this knowledge and these skills are not encountered and practiced routinely, and are often not retained. When an real resuscitation scenario is encountered novice nurses feel unprepared.

According to Lemoine and Daigle (2010) “the keys to safety and competency are education and experience” (p. 144) and high-fidelity simulation can provide both the education and experience required. High-fidelity simulation allows learners to be immersed in realistic situations in a replicated environment. Lemoine and Daigle (2010) emphasize that there are many benefits of high-fidelity simulation education, and have designed a one week course to educate and provide experience to novice neonatal nurses using high-fidelity simulation.

Theoretical perspective.

Lemoine and Daigle (2010) did not explicitly state a theoretical perspective with which their educational model was aligned, although the course was composed of a mixture of didactic classroom education, case studies and high-fidelity simulation, allowing the reader to draw the conclusion that the tenets of adult education theory were applicable.

Findings.

Using high-fidelity simulation during the course allowed for immediate feedback and repetitive practice to provide care with greater confidence and competence when called upon to do so. This unique course allows for the transfer of knowledge and utilization of skills without any risk to patients. Lemoine and Daigle (2010) were able to observe many beneficial changes in the novice nurses, including an increase in behavior and communication related to safety that benefited patient outcomes, as well as increased knowledge retention, and increased confidence and competence. There was a high level of participant satisfaction.

High-fidelity simulation in medical education has shown to lead to more effective learning, improved knowledge, skills, and attitudes. Further research is needed to demonstrate whether simulation training results in improved clinical outcomes for newborns.

Yaeger, K.A., & Arafah, J.M.R. (2008). Making the move from traditional neonatal education to simulation-based training. *Journal of Perinatal & Neonatal Nursing*, 22(2), 154-158

In the descriptive article, Yaeger and Arafah (2008), show how high-fidelity simulation can be incorporated into the NRP program, and the pedagogical approaches that high-fidelity simulation uses.

Summary.

Yaeger and Arafah (2008) review high-fidelity simulation pedagogy that has proven to be beneficial in other industries, such as aviation, and in other segments of healthcare, such as in teaching surgical techniques and adult resuscitation. High-fidelity simulation has been used to teach the effective management of complications associated with obstetrical delivery such as post partum hemorrhage, breech vaginal delivery, babies with shoulder dystocia, pregnancy-induced hypertension, and twin delivery. This has had the positive result of a decreased incidence of hypoxic-ischemic encephalopathy, a condition that can be associated with complicated obstetrical delivery.

Theoretical perspective.

A summary of Kolb's experiential learning theory (ELT) is provided, by which the learner progresses through four stages of learning to make meaning of an experience. The learner then draws on this knowledge in future decision making, and tests the new concepts that have been learned when new experiences arise. This is a student centered theory that focuses on the learner, allowing him or her to process an experience and derive meaning and learning from it. This methodology parallels the pedagogy used in high-fidelity simulation.

Findings.

Yaeger and Arafeh (2008) contend that the traditional method¹ of teaching the Neonatal Resuscitation Program (NRP), using didactic instruction and multiple choice exams, does not offer opportunities to synthesize and apply knowledge, a tenet of adult learning theory. They contend that high-fidelity simulation is the most effective way to teach the NRP. Traditional pedagogical methods provide for limited hands-on experience and do not provide for opportunities to practice skills such as clear communication, leadership, and delegation of tasks during an emergency situation. Traditional methods of education also do not allow the learners to demonstrate or reflect on the new knowledge they have gained. Yaeger and Arafeh (2008) point out the important role that debriefing and facilitated discussions play after high-fidelity simulation to allow learners to reflect on their own and others' performances and synthesize the learning that has occurred. High-fidelity simulation provides opportunities for cognitive, technical, and behavioral skills to be gained while being congruent with adult learning principles.

Lindamood, K.E., & Weinstock, P. (2011). Application of high-fidelity simulation training to the neonatal resuscitation and pediatric advanced life support programs. *Newborn & Infant Nursing Reviews*, 11(1), 24-27. doi:10.1053/j.nainr.2010.12.010

The article provides an overview of high-fidelity simulation education with its application to Pediatric Advanced Life Support (PALS) and the NRP.

Summary.

The authors put forward that the training and skills required in neonatal and pediatric resuscitation management are especially important because the risk is high and the margin of error is so small in the neonatal population. They also note that in previous studies of pediatric

¹ The 2011, 6th edition of NRP now uses simulation as a method of teaching (Zaichkin & Weiner, 2011).

resuscitation, retention of basic knowledge and skills degraded over time and, as such, Lindamood and Weinstock (2011) feel that there is a need for “innovative and effective measures in the education of multidisciplinary health care teams involved in providing care to the sick child and/or neonate” (p.24).

To this end, Lindamood and Weinstock (2011), give a brief history of high-fidelity simulation, an evaluation of debriefing, and a review of adult learning theory. The literature surrounding high-fidelity simulation is also summarized, and demonstrates that the acquisition of non-technical skills (such as leadership, communication, and team efficacy) is improved.

Theoretical perspectives.

The authors contend that high-fidelity simulation is well aligned with the principles of adult learning theory, specifically that adult learners are independent, self-directed and internally motivated spurred on by professional or social obligations (Lindamood & Weinstock, 2011). Kolb’s four-phase learning cycle is also used to understand the process of knowledge acquisition.

Findings.

Lindamood and Weinstock (2011) concluded that high-fidelity simulation, in combination with debriefing, provides many benefits to education and is well aligned with adult learning principles when teaching neonatal and pediatric resuscitation.

Fawke, J., & Cusack, J. (2011). Neonatal simulation – training a workforce for the future.

Infant, 7(1), 9-11

Fawke and Cusack (2011) provide a clinical description (case report) of the Leicester simulation training program and an overview of the types of simulation, from low-fidelity to high-fidelity.

Summary.

This opinion-type article was based on their experiences, and concluded that it is not as important to have high-fidelity simulation as it is to choose the appropriate type of simulation for the type of training that is being provided. Simulation allows for learning by repetitive, deliberate practice. Simulation can also be performed at “point of care”, in the healthcare provider’s usual working environment. This offers some potential cost reduction for simulation education and has less impact on service provision, as the healthcare providers are not taken off-site to train using simulation. Fawke and Cusack (2011) make explicit that debriefing using a skilled facilitator is critical to simulation training and that the degree of fidelity of the mannequin is relatively less important to overall learning.

Theoretical perspective.

Fawke and Cusack (2011) review two learning theories. Dreyfus' model of skill acquisition puts forward that a healthcare practitioner moves from novice to expert over a period of time. Fawke and Cusack (2011) maintain that high-fidelity simulation helps to accelerate the time it takes to achieve “expert” skills by taking advantage of deliberate practice. Kolb's phases of adult learning is also reviewed. Kolb’s theory is that learning has four phases and centers on experiential learning and “learning by doing” (Fawke & Cusack, 2011, p. 10). Fawke and Cusack (2011) have adapted Kolb’s model to demonstrate that high-fidelity simulation fits perfectly within this model, and is well suited for education in the clinical environment.

Findings.

Fawke and Cusack (2011) reported the findings of other researchers which include the benefits of high-fidelity simulation: developing leadership abilities, communication

competencies, team dynamics, clinical management skills for complex situations, and familiarization with crisis resource management.

The authors provide a review of studies that show high-fidelity simulation is beneficial, but state that, although it is shown that there are many educational advantages, there is no direct proof that it changes patient outcomes (Fawke & Cusack, 2011). High-fidelity simulation has been shown to improve surgical skills. High-fidelity simulation is being used as a training tool in extracorporeal membrane oxygenation (ECMO) centers to decrease critical incidents. High-fidelity simulation has also been able to decrease the time to competence by 2.3 hours in surgeons trained using high-fidelity simulation versus those trained in an apprenticeship model. It has also been demonstrated that high-fidelity simulation improves retention of life-support algorithms used in real emergencies. Fawke and Cusack (2011) conclude that high-fidelity simulation provides excellent training for healthcare practitioners and cannot be underestimated as an effective method of education.

Raines, D.A. (2010). Neonatal care at the moment of birth: Using simulation to prepare the nurse. *Advances in Neonatal Care*, 10(4), 176-181. doi:10.1097/ANC.0b013e3181e94160

In the case report type article, Raines (2010) describes a high-fidelity simulation scenario that was conducted in order to provide education to neonatal nurses. Raines (2010) believes that nurses must be able to rapidly identify changes from normal, in infants during their transition to extrauterine life. Based on the studies described in the article, Raines (2010) contends that high-fidelity simulation allows nurses to practice for timely intervention, recognition and response, and can prevent further deterioration and potential resuscitation or an NICU admission, without compromising an actual patient's safety.

Summary.

High-fidelity simulation allows interaction and immersion in a situation, and allows neonatal nurses to address the care required for neonates during the time sensitive period of transition to extrauterine life. High-fidelity simulation allows events to mimic actual circumstances in that they occur simultaneously and nurses are able to witness, learn, and participate in the practices that provide safe and effective care.

Theoretical perspective.

The authors did not explicitly espouse a theoretical underpinning associated with the high-fidelity simulation scenario that is described in the article.

Findings.

Although the studies cited rely on participant reports, and no actual measures of behaviors or patient outcomes are made, Raines (2010) affirms that high-fidelity simulation is a valuable teaching tool. Raines (2010) asserts that it allows theory to be put into practice and can increase professional development, increase expertise with neonatal assessment, develop cognitive awareness, help with performing psychomotor skills, increase confidence and allow for better assessment of when to seek additional assistance. High-fidelity simulation is noted to have many benefits, although there are no studies that are specific to neonatal high-fidelity simulation, except those focused on neonatal resuscitation.

Raines (2010) expresses that high-fidelity simulation adds a dimension to traditional teaching and “allows the integration of technical skills with the knowledge and the application of professional judgment foundational to safe and effective nursing care” (p.178). In the traditional apprenticeship model, the needs of the patient determine the educational experience of the learner; using high-fidelity simulation, the learner’s educational needs determine the educational

experience. High-fidelity simulation is also unique in that it allows the learner to fail and learn from negative consequences thus learning from their mistakes without risk to an actual patient. Raines (2010) concludes that “nurses who participate in these simulation experiences may be better educated and prepared to recognize and respond to the nursing care needs of the neonate in the practice setting” (p.181).

