

**BUILDING CAPABILITY: IMPACT OF LOW AND HIGH-FIDELITY
MANIKINS ON NEONATAL RESUSCITATION SIMULATION**

LINDA GUST

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Dedication Page

To my loving husband, Ralph, for supporting me throughout this journey.

To my children Nicholas, Michael, and Jessica, I love each of you.

Abstract

Purpose: Does manikin fidelity affect learning outcomes in neonatal resuscitation simulation? **Description:** This experimental design accessed and randomly assigned health care professionals (HCP) (N=60), who completed Neonatal Resuscitation Program (NRP) recertification in a simulation lab. The experimental group used a high-fidelity manikin. The control group recertified using a low-fidelity manikin. Dependant variables included learning outcomes of confidence, skill performance, and knowledge. These were measured using the newly developed Neonatal Resuscitation Confidence Tool (NRCT), Megacode Assessment, and NRP written exam. Both groups underwent the same simulated resuscitation scenario. **Outcome:** A significant increase in confidence with simulation was found ($p<.001$). HCPs using the high-fidelity simulator did not have a significant increased level of confidence, knowledge or skill performance compared to using the low-fidelity simulator. However, there was a significant increase in confidence with repeated NRP courses ($p=.003$). **Implications:** The use of simulation for NRP is important to increase capability with increased practice intervals.

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Chapter 1

Purpose of Study

Simulation-based education is a new trend in medical and nursing schools (CASN, 2007; Issenberg, McGaghie, Petrusa, & Scalese, 2005; Jeffries, 2005) and more recently in hospitals to train staff nurses (Gaba, 2004; Rau, 2004; Yaeger et al., 2004; Zenkonis & Gantt, 2007). Most of the hospital applications are in adult critical care areas (Zenkonis & Gantt, 2007).

Simulation is a relatively new technology which is not well defined. Simulation can mean the manikin, the method, and/or the environment. In the past, simulation consisted of static manikins with low realism (fidelity) to teach skills such as cardio-pulmonary resuscitation (CPR) (Seropian, Brown, Gavilanes, & Driggers, 2004). Newer manikin developments have focused on increasing their fidelity by adding tiny speakers in the body and computerizing some body functions. High-fidelity manikins are lifelike with moving eyelids, breathing movements, heart rate, and other human characteristics. The computer operated manikin has the ability to upload preprogrammed scenarios which control body functions that react according to the interventions applied to the manikin (Seropian, et al., 2004). Initially all high-fidelity manikins were modeled as adults but recently, companies have expanded to make high-fidelity child and infant manikins.

Purchases of expensive high-fidelity manikins in medical and nursing schools have spurred the development of high-fidelity environments including sophisticated simulation laboratories that replicate hospital units. As well, educators and manikin companies have developed high-fidelity scenarios; complex computer-based simulation

of patient conditions with relevant vital signs and cues for instructors (Lynch, 2004; Seropian, et al., 2004; Yaeger, et al., 2004).

Nurse educators have often questioned the best use of this new technology (Jeffries, 2007; Nehring & Lashley, 2004). Many studies suggest high-fidelity simulations consisting of high-fidelity manikins, environments, and scenarios provide a safe place to practice scenarios for health practitioners who have not encountered live patients (CASN, 2007; Jeffries, 2007; Nehring & Lashley, 2004). Simulation provides the opportunity to practice and reflect on that practice while encountering the possibility of mistakes (Nehring, Ellis, & Lashley, 2001; Wilson, Sheperd, Kelly, & Pitzner, 2004). Other benefits of simulation include; non-threatening, standardized, goal-orientated, and realistic clinical experience (Medley & Horne, 2005; Steadman et al., 2006). Studies also suggest high-fidelity simulation can assist students and staff to be better prepared nurses with the ability to quickly transition to real live complex care environments (CASN, 2007).

Simulation-based teaching addresses learning outcomes such as knowledge, confidence, skill performance, critical thinking, and satisfaction (Jeffries, 2005). The latest studies are focused on determining whether these learning outcomes are achieved using high-fidelity simulation (Beyea, von Reyn, & Slattery, 2007; Hyland & Hawkins, 2009; Nehring & Lashley, 2004; Wilson, et al., 2004). Further research is necessary to determine if the expected learning outcomes are achieved with high-fidelity simulation compared to other methods, and which aspects of simulation are necessary for particular learning outcomes.

Building capability is an outcome-based approach which includes knowledge, skill performance, and confidence (Fraser & Greenhalgh, 2001; McNeil, Hughes, Toohey, & Downton, 2006; Walsh, Gordon, Marshall, Wilson, & Hunt, 2005). Currently the goal of this approach is to educate nursing staff in the hospital and ensure competence in their practice. High-fidelity simulation is being explored as a method to further bridge the gap from practice to reality by building knowledge, skill performance, and confidence thereby fostering capability.

The Neonatal Resuscitation Program (NRP)¹ educates nurses to safely resuscitate newborns. Currently, NRP uses a teaching method that employs low-fidelity manikins with low-fidelity simulation scenarios. In the past, the Neonatal Resuscitation Program (NRP) guidelines exclusively emphasized knowledge and skill performance. In the most recent guideline, NRP increased the practice and skill performance testing to include real equipment and to occur in real time. High-fidelity manikins have been used for NRP testing in some centers (Halamek et al., 2000). Increasing the fidelity of simulation training for NRP is being explored as a method to bridge the gap from practice to reality in complex delivery environments (Halamek, 2008).

Justification for Study

High-fidelity simulation has been found educationally effective for the medical and nursing fields (CASN, 2007; Issenberg, et al., 2005; Vozenilek, Huff, Reznick, & Gordon, 2004). Issenberg et al. (2005) completed a systematic review focusing on 109 empirical studies that used simulation as an educational assessment with comparative

¹ NRP - is an evidenced based Neonatal Resuscitation Program developed and implemented by Canadian Paediatric Society.

research as an education intervention. They found a widespread use of simulation in medical education that lead to effective learning. However, these studies did not compare high-fidelity simulation to low-fidelity, the current practice several as a control. Is high-fidelity simulation more effective than low-fidelity simulation?

Nurse educators have studied the uses of high-fidelity simulation with nursing students (Baillie & Curzio, 2008; Reilly & Spratt, 2006; Wilson, et al., 2004). Offering high-fidelity simulation experiences for nursing students is a new trend used to practice the management of critical incidents without harming real patients (Meek, 2008; Nehring & Lashley, 2004). Less common critical incidents that are rare and life threatening have received the most benefit from simulation, for example, anaphylaxis reactions. Nursing educators are using high-fidelity simulation to practice new skills as well as an orientation tool to new practice areas (Beyea, et al., 2007; Rauen, 2004; Reilly & Spratt, 2006). In contrast, little research has been conducted on use of simulation for experienced nurses.

Jeffries (2005) developed a framework for simulation design. Design characteristics and simulation intervention impacts learning outcomes. Manikin fidelity and complexity of the simulation are two of these characteristics. Some studies have explored the use of low-fidelity manikins and resultant learning outcomes (Cioffi, Purcal, & Arundell, 2005; Goldenberg, Andrusyszyn, & Iwasiw, 2005; Mole & McLafferty, 2004; Shearer & Davidhizar, 2003; Steadman, et al., 2006). Other studies have examined high-fidelity manikins and learning outcomes (Childs & Sepples, 2006; Feingold, Calaluce, & Kallen, 2004; Lasater, 2007; Nehring & Lashley, 2004; Reilly & Spratt, 2006; Wilson, et al., 2004). Research, however, is required to compare low and high-fidelity manikins with the complexity of the simulation and the learning outcomes.

High-fidelity simulation research has explored many different student learning outcomes (Baillie & Curzio, 2008; Beyea, et al., 2007; Hyland & Hawkins, 2009). Jeffries' (2005) simulation framework identifies five learning outcomes associated with simulation; knowledge, confidence, skill performance, critical thinking, and satisfaction. In terms of nursing students' skill performance, confidence and satisfaction have been found to be significant learning outcomes for adult high-fidelity simulation. Critical thinking is also an effective learning outcome from simulation (Nehring & Lashley, 2004; Zenkonis & Gantt, 2007). The learning outcomes of skill performance, knowledge, and confidence, have not been measured for the specific population of NRP using simulation. CASN (CASN, 2007) reported future simulation research should "establish a focus on highly specific outcomes measures, with specific target populations" (p.75). The CASN report also recommends studying learning theory used in simulation. Simulation is based on the philosophical underpinnings of constructivism. Simulation learners construct their own realities based on previous knowledge and experiences. Simulation-based learning brings the learner to a new truth (Lasater, 2007) and this truth is a new capability.

A capability learning method is especially important for experienced nurses who must constantly adapt to a changing environment. Building capability goes beyond developing competence. Capable nurses adapt to ongoing change, continue to develop new knowledge and experience, and advance their performance (Fraser & Greenhalgh, 2001; Stephenson, 1998). Capability is demonstrated with knowledge, skill performance, and confidence in communication, teamwork, and leadership. Research is needed to demonstrate if simulation-based learning builds capability.

Simulation and Neonatal Nursing

Low-fidelity simulations have been used for some time in neonatal nursing. Critical care courses such as the Neonatal Resuscitation Programs (NRP) and Pediatric Advanced Life Support (PALS) have used low-fidelity manikins for the past 20 years. Recently, high-fidelity simulations have been used for NRP and PALS courses in some centers. Yaeger, et al., (2004) found that participants prefer high-fidelity in their training compared to traditional education using low-fidelity manikins in classroom settings. The realism of high-fidelity can create elevated stress levels as experienced in a live environment.

There is general agreement in the literature that the use of simulation-based training is more beneficial than traditional methods to prepare health care workers for dynamic and complex environments (Anderson, Aylor, & Leonard, 2008; Halamek, 2008). Unfortunately, NRP-prepared nurses do not always feel capable of performing neonatal resuscitation in live situations (Halamek, 2008). NRP is looking for ways to better prepare health care workers for dynamic and complex environments reflective of neonatal resuscitation. Simulation-based training is a non-linear learning method that builds capability by providing confidence in the areas of skill performance, knowledge, and communication skills (Fraser & Greenhalgh, 2001). This study was integral to testing the fidelity simulation environment, as well as the scenarios that built capability for NRP trained nurses.

An important question concerns what simulation design should be included for specific learning outcomes. There is no indication in the literature that a *high-fidelity manikin* is necessary to contribute to a successful *high-fidelity simulation*. With the

increased use of high-fidelity manikins, numerous well designed simulation laboratories have been established. These laboratories have developed dynamic simulations including clear objectives, complex environments that mimic a delivery room, with appropriate visual and auditory cues and skilled debriefing. Halamek (2008) asks “is it the methodology (immersion into realistic scenarios followed by facilitated debriefings), not the technology (i.e. high versus low-fidelity manikins), that is most critical in simulation-based training?” (p. 452). Could you have the same learning outcomes and skill acquisitions if you used the same well designed simulation with a low-fidelity manikin?

The current NRP training “focuses on technical skill and cognitive knowledge training” (Anderson, et al., 2008, p. 597) but this does not transfer seamlessly to the real environment. To fill the knowledge and skill transfer gap, hospital administrators often buddy novice practitioners with experienced staff to help them gain confidence with resuscitations. The NRP has attempted to teach important behaviors, such as communication and teamwork, as listed in the NRP instructor manual (American Academy of Pediatrics and American Heart Association, 2006a). However, the static domain of the classroom in the current traditional training method, which makes use of a manikin and basic setup, has limitations incorporating such behaviors as communication and teamwork, since a team and family members are not present (Halamek, 2007). In order to transform learners into resuscitation experts faster, NRP requires a dynamic, complex, and technical domain like simulation-based training (Anderson, et al., 2008; Halamek, et al., 2000). The simulation model required needs to include complex realistic environments with appropriate cues of stressful conditions. The roles of both healthcare professionals and patient-family members must be acted out in such a way as to achieve

suspension of disbelief by the subject (Halamek, et al., 2000). During training, the subject needs to feel the stress of the consequences of her/his actions. A debriefing inquiry immediately following the simulation session would use constructive explanation to further enhance capability.

The learning outcomes measured in this study included skill performance, knowledge, and confidence. Skill performance and knowledge are learning outcomes measured in all NRP courses(American Academy of Pediatrics and American Heart Association, 2006a). NRP (2006a) and Halamek (2008) recognize there is a need to use simulation to teach additional behavioral skills that include communication, leadership, and teamwork. Confidence associated with behavioral skills as well as skill performance, and knowledge was measured in this study to assess the level of capability to perform neonatal resuscitation.

This study made use of a control and experimental group in which the simulation design remained constant, but where the level of manikin fidelity (low versus high) was manipulated. The learning outcomes of skill performance, knowledge, and confidence determined capability.

Purpose Statement

The research question that guided this study was, “Does manikin fidelity affect learning outcomes in neonatal resuscitation simulation?”

The purpose of this experiment was to compare the resultant learning using low and high-fidelity manikins in a sophisticated simulated neonatal resuscitation environment and scenario. The independent variable was the fidelity of the manikin. The dependent variables included the learning outcomes: skill performance as measured by

Neonatal Resuscitation Program (NRP) Megacode; knowledge as measured by NRP Evaluation; and confidence as measured by Neonatal Resuscitation Confidence Tool (NRCT). A secondary purpose of this study was to develop and test the NRCT instrument to measure the confidence of health care professionals performing neonatal resuscitation.

Theoretical Framework

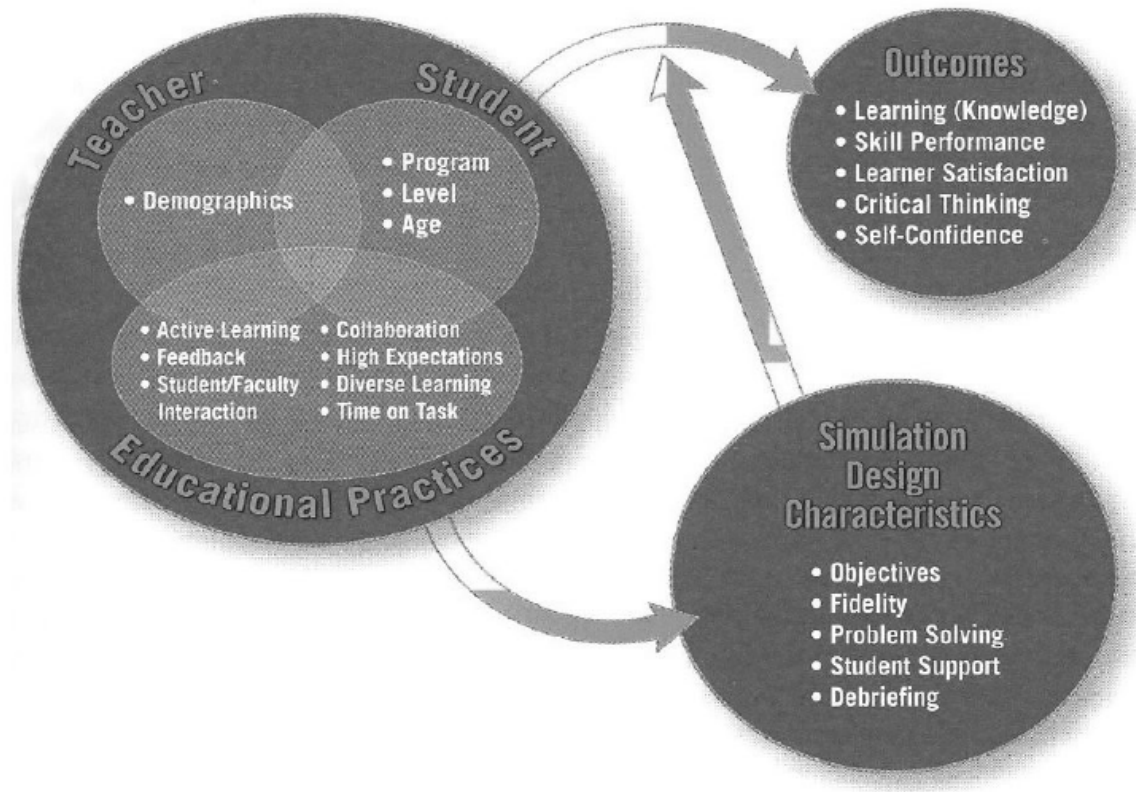


Figure 1. Simulation Model (Jeffries, 2005). A framework to assist simulation design and to understand the relationships between the components involved in simulation.

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The theoretical framework used for the study was the Simulation Model. “Successful learning from the use of simulations requires proper simulation design and the appropriate organization of the student in the simulation” (Jeffries, 2005, p. 97).

Jeffries developed a framework, Simulation Model, to design, implement, and evaluate simulation. The model suggests that learning outcomes are dependent on the characteristics of a teacher, student, and educational practices. Use of simulation influences the following learning outcomes; knowledge, skill performance, learner satisfaction, critical thinking, and self-confidence. Following Jefferies Simulation Model and in this study, the teacher was the NRP instructor and simulation coordinator. The student subjects were health care workers re-certifying in neonatal resuscitation. The educational practice was neonatal resuscitation. The study examined the impact of simulation on the outcomes of skill performance, knowledge, and confidence dimensions of capability. This study did not test critical thinking or learner satisfaction as suggested in the Simulation Model, as a survey to test repeated measures on these outcomes was not found and Fraser and Greenhalgh (2001) did not include these outcomes as traits to build capability.

Definition of Terms

The following is a list of terms and their meanings used in this study.