LeFlore, J.L. & Anderson, M. (2008). Effectiveness of 2 methods to teach and evaluate new content to neonatal transport personnel using high-fidelity simulation. *Journal of Perinatal and Neonatal Nursing*, 22(4), 319-328

In this comparison study the authors sought to answer the question of which type of high-fidelity simulation would provide the most effective teaching, learning, and evaluation to a subspecialty of neonatal personnel: the neonatal transport team. Both methods of high-fidelity simulation instruction were found to be effective and satisfying to the participants, however, it was noted that there were decreased communication scores in the “instructor modeled learning” approach.

Summary.

When critically ill neonates are born in community hospitals, they are often required to be moved to a tertiary care facility, with a specialized NICU, for ongoing care. The neonatal transport team is called upon to manage and transport these critically ill neonates. It is of the utmost importance that the neonatal transport team members be well trained and highly skilled in the stabilization and transport of these types of neonates.

LeFlore and Anderson (2008) evaluated two methods of training the neonatal transport team using high-fidelity simulation. The first method was termed “self-paced modular learning”.

Using this method the transport team members proceed through a simulated scenario with no instructor or educator involvement until the debriefing session at the end of the scenario. The second approach to high-fidelity simulation that was tested was “instructor modeled learning”. This approach used clinical experts to first model the appropriate responses and actions while the transport team members observed. The transport team members were then asked to complete the same scenario that they had observed followed by participation in a modified debriefing session. The “instructor modeled” scenario had previously been found to be a more effective approach in a study of neonatal nurse practitioners learning using high-fidelity simulation.

Theoretical perspective.

LeFlore and Anderson (2008) looked to Bandura’s Social Learning Theory and Kolb’s Experiential Learning Theory as the philosophical underpinnings guiding these pedagogical approaches. Bandura’s Social Learning Theory stresses the importance of observing and modeling the correct behavior. Kolb’s Experiential Learning Theory centers on learning by doing, and reflecting on the learners’ own experiences to gain knowledge.

Findings.

It was found by LeFlore and Anderson (2008) that both approaches to high-fidelity simulation were effective, and provided the learners with a highly satisfying experience. Objective data was obtained and valid statistical analyses could be made. Both approaches can be used to meet the identified learning objectives, and were found to be more rewarding than learning using task trainers. LeFlore and Anderson (2008) observed that, although both approaches were effective, the “instructor modeled” approach was not as effective at changing overall behavior in experienced personnel. In fact there were decreased scores in team communication with the “instructor modeled” approach. This has caused LeFlore and Anderson

(2008) to propose additional research exploring how to change behaviors of experienced personnel, using Lewin's Change Theory as a philosophical underpinning.

Although this article focuses on a subspecialty of neonatology, the neonatal transport team, I feel that this article is applicable to the teaching and learning needs of experienced neonatal nursing teams in general.

Synthesis of the Research

Following the review and description of each article, the articles were reviewed again and common threads were identified. These were categorized and organized using an EXCEL spreadsheet that had been created. This process resulted in six themes being identified. In this section, the six major themes presented are: (1) the benefits of high-fidelity simulation; (2) safety and patient care; (3) the challenges associated with this pedagogical approach; (4) theoretical frameworks associated with high-fidelity simulation; (5) the role that high-fidelity simulation plays as compared with traditional forms of education; and (6) the importance of debriefing after a high-fidelity simulation experience. Suggestions for future research and innovative future uses of high-fidelity simulation education for neonatal nurses are also discussed.

Theme 1: Benefits of High-Fidelity Simulation

The literature identifies many causes for the efficacy of high-fidelity simulation and many positive reasons to use high-fidelity simulation as a pedagogical approach. It was determined that there were three main categories of benefits associated with this method of teaching: (I) for identifying and improving communication and teamwork; (II) as an innovative pedagogical approach, (III) to aid in skill acquisition, confidence and participant satisfaction.

Benefit (I): Communication and Teamwork

High-fidelity simulation does not simply apply to the physical, hands-on training of the learner.

Rather, high-fidelity simulation scenarios center on real situations and require the learners to train in all aspects of nursing practice, including communication. One of the clear benefits of high-fidelity simulation education for neonatal nurses noted in the literature was its positive effect on communication and teamwork (Cates & Wilson, 2011; Fawke & Cusack, 2011; LeFlore & Anderson, 2008; Lemoine & Daigle, 2010; Yaeger et al., 2004). Learners are able to practice their skills and collaborate as a team, just as would be the case in an actual patient care situation, with the benefit of causing no potential harm to the patient (Cates & Wilson, 2011; Yaeger et al., 2004). LeFlore and Anderson (2008) assert that high-fidelity simulation is an effective means to develop appropriate communication skills and practice working as a team; they state that “teams that practice together in simulated clinical scenarios are more effective in caring for patients in real life” (p.320). Similarly, Fawke and Cusack (2011) assert that high-fidelity simulation is useful for teaching leadership, communication, and team dynamics. The increase in cognitive knowledge and technical skills and the improved teamwork ultimately contribute to the provision of competent and safe care to patients (Lemoine & Daigle, 2010). As well, Cates and Wilson (2011) feel that the opportunity to practice as a team and refine leadership and communication skills lead to a safer practice and improved outcomes, and improvements in the quality of care. In summary, both improved communication and enhanced teamwork are advantages of high-fidelity simulation education for neonatal nurses.

Benefit (II): Innovative Pedagogical Approach

High-fidelity simulation education provides another dimension to teaching (Raines, 2010), offering active learning (Cates & Wilson, 2011) using authentic case studies to allow students to practice realistic situations (Fawke & Cusack, 2011; Yaeger et al., 2004) in a student-centered learning environment (Cates & Wilson, 2011). High-fidelity simulation for neonatal

nurses can provide individualized learning, and the scenarios can be tailored to meet the skill level of the learner, from novice to expert (Cates & Wilson, 2011; Fawke & Cusack, 2011; LeFlore & Anderson, 2008, Raines, 2010; Yaeger et al., 2004). Learners are given the opportunity to learn through deliberate and repetitive practice (Fawke & Cusack, 2011), and are allowed to test their newly formed knowledge and solidify their learning (Yaeger & Arafah, 2008). The high-fidelity simulation scenarios take place in “real time” giving a true sense of the time pressure and stress, as well as an opportunity for the learner to experience that often events occur simultaneously; these factors are not easily imparted using traditional teaching methods (Raines, 2010; Yaeger et al., 2004). Lindamood and Weinstock (2011) state that “through immersion in realistic environments, high-fidelity simulation leads to heightened emotionality and, therefore, deeper engagement of the learner” (pg. 24).

Traditional teaching methods usually focus on cognitive learning separate from technical education (Yaeger & Arafah, 2008). High-fidelity simulation is not only able to combine the training of cognitive and technical skills it also incorporates behavioral skills (Fawke & Cusack, 2011; Lemoine & Daigle, 2010; Lindamood & Weinstock, 2011; Yaeger & Arafah, 2008) and professional judgment (Raines, 2010). High-fidelity simulation allows for the blending of theory and practice (Cates & Wilson, 2011; Lemoine & Daigle, 2010; Raines, 2010) and helps the student to validate clinical judgment, critical thinking (Cates & Wilson, 2011; Lindamood & Weinstock, 2011), and cognitive awareness (Raines, 2010), leading to a form of education that is comprehensive (Yaeger & Arafah, 2008). Cates and Wilson (2011) assert that using high-fidelity simulation education improves outcomes in areas that are often difficult to teach or assess using conventional educational methods such as the application of knowledge, leadership, delegation, decision-making, enhanced critical thinking skills, and communication. Another

unique educational innovation that high-fidelity simulation provides is that it allows for the student to learn by trial and error and learn from negative consequences (Raines, 2010), reinforcing the lessons learned.

More than an educational tool, high-fidelity simulation can also be used as a method for evaluation. Using high-fidelity simulation as a means of evaluation ensures that the same clinical scenarios are given to each test-taker (Cates & Wilson, 2011), and “allows for evaluation of theoretical competency, proficiency of technical skills, efficacy of communication, and teamwork and assessment of critical thinking skills” (Cates & Wilson, 2011, p.321). In summary, “simulation-based training embodies many of the strengths of traditional training programs while minimizing many of the intrinsic limitations” (Yaeger et al., 2004, p.327).

Benefit (III): Skill Acquisition, Confidence, and Participant Satisfaction

When comparing high-fidelity simulation to traditional teaching methods, Lindamood and Weinstock (2011) witnessed increased critical thinking, knowledge acquisition and retention, and observed an increase in the quality and mastery of skills among those trained using high-fidelity simulation methods. This literature review found that there was an overall improvement in cognitive, behavioral, and technical skills as well as improved knowledge retention and improved attitudes reported by the learners (LeFlore & Anderson, 2008; Lindamood & Weinstock, 2011; Raines, 2010; Yaeger et al., 2004). One caveat should be raised: there are apparent deficiencies in the articles related to a lack of quantitative measurement of the skill acquisition and a concomitant lack of evidence of retention of the skills acquired.

The use of high-fidelity simulation provides students with the opportunity for repetitive practice of skills, assessing and reassessing these over several high-fidelity simulation scenarios (LeFlore & Anderson, 2008; Lemoine & Daigle, 2010; Raines, 2010; Yaeger et al., 2004), which

in turn leads to greater safety and competence (Lemoine & Daigle, 2010). High-fidelity simulation education allows for the ability to mimic varied patient situations (LeFlore & Anderson, 2008) and the students are able to learn how to manage rare or unusual complications and situations (Fawke & Cusack, 2011; LeFlore & Anderson, 2008; Raines, 2010). For example, high-fidelity simulation can be used to educate neonatal nurses in the modalities of treatment related to infants with gastroschisis or infants with extremely low birth weight infants, conditions that obviously cannot be induced on a live patient for education purposes.