1. *Simulation*. “A technique, not a technology” (Gaba, 2004, p. i2), used to mimic clinical reality in a sequential decision-making event or a situation in which subjects fulfill assigned roles to manage discipline-specific tasks according to the guidelines provided by the instructor (Hertel & Millis, 2002; Seropian, et al., 2004).
2. *Fidelity*. The level of realism or authenticity of the simulation (Jeffries, 2007).
3. *High-fidelity manikin*. Uses a very high degree of realism in the creation of life-like models of the body with computer programming (CASN, 2007). Outward

appearance and response is realistic to subject interventions (Seropian, et al., 2004).

4. *Low-fidelity manikin*. Static life-size human models with no animations like heart sounds (Hyland & Hawkins, 2009).
5. *High-fidelity simulation*. Uses a very high degree of realism in simulation design.
6. *Confidence*. Belief in one's own abilities (Sinclair, 1994). (Measured in this study using the Neonatal Resuscitation Confidence Tool (NRCT).)
7. *Capability*. "Extent to which individuals can adapt to change, generates new knowledge, and continues to improve their performance" (Stephenson, 1998, p. 799). Measured in this study by testing confidence in knowledge, skill performance, and behaviors using the Neonatal Resuscitation Confidence Tool (NRCT).
8. *Skill performance*. The ability of subjects to perform clinical skills accurately with hand-eye coordination and in a timely manner (Tuggy, 1998). Measured in this study using the NRP Megacode (American Academy of Pediatrics and American Heart Association, 2006a).
9. *Knowledge*. The facts, feelings, or experiences known by a person (Sinclair, 1994). Measured in this study using the NRP Evaluation (American Academy of Pediatrics and American Heart Association, 2006b).

Hypothesis

In this study the researcher addressed the following hypotheses:

1. Regardless of the fidelity of the manikin, confidence will increase due to the simulation-based training method for health care professionals recertifying in neonatal resuscitation.
2. Confidence will increase more so with the use of high-fidelity manikins compared to low-fidelity manikins for health care professionals recertifying in neonatal resuscitation using a high-fidelity simulation scenario.
3. Confidence will continue to increase following a real clinical resuscitation for those health care workers trained with high-fidelity manikins compared to low-fidelity manikins, recertified in neonate resuscitation using a sophisticated simulation scenario.

Instrument Development

4. The Neonatal Resuscitation Confidence Tool (NRCT) developed and tested in this study will demonstrate acceptable psychometric properties regarding reliability and validity.

Significance of Study

This study evaluated the most effective use of high-fidelity manikins in neonatal resuscitation training and the degree of manikin fidelity necessary to produce the learning outcomes required in neonatal resuscitation. The Canadian Pediatric Society is working with the American Academy of Pediatrics to develop the sixth edition of the Neonatal resuscitation textbook and program. Increasing the use of simulation and debriefing will be incorporated in the new NRP guidelines. In reality, not all health centers will be able to purchase high-fidelity simulators as they are very expensive. Thus, there was a need to establish evidence to base the recommendations of equipment offered in the guidelines.

Also, it was important to determine if the emphasis should be on the simulation environment or the manikin. This study further explored if simulation-based training is required for educating neonatal resuscitation.

Developing capability in neonatal resuscitation requires testing and testing requires measuring. The development of the NRCT provided a tool to measure future neonatal resuscitation simulations and validate future studies.

Summary

There is a need to study the type of manikin fidelity used in neonatal resuscitation simulation; there is also a need to be responsive to the changing work environment. Using traditional static classroom learning methods to teach neonatal resuscitation is no longer adequate. Learners are not prepared to work in dynamic complex environments without additional training. The non-linear learning environment of simulation is an ideal learning method to build capability (Fraser & Greenhalgh, 2001). Currently, certification in NRP requires significant practice on real infants before a health care worker feels confident to work independently. This is usually accomplished with the health care providers working as a second person, alongside an experienced person. Alternatively an inexperienced worker, working independently without confidence, learns on the job. The learning experiences in the real clinical environment are random and may present some risk to patients (Halamek, 2008). Some critical incidents are rare and not practiced on real patients. Learners need to be able to respond appropriately to a crisis with the potential of adverse outcomes. Health care providers working with neonates need to be capable of performing neonatal resuscitation in a complex environment independently.

High-fidelity simulators are very expensive. Many smaller health care facilities that resuscitate neonates want to use technology effectively. Knowing the different learning outcomes achieved with the use of low-fidelity simulators and expensive high-fidelity simulators is important. NRP is in the process of developing the sixth edition, expecting completion by 2010 or 2011. The Alberta Perinatal Health Program has stated the use of simulation and debriefing will be included in the new edition. This study was important to provide evidence to the Canadian Pediatric Society in order to determine the requirements of manikins in simulation for NRP. In addition, the study provided evidence as to the expected learning objectives for each type of manikin used in the program. The development of the Neonatal Resuscitation Confidence Tool is relevant for future studies with respect to (a) measuring confidence (b) repeated measure of confidence and (c) determining simulation design with regards to confidence.

Chapter 2

Literature Review

Application of Simulation in Medicine

Patient simulators play a role for medical students at all levels. Advanced clinical skills associated with clinical situations such as anaphylaxis, cardiopulmonary arrest, and pulmonary embolism can be practiced risk free. A simulated patient's condition will deteriorate if an inappropriate therapy is provided by the learner (Good, 2003). Bradley (2006) describes different types of simulators used in medical education. Computer-based systems; simulated patients, professional actors trained to play the part of patients; and integrated low-fidelity and high-fidelity manikins used as adjuncts in learning.

According to Bradley (2006), the first use of sophisticated simulator manikins began in the late 1960's. The first high-fidelity manikin was able to breathe, blink eyes, respond to medications and much more. However, these manikins were very expensive and without an evident need they were rarely used. In the 1980's, medical schools started looking for different teaching methods because of skill deficiencies in resident physicians (Bradley, 2006). High-fidelity manikins were found very useful for anesthesiology training (Good, 2003; Scavone et al., 2006). Residents were able to monitor the "patient", induce anesthesia, secure an airway, and monitor the anesthesia and oxygen gases as well as muscle paralysis. Advanced manikins also have drug recognition ability (METI Medical Education Technologies Inc, 2005). First year anesthesia residents learned basic anesthesia skills faster and senior anesthesia residents practiced more advanced skills in rare scenarios without harming patients (Good, 2003). Today, there are more than 2500

high-fidelity manikins in health education facilities around the world (METI Medical Education Technologies Inc, 2005).

Kneebone (2005) found too much emphasis was on the technology of the manikin instead of the simulation design. Kneebone proposed a theory to base the use of high-fidelity manikins for procedural skills. Kneebone outlined criteria to develop the simulation environment and scenarios including placement of expert assistants to provide supportive, motivational and a learner-center environment. Learning by doing i.e. with live patients (Vozenilek, et al., 2004, p. 149) is no longer the only acceptable practice in medical education since it leaves much to chance. The use of new technology like high-fidelity manikins enhances training by allowing medical students to practice complex scenarios in a controlled setting.

Steadman et al. (2006) compared learning with a high-fidelity manikin to interactive problem-based learning. They evaluated the skills of medical students using a standardized checklist and found critical assessment and management skills superior for simulation learning with the high-fidelity manikin. Morgan, Cleave-Hogg, Desousa, and Lam-McCulloch (2006) claim that high-fidelity manikins assisted medical students to apply theory to practice in pharmacology and performance. Gordon et al. (2005) used medium fidelity manikins, not as computerized as high-fidelity manikins, and identified an increase in knowledge and clinical skills as well as communication skills using pre and post skills checklists and a multiple-choice test on the medical student's management of acute stroke patients. In both studies a control was not used. Without a comparison group, the evidence is weaker and limits the claim that simulation is the best method to achieve increased knowledge and enhanced skill performance.

In a Best Evidence Medical Education (BEME) systemic review, Issenberg et al. (2005), focused on 109 medical simulation studies. The researchers concluded, “high-fidelity medical simulations are educationally effective and simulation-based education complements medical education in patient care settings” (Issenberg, et al., p. 10). The study did not evaluate a comparison of other educational methods.

Medical residents use many types of technical simulators to develop complicated procedural skills. High-fidelity manikin technology is currently used by medical residents. In the past these skills were learned by chance on live patients. Meek (2008) reported the usefulness of anesthetic high-fidelity manikins depends on the ability to recreate realistic scenarios. Meek described simulators as “not suitable for stand-alone assessment of competence” (p. 356), also stating there is no evidence to show the link between competence on high-fidelity manikins and real patients. Meek suggests more benefit in high-fidelity manikins as a means to practice the management of critical incidents without harming real patients. Less common critical incidents that are rare and life threatening have the most benefit from simulation.

Nowadays medical students are able to learn common and rare clinical skills without placing patients at risk. Although the use of high-fidelity simulation is most well (CASN, 2007) developed in the medical profession, nursing schools are rapidly adopting the use of simulation.

Alternate Forms of Simulation in Nursing

Nursing schools and hospital nurse educators have used manikins for skill development for years (CASN, 2007). In the past, manikins were used as task trainers to

simulate and teach single psychomotor skills e.g. inserting intravenous catheters (CASN, 2007; Lasater, 2007; Seropian, et al., 2004).

Role Playing

More recently, educators are looking toward simulation in all forms to develop nursing skills in the most efficient manner. Many forms of simulation have been effective in developing essential learning outcomes such as confidence. Role playing is a teaching method used for preparing students for clinical practice (Goldenberg, et al., 2005; Shearer & Davidhizar, 2003). Shearer and Davidhizar(2003) emphasized the value of the simulation method of role playing for developing cultural sensitivity with students preparing for clinical practice. Goldenberg et al.(2005) reported role playing used in classroom simulation increased confidence for health teaching.

Videotaping

Videotaping is also a simulation method used in nursing programs. Chan, et al. (2001) studied the use of videotaped vignettes on enhancing critical thinking. Using the California Critical Thinking Skills Test, they did not find an increase in core critical thinking but found videotaping helpful in increasing nursing knowledge. Graling and Rusynko (2004) used videotape playback to evaluate novice operating room nurses. In looking for a technique to increase the competence of preoperative novice nurses, Graling and Rusynko set-up simulated operating rooms with low-fidelity manikins. The videotape playback technique helped to fine tune critical thinking, prioritization, and unique high-tech psychomotor skills used in the operating room.

Simulated Patients

Other nursing and medical schools have explored the use of simulated patients; actors (not manikins) are used to role play patients (Jenkins, Shaivone, Budd, & Griffith, 2006; Mole & McLafferty, 2004). Jenkins et al used teaching associates to simulate patients with genitourinary conditions and found efficacy especially in the improvement of confidence in nurse practitioner students. The aim of the Mole and McLafferty study was to enhance team work, and to consolidate clinical, management and organizational skills. The results were that 83% of the students agreed the exercise helped them think more quickly and prioritize their work as well as the opportunity to practice in a safe environment. Some students did not enjoy role playing. Both studies found orchestrating simulated patient experiences to be time consuming and resources including actors were limited and inconsistent.

Virtual Patients

Computer-based learning is another simulation method studied (Garrett & Callear, 2001; Kiegaldie & White, 2006). Kiegaldie and White found the Virtual Patient, a computer program used to simulate assessment of patients, useful in developing confidence among postgraduate nursing students. Garrett and Callear explored uses of a computer-based intelligent multimedia simulation, finding some benefits in decision making; and disadvantages in the Intelligent Tutoring System. It was time consuming and costly to develop and the knowledge-base of the program developed was too general and limited in scope. Computer-based learning holds promise if developed with specialized detail for a specific domain of knowledge.

Mixed Simulation Methods

Childs and Sepples (2006) tested the use of a combination of learning methods including case studies, CD-Rom, and high-fidelity simulator in nursing cardiac scenarios. Fifty five senior capstone nursing students were tested, with results of increased critical thinking abilities and psychomotor skill development from the combination of methods.

High-fidelity Simulation: Manikins

There are a number of different types of manikin simulators. They can range from low-fidelity to high-fidelity. Low-fidelity simulators are static manikins that are a whole patient or parts of a body e.g. resuscitation Anne manikins are used to learn CPR, and Chester Chest are used to learn central line skills (Seropian, et al., 2004). These simulators are useful in learning technical skills.

High-fidelity manikins have human characteristics like pulse and breathing. They also respond to physical and pharmacological interventions (Seropian, et al., 2004). Some advantages of high-fidelity computer based simulations are that they supply safe, reproducible, predictable, programmable leaning situations that may be used off site (Medley & Horne, 2005; Seropian, et al., 2004). In terms of disadvantages; they are costly (Seropian, et al., 2004) and more technical.

High-fidelity manikins are engineered with computer programs, drivers, and devices that use mathematical equations to change neurological systems on the manikin such as constricting pupils. The instructor is able to start setting up the computer with preloaded patients of different ages with different conditions. Instructors are then able to modify these patients, and build patients of their own (Lynch, 2004).

High-fidelity Simulation: Environment

The simulation starts with the manikin dressed up with wardrobe including items such as a wig and glasses to match the age and gender of the patient in the scenario on the computer program. The room is set up with props, equipment and medical supplies. A template is designed for each scenario with set-up and instructor direction. The scenario development involves embedding errors such as a motor vehicle accident patient with an allergy and who is missing an allergy bracelet, an IV pump set at the wrong rate (Hennemen, Cunningham, Roche, & Curnin, 2007). Incorrect assessments and follow-up result in negative consequences for the patient.

The simulation can be videotaped. Scenarios can be viewed live in a separate room and/or videotaped and viewed during a debriefing. Debriefing is necessary to review the subject's behavior and decision making with constructive evaluation (Hennemen, et al., 2007; Nehring, et al., 2001). Videotaping is an option in debriefing. Successful simulation and debriefing requires a prepared teacher (Jeffries, 2007; Medley & Horne, 2005). The teacher/facilitator guides the student-focused scenario to a pre-determined goal.

Simulation offers the opportunity for students to practice interventions in a safe environment, observe the consequences when wrong decisions are made, practice making good decisions and build confidence and satisfaction in nursing practice. Simulation is a sophisticated technique which so far is a new trend. Research is required to find effective uses of simulation technology for our current practices.

Applications of High-fidelity Manikins and Simulation in Nursing

Nursing Schools

The use of high-fidelity manikins is a new teaching strategy for nursing educators and many educators are still learning how to incorporate their use (Nehring & Lashley, 2004). Looking at the current use of simulations, Nehring and Lashley surveyed 34 nursing schools and six simulator centers use of high-fidelity manikins. “Respondents commented that (high-fidelity manikin) is useful for developing critical thinking skills, applying theory to practice, providing a better transition to clinical experiences, and providing a safe, simulated experience” (Nehring & Lashley, p. 247). Reilly and Spratt (2006) completed a qualitative research project looking at the perceptions of undergraduate students with high-fidelity simulation-based learning. After students used a high-fidelity manikin in a cardiac simulation scenario, the students were interviewed three days and eight weeks following the simulation and five weeks following their clinical placement experience. The perceptions of the students suggested many benefits including increased confidence, critical thinking, and satisfaction. Students also reported simulation enhanced their importance of understanding and provided better retention using a hands-on-approach.

Feingold, Calaluce, and Kallen (2004) studied the use of high-fidelity simulation with advanced acute care scenarios on n=97 undergraduate nursing students. Most of the undergraduates found the scenarios realistic and experienced enhanced decision making and learning. Eighty percent of the learners believed the simulation was an adequate test of the clinical skills. Yet, only 54% found the skills in the simulation scenarios transferable to real clinical settings including competence, confidence, and preparedness.

Nehring, et al. (2001) tested senior nursing students using a high-fidelity manikin with advance medical/surgical simulation scenarios. The convenience sample of 42 nursing students completed a pretest, a posttest after the scenario, and a posttest five to seven days after the scenario. There was a significant difference from the first pretest to the posttest, but not the second posttest indicating retention of learning. The researchers, however, did not indicate the outcomes measured and did not use a control.

A comparison study was performed in the United Kingdom. The researchers compared learning outcomes of 179 nursing students in their last semester of clinical practice (Baillie & Curzio, 2008). For one week of the clinical practice, the students either spent five days in a nursing lab using a low-fidelity manikin or attended clinical practice with real patients. Students at the end of their nursing education clinical placement found benefit in the simulation based training with an increase in confidence, satisfaction, and perceived practice skills. However, there was no significant difference in the learning outcomes in comparison to the student without the simulation training (Baillie & Curzio). This study only compared use of a low-fidelity manikin; the results may have been different with a high-fidelity manikin or a high-fidelity environment.

Cioffi, Purcal, and Arundell (2005) conducted a study with midwifery students, using 36 graduate diploma students comparing an experimental group on the high-fidelity manikin and a control group receiving scheduled lectures. Post tests on the high-fidelity manikin showed significant faster decision making abilities and confidence. This study did not utilize nursing students and did not compare different simulation designs i.e. low-fidelity.

Nursing Practice

Some studies have been conducted to look for the best use of high-fidelity manikins for education within the practice context. High-fidelity simulation can be used to enhance problem-based learning (Wilson, et al., 2004) and useful for orientation (Beyea, et al., 2007; Rauen, 2004; Zenkonis & Gantt, 2007). According to Beyea, von Reyn, and Slattery (2007), high-fidelity manikin simulation can benefit novice nurses regarding competence, confidence, and readiness. Beyea, et al. used qualitative and quantitative methods to measure competency of 42 nurse residents using a visual analog scale, a competency questionnaire, and feedback from clinical and administrative leaders. The nurse residency program used high-fidelity simulation in orientation to nursing jobs in a hospital as transition from novice nurse to competent nursing practice. The study did not have a control but did find the high-fidelity simulation experience increased clinical productivity and decreased orientation needs. Rauen (2004) suggests high-fidelity simulation is useful for orientation in cardiac surgery. Unlike other simulators, high-fidelity can employ the whole nursing process (Rauen). Rauen also discussed the benefit of learning in a safe and controlled environment. Zenkonis and Gantt (2007) agreed high-fidelity simulation is useful for orientation of new staff to a new area. Zenkonis found high-fidelity simulation enhanced necessary psychomotor, critical thinking, and problem solving skills in an emergency room scenario.