Using high-fidelity simulation, learners are able to see immediate improvements in their clinical performance which contributes to their confidence (Raines, 2010; Yaeger et al., 2004). Students reported an increased confidence in recognizing subtle changes in their patient's condition, as well as performing technical and non-technical skills after high-fidelity simulation training (Raines, 2010; Yaeger et al., 2004). Students also self-reported an increased level of assurance when taking on full patient care responsibilities (Yaeger et al., 2004). High-fidelity simulation allows the student to practice problem solving, hone their technical skills, and demonstrate their competence (Cates & Wilson, 2011; Lemoine & Daigle, 2010; Yaeger & Arafeh, 2008).

Throughout the literature it was noted that participants that were taught using high-fidelity simulation indicated a high level of satisfaction with this learning method (LeFlore & Anderson, 2008; Raines, 2010). Participant evaluations were extremely positive, with most preferring this method of teaching over traditional methods (Yaeger et al., 2004).

In summary, the identified benefits of high-fidelity simulation training is the improved acquisition of skills, the reported increased level of self confidence, improved communication and teamwork, and a high level of satisfaction with this method of education.

Theme 2: Safety and Patient Care

High-fidelity simulation offers an innovative method of teaching without compromising the safety of patients (Lemoine & Daigle, 2010; Raines, 2010; Yaeger et al., 2004). High-fidelity simulation is an excellent tool to allow students to reason, practice difficult tasks, and improve nurses' preparedness without causing harm to the patient (Yaeger et al., 2004). Similar to its value in aviation, high-fidelity simulation is perfectly suited to help train for high-risk, low frequency events (Cates & Wilson, 2011; LeFlore & Anderson, 2008; Lindamood & Weinstock, 2011). Lemoine and Daigle (2010) noted that as "participants [in high-fidelity simulation education] engaged in behavior and communication skills that promoted the enhancement of safety, this resulted in increased positive patient outcomes" (pg. 145). Similarly, Raines (2010) noted that after high-fidelity simulation education, participants were observed to be more willing to seek additional support or assistance in a timely manner, which can in turn lead to increased patient safety.

Cates and Wilson (2011) put forward that high-fidelity simulation education minimizes the risk of repeated failures and the establishment of false confidences in a real clinical setting, by allowing for education that trains to the weaknesses of the learner, rather than his or her strengths, as is found to occur in education in the clinical setting. Yaeger et al. (2004) stated that "the financial implications of preventable medical errors pale in comparison to the morbidity and mortality that could potentially be prevented through use of more effective and authentic educational methods and instructional strategies" (pg. 330). The primary focus in nursing education is always on patient safety. A major advantage of high-fidelity simulation is that it provides an excellent training medium with no risk to patient safety.

Theme 3: Challenges of High-Fidelity Simulation

Throughout the literature there were four major challenges identified as being associated with high-fidelity simulation training for neonatal nurses, namely: cost, technical issues, time, and faculty requirements.

Cost and Technical Issues

The most prevalent disadvantage noted throughout the literature is the cost associated with high-fidelity simulation training (Fawke & Cusack, 2011; Lindamood & Weinstock, 2011; Yaeger et al., 2004). A high-fidelity human simulator can cost between \$30,000 and \$175,000 (Birkhoff & Donner, 2010), with the price increasing in proportion to the complexity of the simulator (Broussard et al., 2009). Other associated costs relate to the need to procure large spaces in which to carry out the high-fidelity simulation scenarios and store the equipment (Lindamood & Weinstock, 2011; Yaeger et al., 2004).

To mitigate the high cost and space requirements of high-fidelity simulation in a simulation center, high-fidelity simulation has started to be performed “in situ” or at the point of care (Cates & Wilson, 2011; Fawke & Cusack, 2011). This allows the high-fidelity simulation to occur in the actual environment where the learners work, having the added benefit of allowing the learners to use the familiar equipment and work with their actual co-workers in their own neonatal unit (Fawke & Cusack, 2011). This also has less impact on service provision, and should prove to be more cost-effective, as staff are not removed from their work environment for a whole day to train at a high-fidelity simulation center. Instead, the training can occur while staff remain at work (Fawke & Cusack, 2011), providing the learners a familiar environment and saving costs.

Additional costs linked with high-fidelity simulation relate to the highly complex technical aspects of this training. Yaeger et al. (2004) point out the high cost and requirement of employing technical staff to maintain the equipment hardware and software, and for trained staff to run the simulator.

Time and Faculty Requirements

The time required for educators to train to use the highly sophisticated high-fidelity simulation equipment, as well as to develop scenarios, conduct research, and design reliable methods of testing students are all disadvantages of high-fidelity simulation training (Fawke & Cusack, 2011; Lindamood & Weinstock, 2011). Time is also required for educators to be trained and practice the art of debriefing, as this is an emotionally charged and complex process that is vital when using high-fidelity simulation (Lindamood & Weinstock, 2011).

The literature highlighted that there was an increased need for more faculty when using high-fidelity simulation in neonatal nursing education (Lindamood & Weinstock, 2011) because each high-fidelity simulation group could optimally train only four to five students. This is a much smaller group than in traditional nursing education, where the limit would be the capacity of the classroom, hence more faculty time is required to train the increased number of sessions.

Fawke and Cusack (2011) noted that another challenge associated with high-fidelity simulation is that the high-fidelity simulation centers are not available to the whole multidisciplinary team resulting in differing learning experiences and approaches within the team. Also, it is often the case that those who practice outside a large urban center or removed from a medical teaching facility do not have access to the use of a large high-fidelity simulation center (Fawke & Cusack, 2011).

Theme 4: Theoretical Frameworks

Throughout the literature there were several different theoretical frameworks that were identified as being relevant to the study of high-fidelity simulation education for neonatal nurses. Adult education theory was cited as an important grounding principle for high-fidelity simulation (Cates & Wilson, 2011; Lindamood & Weinstock, 2011; Yaeger & Arafeh, 2008; Yaeger et al., 2004). This theory, often ascribed to Malcolm Knowles (Murrell, Russell, Hartig & Care, 2007), includes the assertion that adults are independent learners (Cates & Wilson, 2011; Yaeger & Arafeh, 2008; Yaeger et al., 2004), bring in a wealth of previous life experiences to their education (Yaeger & Arafeh, 2008; Yaeger et al., 2004), and are internally motivated to learn (Cates & Wilson, 2011; Yaeger & Arafeh, 2008). Adult learners also have a need for immediate hands-on practice (Cates & Wilson, 2011; Yaeger et al., 2004), are motivated to learn because of their social or professional roles (Cates & Wilson, 2011; Yaeger et al., 2004), and attain immense satisfaction from the immediate application of the knowledge they have gained (Cates & Wilson, 2011; Yaeger et al., 2004).

Kolb's Experiential Learning Theory was also highlighted in four of the articles as a useful framework for studying high-fidelity simulation for neonatal nurses (Fawke & Cusack, 2011; LeFlore & Anderson, 2008; Lindamood & Weinstock, 2011; Yaeger & Arafeh, 2008). This theory centers on four stages of adult learning: "immediate or concrete experiences² are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experiences" (Kolb, Boyatzis & Mainemelis, 2001, pg. 230). This is a student-centered approach (LeFlore & Anderson, 2008) that is well suited for use with high-fidelity simulation (Yaeger & Arafeh, 2008). Kolb's theory

² Note: the underlined words are a direct reflection of the cited text

places an emphasis on the learner's previous experiences that are brought with them to the educational forum (LeFlore & Anderson, 2008), as well as the importance of learning through participation (Fawke & Cusack, 2011; LeFlore & Anderson, 2008), and reflection about the learning experience (LeFlore & Anderson, 2008; Lindamood & Weinstock, 2011). Kolb's theory is important for educators, as it can enhance the learning that occurs. Kolb contends that educators can achieve the enhancement of learning by creating "learning spaces that promote growth producing experiences for learners" (Kolb & Kolb, 2005, p. 205) and must match their instructional method with the learning style of the students (Kolb, Boyatzis & Mainemelis, 2001). Educators must also "provide the opportunity for reflection on and meaning making about experiences that improve the effectiveness of experiential learning" (Kolb & Kolb, 2005, p.208). These are all important cornerstones of the high-fidelity simulation experience.

Although not as extensively cited as Kolb's Experiential Learning Theory or Adult Learning theory, three other theories were also discussed in the literature as frameworks that might be used for high-fidelity simulation education for neonatal nurses. Bloom's Taxonomy which depicts learning as evolving from the lowest level of critical thinking to higher cognitive complexity was cited (Yaeger & Arafah, 2008; Yaeger et al., 2004). It was asserted that traditional education requires learners to simply think at the lowest level (Yaeger & Arafah, 2008; Yaeger et al., 2004), whereas high-fidelity simulation provides an opportunity to think at a higher level including analysis, synthesis and evaluation of the content (Yaeger & Arafah, 2008; Yaeger et al., 2004). Kolb's theory could be thought of as subset of Bloom's Taxonomy, as Kolb augments and expands on the process by which learning is achieved at the highest level of cognitive complexity as described by Bloom.

In one article, Bandura's Social Learning Theory was used as a framework for high-

fidelity simulation for neonatal nurses (LeFlore & Anderson, 2008). In this theory, it is hypothesized that new knowledge is gained through observation and modeling of behaviors, attitudes and emotional reactions (LeFlore and Anderson, 2008). This theory could be a useful framework for high-fidelity simulation, as learners are able to observe and model the successful actions of their peers, incorporate these into their current understanding and develop new knowledge. This parallels constructivist theory.

Dreyfus' Model of Skill Acquisition was also cited as a framework that works well with high-fidelity simulation (Fawke & Cusack, 2011). In this model, students learn skills by deliberate, repetitive practice. The student's progress from novice to expert is followed and it is asserted that, with the use of high-fidelity simulation, the time to reach the "expert" standing is shortened (Fawke & Cusack, 2011). This model is akin to constructivist theory, in that students are able to continually build on previous knowledge, through repetitive practice, and are able to use this new knowledge to increase their standing from novice to expert.

High-Fidelity Simulation and Constructivist Theory

Although not explicitly stated in any of the articles, the theoretical frameworks used to describe high-fidelity simulation all have similarities and components of constructivist theory. Similarities among the theoretical frameworks cited within the articles reviewed, constructivist theory, and high-fidelity simulation are summarized in Table 2. In particular, each framework cited requires a student-focused learning environment to enhance learning and understanding, a central feature of both high-fidelity simulation and constructivist theory (Peters, 2000).