The use of simulation in nursing education is transforming nursing laboratories. Hyland and Hawkins (2009) studied nursing laboratories that have purchased high-fidelity manikins and have transformed them into high-fidelity simulation laboratories and found confidence in practice to be one of the primary learning outcomes as well as an

opportunity to practice in a safe environment to be useful. They reported a need for research to identify teaching strategies to apply this new technology into nursing education.

An inventory of simulation use in Canada was conducted in 2007. The (CASN, 2007) surveyed 71 health care professional schools targeting nursing schools, identifying 70% of respondents used simulation in the school with 52% using high-fidelity simulation. The report found simulation was used to improve patient safety and better prepare practitioners; as well simulation was a valuable technique to foster team building.

Summary of Application of Simulation

Educators have explored different methods of simulation. The high-fidelity simulation learning method demonstrated an increase in critical thinking, psychomotor skills, confidence, competence, and satisfaction in most studies (Baillie & Curzio, 2008; Cioffi, et al., 2005; Hyland & Hawkins, 2009). Many studies discussed the need for more work in simulation design and planning. None of the studies compared learning outcomes from simulation with existing approaches or different simulation methods. Most studies used adult high-fidelity manikins and adult critical care scenarios with students. No studies found used high-fidelity manikins to measure the capability of neonatal resuscitation on staff nurses or compared the fidelity of the manikins in simulation-based training.

Learning Theory

Learning theory can explain what happens when learning takes place. Educators are looking to establish the best use of simulators. The link between simulators and learning is important. Miller (1990) created a framework for clinical assessment. She used

a triangle design with knowledge at the base, building up to competence, with performance and action at the top. Miller argued that a student must not only *know how* they know they must *show how* they know. Testing knowledge alone does not necessarily predict performance and action. Wilford and Doyle (2006) applied Miller's framework to high-fidelity simulation. As simulation sophistication increased, learning moved up the triangle with great speed from *knowledge* of a skill to *doing* skill in practice. More realistic learning environments are rewarded with the greatest success. For example, "simulation allows the creation of realistic simulations to allow greater retention of what is learned" (Wilford & Doyle, 2006, p. 928). Learning theory structures how learning takes place within the context of simulation. The next section offers a theoretical base pertaining to design of simulation that maximizes learning capabilities.

Simulation Design Theory

Dutta, Gaba, and Krummel (2006) emphasized the difference between simulator, the manikin; and simulation, the realistic hospital setting with an appropriate scenario. They also strongly believe simulation is an adjunct to learning and should not be used as a replacement to actual and eventual practice on live patients.

As noted in the previous section, Miller emphasized the importance of realistic simulation in terms of learning theory and simulation. Jeffries (2005) goes the next step, providing a framework developed to design, implement and evaluate simulations. This study was based on Jeffries' theoretical framework, Simulation Model (Figure 2). The model has five major components, each with associated variables. The simulation is dependent on the first three components; teacher, student and educational practices. The fourth component is the proposed outcomes. Outcomes are dependent on the best

practices of the teacher and the level of education of student. Intervention is the fifth component which includes the design and setup of the simulation. Successful learning requires a suitable simulation design with appropriate objectives, fidelity, complexity, cues, and debriefing (Jeffries, 2006). Future research is required to identify appropriate design and outcomes for each specific educational practice.

The teacher is crucial to the success of the simulation. The teacher prepares and guides the student to achieve learning, skill performance, and confidence. Student participation and expectations will produce varied outcomes of learning and satisfaction. The characteristic of the simulation including the objectives, cues, and debriefing are dependent on the educational practices of the teacher. These factors are all indicators of the expected outcomes.

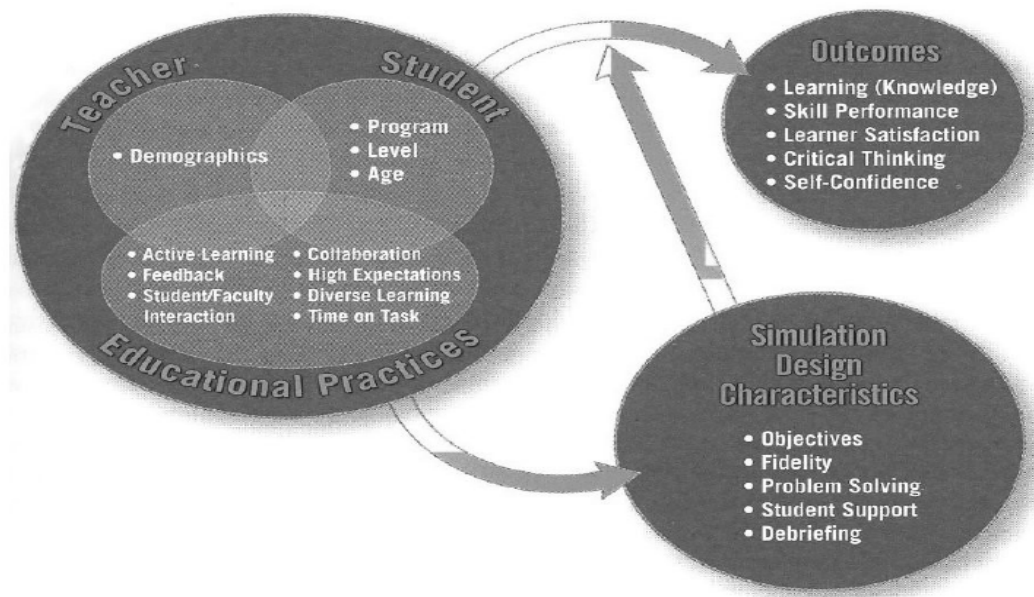


Figure 2. Simulation Model(Jeffries, 2005). A framework to assist simulation design and understand the relationships between the components involved in simulation. Reprinted by permission of the National League for Nursing, Nursing Education Perspectives, see Appendix A.

Building Capability

High-fidelity simulations can be used to improve learning and develop clinical judgment. Lasater (2007) explored first year student experiences using adult high-fidelity manikins and found that simulation integrated learning increased the breadth of experience gained. Simulation can also bridge the gap from theory to practice (Lasater).

Simulation has a philosophical underpinning of constructivism. Practitioners “construct their own individual realities” (Rogers, 2005, p. 154) based on previous knowledge and experience of self or others. Constructivism based learning promotes learning outcomes of a higher-order (Lathrop, Winningham, & VandeVusse, 2007). The higher-order is capability. Simulation supports multiple perspectives and interpretation by the learner. As with constructivism, the instructor acts as a guide with respect to simulation. Simulation is a process for active learners to build new knowledge from past knowledge and experience. Learners must also apply current understandings to simulation to construct new knowledge. Debriefing entails the subject’s own reflective experiences to gain an understanding and make judgment of their own practice.

Fraser and Greenhalgh (2001) examined the need in the United Kingdom for health care workers to adapt to the complexity of patient care. Teaching health care practitioners to be competent was not enough; they were challenged to teach practitioners to be capable. Competence is what individuals “know or are able to do in terms of knowledge, skill, and attitude” (p. 799) in a familiar environment. Capability takes the learning to a higher-level. It looks at the “extent to which individual can adapt to change, generate new knowledge and experience, and continue to improve their performance” (p. 799). Capability is a newer concept within nursing. Capability addresses

interprofessional needs, adapting to change, developing new behaviors and improving performance as needed for the transition from competency to capability (Walsh, et al., 2005). Fraser and Greenhalgh also observe that capability involves the need for process and the use of non-linear methods such as simulation. McNeil, Hughes, Toohey, and Dowton (2006), built a medical curriculum that is a capability-based program with learning outcome as the focus. The development of capability encompasses knowledge and skill as well as the ability to work in an unfamiliar and changing circumstance with confidence, good communication, and teamwork. Ebrall (2007) suggests capability as an essential learning level for chiropractic education. Capability is a deeper learning that includes applying the how and where of the education. Capability enables the use of appropriate behaviors and decision making in changing environments.

Stephenson (1998) considers capability as a higher quality of education,

Capable people have confidence in the ability to take effective and appropriate action, explain what they are about, live and work effectively with others, and continue to learn from their experiences as individuals and in association with others, in a diverse and changing society (p.1).

Stephenson measures capability by the confidence in one's knowledge, skill, self-esteem and values.

Capability is a combination of knowledge, skill, confidence and behaviors such as teambuilding, communication, and leadership (Ebrall, 2007; Fraser & Greenhalgh, 2001; McNeil, et al., 2006; Stephenson, 1998; Walsh, et al., 2005). This study measured the learning outcomes of knowledge, skill, and confidence as a measure of capability.

Neonatal Resuscitation

Two significant uses of simulation are for education purposes and for clinical training. Education emphasizes conceptual knowledge and basic skills; clinical training

emphasis is on the actual tasks of a designated area (Gaba, 2004). Low-fidelity simulations have been the standard for competency courses such as Advanced Cardiac Life Support (ACLS), Pediatric Advanced Life Support (PALS), and Neonatal Resuscitation Program (NRP) (Yaeger, et al., 2004). Recently, high-fidelity simulations have been introduced and used for evaluation in NRP and PALS courses in areas that have developed sophisticated simulation laboratories. Subjects spend more time actively learning and prefer high-fidelity simulations (Yaeger, et al.). Simulation offers novice nurses the ability to practice extensively before practicing on live patients. Simulation scenarios can teach simple or very advanced, complicated, multidiscipline events (Medley & Horne, 2005).

The Neonatal Resuscitation Program (NRP) was first developed in 1987 as a best practice protocol for neonate resuscitation. The program is currently using the fifth edition; a sixth edition is forthcoming. “NRP lays the foundation of skills so the providers can build increasing resuscitation proficiency” (American Academy of Pediatrics and American Heart Association, 2006a, pp. 1-2). The current course consists of reading the evidence-based Neonatal Resuscitation textbook, passing a 94 question knowledge exam, and practicing neonatal resuscitation on a low-fidelity manikin with real equipment in a classroom setting usually with one or two other subjects. The skill performance is evaluated during a Megacode performance. The Megacode consists of a neonatal resuscitation scenario that is read out by the instructor. The subject works in real time and performs the resuscitation on the manikin as if it is a real resuscitation, using real equipment. Once the subject has passed both the knowledge exam and Megacode, she or he is considered to be a Neonatal Resuscitation Program provider for two years. After this

time he/she would take a renewal course. NRP does not guarantee certification or competence once a person has taken the course. Recent studies have explored using high-fidelity manikins for neonatal resuscitation program uses. Halamek (2008) highlights the limitations of traditional training environments as more passive and not realistic, and where clinical environments place patients at risk, and the practice is often random.

High-fidelity simulation can potentially improve the learning outcomes in NRP. Halamek et al. (2000) studied 38 subjects in a high-fidelity simulation-based training in a realistic delivery room setting. The scenarios created stressful conditions comparable to real delivery rooms. Subjects highly rated the scenarios and debriefing and the overall program met their approval. Anderson et al. (2008), portrayed simulation as an education strategy necessary to teach resuscitation teams behavioral skills such as communication, leadership, and teamwork. The debriefing using video review and reflection developed and explored the skills performed. Yaeger, et al. (2004), discuss an example of a simulation-based training developed for NRP. They emphasized the importance of constructive debriefings following the scenarios to enhance learning. Some of the listed benefits to simulation over traditional methods are an increase in confidence and the achievement of competence sooner and without risk to human patients.

Jukkala and Henly (2007) developed two instruments to measure knowledge, experience, and comfort level of NRP providers. They found nurses with more years of experience had more knowledge but not more comfort. Rural and urban nurses had equal levels of knowledge but rural nurses had less experience and had less comfort in neonatal resuscitation.

Simulation provides a learning tool to develop necessary behavioral skills for neonatal resuscitation not provided in traditional methods (Halamek, 2008). “Simulation-based training is an ideal training methodology in that it allows trainees to practice integration of all the skill (cognitive, technical, and behavioral)” (p. 451). Halamek questions whether the methodology of high-fidelity simulation is more important than the high-fidelity manikin technology.

Summary

There has been increased interest in the studies on simulation. Studies have shown simulation-based training is an effective method used in nursing education; especially with the management of critical incidents that are difficult to practice on live patients. Simulation produces positive learning outcomes of knowledge, skill performance, confidence, satisfaction, and critical thinking. Confidence increased in several simulation methods including high-fidelity (Baillie & Curzio, 2008; Beyea, et al., 2007; Cioffi, et al., 2005; Feingold, et al., 2004; Goldenberg, et al., 2005; Hyland & Hawkins, 2009; Jenkins, et al., 2006; Kiegaldie & White, 2006). These studies did not test the confidence in ability but rather surveyed in general terms if confidence improved. Research is lacking in studying the complexity of technology required to achieve each of these learning outcomes and to apply this to neonatal resuscitation. Research is needed to assess the importance of the type of fidelity in the simulation environment. Research is also needed to develop tools to assess the learning outcomes of neonatal resuscitation training.

Chapter 3

Method

A pretest-posttest experiment design was used in this study. Sixty randomly assigned health care professionals (HCP) completed their Neonatal Resuscitation Program (NRP) recertification in a simulation lab. The experimental group engaged their NRP recertification with a high-fidelity manikin. The control group recertified using a low-fidelity manikin. Dependent variables included learning outcomes of confidence, skill performance, and knowledge. These were measured using the newly developed Neonatal Resuscitation Confidence Tool (NRCT), Megacode Assessment, and NRP written exam. Both groups underwent the same simulated resuscitation scenario in a simulated delivery room, including a maternal manikin, a paternal actor, full team of resuscitation staff, followed by debriefing. Data were analyzed using repeated-measures ANOVA.

Ethics

A letter of Research Intent was sent to the Children's Health and Women's Health Program Directors at a regional hospital and approval for access was received (Appendix B). The study underwent ethical review by the Chinook Health Regional Research Committee, University of Lethbridge Human Subjects Research Committee, as well as the Lethbridge College Ethics Board. Subjects agreeing to be involved in the study signed a consent form (Appendix C) assuring the test responses were to remain anonymous. The informed consent (Appendix D) included explanation of the study, contact information, the right to withdraw from the study at any time and without negative consequences, as well as opportunity for the subjects to obtain research findings. Each subject was provided a copy of the informed consent. The anonymity of each subject was protected.

Each subject's name was coded with a number at time of consent to the research. The NRP written exam, Megacode and NRCT only included the coded number of each subject. All identifying information was removed. The forms were all pre-coded and the subject signed consents. The rest of the forms in the envelope only contained the corresponding code number. Only the researcher had access to the consents and listing of names. One of the instructors sent all the exam results to the Canadian Paediatric Society for NRP Renewal. Data including demographics, consent, NRCT, Megacode Assessments, and NRP exams will be stored in a locked filing cabinet (researcher's home office) and will only be accessible to the investigator. The data consent forms, and all materials arising from the study will be appropriately disposed of as confidential waste five years after completion of the study. The subjects were not exposed to any risks. The subjects benefit by completing the NRP Renewal in an advanced learning environment.

Access and Recruitment

The subjects in this study included a convenient sample of registered nurses and registered respiratory technologists from the Neonatal Intensive Care Unit (NICU) and Delivery Suite. All subjects worked in a regional (tertiary) hospital or rural hospital. All subjects spoke English. The opportunity to participate in the study was offered to all health care professionals requiring Neonatal Resuscitation Program Renewal in the region in May and June, 2009. The subjects were recruited by Neonatal Resuscitation Program (NRP) instructors sending out a letter of invitation (Appendix E) via e-mail to all NICU and Delivery Suite nurses, as well as rural nurses and later extended to registered respiratory therapists. A poster (Appendix F) was placed in the NICU, Delivery Suite, and rural hospitals.

Subjects were randomized into two main groups. The size of the groups was determined through the use of a power analysis. The effect size was estimated by looking at previous written tests of the knowledge and skill performance tests (megacode) compared to a projected effect from the study. Using an alpha of 0.5 and a beta of 0.20, as well as the practicality of available subjects, the sample size was determined as 30 subjects in each group. The total number of available staff was approximately $N = 70$. The estimated sample was between 50 and 70 subjects.

Sample

Sixty nurses and registered respiratory therapists participated in the study (See Table 1). One subject did not fill in the demographics and consent and was omitted. There were 50 Registered Nurses (all female), 31 with a nursing diploma and 18 with a bachelor degree in nursing. Seven nurses have additional advanced Neonatal Certification and one was also a midwife. As well there were nine Registered Respiratory Therapists (5 female, 4 male).

The areas of work were as follows; 35 participants worked in the Delivery Suite, 24 in the Neonatal Intensive Care Unit (NICU), four in a rural hospital, and eight worked in other areas including Maternal Child and the Operating Room. Some of these subjects worked in more than one area. All subjects had completed the NRP course within the last two years and worked with neonates. The number of times subjects had previously completed the course ranged from 1-19 times. Work experience in a delivery suite or NICU ranged from 0-36 years.

Table 1

Work Area and Discipline/Education Demographics in Control and Experiment

Characteristic	Low-fidelity	High-fidelity
	Control	Experimental
Work Place	N= 59	
Delivery Suite	16	19
NICU	12	12
Rural	3	1
Other	4	4
Discipline	N= 59	
Respiratory Therapist	3	6
Registered Nurse	25	25
Education		
Nursing Diploma	17	15
Neonatal Certification	3	4
Midwifery	0	1
Bachelor of Nursing	8	10

Method

The site of the study was at Lethbridge College, in the Simulated Patient Health Environment for Research and Education (SPHERE) room.

Table 2

Example of One Day in SPHERE

April 29 – July 18	
0900 – 1900	
Practice and debriefing	Session one
Megacode	0900-1300
Exam	3 subjects
	Session two
	1200-1600
	3 subjects
	Session three
	1500-1900
	3 subjects

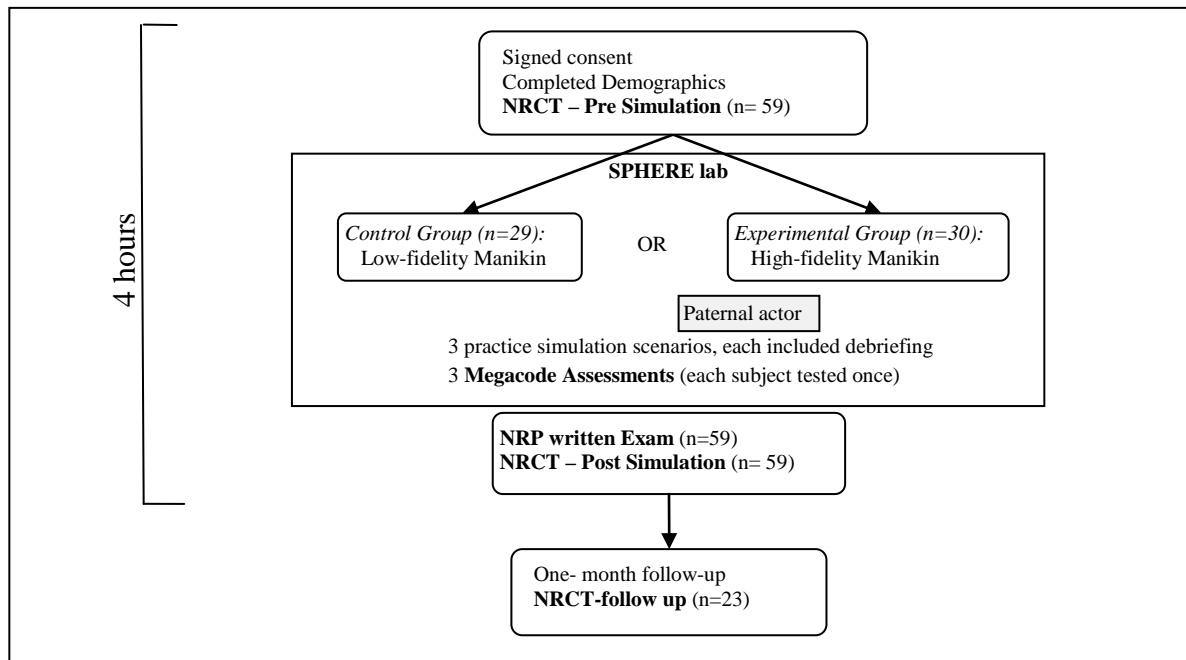
Note. The practice and debriefing, Megacode, and exam were the same format for each of the three session with an overlap in the Exam of the earlier session and the practice of the later session. The exam was written in a separate room.

An example of one day in SPHERE is outlined in at Table 2. The simulation sessions were held over six weeks and approximately nine subjects a day attended. The control group included a low-fidelity manikin as was usual for the NRP classes; the experimental group was assigned a high-fidelity manikin. The experiment was held over ten different days. The subjects registered in advance for one of the days. There were three sessions per day for ten days for a total of 24 sessions (not every day had three sessions). Originally there were nine days but scheduling around work schedules was difficult for some staff. To maintain a three subjects per manikin ratio and since there was only one manikin, only three subjects could register into each time slot. Therefore, optimal timeslots filled up quickly. Also some subjects were unable to attend their scheduled slots and needed to be rescheduled thus an extra day was added.

The manikin assignment was randomized and consequently the subjects who participated in the study were randomized. The randomization procedure was achieved through cards. Each card was 4 x 6 cm and of the same color. There were 24 cards, 12

had the words “High-fidelity” and 12 cards had the words “Low-fidelity” printed on them. The face of all 24 cards was the same. The cards were shuffled and then the technician who set up the simulation lab picked a card prior to each session set up. Thus the room was set up with either the high or low-fidelity manikin according to the card. Each subject had a 50% chance of using either manikin. There was an equal number of high and low manikin scenarios. The subjects did not know which manikin they would be using until they entered the room.

Both groups, high and low-fidelity manikin, underwent the same simulated neonatal resuscitation scenario in a simulated delivery room, including a maternal manikin, a paternal actor, team of resuscitation staff consisting of three of the subjects, followed by a debriefing. Twenty-nine subjects were randomly assigned to the low-fidelity manikins using a Laerdal Neonatal Resuscitation Baby capable of bag-valve-mask ventilation, intubation, chest compressions, and umbilical catheterization. This manikin was not capable of heart rate, respirations, crying, or computerization. The other 30 subjects were assigned to a high-fidelity manikin using a Laerdal SimNewB; a computerized manikin capable of the above traits as well as heart sounds, breath sounds and chest rise, cyanosis, tone and movement, and crying; all reactive to a computer program (Laerdal Medical, 2008).



Note. NRCT = Neonatal Resuscitation. Confidence Test. SPHERE = Simulation Patient Health Environment for Research and Education.

Figure 3 Graphic representation of the research study.

A pretest-posttest control group design with repeated measure.

See Figure 3 for a graphic design of the study. Using the Nursing Education Simulation Framework (Jeffries, 2005), the following learning outcomes were measured; skill performance, knowledge, and confidence.

Skill Performance

Skill performance included practice, debriefing, and evaluation. Practice and Megacode scenarios were originally developed based on scenarios provided by the SimNewB and input from all instructors to ensure realistic detail, challenging, and relevant practice (Halamek, 2008)(Appendix G). The scenarios were formatted for use with both the low and high-fidelity manikins. Skill performance was measured using the NRP Megacode Assessment Form (American Academy of Pediatrics and American Heart Association, 2006b), following the NRP guidelines during the simulation. Five NRP instructors performed the Megacode evaluations. The researcher met with the five

instructors and practiced the scenarios, debriefing, and compared the exact requirements for each score on the megacode. Each instructor took turns evaluating a mock megacode performed by one of the instructors. Consensus from all five instructors was achieved on the scoring of each megacode scenario. Based on this consensus, the researcher added notes to the Megacode Assessment Form for consistent evaluation (Appendix H). The evaluators were also provided a Roles and Responsibilities Handout as well as an agenda (Appendix I).

Subject's Knowledge

The subject's cognitive knowledge was measured using the NRP evaluation (American Academy of Pediatrics and American Heart Association, 2006b) following the simulation. The 96 multiple-choice questions were based on the NRP textbook. The subjects were expected to review the NRP textbook prior to the simulation day. They were allowed 1.5 hours to complete the exam.

Confidence

Confidence was first measured by each subject completing Neonatal Resuscitation Confidence Test (NRCT) surveys when the subjects arrived, prior to attending the simulation; secondly, following the simulation and exam; and thirdly each subject was given a preaddressed envelope to be returned in one month with the completed survey enclosed. They completed the confidence survey and marked on the top if they resuscitated of a real live infant during the past month. The completed NRCT confidence surveys were returned to the researcher by mail.

Instrument Development and Analysis

Following an extensive literature search the only relevant instrument found was the “Student Satisfaction and Self-Confidence in Learning” instrument through the National League of Nursing (NLN). Permission to use the tool was granted. However, the NLN tool measured satisfaction and self-confidence of students in a medical surgical curriculum, not by staff nurses or neonatal resuscitation. The variable in the NLN tool was simulation and not the fidelity of the manikin. It was not possible to use the tool for a pretest or repeated measures as all questions were in relation to the simulation instead of the clinical practice that is resuscitation which is repeated. Dr. L.P.Halamek was contacted and permission was received to use the Neonatal Resuscitation Behavior Performance Evaluation and Neonatal Technical Performance Evaluation tools. Although these tools measured performance and (teamwork) behavior they did not measure capability or confidence of knowledge and could not to be used as pretest or repeated measures since the instructor scored the behavior of teamwork during the simulated skill performance.

Thus, a decision was made to develop a new tool. The new tool, Neonatal Resuscitation Confidence Tool (Appendix J), measured the confidence of a health care worker to perform neonatal resuscitation. Confidence was measured by the subject’s self reported confidence of ability in performance of skill, knowledge, and in behavior of neonatal resuscitation. The tool consists of a 24-item criteria reference measuring of confidence in skill, knowledge, and behavior based on the NRP objectives. The one to four Likert-type scale, categorized the subject’s degree of confidence, with one indicating “not at all confident” and four indicating “very confident”. The total possible score

ranges from 24 – 96 points (1 x 24 to 4 x 24). The psychometric properties of this tool were established during the course of the study.

The instrument was assessed for content and construct validity. Content experts examined the format, content, and clarity of each item to see how representative the questions were of the universe of all questions (Polit, 1996). Four content experts, two local NRP instructors and two from the Alberta Perinatal Health Program based out of Edmonton, verified content validity of Neonatal resuscitation Confidence Tool (Appendix K). The scores were combined from the four judges and some minor changes were made to the format and demographic questionnaire adding Midwifery and PhD as possible levels of education. The experts rated each question from one to four with one reflecting “not relevant” and four reflecting “very relevant” with a mean score of 3.59 out of 4.0

The experts also made recommendations that questions be deleted and/or edited. The dimensions of confidence in neonatal resuscitation were represented by the set of items once edits were made; including adding the use of CO₂ detectors and blended oxygen administration. Comments from one evaluator addressed the audience (nurse, physician) regarding questions on leadership, delegating, and calling for help. The use of the phrase “leadership role” was questioned since there were different meanings, for people. Other words were considered to replace the word leadership, but they also changed the meaning. Leadership was left unchanged on the form because behavior skills such as leadership and effective communication are neonatal resuscitation program objectives (American Academy of Pediatrics and American Heart Association, 2006a; Anderson, et al., 2008; Halamek, 2007) and an important indicator of confidence. The

NRCT form was edited with the recommendations of the experts, leaving five demographic questions and 24 survey questions.

A reliability psychometric test was performed following data collection. A Cronbach's Alpha analysis provided an index of reliability regarding the consistency of measure for each of the 24 items in the instrument. In comparing how all the subjects answered the survey, there should have been some internal consistency as to how each question was answered. An item analysis was performed after the instrument was used in the study. Any one item having an alpha score of less than 0.70 was recommended for editing or deletion for future studies. The goal was to have an overall score of greater than 0.70 (Norwood, 2000). Using SPSS 15.0 reliability testing was conducted, the Cronbach's Alpha based on standardized items scored .949 for 24 items. With this high alpha reliability, no further changes were made.

Construct reliability testing was performed on the NRCT following completion of the study. The known-groups technique was used for construct validity following data collection (Polit, 1996). Individual items that scored less than three were examined to ensure the low score in the question matched the expected differences of the group. One example was the question on "ability to perform positive pressure ventilation on a neonate". This item was scored lower by Delivery Suite nurses compared to the respiratory therapists as they used this skill more often. All the items reviewed were found to match the expected differences in groups and the questions were left intact.

Test-retest reliability would not be accurate for the two NRCT retests since the conditions changed. The initial survey was prior to simulation, then post simulation, and

then follow-up in one month. Furthermore, a factor analysis was not possible as a measure of validity because the sample size was less than 150.

The Pre NRCT tool included five demographic questions (Appendix L).

- The first question asked, “What area(s) do you work in?”
 - Answer included; ‘NICU’, ‘Delivery room’, ‘Rural Hospital’ or, ‘Other’.
- The second question asked, “How long have you worked in a Delivery Suite or NICU?”
- “How many neonatal resuscitations requiring positive pressure ventilation have you performed in the past 24 months?”
 - The answers included choices of; zero, 1-4, 5-9, 10-19, 20 or greater.
- The fourth question asked “In your opinion, how many of the above resuscitations had a poor outcome for the neonate?” and
- The fifth question asked “what is your level of education?”
 - The answers included; “diploma, degree, Perinatal/neonatal certificate program, midwifery, masters, or PhD”.

Treatment Design

Each group consisted of a group of three subjects. The number of subjects was determined by two factors: First, three is a realistic number of subjects in a real resuscitation team. Second, three is the maximum manikin-subject ratio, engaging all subjects. The room set up was the same for each group and resembled a delivery room. An adult manikin portraying the mother was present on a bed. The infant manikin was on a radiant warmer. A resuscitation cart was set up with the same resuscitation equipment

used in the hospital. There was a simulation technician and a NRP instructor. The same simulation technician was used for all but two sessions. There were five different NRP instructors. The instructor directed the simulation and operated the remote control of the high-fidelity manikin. This was a realistic model given the costs of an extra instructor or actor. The simulation technician managed the fluids of the manikin and played the role of the physician as well as played the part of a family member actor and followed a script of cues. The physician delivered the infant by placing it on the radiant warmer. The technician's role was also to fill in if only two subjects attended a session. In this case, the technician only performed chest compressions after at least one set of chest compressions were completed by the subject. The subjects were given a practice simulation where each subject was able to practice her/his skill followed by debriefing. The instructor was given scenarios (Appendix G) with a debriefing guide containing standardized information. The learner was also given the opportunity to reflect on her/his learning. Thirty minutes was allowed for each practice and debriefing session. A total of three practice plus debriefing sessions took about one and a half hours. The megacode testing then took place. The instructor ran three megacodes with three different scenarios (Appendix G) each lasting about 20 minutes each. All three subjects worked as a team with each scenario, changing their roles from lead position to assistant. The megacode testing was not videotaped as the available videotaping equipment was dated and it would have been too difficult for the instructors to learn how to use the equipment. As well the instructors had no videotape debriefing experience. The megacode evaluation took about one hour. The instructors scored the megacode and explained the score to the subjects. The subjects were given the opportunity to reflect on their learning. Following a 15 minute break, the subjects wrote

the NRP exam. One and half hours was allowed for its completion. The Post NRCT confidence survey was then filled out and the subjects were given a self-addressed envelope containing the one-month follow-up NRCT survey with explanation.

Chapter 4

Results

Confidence Analysis

For all analyses, a p-value of less than or equal to 0.05 was considered significant and the beta level was set at 0.20.

A repeated-measures ANOVA was used to determine whether a NRP simulation conducted on 59 subjects increased the overall confidence of resuscitation following NRP simulation. The overall confidence levels were as follows: Pre NRP simulation (M = 71.1; SD = 13.6); Post NRP simulation (M = 81.4; SD = 10.6). (There were no missing values). There was no evidence of skewness, kurtosis, or outliers. A significant increase in Confidence was obtained, $F(1.0, 58.0) = 49.7, p < .001$. The ANOVA indicated a significant increase in confidence from pre to post simulation.

A repeated measure mixed design was used to assess whether confidence significantly increased with NRP resuscitation simulation and also, whether confidence changed for subjects using a high-fidelity manikin versus a low-fidelity manikin. The between-group factors were fidelity of manikin (high, low) and the within-group factor was NRCT confidence survey (pre and post). Sixty subjects completed the pre and post NRCT survey. One was deleted because of missing values. This left a total of 59 for each survey. No skewness, kurtosis, or outliers were evident. The following variables were entered as covariates: Number of resuscitations performed in the past two years, the number of NRP courses completed, the number of resuscitation with poor outcomes.

Table 3 displays distribution of the scores.

Table 3

Distribution of Confidence Scores Pre and Post Simulation

Manikin	NRCT Pre	NRCT post
High-fidelity		
Experimental	M = 73.2; SD = 12.3	M = 82.2; SD = 12.2
Low-fidelity		
Control	M = 68.9; SD = 14.8	M = 80.5; SD = 8.8

Note. NRCT = Neonatal Resuscitation Confidence Test. NRCT scores 24 – 96.

No significant effect was obtained for the fidelity of the manikin $F(1, 57) = 1.14$, $p = .289$, partial $\eta^2 = .020$ indicating that overall confidence did not increase with high-fidelity manikins use compared to low-fidelity manikin use. In addition, as illustrated in Table 4, there was a statistically significant confidence x Number of NRP interaction $F(1, 52) = 9.69$, $p = .003$, partial $\eta^2 = .157$ indicating the confidence in subjects who completed more NRP courses in the past, increased significantly more than those that had taken fewer NRP courses following the NRP simulation. Also there was not a statistically significant confidence x number resuscitation interaction $F(1,52) = 3.20$, $p = .080$, partial $\eta^2 = .058$ indicating no increase in the confidence in subjects who resuscitated more neonates in the past two years compared to those who resuscitated fewer neonates following NRP simulation.

Table 4

Correlation between Confidence scores and Simulation Co variants

Confidence compare with			
Source	df	f	p-value
Number of resuscitations	1	3.20	.080
Poor outcome in past resuscitation	1	.145	.705
Number of NRP courses taken	1	9.69	.003*
Worked in NICU	1	2.21	.144
Worked in Delivery Suite	1	.085	.771

Note. *Correlation is significant at the 0.05 level.

Megacode Performance Assessment

Table 5 displays the distribution of megacode scores as a function of fidelity of the manikin. A Mann-Whitney U test was conducted to determine whether the megacode scores of subjects using the high-fidelity manikin (n = 30) differed significantly from the megacode scores of subjects using the low-fidelity manikin (n = 29). There were no missing values. The mean rank of high-fidelity subjects was found to be not significant compared to low-fidelity, $z = -1.93$, $P = .053$ (2-tailed), indicating no significant increase in megacode assessment scores between the low to high-fidelity manikin use. The mean performance score of the low-fidelity manikin was higher than the mean score of the high-fidelity manikin.