Another parallel among high-fidelity simulation, constructivist theory and each framework cited is the assumption that learners bring previous life experiences and prior

knowledge to their learning and that learners are internally motivated and self-directed (Peters, 2000; Young & Maxwell, 2007).

Another similarity among the frameworks cited, constructivist theory and the debriefing aspect of high-fidelity simulation is that each takes “into account what individual students have learned and how they have learned it” (Peters, 2000, p.166).

Further, the success of high-fidelity simulation supports the constructivist theory that students learn best when placed into experiences that challenge their current understanding, can be reflected upon, and from which knowledge can be gained (Peters, 2000; Young & Maxwell, 2007). This is an aspect that is also common to all the frameworks cited.

Table 2: Similarities among high-fidelity simulation, constructivist theory, and theoretical frameworks cited

| | High-fidelity simulation | Constructivist | Kolb | Adult Education | Bloom | Bandura | Dreyfus |
|--|--------------------------|----------------|------|-----------------|-------|---------|---------|
| Previous experiences important | X | X | X | X | X | X | X |
| Actively create knowledge | X | X | X | X | X | X | X |
| Learn through interaction with environment | X | X | X | X | X | X | X |
| Active Learning | X | X | X | X | | X | X |
| Reflections and Debriefing | X | X | X | X | | X | |
| Challenge current thinking | X | X | X | | X | X | |
| Student-focused | X | X | X | | | | |
| Self-directed learning/ Internally motivated | X | X | | X | | | |

Theme 5: High-fidelity Simulation and Traditional Education Compared

“Simulation-based training embodies many of the strengths of traditional training programs while minimizing many of the intrinsic limitations” (Yaeger et al., 2004, p.327). Many of the articles reviewed compared traditional education methodology (solely didactic teaching, or didactic teaching paired with a preceptor) with high-fidelity simulation education (Cates & Wilson, 2011; LeFlore & Anderson, 2008; Lemoine & Daigle, 2010; Raines, 2010; Yaeger & Arafeh, 2008; Yaeger et al., 2004). The conclusions overwhelmingly supported the hypothesis that high-fidelity simulation is clearly a superior pedagogical approach. Traditional education employs a passive format (LeFlore & Anderson, 2008; Yaeger & Arafeh, 2008, Yaeger et al., 2004). In direct contrast to this, students learn when they are active participants, in particular when they apply knowledge in a safe, controlled environment and receive feedback on this application. The cycle repeats itself as students participate in and learn from the feedback process. In summary, it has been clearly established that an active approach to education, as used in high-fidelity simulation, is superior for learning.

Although teacher-centered didactic education allows for a large number of people to receive education in a lecture format, it offers nothing beyond the content that the instructor deems important (Yaeger & Arafeh, 2008). In fact, Lemoine and Daigle (2010) contend that, after orientation sessions presented in a traditional lecture format, new NICU nurses were unprepared for the workplace with minimal experience and untested skills.

Lecture-format, traditional education does not allow for practice with hands-on skills, communication, delegation or leadership (Yaeger & Arafeh, 2008), because there is limited opportunity to practice, especially when compared to high-fidelity simulation, where practice and participation are the *raison d'être*. High-fidelity simulation allows for a dimension that is not

found in traditional education (Raines, 2010): it allows for an opportunity to synthesize and apply knowledge and is congruent with adult learning theories (Yaeger & Arafeh, 2008). According to Cates and Wilson (2011) “mastery of procedural skills is essential when caring for critically ill neonates, but is difficult to practice regularly in the NICU” (p.322). If clinical skills are practiced, the preceptor model is usually applied, where the learner is assigned a more experienced nurse to observe and practice with (Yaeger et al., 2004). The traditional method of employing a preceptor is inadequate; it assumes that all preceptors have the skills to teach, and role-model behavior commendable of duplication (Yaeger et al., 2004). The preceptors that are chosen or volunteer often do not have a background in educational methodologies or the latest research in clinical education (Yaeger et al., 2004). High-fidelity simulation allows trained educators to teach (Yaeger et al., 2004).

Another area where teacher-centered approaches are inferior to high-fidelity simulation is student evaluation. Traditionally, knowledge is tested using an exam format, where the learner is simply asked to memorize and recite facts (Yaeger & Arafeh, 2008) and is not given the opportunity to demonstrate that his or her new knowledge can be applied to patient care (LeFlore & Anderson, 2008; Yaeger & Arafeh, 2008). Teacher-centered evaluation does not allow the learner to reflect on their own learning (Yaeger & Arafeh, 2008), but rather relies on the educator to provide affirmation of learning with a grade on an exam.

Theme 6: Debriefing

Throughout the literature, a central component of high-fidelity simulation education that is consistently identified as being vital is the incorporation of debriefing after the completion of the high-fidelity simulation scenario itself (Cates & Wilson, 2011; Fawke & Cusack, 2011; LeFlore & Anderson, 2008; Lemoine & Daigle, 2010; Lindamood & Weinstock, 2011; Yaeger &

Arafeh, 2008; Yaeger et al., 2004). Debriefing is such a critical element of the high-fidelity simulation experience and learning process that Dr. David Gada, Associate Dean for immersive and simulation-based learning at the Hon Mai and Joseph Goodman Center for Simulation and Immersive Learning at Stanford School of Medicine, is quoted as saying “simulation is really an excuse to debrief” (Cates & Wilson, 2011, p.323).

Debriefing is a time for participants to reflect on the events that took place during high-fidelity simulation, discuss them with others, learn, and modify their behavior as a result (Yaeger & Arafeh, 2008; Yaeger et al., 2004). Debriefing allows learners the opportunity to ask questions of the group, allowing them to compare the thought processes of other students that might have led to different decisions (Yaeger & Arafeh, 2008). The students themselves are able to construct knowledge.

Students bring with them a wealth of prior knowledge, be it nursing knowledge or knowledge from other areas of their lives. Working with their peers during the high-fidelity simulation and debriefing allows students to draw on the knowledge that those peers and the instructor bring, and build on the knowledge that they already possess (Yaeger & Arafeh, 2008). As individuals, the learners are able to reflect on their own learning and improve their performance (Lemoine & Daigle, 2010; Lindamood & Weinstock, 2011; Yaeger & Arafeh, 2008). The group is also permitted the opportunity to discuss and improve on the level of teamwork, communication, and critical decision making that took place (Cates & Wilson, 2011; Yaeger & Arafeh, 2008).

Debriefing is an active form of learning, and facilitating a successful debriefing session is critical to the student’s successful reflection and knowledge acquisition (Cates & Wilson, 2011; Fawke & Cusack, 2011). Lindamood and Weinstock (2011) assert that “when done well,

debriefing best leverages the simulation experience by addressing the emotions of the shared event, while uncovering important practice changes in the individual and team” (pg. 26).

Implications for the Future

As this review has shown, high-fidelity simulation education holds many great implications for neonatal nursing education. The following section contains directions for additional research and to expand high-fidelity simulation education for neonatal nurses with innovative future uses.

Additional Research

As previously noted, the research available on the topic of high-fidelity simulation education for neonatal nurses was comprised principally of qualitative, anecdotal articles. Based on these, high-fidelity simulation appears to be effective for skill acquisition, but there is a need for rigorous objective studies to be carried out to definitively prove the breadth of its effectiveness.

There are many unanswered questions surrounding high-fidelity simulation education for neonatal nurses (Table 3) including the need for more research to be conducted to determine if there is a correlation with competency level, improved patient safety, and favorable patient outcomes after high-fidelity simulation education (Cates & Wilson, 2011).

There is considerable literature that speaks to the high cost of high-fidelity simulation education, but there is a requirement for a study that carries out a rigorous cost-benefit analysis of high-fidelity simulation laboratories and training (Lindamood & Weinstock, 2011). More research is also required to study whether the skills learned in high-fidelity simulation are transferable to real nursing situations, and how high-fidelity simulation training for neonatal nurses impacts the outcome of actual patients (Yaeger et al., 2004).

Table 3: Recommendations for Future Research on High-Fidelity Simulation (HFS) Education for Neonatal Nurses

| Future Research | Key Recommendations for Research |
|-----------------|--|
| Competency | <ul style="list-style-type: none"> • Does neonatal HFS education improve patient care? • Are there favorable patient outcomes after neonatal HFS education? |
| High Cost | <ul style="list-style-type: none"> • Rigorous cost-benefit analysis of establishing HFS labs and training. |
| Skills | <ul style="list-style-type: none"> • Are skills learned with HFS education transferable to real neonatal nursing situations? • Does HFS training impact outcome of actual neonatal patient care? • For how long does the knowledge and skills gained from HFS education last? |

Innovative Future Uses

It has been shown that high-fidelity simulation is an educational innovation that provides training for high-risk activities in a safe and effective manner. A list of nursing activities where high-fidelity simulation might be used to train neonatal nurses (Figure 1) has been compiled.

There are many high-risk nursing activities that are performed in the NICU on a continual basis. These activities are often taught, but not practiced until an actual patient care situation arises, which puts the patient at risk if these skills have not been perfected. It is imperative that these high-risk activities be identified and taught (Sharma, 2013). These activities include, but are not limited to, assisting with endotracheal tube insertion and fixation, inserting intravenous catheters, changing intravenous solutions, assisting with umbilical line insertions, and positioning the patient and assisting with lumbar punctures. Training neonatal nurses using high-fidelity simulation would provide the education and practice to help perfect these activities prior to practice on actual patients.

Beyond the technical aspects of neonatal nursing, high-fidelity simulation education can also be used to educate neonatal nurses in the art of communication with parents or other team members, and to help acquaint neonatal nurses with some of the difficult ethical issues that are often present in the NICU (Fawke & Cusack, 2011). High-fidelity simulation education can also

assist in the advancement of novice nurses, by allowing novice nurses to practice more complex patient care techniques in a simulated scenario prior to being assigned to a sicker, medically complicated and fragile patient.