Table 5

Distribution of Megacode Scores with Fidelity of the Manikin

	Manikin Fidelity	
	High	Low
	Experimental	Control
Megacode Assessment	M = 34.1; SD = 2.32	M = 35.1; SD = 1.04

Note. Megacode is the Neonatal Resuscitation Program test of Performance. Megacode Scores are 0 – 36, the lowest score was 27, a score <31 fails the test.

Table 6 shows the evaluator’s effect on the megacode scores. A Kruskal-Wallis test was conducted to evaluate whether subjects test by 5 different evaluators caused a variance in the megacode scores. There were no missing values. The test found significant variance in the mean rank between the evaluators $\chi^2(4, N = 59) = 14.2, p = .007$.

The order of evaluation effect on the megacode performance is illustrated in Table 7. A Kruskal-Wallis test was also conducted to evaluate whether the order of the megacode testing caused a variance in the megacode scores. There were no missing values. The test revealed no significant differences in the mean rank order between the order of the testing $\chi^2(2, N = 59) = .26, p = .87$.

Table 6

Evaluators Variance on Megacode Results

Megacode Assessment

	High Fidelity (n=30)				
Score 27-32	3	0	0	1	0
Score 33-34	4	0	1	2	3
Score 35-36	8	2	2	2	1
Total	15	2	3	5	4

	Low Fidelity (n=29)				
Score 27-32	1	0	0	0	0
Score 33-34	0	1	0	0	2
Score 35-36	3	3	16	1	3
Total	4	4	16	1	5

Note. Megacode is the Neonatal Resuscitation Program test of Performance. Megacode Scores are 0 – 36, the lowest score was 27, a score <31 fails the test.

Table 7

Order of Evaluation Effect on the Megacode Performance

	<i>Order of Evaluation</i>		
Megacode			
Assessment	<i>1st</i>	<i>2nd</i>	<i>3rd</i>
<i>Score 27-32</i>	1	2	2
<i>Score 33-34</i>	6	4	3
<i>Score 35-36</i>	17	14	10
Total	24	20	15

Note. Megacode is the Neonatal Resuscitation Program test of Performance. Megacode Scores are 0 – 36, the lowest score was 27, a score <31 fails the test.

NRP Exam

A one-way analysis of variance was conducted to evaluate the relationship between the fidelity of the manikin during NRP simulation and the score on the NRP exam. The independent variable, fidelity of the manikin, had two levels, high and low. The dependent variable was the score on the NRP written exam following the simulation. The distribution is displayed in Table 8. A logarithmic transformation was applied to correct the significant skewness and kurtosis observed in the NRP exam scores. The ANOVA was non-significant, $F(1, 58) = 2.96, p = .09$, indicating no significant difference between the high and low manikin use in simulation on the NRP exam however the result is close to significant and trends towards the high-fidelity manikin.

Table 8

Distribution of Exam Scores in Relation to Fidelity of Manikin

Manikin	N	Mean	Standard Deviation	Standard Error	Minimum	Maximum
High-fidelity						
Experimental	30	1.08	.24	.04	.48	1.54
Low-fidelity						
Control	29	.99	.18	.03	.70	1.46
Total	59	1.04	.22	.03	.48	1.54

Follow-up Survey

A repeated measures ANOVA was also used to analyze if confidence significantly increased in one-month following the NRP resuscitation for subjects using the high-fidelity manikin versus the low-fidelity manikin. The between-group factors were fidelity

of manikin (high, low) and the within-group factor was the NRCT confidence survey (pre, post, and one-month follow-up). Only 23 subjects completed the one-month follow-up survey (11 high-fidelity, 12 low-fidelity). No skewness, kurtosis, or outliers were present. Table 9 displays the distribution of scores. The variable, “resuscitated a real infant” was entered as a covariant. No significant effect was obtained for the fidelity of the manikin. $F(1, 18) = 3.6, p = .07$, indicating there was no significant change in confidence for subjects practicing on the high-fidelity manikin versus the low-fidelity manikin in the one month following the NRP course. However this result is close to significant with a trend towards the high-fidelity manikin. No significance between confidence x resuscitation of real infant interaction was found $F(2, 36) = .15, p = 0.87$, indicating no increase in confidence in subjects who resuscitated a live infant verse the subjects who did not.

Table 9

Distribution of NRCT Confidence Survey Pre, Post and Follow-up

Manikin	NRCT		
	Pre	Post	One-month follow-up
High-fidelity			
Experimental	M = 73.2; SD = 12.3	M = 82.2; SD = 12.2	M = 87.4; SD = 7.6
Low-fidelity			
Control	M = 68.9; SD = 14.8	M = 80.5; SD = 8.8	M = 84.1; SD = 10.1

Note. NRCT = Neonatal Resuscitation Confidence Test

A one-way ANOVA analysis of variance was conducted to examine the relationship between the evaluators and the NRCT post confidence survey. The ANOVA indicated no significance, $F(4, 58) = .45, p = .771$, indicating the evaluators did not cause a variance in the NRCT post simulation confidence survey.

A one-way ANOVA analysis of variance was also conducted to evaluate the relationship between performing resuscitation on a live baby with those who did not perform a live resuscitation in the NRCT follow-up confidence survey conducted one month following the NRP simulation. The distribution is displayed in Table 10. The ANOVA indicated no significance, $F(2, 20) = .087, p = .917$, suggesting the subjects who performed resuscitation on a live baby did not have an increase in confidence compared to the subjects who did not perform a live resuscitation one-month following the NRP simulation.

Table 10

Distribution of Follow-up Confidence Scores on Live Resuscitations

Live Resuscitations	N	Mean	Standard Deviation	Standard Error	Minimum	Maximum
No	6	85.5	7.5	3.1	76	95
Yes	13	85.8	10.0	2.8	60	96
Not answered	2	88.5	4.9	3.5	85	92
Total	21	86.0	8.7	1.9	60	96

Note. Live Resuscitation represents subjects who were asked “Have you resuscitated a neonate since your NRP Renewal?”

Chapter 5

Discussion

In regards to hypothesis one: *Regardless of the fidelity of the manikin, confidence will increase due to the simulation-based training method for health care professionals recertifying in neonatal resuscitation.*

The results of this study validate the importance of simulation on confidence. The study found a significant increase in confidence for nurses and respiratory therapists following NRP simulation in a high-fidelity environment including cues from a family member actor as stressors. This supports the constructivist learning approach as the learner had opportunity for a concrete, contextual meaningful experience that was built on previous learning.

Regarding hypothesis two: *Confidence will increase more so with the use of high-fidelity manikins compared to low-fidelity manikins for health care professionals recertifying in neonatal resuscitation using a high-fidelity simulation scenario.*

This hypothesis was not supported. The increase in confidence was not a result of the fidelity of the manikin. “It is the methodology (immersion into realistic scenarios followed by facilitated debriefing), not the technology, that is most critical in simulation-based training” (Halamek, 2008, p. 452).

The use of high-fidelity manikins was new for all the subjects. The manikin used in the study was new to this health region. The subjects had not practiced NRP in an advanced environment prior to this simulation. The use of a high-fidelity manikin engaged more advanced assessment skills as it was more realistic. The low-fidelity manikin did not have a heart rate, breath sounds, or an airway which could be occluded.

When the low-fidelity manikin was used, the subjects were simply required to ask the instructor for the assessment. They were not able to count the heart rate, for example. In the high-fidelity manikin, the subject assessed the heart rate by listening with a stethoscope or feeling the umbilicus for six seconds, counted the heart rate then timed that number by ten. If the manikin was not breathing the subject assessed and evaluated this situation without input from the instructor. The interventions could include repositioning the head or actually intubating the trachea with accuracy and re-assessing the airway for breath sounds, placement of the tube, and CO² exhalation. In the low-fidelity manikin, the subject mimicked these actions and asked the instructor for the result of the assessment. Thus the high-fidelity manikin potentially caused more stress for the subjects. The high-fidelity manikin also is more life-like and draws the subjects into the spirit of the story which in this case is a potentially dying neonate. This stress was akin to realistic stress that would occur in a live resuscitation. Graling and Rusynko (2004, p. 466) found “mock reality exercises can bring novice nurses closer to competency by creating a stress level that they can overcome in the safety of a learning laboratory”. The health care providers in this study were not novice but the same principles of stress may apply. However, this additional stress may not reflect a higher confidence rating as the use of the high-fidelity manikin did a better job at pointing out the difficulties of a real assessment. People often find stressful situations to be very uncomfortable and may rate confidence lower as a result. Subjects using the low-fidelity manikin may not have understood these difficulties and may have felt more confident as a consequence. High-fidelity simulation practices with an increased degree of difficulty is thought to increase mastering of skill (Issenberg, et al., 2005).

Hypothesis three: *The fidelity of the manikin will not increase the learning outcomes of skill performance and knowledge for health care professionals recertifying in neonatal resuscitation using a high-fidelity simulation scenario standard.*

As hypothesized, the impact of the high-fidelity manikin was not significant on the performance evaluation of the Megacode assessment. There was no significant difference in performance scores when the high-fidelity manikin was compared to the low-fidelity manikin. The trend was toward the low-fidelity manikin. Hoadley (2009) had the same finding on a recent study comparing low and high-fidelity simulation of Advanced Cardiac Life Support (ACLS) comparing pre and post knowledge and skill without any significant difference in the fidelity of the manikin. Performance is a little more difficult on the high-fidelity manikin and thus the scoring would likely not be higher. However, this may suggest that the challenge of the high-fidelity manikin would lead to increased performance in future performance evaluations. The Megacode performance evaluation used in the study was a requirement for the NRP recertification and limited the evaluation to the requirements for a low-fidelity manikin. Actual assessments, like counting an accurate heart rate or actually assessing the intubation placement, were not evaluated. Behavior skills like communication, leadership, and teamwork were not included in the megacode performance evaluation either. Future research, using more advanced performance measures and repeated performances is necessary to determine if high-fidelity manikins increase the learning outcome of performance. The performance results were close to being significant with $p=.053$ with the low-fidelity manikin scoring higher than the high-fidelity manikin. When evaluating the resultant scores between the low and high fidelity manikins, these

factors could account for the higher low-fidelity mean score; high-fidelity manikin required a higher skill level by the user to achieve a reasonable level of performance. Other factors are the increased stress levels and variance in instructors. One evaluator scored 16 out of 19 megacodes with the highest score, and all 16 of these involved the low-fidelity manikin.

Even though great detail was taken into account to have equal simulations, practice, and evaluations for all participants, the findings revealed a significant variance among evaluators. All instructors practiced an equal amount of time with the manikin, used the new standardized scenarios, and debriefing. Scripts were used to introduce the practice and evaluations (Appendix M). The same duration of time was allocated for each subject. A guideline was provided along with a three hour practice session consisting of post-scenario debriefing; however, the instructors had different teaching styles. The instructors' limited experience in a guided debriefing was evidenced by an inconsistent ability to follow the standardized debriefing guide. Instructors tended to teach-the-test (megacode) to ensure the learner did well on the megacode instead of providing feedback during the debriefing. Feedback in debriefing was the number one feature that lead to effective learning in an in-depth systemic review of simulation use (Issenberg, et al., 2005). Kneebone (2005) also found feedback a crucial component in simulation. More instruction, practice, and videotaping many have leveled out the variance with the performance evaluation (Gaba, 2004). Educators require the knowledge and skill of how to use simulation (Decker, 2006) including the application of debriefing.

The performance evaluation tool was reviewed with the evaluators and a consensus was achieved in how the scoring would be allocated for actions. However, there still were differences from evaluator to evaluator in this area. Five different evaluators participated in this study. The only way to avoid between-instructor variance would be to use only one evaluator for all assessments. This would be an unreasonable task with a large sample size.

The study did not find a significant difference in NRP exam scores in light of the different manikins used. This was not surprising. Even though the debriefing sessions in the simulation added to the knowledge base, the NRP exam is a pencil and paper written exam that is more based on the extent a subject studies than the simulation input i.e. knowledge recall. The trend was towards the high-fidelity manikin. The instructors were new at debriefing. Perhaps with a bigger effort on debriefing this trend will continue.

Hypothesis four: *Confidence will continue to increase in one month following a real clinical resuscitation for those health care workers trained with high-fidelity manikins compared to low-fidelity manikins, recertified in neonate resuscitation using a sophisticated simulation scenario.*

The confidence survey completed one month following the simulation demonstrated an overall increase in confidence but not an increase attributed to the high-fidelity over the low-fidelity. However, this result was close to significant with the trend towards the high-fidelity manikin. Some of the limitations of this survey included a smaller sample size. Only 23 of the 59 subjects (38.9%) completed the survey. A larger return rate could have provided a more significant result. This result

does trend in the direction that simulation with a high-fidelity manikin provides a greater retention of confidence than simulation with a low-fidelity manikin. And the subjects who performed resuscitation on a live baby did not have increased confidence. Even though this one-month follow-up sample size was small, it demonstrated the practice was more valuable than real-life experience for confidence. Building capability in a concrete, complex, and realistic environment where a person can safely make mistakes is consistent with constructivist principles.

Other Findings

Other interesting findings from this study included the significant increase in confidence from subjects who had taken the NRP course several times in the past. There was no significant increase in subjects who had worked in a NICU or Delivery Suite longer than those that had not. There also was no significant increase in confidence in subjects who had resuscitated more neonates in the past compared to ones who resuscitated fewer neonates. Thus, the increase in confidence was likely more to do with practice on manikins than experience. This finding is in keeping with past studies that found that repetitive practice lead to effective learning (Issenberg, et al., 2005; Kneebone, 2005; McGaghie, Issenberg, Petrusa, & Scalese, 2006).

Instrument Development

Hypothesis five: *The Neonatal Resuscitation Confidence Tool (NRCT) developed and tested in this study will demonstrate psychometric properties of reliability and validity.*

The NRCT confidence instrument demonstrated acceptable reliability and validity. Validity was demonstrated by expert reviewer's agreement on content, format, and clarity

of the tool. The experts scored and commented on the relevancy of the items contained in the NRCT. This study was designed for registered nurses and respiratory therapists and no confidence difference was found between them.

All the items and the instruction for responding to the items were clear once the wording was changed as suggested by the expert panel. Three of the four evaluators agreed on the clarity and edits were made by suggestions of the fourth evaluator.

The experts reviewed the tool and had no recommendations for revisions on the format. There were grammatical edit suggestions. A couple of items were deleted including one on debriefing. The question on 'debriefing with the resuscitation team' was deleted as suggested as this was not an objective of NRP. Two items on 'umbilical insertion' were combined into one item.

Reliability was evidenced by the high Cronbach's Alpha score, .949, indicating high internal consistency of measurement. The NRCT can be useful in measuring future confidence in neonatal resuscitation in practice and for research. Other studies may be designed to use test-retest procedure to examine further psychometric properties of this tool.

Framework

The Simulation Framework (Jeffries, 2005) was very helpful in designing this research study and was used to evaluate the research as well. The design of the simulation was successful. According to the instructors, the timing of sessions, the extent of practice, debriefing, and testing time were appropriate. The number of subjects and facilitators during the simulations worked well. The use of cues to add realism was successful in adding stress and practical communication in the scenarios. No complaints regarding the

design were expressed by the subjects. The Jeffries' framework placed fidelity as an objective which can affect the learning outcomes, knowledge, skill performance, and confidence. The fidelity can refer to the manikin as well as the environment. The use of a high-fidelity environment did result in an increase in confidence. However, this study did not compare different fidelity environments. The use of a high-fidelity manikin did not significantly improve confidence. The framework provided other indicators which affected outcomes including complexity, cues, and debriefing (Jeffries, 2005). These factors were examined carefully in this study to avoid variances between the control and experimental groups. The complexity was designed to be the same for each subject. The "cues" used by the simulation technicians (family actors) were scripted to avoid variances. "Debriefings" were accompanied by a guideline for each instructor to follow, however, variances were found among instructors. The framework suggests that learning outcomes are dependent on the teacher (Jeffries, 2005). Even though the instructors in this study were all NRP instructors their debriefing experience was limited and teaching styles were different. The study indicated instructors require more practice in debriefing in order to increase the learning outcomes of the skill performance and have reliable results in skill performance.

Capability

This study set out to measure learning outcomes including knowledge and skill; and confidence in knowledge, skill, and behaviors as a measure of capability. The simulation of neonatal resuscitation used in this study increased knowledge, skill performance, and confidence in the high-fidelity environment design used in both the control and experimental groups. The manikin fidelity did not have a significant effect on the learning

outcomes of this design or measured outcomes. Capability requires knowledge as well as confidence to apply knowledge and skill in changing situations (Stephenson, 1998). The high-fidelity manikin is suggested (Jeffries, 2007) as being more of a capability builder than the low-fidelity manikin as it permits the instructor to change situations by remote control and thus challenging the learner to take appropriate action. The low-fidelity manikin does not really have the ability to change the situation; the learner needs to ask about changes and the assessment. A connection between the high-fidelity manikin and capability builder was established in this study. More research is needed to further explore the ability of changing situations and learning outcomes of critical thinking and capability building.

The high-fidelity simulation design allows development of capability through practicing the ability to work in a complex environment with the stressor of a family member, working effectively with a team in an unfamiliar context, and feedback and time for reflection in the debriefing session. Each of these factors was used in this study demonstrating an increase in confidence as a whole. Future research should explore different simulation designs looking into each factor separately for example stress on subjects with different complex environment (family members present), working as a team, and debriefing with and without videotaping. Different measured outcomes for example critical thinking; and repeated use of the high-fidelity manikin should be explored as well. The finding of increased confidence with repetitive NRP courses with low-fidelity manikins suggests repetitive use of the high-fidelity manikin to test a higher skill set with deliberate practice with skilled instructors and feedback through debriefing

may increase capability. The use of high-fidelity simulation in environment or manikin with deliberate practice may also accelerate learning (Meek, 2008).

The current NRP guidelines require health care professionals (HCP) to practice and be tested once every two years. A recommendation arising from this study is that HCP who are required to resuscitate neonates, should practice neonatal resuscitation in a high-fidelity environment every six months to a year. Kaczorowski et al. (1998) suggest a decline in skill and knowledge after six months. The knowledge testing could continue to occur every one to two years. Future research should follow-up this and other study groups comparing NRP practiced in high-fidelity simulation every six months to every year or two.

Limitations

The repeated measures of confidence score were limited to the number of subjects who returned the survey in the month following resuscitation training. Only 23 subjects completed the third confidence tool.

This study was limited to the selected simulation design including scenarios and room set-up. Further research is needed to test other design possibilities such as different debriefing techniques taking into consideration the possibility of variance from instructor to instructor based on their teaching styles and simulation experience. The NRP instructors possessed current Canadian Paediatric Society training as of April, 2009. This training included some low-fidelity simulation. However, this study was limited to the simulation training received by the instructors. The instructors did not have previous debriefing experience and very little high-fidelity simulation experience.

The high-fidelity manikin was very technical and new to this health region. The simulation technician was not familiar with the particular manikin although she was very experienced with other high-fidelity manikins. The manikin had some mechanical issues. Initially there was difficulty operating the carbon dioxide detector. This was resolved after the first day and was the result of inexperience with the remote control settings. There was then a mechanical problem with fluid contacting the computer mother board of the manikin. It was later discovered the umbilicus was not pushed in far enough to prevent fluid backup. The result was the manikin was sent away for repair. The timing of this did not affect the study because it was returned before the next scheduled NRP day, except for the day when the manikin malfunctioned. Two groups were not able to use all the functions of the manikin including tone and accurate chest sounds. However, it still performed at much higher level than the low-fidelity manikin.

The design did not include the use of videotaping. Even though videotaping is a valuable component of debriefing and could add to confidence (CASN, 2007; Halamek, et al., 2000; Jeffries, 2006) it is also very technical. Videotaping requires high tech equipment and environments and instructors experienced in debriefing with videotaping. The high-fidelity design of this study incorporated a new learning environment for the subjects which added stress to the testing environment. Even though videotaping would only be used during the debriefing and not during the megacode testing it would add additional stress to the subjects because of unfamiliarity with the use and the fear of others seeing their mistakes. The use of videotaping would add additional stress and should be introduced in a non testing environment that allows instructors to become familiar with the equipment and debriefing prior to NRP testing.

Changes for Future Studies

If this experiment were repeated it would be beneficial to include a quantitative and qualitative component measuring stress. An inquiry on the effect of stress on confidence could add further understanding of the subjects' experience. The use of high-fidelity manikins appears to increase the stress of users. The level of stress could be measured quantitatively with a scientific test like saliva measurements for example, and understood with a quantitative component. Does the stress foster learning and does it help prepare a HCP for the real environment?

This study suggests repeated NRP practice with high-fidelity environments increases confidence. The results of increased confidence with increased number of NRP testing could also be true for stress. Increased practice in high-fidelity environments may decrease stress in the real-live environment.

The other components included in Jeffries Simulation Framework were critical thinking and satisfaction (Jeffries, 2005). Even though the use of the high-fidelity manikin was not significant for knowledge, skill performance, and confidence for neonatal resuscitation, high-fidelity manikins could increase critical thinking and/or satisfaction with neonatal resuscitation.

High-fidelity manikins can increase psychomotor, critical thinking and problem solving (Zenkoni & Gantt, 2007). With increased use of high-fidelity manikins HCPs may have greater assessment and retention of learned skills (Miller, 1990; Wilford & Doyle, 2006). These learning outcomes were not tested within the context of neonatal resuscitation.

One other consideration in the use of high-fidelity manikins was that the instructors needed to have some experience with the mechanics of the manikin prior to its use. One of the instructors, as well the researcher, attended a four hour training session in a simulation lab that included mechanical training on the high-fidelity simulator, however, this session did not address the trouble shooting necessary to fix the problems that arose during the course of the experiment. Expertise with a high-fidelity manikin comes with hands-on experience. In terms of using very technical manikins in simulation, one needs to expect some mechanical glitches and requirement to have technicians available to trouble shoot and repair problems. As well, a replacement manikin should be available.

Conclusion

The use of simulation for Neonatal Resuscitation Program (NRP) Recertification has been found to be significantly important to increase the resuscitation capability of the provider. The emphasis on the high-fidelity environment and methodology are as important as or perhaps more important than the fidelity of the manikin used.

The need for deliberate practice is a significant finding in this study. The improvement in confidence from repeated NRP courses can increase capability and perhaps save lives. Recommendations arising from this study include:

1. Increase NRP practice intervals in a high realistic environment with a low or high-fidelity manikin from every two years to six month intervals.
2. Provide training for NRP instructors to improve simulation and debriefing skills. The more comfortable instructors become with the technology and

simulation methodology, the more likely that outcomes associated with the uses will improve (Jeffries, 2005).

3. Use the most realistic environment possible for NRP practice and megacode simulations.
4. Ongoing research in repeated deliberate practice with high-fidelity simulation will help define the best learning outcomes for neonatal resuscitation. Research can help design the best method of developing capability for novice and expert HCPs in neonatal resuscitation.
5. Future research recommendation is a pre-post design with NRP practice on a high and low-fidelity manikin every six months for two years, measuring confidence and stress.

The NRCT instrument can be used in future neonatal resuscitation research to measure confidence in simulation. Larger studies and studies that are designed to test-retest are necessary to further test the psychometric properties of this tool.

Even though this study did not find the high-fidelity manikin significantly better for capability, it did trend towards the high-fidelity manikin. Likely the high-fidelity simulation methodology should be the focus of future research, however, continued use of high-fidelity manikins and familiarity with the technology are important for continued research in this area. Perhaps high-fidelity simulators would foster confidence if they were used repeatedly in deliberate practice. Future research is needed to evaluate how simulation can enhance quality education and build capability among practitioners.

Does repeated practicing in a stressful environment lower the stress the subjects experience and increase the confidence? Can simulation with a high-fidelity manikin

help a HCP control stress and feel more capable to perform a neonatal resuscitation in a real situation?

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Appendix A: Permission to Use Framework



October 1, 2009

Ms. Linda Gust
Master's Student
University of Lethbridge

Canada

Dear Ms. Gust:

Thank you for your September 27, 2009 email requesting permission to use the Simulation Framework for your master's thesis. I am pleased to give you permission for the following:

“The Nursing Education Simulation Framework,” developed as part of the 2003-2006 NLN/Laerdal Simulation Study and most recently revised and published on page 23 in the work noted below, may be used as the framework for your master's thesis: *Building capability: Impact of low and high fidelity manikins on neonatal resuscitation simulation* and reproduced in the report of that study:

Jeffries, P.R. (2007). Simulation in nursing education: From conceptualization to evaluation. New York: National League for Nursing.


In granting permission to use this Framework, it is understood that the following assumptions operate and “caveats” will be respected:

- ✓ The Framework will be used only for the purpose outlined above.
- ✓ The Framework will be included in its entirety and not modified in any way.
- ✓ The report of your research will acknowledge that the Framework has been included with the permission of the National League for Nursing, New York, NY.
- ✓ An abstract of your thesis, along with a copy of the page acknowledging that permission to include the Framework was granted by the NLN, will be provided to the National League for Nursing for documentation regarding how NLN material is being used.
- ✓ You will purchase at least one copy of the book in which the Theoretical Framework for Simulation Design is published.
- ✓ The National League for Nursing is the sole owner of these rights being granted.
- ✓ No fees are being charged for this permission.

I am pleased that material published by the National League for Nursing is seen as valuable to your research, and I am pleased that we are able to grant permission for its use. Should you have any questions, please feel free to contact me directly.

Gust; Page 2; 10/1/09

Respectfully,

A handwritten signature in black ink that reads "Linda S. Christensen". The signature is written in a cursive style with a large, prominent initial "L".

Linda S. Christensen
Chief Administration Officer
National League for Nursing
61 Broadway, 33rd Floor
New York, NY 10006
lchristensen@nlm.org

Appendix B: Approval



**Alberta Health
Services**
Chinook Health

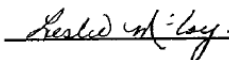
Memo

Date: February 24, 2009
To: Ethics Review Board, Chinook Regional Hospital
From: Leslie McCoy, Senior Program Director, Children's Health
Linda Lacny, Program Director, Women's Health
Re: SUPPORT OF THESIS RESEARCH

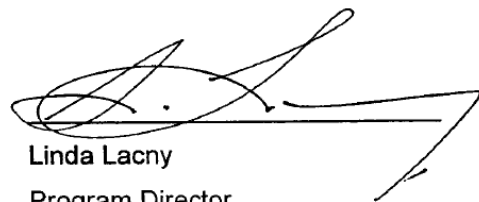
Please be advised we have reviewed and support the project proposed by Linda Gust titled:

Building Capability: Impact of Low and High Fidelity Manikins on Neonatal Resuscitation Simulation.

The findings from this research activity will inform program planning.



Leslie McCoy
Sr. Program Director
Children's Health



Linda Lacny
Program Director
Women's Health

Appendix C: Ethic Review Approvals



Chinook Health Regional Research Committee
Attn: Trudi Jersak, Admin. Support
960 - 15th Street South
Lethbridge, AB T1J 1R5

April 27, 2009

Linda Gust
[Redacted]

Dear Ms. Gust:

Re: Research Study Proposal / File # 2009-03
Building Capability: Impact of Low and High Fidelity Manikins on Neonatal Resuscitation Simulation

Further to your letter dated April 20, 2009, the Committee agrees to the addendum with the inclusion of Registered Respiratory Therapists.

Approval with the inclusion of Registered Respiratory Therapists is hereby provided for this study, pending:

- 1. Receipt of REB from U of L Ethics Committee.**

Upon completion of the above-noted condition, please contact Mark Maxwell (Mark.Maxwell@albertahealthservices.ca) in order to complete your Research Agreement.

Yours truly,

A handwritten signature in black ink, appearing to read "Paul A. Easton".

Paul A. Easton, MD, PhD, FACP, FCCP, FRCP(C), ABSM
Chairman - Chinook Health Regional Research Committee

PE/Lj

cc: Leslie McCoy, Director, Children's Health
Linda Lacey, Director, Women's Health
Mark Maxwell, Legal Counsel-Clinical Trials
File



Office of
Research Services

4401 University Drive
Lethbridge, Alberta, Canada
T1K 3M4

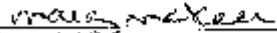
Phone: 403.329.2431
Fax: 403.332.7185

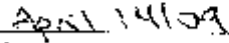
www.uleth.ca/rs

CERTIFICATE OF HUMAN SUBJECT RESEARCH
University of Lethbridge
Human Subject Research Committee

PRINCIPAL INVESTIGATOR: Linda Gust
ADDRESS: School of Health Sciences
University of Lethbridge
4401 University Drive
Lethbridge, AB T1K 3M4
PROJECT TITLE: Building Capability: Impact of Low and High Fidelity
Manikins on Neonatal Resuscitation Simulation
INTERNAL FILE: #842
INFORMED CONSENT: Yes
LENGTH OF APPROVAL: May 6 - June 18/09

The Human Subject Research Committee, having reviewed the above-named proposal on matters relating to the ethics of human subject research, approves the procedures proposed and certifies that the treatment of human subjects will be in accordance with the Tri-Council Policy Statement, the Health Information Act, and University policy.


Human Subject Research Committee


Date April 14/09



Research Ethics Board

REB Approval Form

A. Applicant Information

Name: Linda Gust E-Mail: [Redacted]
Institution: University of Lethbridge Telephone: [Redacted]
Department or School: Health Science
Mailing Address: [Redacted]
Researcher is a: Faculty Staff Student

If a student: Academic Supervisor: David Gregory E-Mail: David.gregory@uleth.ca
Department or School: [Redacted] Phone: [Redacted]
Institution: University of Lethbridge

B. Project Information

Project Title: **Building Capability: Impact of low and high fidelity manikins on neonatal resuscitation simulation**
Start and end dates: May 6 – June 18, 2009
Institution/s at which research will be conducted: Lethbridge College
Ethics approval received or sought from other institution/s: Chinook Health, University of Lethbridge
Funding source/s applied for and/or obtained: Applied for NRP Research Grant from Canadian Pediatric Society

Application #: LC-09-05

Date: March 30, 2009

Approval Signature: _____

**Marko Hilgersom, Chair
Research Ethics Board, Lethbridge College**

Appendix D: Informed Consent

Informed Consent

You have been asked to participate in a research study relating to the use of simulation for neonatal resuscitation.

This study is being conducted as a thesis project for my Masters of Science degree at the University of Lethbridge.

- You are being asked to participate because you are a Registered Nurse or Registered Respiratory Therapist, offering care to neonates, and you are required to undergo NRP Renewal.
- If you agree to take part in this study you will be asked to
 - Take about 10 minutes to complete a Neonatal Resuscitation survey of yourself.
 - When you arrive at the NRP Renewal
 - At the end of the NRP Renewal
 - In one months time
 - The type of information you will be asked to provide is.
 - A survey about your confidence in your skills, knowledge, and behaviors with neonatal resuscitation.
 - As well as standard NRP Megacode and NRP exam
 - The study will include a NRP Renewal as follows:
 - 1 hour of practice in the Simulation Lab at the Lethbridge College, randomly assigned to one of two types of manikins. A static manikin or the SimNewB infant simulator
 - 1 hour of debriefing and updates
 - 1 hour of Megacode testing on the same randomly assigned manikin in the simulation room
 - 1-1 ½ hour to write the NRP exam
 - You will be randomly assigned to one of two types of manikins.
- Taking part in the study would take no more than 4 ½ hours of your time.
- No potential risks are known.
- Potential benefits of taking part in this study include, completing your NRP Renewal with increased practice time in a sophisticated simulation environment.
- The completed results of the study will be used for future NRP simulation design, and will be available in about nine months. If you wish to obtain a copy of the results, provide an e-mail address and I will send you an electronic version.

- Participation in this study is completely voluntary and I will take every measure to ensure anonymity by removing all names and coding the forms. All information related to this study will be handled in a confidential and professional manner.
- I hope you will participate in this study, but if for any reason at any time you decide to withdraw, you are free to do so without prejudice (negative outcomes) and your data will be destroyed. Your NRP Renewal (certification) will not be affected in any way.
- If you have any questions about the study, do not hesitate to contact me at xxx-xxx-xxxx; lgust@chr.ab.ca; or my thesis supervisor, Dr. david Gregory at 403-329-2432; david.Gregory@uleth.ca. Questions regarding your rights as a participant in this research may be addressed to the Office of Research Services, University of Lethbridge (phone: (403)329-2747). Or Issues Management Director, Chinook Health (phone: (403) 382-6003
- By signing this form, you are freely agreeing to take part in this study and indicating that no one is forcing you to take part.

I consent to participate in the study entitled; **"Building Capability: Impact of low and high fidelity manikins on neonatal resuscitation simulation"**.

-----À Detach and Return Signed

I consent to participate in the study entitled, "Building capability: Impact of low and high fidelity manikins on neonatal resuscitation simulation " as described in the letter.

Printed Name and Signature	Date
----------------------------	------

Signature

Appendix E: Letter of Invitation

Is your NRP due?

A unique opportunity is available to build your neonatal resuscitation skill, knowledge, and confidence through the use of new simulation technology.

The use of infant simulation and debriefing for neonatal resuscitation training has the potential to increase the capabilities of nurses in a safe, active learning, and controlled environment.

I am master's student at the University of Lethbridge, performing my thesis research study on infant simulation use for Neonatal Resuscitation. Your involvement in this research can help us understand the best use of simulation for neonatal resuscitation training.

Who can participate?

- If you are a registered nurse working with neonates
- If you are requiring neonatal resuscitation renewal

What would I have to do?

- You would register for NRP renewal on one day between April 29-June 18
- You would attend a 4 hour NRP training at SPHERE at the Lethbridge College
 - Including one hour training on static manikin or the BabySim infant simulator
 - One hour megacode testing
 - One hour of debriefing
 - Complete the NRP exam
 - Take 5 minutes to fill in a survey

How do I participate in this Study?

- Please call Linda Gust at xxxxxx, Masters Student, at University of Lethbridge

Appendix F: Poster



Is your NRP due? Now is the time to Renew



A unique opportunity is available to build your neonatal resuscitation skills, knowledge, and confidence through the use of new simulation technology.

The use of infant simulation and debriefing for neonatal resuscitation training has the potential to increase the capabilities of nurses in a safe, active learning, and controlled environment.

I am a master's student at the University of Lethbridge, conducting my thesis research study on infant simulation use during Neonatal Resuscitation. Your involvement in this research can help me understand the best use of simulation for neonatal resuscitation training.

Who can participate?

- If you are a registered nurse or Registered Respiratory Therapist caring for with neonates
- If you have last taken NRP in 2007 or 2008.
- If you are requiring NRP Renewal.

What would I have to do?