One of the smallest and most fragile of the patients cared for in the NICU is the extremely premature and extremely low birth weight (ELBW) infant. The first hour of life is critically important for these tiny patients (Reynolds, Pilcher, Ring, Johnson & McKinley, 2009). High-fidelity simulation education can provide team training resulting in the most beneficial care for these infants (Reynolds et al., 2009). One activity that has been proven to be beneficial to all infants is skin-to-skin holding (kangaroo care) with the infant's parents (Blomqvist, Rubertsson, Kylberg, Joreskog, Nyqvist, 2012; Gregson & Blacker, 2011; Ludington-Hoe, 2013). This is a relatively simple activity to achieve in a stable NICU patient, but for the patients that are the most fragile, with the most invasive life-sustaining equipment, the beneficial treatment of kangaroo care becomes a Herculean and extremely high-risk task. The simple movement of a fragile infant from its bed to the arms of its parents is an activity that takes precision and a team effort to achieve safely. This makes it another perfect innovative use of high-fidelity simulation education of neonatal nurses.

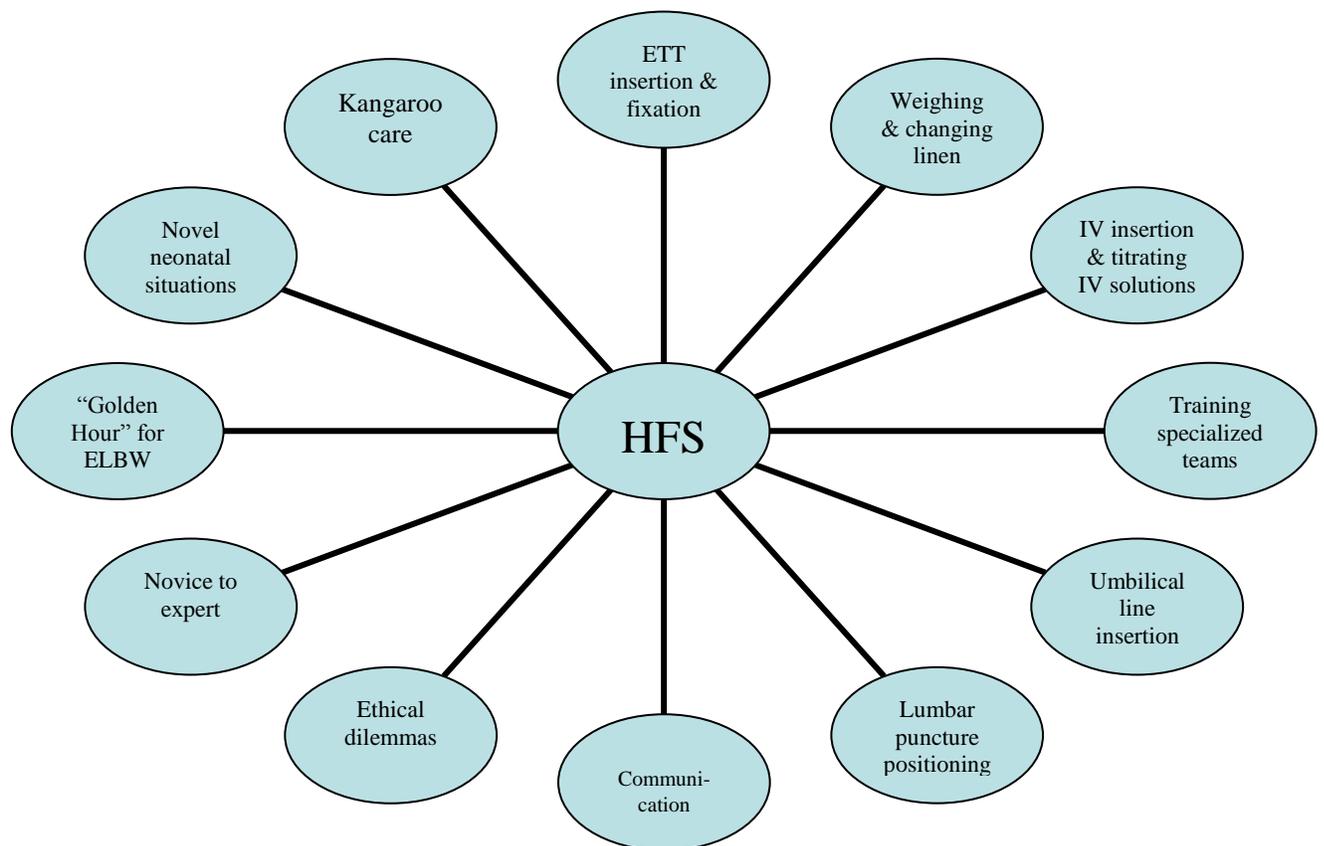
For the most extremely sick and fragile neonate, simply moving them from their bed to be weighed or have their linen changed can be a life threatening procedure. These types of activities could be practiced as a team in a high-fidelity simulation scenario, to help perfect the technique prior to it being performed on a patient.

In the future, as high-fidelity simulation becomes an increasingly mainstream method of education, the possibility of collaboration and cost sharing between universities and hospitals would help to defray the cost of equipment and staff (Lindamood & Weinstock, 2011). High-

fidelity simulation education for neonatal nurses could also be used to help train specialized neonatal personnel such as those on the neonatal transport team (LeFlore & Anderson, 2008) and neonatal nurse practitioners (Cates & Wilson, 2011). It could also be used in novel neonatal situations, such as moving into a new neonatal unit (Bender, Shields & Kennally, 2011).

Neonatal staff could practice actual patient care, on high-fidelity mannequins, in a new NICU unit. This would facilitate the determination of locations of potential safety hazards, or help identify changes in practice or design that might be required prior to moving into the new unit permanently when actual patient care would be required to be undertaken (Bender et al., 2011).

Figure 1. Innovative Future Uses of HFS for Neonatal Nurses



Limitations of the Literature Review

As previously noted many of the articles included in this integrative literature review are not research based and stem from opinion articles, case reports, anecdotes and clinical descriptions. Very little primary research, involving objective, quantitative data was discovered on this topic, and only one was included in this literature review. Therefore, conclusions based on evidence regarding the efficacy of high-fidelity simulation education for neonatal nurses cannot be definitively drawn.

Although the framework outlined by Whittmore and Knafl (2005) was followed, and the literature review was comprehensive and included more than one research modality, there remain some limitations to this review itself. The large volume of articles that had to be reviewed by a single individual was one of the greatest limitations: there was not a cadre of literature reviewers providing unique points of view, or alternative opinions on data analysis, data evaluation or theme identification which might have provided a richer outlook.

Related to this is the limitation of only including the articles that ranked highest on the relevance and rigor scale that was developed. With additional researchers to help review and write the literature review those articles that rated “moderate” on the relevance and rigor scale perhaps could have been included in this literature review. These are instead available for research at a later time. Further, this review focused solely on articles that provided the highest level of relevance and rigor on a scale that was devised, which was not reviewed for validity or reliability.

Another limitation to this review is that only articles written in English were examined. There could have been additional valuable research discovered in articles written in other languages, but those articles were unavailable in translation.

Conclusion

Although high-fidelity simulation training has been used for many years in the aviation and military industries, its use is relatively new to the healthcare field. As has been demonstrated in this literature review, there are indications that high-fidelity simulation might be valuable, and there are many innovative uses for high-fidelity simulation education for neonatal nurses. There are many unanswered questions and a need for a more rigorous quantitative approach to responding to these questions. Despite this obvious gap in the research, the articles presented are useful in focusing future research, creating research ideas, and providing anecdotal background to guide research endeavors about the efficacy of high-fidelity simulation education for neonatal nurses. These articles also help to broaden the understanding of the benefits of high-fidelity simulation and can play an important part in moving high-fidelity simulation in neonatal nursing forward.

Further, it is advisable that high-fidelity simulation education work in concert with more traditional methods of pedagogy to present an all-encompassing and holistic model of education for neonatal nurses and to take full advantages of both approaches. Although it has been demonstrated that non-technical skills, such as communication, leadership, and teamwork are successfully acquired using high-fidelity simulation, it has not yet been established that this educational initiative can improve patient care.

Despite any potential caveats, high-fidelity simulation education for neonatal nurses is a true innovation in teaching. It allows the students to be immersed in real-life situations, draw on their past experiences and comprehension, apply new knowledge and gain a deeper understanding of the subject being taught. There are many theoretical frameworks that help guide this nursing pedagogy. Compared to traditional education, high-fidelity simulation has the

ability to increase critical thinking and knowledge retention by using an active, student-centered method of education. High-fidelity simulation allows the learner to bring their existing knowledge and build on it, and use debriefing and reflection to contribute to a deeper understanding. High-fidelity simulation has proven to be effective in improving teamwork, increasing communication, and is an innovative pedagogical approach. It has been demonstrated that there is a high level of student satisfaction with this type of training. Successful implementation of high-fidelity simulation in the medical and aviation fields has contributed to the saving of many lives. For this reason alone, nursing education, particularly neonatal nursing should be quick to embrace this invaluable tool.