- You would register for NRP Renewal on
May 6, 7, 12, 14, 21,
June 2, 4, 9 or 18

**0900-1330,
1200-1630, or
1500-1930**

- You would attend a 4 ½ hour NRP training at SPHERE at the Lethbridge College
 - One hour training on static manikin or the SimNewB neonate simulator
 - One hour megacode testing
 - One hour of debriefing
 - Complete the NRP exam
 - Take 10 minutes to fill in a survey

How do I participate in this Study?

- Please call Linda Gust. XXXXXXXX.
Masters student, at University of Lethbridge

Appendix G: Practice and Megacodes

Practice #1

Practice #1			
Monica, a 27-year-old primipara woman entered the hospital in active labor at 32 weeks gestation admitted following an MVA. She had had some vaginal bleeding since arriving in the delivery suite. Fetal heart-rate tracing show late decelerations. She is fully dilated and about to deliver. The father is present.			
Father Actor	"What are you doing?" "Is something wrong with my baby?"		
State 1 • Set lungs at closed	Heart rate: 40 Respiration rate: 4 Lung sounds: coarse CO ₂ : On Vocal sounds: Off	Color: Blue Cry: None Tone: Limp	Small Placental Abruption Delivery Suite – vaginal 32 weeks' gestation Amniotic fluid clear Estimated weight: 2500 g
Lead learner	Check bag, mask and oxygen supply:		
"Baby is born, cord is clamped and cut", physician places baby on radiant warmer ,stating, "you have a baby boy, about a 2500 gramer"			
Within 30 seconds	Term? Clear amniotic fluid? Breathing or crying? Good muscle tone?		Low fidelity: Asks or indicates High fidelity: States answers verbally or indicates otherwise
	Provide warmth, position, clear airway, dry, stimulate, reposition		
	Evaluate respiration, heart rate, and color Call for help and have 2 nd learner initiate Neonatal Resuscitation Record		
After suctioning change lungs to open or "air went in"	Provide effective PPV Heart rate not rising and chest not moving: • Reapply mask, lift jaw forward (seal) • Reposition head, check secretions, open mouth (obstruction) • Increase pressure (resistance)- (not necessary) 1 HR-40, RR-0	No or ineffective PPV Will fail megacode if suctioning or increases pressure prior to reapplying mask and lifting jaw forward 0 HR-0, RR-0	
30 seconds later	Check for improvement in heart rate (no improvement) Perform intubation Confirm placement with CO ₂ detector (will turn yellow), evaluate heart rate, check air entry Add sat probe and blended oxygen if greater than 90 seconds		
	Yes -intubation 1 HR-40, RR-0	Perform corrective action ←	No intubation or poor placement 0 HR-0, RR-0
	Evaluate respirations, heart rate, and color		
30 seconds later	1 HR-40, RR-0		
	Start chest compressions coordinated with PPV with 100% oxygen		
	Yes-chest compression 1 HR-40, RR-0	Perform corrective action ←	No chest compressions 0 HR-0, RR-0
30 seconds later	Evaluate respirations, heart rate, and color		
	Improved 2 HR-70, RR-4		
	Discontinue chest compressions		
30 seconds later	Evaluate respirations, heart rate, and color		

	Improved 5 HR-140, RR-40
30 seconds later	Evaluate respirations, heart rate, and color
	Extubate
	Provide post-resuscitation care

Observe for debriefing points:

- Technical skill performance
- Communication
- Leadership
- Boundary issues
- Decision making

Debrief - Want learners to reflect on learning

Observe -Remark-Inquiry

- At least once for each participant
- Good or bad

Observe: Say what you saw, e.g. I noticed... you tried to suction prior to fixing the seals

Remark: Compare to the ideal e.g. NRP recommends ...always ensuring a good seal of the mouth and nose prior to fixing obstruction (suctioning)

Inquiry: What was happening for the learner? e.g. What was happening with you?

Possible questions


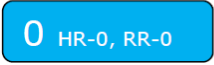
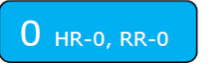





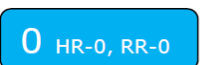
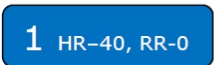

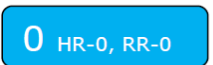
- What is something you are proud of as a team member?
- What is something you would want to change as a team member?
- How well did you communicate with the grandmother?
- **Why are O2 sat probes** added? To prevent hyperoxygenation and to gauge adjustments in oxygenation. Not as an indicator of when to add oxygen.
- When should **oxygen** be added? After 90 seconds PPV, intubation, or chest compressions are performed.
- If you are unable to intubate within 20 seconds, what can you do?
 - Quickly demonstrate a **LMA insertion** and allow the participants to try
- What can you do if extubate and the respirations are not optimal?
 - Quickly demonstrate **CPAP**

Do not let them leave without correcting serious mistakes!

Practice #2

Practice # 2			
A 28-year-old female presents in early labor at 39 weeks gestation. Prenatal course has been uneventful. There are known allergies. Continuous prenatal care has been received. There is no history of medication use other than prenatal vitamins. Fetal heart-rate monitoring show occasional late decelerations. The cervix dilates progressively, and a judgment is made to allow a vaginal delivery. The Grandmother is present.			
Grandmother Actor	Grandmother is at the radiant warmer with video camera in hand. "We sure didn't do that when I had my baby" "Just hold that baby up by its feet and give it a good smack on its buttock and it will be just fine"		
State 1 • Set Lungs at closed • Apply meconium to chest and legs	Heart rate: 40 Respiration rate: 0 Lung sounds: None	Color: Blue Cry: None Tone: Limp	Meconium Vaginal Delivery 39 weeks' gestation Meconium-stained amniotic fluid Estimated weight: 3500 g
Lead learner	Check bag, mask and oxygen supply: "The cord is clamped and cut, and the newborn is handed off". "you have a baby boy, about 3500g"		
Within 30 seconds	Term? Clear amniotic fluid? NO Breathing or crying? Good muscle tone?	Low fidelity: Asks or indicates High fidelity: States answers verbally or indicates otherwise	
	Assess if baby is vigorous: • Good respirations? Good muscle tone? Heart rate > 100? (not vigorous)		
	Provide warmth and position Call for help and initiate Neonatal Resuscitation Record		
	Intubate, suction mouth and trachea		
	Yes-cleared of meconium 2 HR-70, RR-4	Perform corrective action ←	No intubation and/or suction 1 HR-40, RR-0
	Dry, stimulate, reposition head Evaluate respiration, heart rate, and color		
After suctioning change lungs to open or "air went in"	Provide effective PPV Heart rate not rising and chest not moving: • Reapply mask, lift jaw forward (seal) • Reposition head, check secretions, open mouth (obstruction) • Increase pressure (resistance)- (not necessary) 2 HR-70, RR-4	No or ineffective PPV Will fail megacode if suction or increases pressure prior to reapplying mask and lifting jaw forward 1 HR-40, RR-	
	Check for improvement in heart rate (no improvement) Perform intubation Confirm placement with CO ₂ detector (turns yellow), evaluate heart rate, check air entry Add sat probe and blended oxygen if greater than 90 seconds		
	Yes - intubated 1 HR-40, RR-0	Perform corrective action ←	No intubation or poor placement 0 HR-0, RR-0

Practice #3

Practice #3			
A 20-year-old woman near term enters the emergency department complaining of sudden onset of intense abdominal pain associated with contractions. A rigid abdomen and persistent fetal bradycardia is noted. Additional skilled personnel are called to the operating room. An emergency cesarean section is performed. The boyfriend is anxiously awaiting information regarding his girlfriend and newborn daughter.			
Boyfriend Actor	Stating. "Is the baby okay?" "Why is she so blue?" "How is she going to breastfeed with that tube in her?"		
State  • Set Lungs at closed	Heart rate: 0 Respiration rate: 0 Lung sounds: 0 CO ₂ : On Vocal sounds: Off	Color: Blue Cry: None Tone: Limp	Placental Abruption Emergency cesarean section 38 weeks' gestation Amniotic fluid-no meconium Estimated weight: 3000 g
Lead learner	Check bag, mask and oxygen supply:		
Baby is placed on radiant warmer. Physician states "it is a girl, about 3 kg and Mom had a placental abruption			
	Term? Clear amniotic fluid? Breathing or crying? Good muscle tone?	Low fidelity: Asks or indicates High fidelity: States answers verbally or indicates otherwise	
Within 30 seconds	Provide warmth, position, clear airway, dry, stimulate, reposition		
	Evaluate respiration, heart rate, and color		
	Call for help and initiate Neonatal Resuscitation Record		
After suctioning change lungs to open or "air went in"	Provide effective PPV Heart rate not rising and chest not moving: • Reapply mask, lift jaw forward (seal) • Reposition head, check secretions, open mouth (obstruction) • Increase pressure (resistance)- (not necessary)	No or ineffective PPV Will fail megacode if suction or increases pressure prior to reapplying mask and lifting jaw forward	
			
	Check for improvement in heart rate (no improvement)		
	Perform intubation Confirm placement with CO ₂ detector, evaluate heart rate, check air entry (add sat probe and blended O ₂ if greater than 90 seconds)		
	Yes - intubated 	Perform corrective action 	No intubation or poor placement 
30 seconds later	Evaluate respirations, heart rate, and color		
		Perform corrective action 	
	Start chest compressions coordinated with PPV with 100% oxygen		
	Yes -chest compressions 	Perform corrective action 	No chest compressions 
30 seconds later	Evaluate respirations, heart rate, and color		

	Administer epinephrine in a timely manner <ul style="list-style-type: none"> Initial dose in ETT tube (not with LMA) Asks 3rd learner to insert UVC Prepares second dose of epinephrine for UVC 			
	<table border="1"> <tr> <td>Yes - epinephrine 1 HR-40, RR-0</td> <td>Perform corrective action ←</td> <td>No epinephrine 0 HR-0, RR-0</td> </tr> </table>	Yes - epinephrine 1 HR-40, RR-0	Perform corrective action ←	No epinephrine 0 HR-0, RR-0
Yes - epinephrine 1 HR-40, RR-0	Perform corrective action ←	No epinephrine 0 HR-0, RR-0		
30 seconds later 2-6 times	Evaluate respiration, heart rate , and color			
	Administer volume expander over 5- 10 minutes 2 nd dose of epinephrine in UVC would need to wait 3 minutes (optional)			
	Evaluate respirations, heart rate, and color			
	<table border="1"> <tr> <td>Yes – volume expander 2 HR-70, RR-4</td> <td>Perform corrective action ←</td> <td>No volume expander 1 HR-40, RR-0</td> </tr> </table>	Yes – volume expander 2 HR-70, RR-4	Perform corrective action ←	No volume expander 1 HR-40, RR-0
	Yes – volume expander 2 HR-70, RR-4	Perform corrective action ←	No volume expander 1 HR-40, RR-0	
	Discontinue chest compressions Continue PPV			
	Improved 4 HR-160, RR-60			
Discontinue PPV and start CPAP				
30 seconds later	Evaluate respirations, heart rate, and color			
	Provide post-resuscitation care			

Observe for debriefing points:

- Technical skill performance
- Communication – with colleagues, with boyfriend
- Leadership
- Boundary issues
- Decision making

Observe -Remark-Inquiry

- At least once for each participant
- Good or bad

Observe: Say what you saw, e.g. I noticed... you did not intubate before chest compressions

Remark: Compare to the ideal e.g. NRP recommends ...if there is not an improvement in heart rate and you have effective bagging, you should intubate.

Inquiry: What was happening for the learner? e.g. What was happening for you?



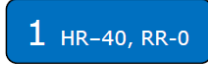
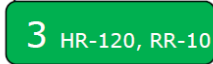
Possible questions:

- Did you feel comfortable with answering the boyfriend’s question?
- What is the dosing for Epinephrine?
- When do you add volume expander? If no improvement following epinephrine.


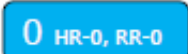
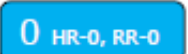
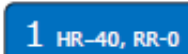


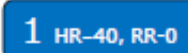

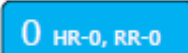
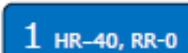

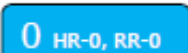
Megacode #1



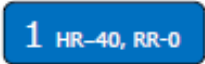
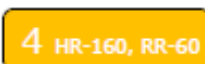
Megacode #1			
<p>A pregnant woman at 37 weeks' gestation is admitted to the labor and delivery unit. Pregnancy has been complicated by a placenta previa. The patient arrived contracting and having vaginal bleeding. Following ultrasound and evaluation of bleeding, it is decided that an emergency cesarean section will be performed. Amniotic fluid was clear. The radiant warmer is turned on. The estimated weight is 3500g</p>			
<p>State</p> <p>0</p> <ul style="list-style-type: none"> Set Lungs at closed 	<p>Heart rate: 0 Respiration rate: 0 Lung sounds: 0 CO₂: On Vocal sounds: Off</p>	<p>Color: Blue Cry: None Tone: Limp</p>	<p>Placenta Previa Emergency cesarean section 37 weeks' gestation Amniotic fluid clear Estimated weight: 3500 g</p>
Lead learner	Check bag, mask and oxygen supply:		
"The cord is clamped and cut, and the infant is handed off." Baby is placed on radiant warmer. Physician states "it is a girl, about 3.5 kg"			
	<p>Term? Clear amniotic fluid? Breathing or crying? Good muscle tone?</p>	<p>Low fidelity: Asks or indicates High fidelity: States answers verbally or indicates otherwise</p>	
Within 30 seconds	<p>Provide warmth, position, clear airway, dry, stimulate, reposition</p> <p>Evaluate respiration, heart rate, and color</p> <p>Call for help and initiate Neonatal Resuscitation Record</p>		
After suctioning change lungs to open or "air went in"	<p>Provide effective PPV Heart rate not rising and chest not moving:</p> <ul style="list-style-type: none"> Reapply mask, lift jaw forward (seal) Reposition head, check secretions, open mouth (obstruction) Increase pressure (resistance)- (not necessary) <p>0 HR-0, RR-0</p>	<p>No or ineffective PPV</p> <p>Fails megacode if suction or increases pressure prior to reapplying mask and lifting jaw forward</p> <p>0 HR-0, RR-0</p>	
	<p>Check for improvement in heart rate (no improvement)</p> <p>Perform intubation Confirm placement with CO₂ detector, evaluate heart rate, check air entry Add sat probe and blended oxygen if greater than 90 seconds</p>		
	<p>Yes - intubated</p> <p>1 HR-40, RR-0</p>	<p>Perform corrective action</p> <p>←</p>	<p>No intubation or poor placement</p> <p>0 HR-0, RR-0</p>
30 seconds later	Evaluate respirations, heart rate, and color		
	Start chest compressions coordinated with PPV with 100% oxygen		
	<p>Yes - chest compression</p> <p>1 HR-40, RR-0</p>	<p>Perform corrective action</p> <p>←</p>	<p>No chest compressions</p> <p>0 HR-0, RR-0</p>
30 seconds later	Evaluate respirations, heart rate, and color		
	<p>Administer epinephrine in a timely manner</p> <ul style="list-style-type: none"> Initial dose in ETT tube (not with LMA) Asks 3rd learner to insert UVC Prepares second dose of epinephrine for UVC 		
	<p>Yes - epinephrine</p> <p>1 HR-40, RR-0</p>	<p>Perform corrective action</p> <p>←</p>	<p>No epinephrine</p> <p>0 HR-0, RR-0</p>

Capability in Neonatal Resuscitation Simulation

30 seconds later 2-6 times	Evaluate respiration, heart rate , and color		
	Administer volume expander over 5- 10 minutes 2 nd dose of epinephrine in UVC would need to wait 3 minutes (optional)		
	Yes – volume expander 	Perform corrective action 	No volume expander 
30 seconds later	Evaluate respirations, heart rate, and color		
	Discontinue chest compressions Continue PPV		
	Improved 		
	Discontinue PPV, start CPAP		
30 seconds later	Evaluate respirations, heart rate, and color		
	Provide post-resuscitation care		




Megacode #2

Megacode #2			
Mary is 36 year old woman, gravida 1 Para 0 at 41 weeks gestation. She was admitted 18 hours ago in spontaneous labor after spontaneous rupture of membranes at home. She has an epidural and is being augmented for labor dystocia. She has been fully and pushing for the last two hours. And the baby is about to deliver.			
State  • Set Lungs at closed	Heart rate: 0 Respiration rate: 0 Lung sounds: 0 CO ₂ : On Vocal sounds: Off	Color: Blue Cry: None Tone: Limp	Labor dystocia Vaginal delivery 41 ³ / ₇ weeks' gestation Amniotic fluid clear Estimated weight: 3000 g
Lead learner	Check bag, mask and oxygen supply:		
Baby is finally delivered and Doctor states "Oh no, the cord ruptured" Doctor manages to clamp cord and places baby on warmer, announces " you have a baby boy, about 3000g"			
Within 30 seconds	Term? Clear amniotic fluid? Breathing or crying? Good muscle tone?		
	Provide warmth, position, clear airway, dry, stimulate, reposition		
	Evaluate respiration, heart rate, and color		
	Call for help and 2 nd learner initiates Neonatal Resuscitation Record		
After suctioning change lungs to open or "air went in"	Provide effective PPV Heart rate not rising and chest not moving: <ul style="list-style-type: none"> • Reapply mask, lift jaw forward (seal) • Reposition head, check secretions, open mouth (obstruction) • Increase pressure (resistance)- (not necessary) 	No or ineffective PPV Fails megacode if suction or increases pressure prior to reapplying mask and lifting jaw forward 	
	Check for improvement in heart rate (no improvement) Perform intubation Confirm placement with CO ₂ detector, evaluate heart rate, check air entry Add sat probe and blended oxygen if greater than 90 seconds		
30 seconds later	Yes – intubation 	Perform corrective action 	No intubation/poor placement 
	Evaluate respirations, heart rate, and color		
30 seconds later	Start chest compressions coordinated with PPV with 100% oxygen		
	Yes – chest compressions 	Perform corrective action 	No chest compressions 
	Administer epinephrine in a timely manner <ul style="list-style-type: none"> • Initial dose in ETT tube (not with LMA) • Asks 3rd learner to insert UVC • Prepares second dose of epinephrine for UVC 		
30 seconds later	Evaluate respirations, heart rate, and color		
	Yes - epinephrine 	Perform corrective action 	No epinephrine 
30 seconds later 2-6 times	Evaluate respiration, heart rate , and color		