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Appendix A

Literature Review Protocol(Adapted From: Polit & Beck, 8th ed., 2008, Lippincott Williams & Wilkins, p. 120)

Citation: Authors: _____
 Title: _____
 Journal: _____
 Year: _____ Volume: _____ Issue: _____ Pages: _____

Type of Study: Quantitative Qualitative Mixed Method

Location/Setting: _____

Key Concepts/
 Variables: Concepts: _____
 Intervention/independent variable: _____
 Dependent Variable: _____
 Controlled Variable: _____

Framework/Theory: _____

Design Type: Experimental Quasi-experimental Non-experimental
 Specific Design: _____
 Blinding? None Single: _____ Double: _____
 Description of Intervention: _____

 Comparison Group(s): _____
 Cross-sectional Longitudinal/Prospective # of data collection points _____

Qualitative Tradition: Grounded Theory Phenomenology Ethnography Other _____
 Sample: Size: _____ Sampling Method: _____
 Sample Characteristics: _____

Data Sources: Type: Self-report Observational Biophysiologic Other _____

 Data Quality: _____

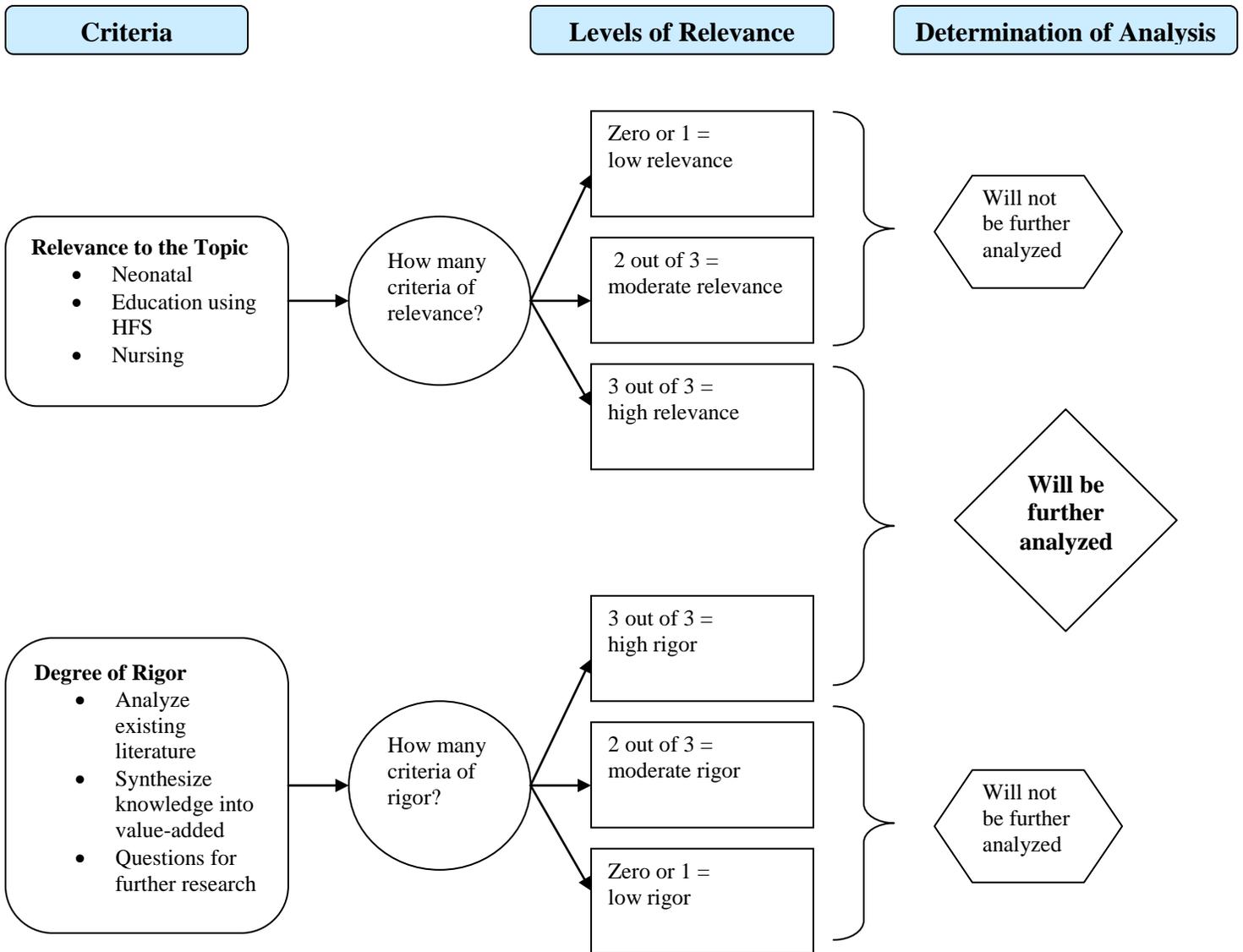
Statistical Tests: Bivariate: T test ANOVA Chi-square Pearson's *r* Other: _____
 Multivar: Multiple regression MANOVA Log regression Other: _____

Findings: _____
 Effect Sizes: _____
 Themes: _____

Recommendations: _____

Strengths: _____
 Weaknesses: _____

Appendix B



Appendix C

Articles rated “moderate” on either relevance or rigor scale

| Citation | Summary | Rating Scale |
|---|--|--|
| <p>Cates, L.A. (2011). Simulation training: A multidisciplinary approach. <i>Advances in Neonatal Care</i>, 11(2), 95-100. doi: 10.1097/ANC.obo13e318210d16b</p> | <p>Healthcare is one of a few high-risk industries not required to do high-fidelity simulation training. Benefits: affordable, ability to be standardized, highly-effective, increased technical skills. Able to practice assessment, diagnosis, treatment. Improved outcomes. Able to teach topics that are difficult to train or assess by conventional education. Debriefing is key. Exposure to high-risk situations with no risk to patient or student. Safe and non-punitive learning. Direct observation of competency and skills. High-fidelity simulation should be key to quality improvement strategies. Enhancing Simulation Act of 2009, in support of high-fidelity simulation in health care (did not pass). Future Research on: decreased error rates after high-fidelity simulation, improved ACLS skills, increased technical skills (e.g. airway management).</p> | <p>Relevance = 2 (not specific to nursing)</p> <p>Rigor = 3</p> |
| <p>Colacchio, K., Johnston, L., Zigmont, J., Kappus, L., & Sudikoff, S.N. (2012). An approach to unit-based team training with simulation in a neonatal intensive care unit. <i>Journal of Neonatal-Perinatal Medicine</i>, 5, 213-219. doi: 10.3233/NPM-2012-57111</p> | <p>Team STEPPS is designed with the goal to create a culture of safety in healthcare. Study of blinded observers reviewed video of resuscitations for analysis of teamwork. HiFi group vs. Low Fi group. HiFi group showed more frequent teamwork and better workload management than the Low Fi group. Most studies done in simulation centers vs. "in situ". In situ allows for the realistic complexities of actual clinical environment without the hazards of real life and no risk to patients. Future Research: In situ vs. simulation center - which is more effective at improving skills/ level of knowledge? This study used in situ simulation with a multidisciplinary team over 2 months to rapidly improve team work. Found that participants thought team work was pretty good prior to simulation, and slightly improved post simulation. The course was ranked highly by participants and they felt that it met the objectives of team work and leadership and would apply the skills to their daily practice.</p> | <p>Relevance = 2 (Team training, not specific to nursing)</p> <p>Rigor = 3</p> |

| Citation | Summary | Rating Scale |
|--|--|--|
| <p>Halamek, L.P. (2008). The simulated delivery-room environment as the future modality for acquiring and maintaining skills in fetal and neonatal resuscitation. <i>Seminars in Fetal and Neonatal Medicine</i>, 13(6), 448-453. doi:10.1016/j.siny.2008.04.015</p> | <p>Neo Team needs to work well with obstetric team. Must be skilled at interpreting visual, auditory and tactile cues. JCAHO Sentinel event alert: poor communication played a role in 3/4 of the neonatal deaths. Team training and clinical drills recommended. Traditional education (classroom + clinical = many drawbacks). Does not take into account learner's strengths/weaknesses and previous life experiences. Learning by doing rather than observing. Traditional education focuses on the individual not on team learning. Learning is best facilitated with active not passive and integrating cognitive, technical and behavioral. Simulation is the standard in other industries (military, aviation, nuclear power). NeoSim program at Stanford University is very successful. Simulation training in obstetrics demonstrated enhanced content knowledge and improved technical skills. Demonstrated better 5 minute APGAR scores, decrease in HIE. These results lasted 5 years after simulation training. Benefits: scenarios built around learning objectives, scenarios are realistic, challenging and relevant. Ability to demonstrate diverse skills, under pressure in a complex and dynamic environment. Simulation provides key auditory and tactile cues. Goal of simulation: Provide training that mimics conditions encountered in the real environment. Ethical imperative: Is it ethical to maintain skills solely by caring for real patients? Challenges and future research: Identifying and replicating key environmental cues, current Neo simulators are low on realism and high cost, require an appropriate validated matrix if using simulation for evaluation, need a calculation on return of investment of simulation.</p> | <p>Relevance = 2 (not specific to nursing).</p> <p>Rigor = 3</p> |

| Citation | Summary | Rating Scale |
|---|---|---|
| <p>Hensel, D., Kathman, J., Hendricks, R., & Ball, S. (2012). Building partnerships using student role models for neonatal resuscitation simulation. <i>Journal of Continuing Education in Nursing</i>, 43(12), 550-554. doi:10.3928/00220124-20120904-33</p> | <p>A quasi-experimental design: experienced nurses with little simulation education experience were divided into two groups. Both groups participated in the NRP classes and simulation scenarios. Prior to participating in the simulation scenarios, one group watched a DVD of an NRP simulation scenario with experienced NRP instructors. The other group watched a DVD of novice student nurses perform NRP. Both groups were asked to complete a post-encounter satisfaction questionnaire and a debriefing session took place. It was found that the satisfaction and learning was high with both groups, and neither group found it anxiety producing. It was found that having collaboration with student nurses that are familiar with simulation was beneficial for experienced nurses that had little experience with simulation, and it was suggested that more partnerships between academic settings and clinical settings be formed.</p> | <p>Relevance = 2 (not neonatal)</p> <p>Rigor = 2 (no questions for further research)</p> |
| <p>Murphy, A.A., & Halamek, L.P. (2005). Educational perspectives: Simulation-based training in neonatal resuscitation. <i>Neoreviews</i>, 6, e489e492. doi: 10.1542/neo.6-11-e489</p> | <p>Traditional medical education vs. simulation. Adult education theory linked with simulation (independent thinking, self-directed, internally motivated, related to social/professional goals, seeking immediate application of roles, have a wealth of experience and knowledge to draw from). Debriefing is key. Trainees like simulation education (recreates lifelike situations, feel training is beneficial, more time in "active learning", engages intellect more, found simulation more relevant than traditional education, develops technical, behavioral and critical thinking skills, gives increased ability to transfer skills to a real life situations). Benefits of simulation are outlined (increased clinical experiences vs. "education by random opportunity" (pg e489), convenient scheduling, decreased hospital resources: decreased time spent teaching in expensive clinical settings, safer).</p> | <p>Relevance = 2 (nursing not specifically mentioned)</p> <p>Rigor = 2 (no questions for future research)</p> |
| <p>Pilcher, J., Goodall, H., Jensen, C., Huwe, V., Jewell, C., Reynolds, R., & Karlsen, K.A. (2012). Simulation-based learning: It's not just for NRP. <i>Neonatal Network</i>, 31(5), 281-287. doi: 10.1891/0730-0832.31.5.281</p> | <p>5 article compilation of uses on neonatal simulation (outside of NRP). Benefits and barriers explained. Simulation also good for new graduate nurse orientation. Good for practicing emergencies scenarios, communication with families and yearly competency assessment. Debriefing also important. Anecdotal article of accounts of ways simulation is being used in neonatal education.</p> | <p>Relevance = 3</p> <p>Rigor = 2 (no questions for future research)</p> |

| Citation | Summary | Rating Scale |
|---|--|---|
| <p>Smith, J.R., & Cole, F.S. (2009). Patient Safety: Effective interdisciplinary teamwork through simulation and debriefing in the neonatal ICU. <i>Critical Care Nurse Clinics of North America</i>, 21, 163-179. doi: 10.1016/j.ccell.2009.01.006</p> | <p>Communication and teamwork. IOM recommends simulation to enhance teamwork and improve patient safety. Simulation to help increase communication and teamwork, leadership and competency. Debriefing is essential. Benefits and barriers addressed. Suggested using simulation to teach medical futility/end-of-life discussions and care. Suggested further research: evaluate effectiveness of simulation on interdisciplinary teamwork and on improved patient care. Synthesized the IOM recommendations.</p> | <p>Relevance = 2 (not nursing specifically, but interdisciplinary team)</p> <p>Rigor = 2 (No synthesis into value-added)</p> |
| <p>Reynolds, R.D., Pilcher, J., Ring, A., Johnson, R. & McKinley, P. (2009). The golden hour: Care of the LBW infant during the first hour of life. One unit's experience. <i>Neonatal Network</i>, 28(4), 211-219.</p> | <p>One neonatal intensive care unit's implementation of a "Golden Hour" evidence-based care process for low birth with infants. Simulation education is used for the training provided to the NICU staff.</p> | <p>Relevance = 2 (Simulation is used for education in this article, but the focus is not simulation education)</p> <p>Rigor = 3</p> |
| <p>Sharma, A. (2013). From evidence to implementation: Introducing neonatal simulation to a tertiary neonatal centre in the UK. <i>Open Journal of Pediatrics</i>, 3, 10-16. doi:10.4236/ojped.2013.31002</p> | <p>Simulation compliments existing education. Its purpose is to achieve higher standards. Simulation allows for multidisciplinary teams to train together, develop teamwork, communication, safe environment where rare and complex scenarios can be practiced. Traditionally education and training of professionals are done separately. Simulation allows team training, similar to working in a clinical environment. HFS compliments existing education models. Simulation provides active participation, not simply observation. Benefits explored. Simulator validity and effective feedback are important tenets of simulation. Debriefing is critical to learning. Must include educators from all disciplines, and adapt the curriculum to meet the competencies of all participants. Use neonatal simulation as a compliment and adjunct to other methods of training. Focus on multidisciplinary team training, communication and discussing medical errors.</p> | <p>Relevance = 3</p> <p>Rigor = 2 (minimal questions for further research, weak on analyzing other literature into value added)</p> |

| Citation | Summary | Rating Scale |
|--|---|---|
| Wolfson, W. (2009). Saving SimBaby: Can simulation training improve patient safety by leveling the nurse-physician hierarchy? <i>American Journal of Nursing</i> , 109(11), 24-25. | A general overview of neonatal simulation is given, and a focus on team communication and the use of simulation to help in leveling the physician/nurse hierarchy is discussed. | Relevance = 2 (not nursing specifically) Rigor = 2 (no synthesizing of other literature for value added) |

Appendix D

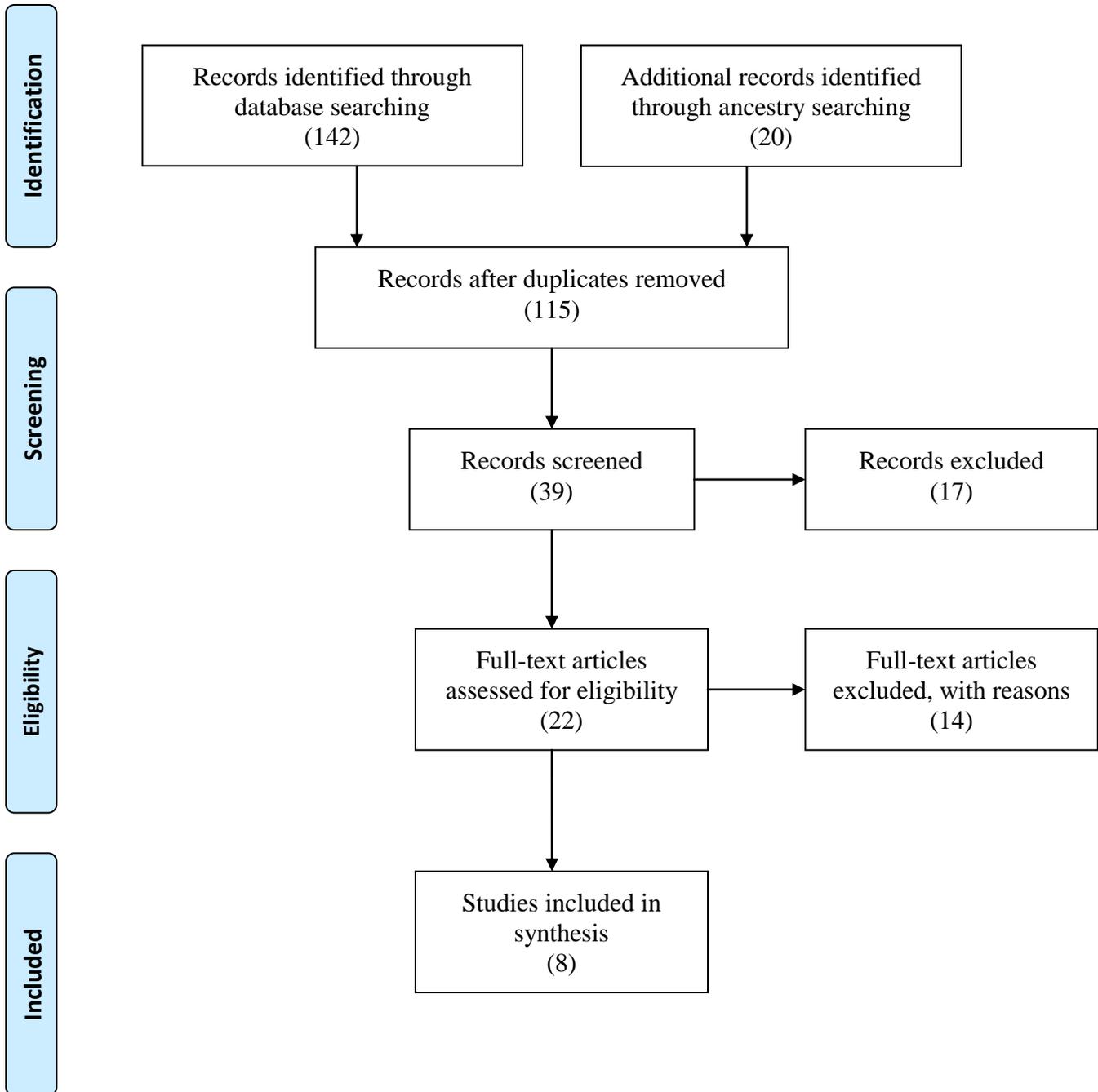
Full Text Articles Excluded

| Citation | Purpose | Exclusion Criteria |
|---|--|--|
| Bender, J., Shields, R., & Kennally, K. (2011). Transportable enhanced simulation technologies for pre-implementation limited operations testing: Neonatal intensive care unit. <i>Simulation in Healthcare</i> , 6(4), 204-212. doi:10.1097/SIH.0b013e3182183c0b | To test a new NICU physical space, discover and resolve process gaps, help in staff orientation and comfort with the new space. | Relevance = 1 (did not include education of neonatal nurses) |
| Cates, L.A. (2011). Simulation training: A multidisciplinary approach. <i>Advances in Neonatal Care</i> , 11(2), 95-100. doi: 10.1097/ANC.0b013e318210d16b | Discusses the importance of high-fidelity simulation as a training tool to develop and maintain competency with neonatal resuscitation techniques. | Relevance = 2 (not specific to nursing) Rigor = 2 (no questions for future research) |
| Cates, L.A., & Armentrout, D. (2013). Simulation with synergy and community energy. <i>Advances in Neonatal Care</i> , 13(2), 97-102. doi:10.1097/ANC.0b013e318285fb82 | Discussion of simulation education in a Neonatal Nurse Practitioner training program at the University of Texas Medical Branch-Galveston | Relevance = 2 (narrow focus on neonatal nurse practitioner training) Rigor = 1 (no analysis of literature, no questions for further research) |
| Colacchio, K., Johnston, L., Zigmont, J., Kappus, L., & Sudikoff, S.N. (2012). An approach to unit-based team training with simulation in a neonatal intensive care unit. <i>Journal of Neonatal-Perinatal Medicine</i> , 5, 213-219. doi: 10.3233/NPM-2012-57111 | Employee training on the fundamentals of effective teamwork, in the Yale Neonatal Intensive Care Unit. | Relevance = 2 (not specific to nursing education, team training) |
| Halamek, L.P. (2008). The simulated delivery-room environment as the future modality for acquiring and maintaining skills in fetal and neonatal resuscitation. <i>Seminars in Fetal and Neonatal Medicine</i> , 13(6), 448-453. doi:10.1016/j.siny.2008.04.015 | Simulation training for acquiring and maintaining skills and techniques in neonatal resuscitation | Relevance = 2 (not specific to nursing education) |

| Citation | Purpose | Exclusion Criteria |
|---|--|--|
| Hensel, D., Kathman, J., Hendricks, R., & Ball, S. (2012). Building partnerships using student role models for neonatal resuscitation simulation. <i>Journal of Continuing Education in Nursing</i> , 43(12), 550-554. doi:10.3928/00220124-20120904-33 | Explored how nursing students that were familiar with simulation from their training, could help the learning of experienced nurses that were less familiar with simulation. | Relevance = 2 (not neonatal nursing education, student and experienced nurse partnership) Rigor = 2 (no questions for further research) |
| Kassab, M., & Kenner, C. (2011). Simulation and neonatal nursing education. <i>Newborn & Infant Nursing Reviews</i> , 11(1), 8-9. doi: 10.1053/j.nainr.2010.12.006 | Brief overview of simulation education | Rigor 1 = (no synthesis of knowledge into value-added, no questions for further research) |
| Murphy, A.A., & Halamek, L.P. (2005). Educational perspectives: Simulation-based training in neonatal resuscitation. <i>Neoreviews</i> , 6, e489e492. doi: 10.1542/neo.6-11-e489 | Simulation training is compared to traditional medical education for neonatal resuscitation | Relevance = 2 (medical education, not nursing education) Rigor = 2 (no questions for further research) |
| Pilcher, J., Goodall, H., Jensen, C., Huwe, V., Jewell, C., Reynolds, R., & Karlsen, K.A. (2012). Simulation-based learning: It's not just for NRP. <i>Neonatal Network</i> , 31(5), 281-287. doi: 10.1891/0730-0832.31.5.281 | General overview of simulation and historical background and 5 mini-articles describing how simulation has been used to promote learning | Rigor = 2 (no questions for further research) |
| Reynolds, R.D., Pilcher, J., Ring, A., Johnson, R. & McKinley, P. (2009). The golden hour: Care of the LBW infant during the first hour of life. One unit's experience. <i>Neonatal Network</i> , 28(4), 211-219. | One unit's experience with video-taped simulation and debriefing to promote a reduction in complications associated with low birth weight infants in the first hour of life. | Relevance 2 = (not specifically using simulation as an educational modality.) |
| Sharma, A. (2013). From evidence to implementation: Introducing neonatal simulation to a tertiary neonatal centre in the UK. <i>Open Journal of Pediatrics</i> , 3, 10-16. doi:10.4236/ojped.2013.31002 | Introduction of simulation training in a neonatal unit in Southampton, U.K. | Rigor = 2 (no questions for further research and synthesizing knowledge into value added was weak) |

| Citation | Purpose | Exclusion Criteria |
|---|---|--|
| Smith, J.R., & Cole, F.S. (2009). Patient Safety: Effective interdisciplinary teamwork through simulation and debriefing in the neonatal ICU. <i>Critical Care Nurse Clinics of North America</i> , 21, 163-179. doi: 10.1016/j.ccell.2009.01.006 | Review of error reduction with effective team work and debriefing used in high-fidelity simulation | Relevance = 2 (not neonatal nursing education) Rigor = 2 (no questions for further research) |
| Stayt, L.C. (2012). Clinical simulation: A <i>sine qua non</i> of nurse education or a white elephant? <i>Nurse Education Today</i> , 32, e23-e27. doi:10.1016/j.nedt.2011.06.003 | Examines the learning theory that underpins clinical simulation using Carper's patterns of knowing | Relevance = 1 (not nursing specifically, not neonatal focused) |
| Wolfson, W. (2009). Saving SimBaby: Can simulation training improve patient safety by leveling the nurse-physician hierarchy? <i>American Journal of Nursing</i> , 109(11), 24-25. | Case report of Seattle Children's Hospital using SimBaby technology to train staff in the pediatric advanced life support (PALS) algorithms | Relevance = 2 (not nursing specifically) Rigor = 2 (no synthesis of knowledge into value-added) |

Appendix E



Appendix F

Highlights and Observations of Eight Full Text Articles Forming the Basis of This Integrative Literature Review

| Citation | Highlights | Observations |
|--|---|--|
| <p>Cates, L.A., & Wilson, D. (2011). Acquisition and maintenance of competencies through simulation for neonatal nurse practitioners. <i>Advances in Neonatal Care</i>, 11(5), 321-327. doi:10.1097/ANC.ob013e31822a34a0</p> | <ul style="list-style-type: none"> °Opinion article °Based on successful use of high-fidelity simulation by health care professionals (e.g. Institute of Medicine, Medical Counsel of Canada etc). °Institute of Medicine report outlines the importance of simulation in the future of nursing education °High-fidelity simulation is effective in achieving and maintaining skill mastery °Useful in competency evaluation: tests ability to perform; levels the playing field (same conditions for all test-takers) °Can demonstrate evolution of skills mastery °Debriefing is crucial | <ul style="list-style-type: none"> °Quotes studies of effective HFS education from other disciplines °Opinion based on the fact that high-fidelity simulation is used as a means of credentialing in other health care professions °Not proven that patient care is affected °Areas for future research are identified |

| Citation | Highlights | Observations |
|---|--|---|
| <p>Fawke, J., & Cusack, J. (2011). Neonatal simulation – training a workforce for the future. <i>Infant</i>, 7(1), 9-11</p> | <ul style="list-style-type: none"> °Case report. Clinical description of Leicester simulation training program. °Degree of fidelity not as important as choosing appropriate type of simulation for type of training °High-fidelity simulation allows for repetition (practice is a key aspect) °Can be carried out at point of care: cost savings °Importance of debriefing using skilled facilitator °Accelerates movement from novice to expert (due to practice) – some data provided °Fits with Kolb’s model of adult learning °No proof of improved patient outcomes | <ul style="list-style-type: none"> °Opinion piece, based on their experience. They observed specific communication, good leadership, role clarity °Some quantitative data regarding effectiveness of high-fidelity simulation °Cost saving ideas |
| <p>LeFlore, J.L. & Anderson, M. (2008). Effectiveness of 2 methods to teach and evaluate new content to neonatal transport personnel using high-fidelity simulation. <i>Journal of Perinatal and Neonatal Nursing</i>, 22(4), 319-328</p> | <ul style="list-style-type: none"> °Comparison of “self-paced modular learning” (no instructor) with “expert-modeled learning” both using HFS °Both found to be effective °Instructor-modeled found not as effective at changing behavior and decreased team communication | <ul style="list-style-type: none"> °Only article with statistical analysis completed and where objective conclusions could be drawn °Additional research proposed |

| Citation | Highlights | Observations |
|---|---|--|
| <p>Lemoine, J.B., & Daigle, S.C. (2010). Neonatal resuscitation simulation: Improving safety while enhancing confidence and competence. <i>Nursing for Women's Health</i>, 14(2), 143-145. doi:10.1111/j.1751-486X.2010.01528.x</p> | <ul style="list-style-type: none"> °Case report of high-fidelity simulation to prepare novice nurses (1-week, 40-hour course) °Instructors observed increased behavior and communications that promoted safety °Allowed the participant the opportunity for repeated practice. °Patient outcomes benefited °Increased knowledge and confidence | <ul style="list-style-type: none"> °Observational results particularly related to patient outcomes °Results were participant-reported or observational by instructors. No quantitative data. |
| <p>Lindamood, K.E., & Weinstock, P. (2011). Application of high-fidelity simulation training to the neonatal resuscitation and pediatric advanced life support programs. <i>Newborn & Infant Nursing Reviews</i>, 11(1), 24-27. doi:10.1053/j.nainr.2010.12.010</p> | <ul style="list-style-type: none"> °Overview of HFS education and its application to the NRP and Pediatric Advanced Life Support (PALS) program. °Review of other publications showing acquisition of skills. °Table of 10 studies summarized. Results include: <ul style="list-style-type: none"> • acquisition of non-technical skills (leadership, communication, team efficacy) • some improvement in skill performance (time to completion of identified tasks) °High-risk, low margin of error with neonates °Need for measures to combat degrading of skills and knowledge over time °High-fidelity simulation aligns well with adult learning principles | <ul style="list-style-type: none"> °Recognition that skills and knowledge must be maintained °Potential for high-fidelity simulation, given its compatibility with adult learning principles |

| Citation | Highlights | Observations |
|---|---|---|
| <p>Raines, D.A. (2010). Neonatal care at the moment of birth: Using simulation to prepare the nurse. <i>Advances in Neonatal Care</i>, 10(4), 176-181. doi:10.1097/ANC.0b013e3181e94160</p> | <ul style="list-style-type: none"> °Summary article, describing other studies °High-fidelity simulation allows technical skills to be integrated with knowledge and professional judgment °Learners' educational needs can be met, even if appropriate patient does not exist °Allows student to learn from mistakes without risk to patient | <ul style="list-style-type: none"> °Reports studies that are mostly participant reports, no actual measures of behaviors or measures on patient outcomes. °Unique advantages of high-fidelity simulation delineated |
| <p>Yaeger, K.A., & Arafah, J.M.R. (2008). Making the move from traditional neonatal education to simulation-based training. <i>Journal of Perinatal & Neonatal Nursing</i>, 22(2), 154-158.</p> | <ul style="list-style-type: none"> °Descriptive article: how High-fidelity simulation can be incorporated into the NRP program and what pedagogical approaches it uses. °Traditional methods of teaching the NRP compared to high-fidelity simulation pedagogy for teaching the NRP °Traditional: no opportunity to synthesize or apply knowledge; cannot practice communication, leadership, delegation; no opportunity to reflect on new knowledge | <ul style="list-style-type: none"> °Applies well to constructivism °Studies done in other healthcare disciplines cited to demonstrate HFS education improves patient outcomes |

| Citation | Highlights | Observations |
|--|---|---|
| <p>Yaeger, K.A., Halamek, L.P., Coyle, M., Murphy, A., Anderson, J., Boyle, K., ... Smith, B. (2004). High-fidelity simulation-based training in neonatal nursing. <i>Advances in Neonatal Care</i>, 4(6), 326-331. doi:10.1016/j.adnc.2004.09.009</p> | <ul style="list-style-type: none"> ◦ Describes primary research which relied on participants' subjective evaluations of the training ◦ The reported research noted that the participants spent more time in active learning than occurs with traditional modalities ◦ HFS compared to traditional education methodologies ◦ Traditional: uses lowest level of Bloom's 6-level taxonomy ◦ High-fidelity simulation: higher on taxonomy scale - hands-on, active learning, immediate feedback. HFS well aligned with the tenets of adult learning theory ◦ High-fidelity simulation self-reported as improving skills | <ul style="list-style-type: none"> ◦ Data based on self-reporting with not mean of objective measure ◦ Assumptions regarding traditional not always validated (preparation of preceptors, their ability to teach) ◦ Recommendations for future research and practice |