	Administer volume expander over 5- 10 minutes 2 nd dose of epinephrine in UVC would need to wait 3 minutes (optional)		
	Yes – volume expander 	Perform corrective action 	No volume expander 
	Discontinue chest compressions Continue PPV		
30 seconds later	Evaluate respirations, heart rate, and color		
	Improved 		
	Discontinue PPV, starts CPAP		
30 seconds later	Evaluate respirations, heart rate, and color		
	Provide post-resuscitation care		

Megacode #3

Megacode - #3			
Sally is a 17 year old woman in the delivery room. Gravida - 1 Para- 0, estimated date of confinement of 39 ³ / ₇ . Her membranes were artificially ruptured two hours ago for thick meconium stained amniotic fluid. Fetal heart-rate monitoring showed complicated variable decels. The vertex is visible on the perineum with pushing. Paul, her partner is helping by holding her legs while she pushes. Prepare for delivery.			
State <div style="border: 1px solid black; background-color: #0070C0; color: white; padding: 5px; display: inline-block; border-radius: 5px;">1</div> <ul style="list-style-type: none"> Set Lungs at closed Apply meconium to chest and leg 	Heart rate: 40 Respiration rate: 0 Lung sounds: None	Color: Blue Cry: None Tone: Limp	Meconium Vaginal Delivery 39 ³ / ₇ weeks' gestation Meconium-stained amniotic fluid Estimated weight: 3500 g
Check bag, mask and oxygen supply:			
Baby is placed on radiant warmer. Physician states "it is a boy, about 3500g"			
Within 30 seconds	Term? Clear amniotic fluid? Breathing or crying? Good muscle tone?		Low fidelity: Asks or indicates High fidelity: States answers verbally or indicates otherwise
	Assess if baby is vigorous: <ul style="list-style-type: none"> Good respirations? Good muscle tone? Heart rate > 100? 		
	Provide warmth and position		
	Call for help and initiate Neonatal Resuscitation Record		
	Intubate, suction mouth and trachea		
	Yes - intubate <div style="border: 1px solid black; background-color: #70AD47; color: white; padding: 5px; display: inline-block; border-radius: 5px;">2 HR-70, RR-4</div>	Perform corrective action 	No - intubation and/or suction <div style="border: 1px solid black; background-color: #0070C0; color: white; padding: 5px; display: inline-block; border-radius: 5px;">1 HR-40, RR-0</div>
Dry, stimulate, reposition head			
Evaluate respiration, heart rate, and color			
After suctioning change lungs to open or "air went in"	Provide effective PPV Heart rate not rising and chest not moving: <ul style="list-style-type: none"> Reapply mask, lift jaw forward (seal) Reposition head, check secretions, open mouth (obstruction) Increase pressure (resistance)- (not necessary) <div style="border: 1px solid black; background-color: #0070C0; color: white; padding: 5px; display: inline-block; border-radius: 5px;">0 HR-0, RR-0</div>		No or ineffective PPV Fails megacode if suction or increases pressure prior to reapplying mask and lifting jaw forward <div style="border: 1px solid black; background-color: #0070C0; color: white; padding: 5px; display: inline-block; border-radius: 5px;">0 HR-0, RR-0</div>
	Check for improvement in heart rate (no improvement)		
Perform intubation Confirm placement with CO ₂ detector, evaluate heart rate, check air entry Add sat probe and blended oxygen if greater than 90 seconds			
Yes - intubation <div style="border: 1px solid black; background-color: #0070C0; color: white; padding: 5px; display: inline-block; border-radius: 5px;">1 HR-40, RR-0</div>	Perform corrective action 	No intubation or poor placement <div style="border: 1px solid black; background-color: #0070C0; color: white; padding: 5px; display: inline-block; border-radius: 5px;">0 HR-0, RR-0</div>	
30 seconds later	Evaluate respirations, heart rate, and color		

	Start chest compressions coordinated with PPV with 100% oxygen		
	Yes – chest compressions 1 HR-40, RR-0	Perform corrective action 	No chest compressions 0 HR-0, RR-0
30 seconds later	Evaluate respirations, heart rate, and color		
	Administer epinephrine in a timely manner <ul style="list-style-type: none"> Initial dose in ETT tube (not with LMA) Asks 3rd learner to insert UVC Prepares second dose of epinephrine for UVC 		
	Yes - epinephrine 1 HR-40, RR-0	Perform corrective action 	No epinephrine 0 HR-0, RR-0
30 seconds later 6 times (3 min)	Evaluate respirations, heart rate, and color		
	2 nd dose of epinephrine in UVC would need to wait 3 minutes Administer volume expander over 5- 10 minutes (optional- no bleed)		
	Yes – 2 nd epinephrine 2 HR-70, RR-4	Perform corrective action 	No epinephrine 0 HR-0, RR-0
30 seconds later	Evaluate respirations, heart rate, and color		
	Discontinue chest compressions Continue PPV Improvement 3 HR-120, RR-10		
30 seconds later	Evaluate respirations, heart rate, and color		
	Improvement 5 HR-140, RR-40 Discontinue PPV Provide post-resuscitation care		

Appendix H: Megacode Assessment Form

Megacode Assessment Form (Advanced) - Canadian Adaptation

Learner:Code#:		Order of Evaluation: 1st 2nd 3rd	Fidelity of Manikin: High or Low		
Evaluator:		Date:			
Lessons completed: 1-4 5 6		PASS ____	REEVALUATE ____		
<p>Scoring: 0 = Not Done 1 = Done incorrectly, incompletely, or out of order 2 = Done correctly in order</p> <ul style="list-style-type: none"> Student must perform each of the 5 bold items correctly. Scenario must include required items from each lesson that the student has completed. All students must complete Lessons 1-4 and Closure. Students taking Lesson 6 must prepare and insert or assist with umbilical venous catheter placement and administer medication (if appropriate to learner's role/scope of practice). These skills are not scored, and are not considered when computing the student's score. However, the instructor may decide if the student needs additional feedback and instruction on these skills. Lessons 7 through 9 skills and concepts may be included on Megacode. These skills are not scored, and are not considered when computing the student's score. However, the instructor may decide if the student needs additional feedback and instruction on these skills. 					
Lesson	Possible Points (circle)	Item	0	1	2
1	2	Checks Bag, Mask, and Oxygen Supply			
	2	Asks 4 Assessment Questions (Term? Meconium? Breathing? Tone?)			
2	2 optional	(optional) If meconium, determines if endotracheal suction is indicated (#3 only)			
	2	Positions head, suctions mouth then nose			
	2	Dries ¹ , removes wet towels and repositions			
	2	Requests description of breathing, heart rate, and color			
3	2	Indicates need for positive-pressure ventilation (Apnea, heart rate <100 beats per minute [bpm], central cyanosis despite supplemental O₂)			
	2	Provides positive-pressure ventilation correctly (40-60 breaths/min)			
	No score	Administers oxygen appropriately ² .	No score		
	2	Checks for improvement in heart rate (Instructor note: Heart rate does NOT improve.)			
	2	Takes corrective action when heart rate not rising and chest not moving (Reapply mask, lift jaw forward, reposition head, check secretions, open mouth, increase pressure if necessary.)			
2	Reevaluates heart rate (Instructor note: Heart rate must remain <60 bpm.)				
4	2	Identifies need to start chest compressions with 100% oxygen (Heart rate <60 bpm despite 30 seconds of effective positive-pressure ventilation)			
	2	Demonstrates correct compression technique (Assess correct finger or thumb placement, compress one third of the anterior-posterior diameter of the chest.)			
	2	Demonstrates correct rate and coordination with ventilation (Ask student and assistant to switch positions.)			
5	2	Identifies need for intubation			
	2	Intubates or assists intubation correctly			
6	2	Identifies need for epinephrine (Heart rate <60 bpm despite positive-pressure ventilation and compressions)			
	No score	Prepares correct doses of epinephrine in appropriate-sized syringe (0.1 mL/kg IV and 1.0 mL/kg ET)	No score		
		Administers ET dose while umbilical catheter being prepared			
		Prepares umbilical venous catheter for insertion			
2	Inserts umbilical venous catheter				
2	Administers epinephrine via umbilical venous catheter and/or endotracheal tube				
2 optional	(optional) Identifies need for volume administration (# 1 & 2 only)				
Closure	2	Continues/discontinues positive-pressure ventilation appropriately or weans free-flow oxygen			
	X .85	Total of all circled points (38 points maximum) Multiply total by .85 = minimum acceptable passing score			
Student's Score Subtotals					
Student's Total Score (add subtotals)					
Performed all 5 bold items correctly?			Y	N	Reevaluate

(1) Drying the skin does not apply to babies < 28 weeks; these babies should be placed wet into a food-grade polyethylene bag below the neck
 (2) Ventilate with 21% oxygen IF < 90 seconds of age; with supplemental O2 if > 90 seconds of age

For use in Canada

Appendix I: Roles, Responsibilities, Agendas, and Scoring

Building capability: Impact of low and high fidelity manikins on neonatal resuscitation simulation

May 6, 7, 12, 14, 21, June 2, 4, 9, and 18th, 2009

Roles and responsibilities

SPHERE coordinator

Set up room as delivery room

- Maternal manikin

- Radiant warmer close to wall oxygen

- Red emergency cart next to warmer with top cleared

- Oxygen blender (attached to wall oxygen) next to warmer

Set up randomly selected manikin

- Infant manikin on radiant warmer

- Umbilicus primed with artificial blood

- If SimNewB:

 - Air compressor and manikin controller attached to manikin

 - CO2 attached to air compressor

 - Remote controller on warmer

Simulation:

- Plays family member in practice scenarios

NRP Instructor

Set up:

- Set up NRP supplies on red cart

- Ensure blender is functioning

Simulation:

- Coordinate the simulation

- Places “baby” on warmer when simulation starts

- Operate the remote control

- Facilitate the debriefing

- Score the megacodes

Administer NRP written evaluation in debriefing room

Clean up:

- Clean up NRP supplies

- At end of day: Clean artificial blood out of manikin

- SimNewB: Turn off air compressor and manikin controller

Collect

- Ensure NRCT, Megacode, and NRP Exam only have coded numbers on them, no names

- Megacode

- Place pre and post NRCT, Megacode, and NRP exam in envelope in SPHERE room.

Agenda Group 1

Three groups each day. Each group will consist of one NRP instructor and 3 subjects.
0900-1330, 1200-1630, and 1500-1930

0900 Group will meet in hall outside of SPHERE lab
Fill in roster (instructor and subjects) (one sheet per day, leave in binder)
Sign research consent
Subjects complete NRCT (pre)survey

0915 In SPHERE room,
NRP instructor will read Script for Practice Scenarios
Start Practice scenario #1
Debrief (15 minutes)

0945 Practice scenario #2
Debrief (15 minutes)

1015 Practice Scenario #3
Debrief (15 minutes)

5 minute break

1100 Test Megacodes. Read Script for Megacodes
Perform Mega codes #1, 2, & 3
20 minutes each including reviewing score, no debriefing

1200 Move to debriefing room and have subjects write NRP exam (allow up to 1½ hours)
Mark NRP exam
Subjects complete NRCT (post)survey
Give each subject the small envelope containing the NRCT Post-one month survey.
Encourage to fill it out in One Month (date is on envelope) and return it to Linda via the
hospital train (translogic) as addressed.
Place all forms in manila envelope and seal
Place manila envelope in blue file box

Agenda Group 2

Three groups each day. Each group will consist of one NRP instructor and 3 subjects.
0900-1330, 1200-1630, and 1500-1930

1200 Group will meet in hall outside of SPHERE lab

Fill in roster (instructor and subjects) (one sheet per day, leave in binder)

Sign research consent

Subjects complete NRCT (pre)survey

1215 In SPHERE room,

NRP instructor will read Script for Practice Scenarios

Start Practice scenario #1

Debrief (15 minutes)

1245 Practice scenario #2

Debrief (15 minutes)

1315 Practice Scenario #3

Debrief (15 minutes)

5 minute break

1400 Test megacodes. Read Script for Megacodes

20 minutes each including reviewing score, no debriefing

1500 Move to debriefing room and have subjects write NRP exam (allow up to 1½ hours)

Mark NRP exam

Subjects complete NRCT (post)survey

Give each subject the small envelope containing the NRCT Post-one month survey.

Encourage to fill it out in One Month (date is on envelope) and return it to Linda via the hospital train (translogic) as addressed.

Place all forms in manila envelope and seal

Place manila envelope in blue file box

Agenda Group 3

Three groups each day. Each group will consist of one NRP instructor and 3 subjects.
0900-1330, 1200-1630, and 1500-1930

1500 Group will meet in hall outside of SPHERE lab
Fill in roster (instructor and subjects) (one sheet per day, leave in binder)
Sign research consent
Subjects complete NRCT (pre)survey

1515 In SPHERE room,
NRP instructor will read Script for Practice Scenarios
Start Practice scenario #1
Debrief (15 minutes)

1545 Practice scenario #2
Debrief (15 minutes)

1615 Practice Scenario #3
Debrief (15 minutes)

5 minute break

1700 Test megacodes
20 minutes each including reviewing score, no debriefing

1800 Move to debriefing room and have subjects write NRP exam (allow up to 1½ hours)
Mark NRP exam
Subjects complete NRCT (post)survey
Give each subject the small envelope containing the NRCT Post-one month survey.
Encourage to fill it out in One Month (date is on envelope) and return it to Linda via the
hospital train (translogic) as addressed.
Place all forms in manila envelope and seal
Place manila envelope in blue file box

Megacode Assessment Form

Forms will be pre assigned subject Code #s,

Ensure each subject has the corresponding code # form the master sheet.

Do not add names

Include evaluator Name

Include order of evaluation: 1, 2 or 3

Scoring:

0 = Not Done

1 = Done incorrectly, incompletely, or out of order

2 = Done correctly in order

- Subject must perform each of the 5 bold items correctly.

If Subject fails Megacode:

Allow them to complete the megacode and score appropriately

Allow them to repeat the megacode if time permits

If subject fails on second attempt:

Point out some things they have done well

Instruct them to practice on their own time

Instruct subject to contact their educator to arrange a retest at the hospital

NRP Exam

Forms will be pre assigned a subject Code #.

Ensure each subject has the corresponding code# from master sheet.

Allow up to 1 ½ hours to write.

Mark exam outside of room

If subject passes a section and has question(s) wrong

Show them the correct answer and ask them to review the question.

Discuss any misunderstandings.

If subject has failed a section.

Do not show them the right answers

Provide them with a new answer sheet and allow them to rewrite the section(s)

If a subject has failed to pass lessons in a second attempt

The learner must retake the entire evaluation

Instruct them to contact their educator and arrange to rewrite at a different time

Appendix J: NRCT

Neonatal Resuscitation Confidence Tool				Pre-NRP Code # _____
<p>Instructions: Please indicate your opinion about each statement with the appropriate response to the right of each statement. Check off the box that most reflects your level of confidence. There are no right or wrong answers. Please be truthful and describe how confident you really are, not how confident you would like to be. Your response is confidential and will not reflect on your NRP renewal.</p>				
How confident are you in...	1 Not at all confident	2 Somewhat confident	3 Moderately confident	4 Very confident
1. Resuscitating an apneic neonate	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
2. Anticipating and preparing for a resuscitation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
3. Assuming the leadership role in a neonatal resuscitation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
4. Communicating effectively during a neonatal resuscitation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
5. Delegating the workload during a neonatal resuscitation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
6. Clearing the mouth and nose of secretions	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
7. Assisting management of a neonate if meconium is present and the neonate is not breathing	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
8. Recognizing the need for assistance and calling for help	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
9. Preparing for a resuscitation of a 27 week gestation neonate	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
10. Maintaining professional behavior during a neonatal resuscitation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
11. Recognizing the need to use positive pressure ventilation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
12. Performing positive pressure ventilation on a neonate	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
13. Evaluating the effectiveness of positive pressure ventilation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
14. Recognizing when to administer oxygen during a resuscitation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
15. Administering blended oxygen	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
16. Performing chest compressions	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
17. Documenting on the Neonatal Resuscitation Record	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
18. Resuscitating a neonate when the family are asking questions	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
19. Working effectively as a member of a team during a resuscitation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
20. Assisting with the intubation of a neonate	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
21. Assessing endotracheal tube placement including the use of a CO ₂ detector	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
22. Communicating with the family during a difficult resuscitation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
23. Assessing the need for an umbilical catheter	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
24. Preparing an epinephrine dose for a 3 kg neonate	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4

Appendix K: Content Expert Form

Content Validity

1. Assess the relevancy of each item for the confidence of neonatal resuscitation?

- 1 = not relevant
- 2 = somewhat relevant
- 3 = quite relevant
- 4 = very relevant

2. Are all of the dimensions of confidence in neonatal resuscitation represented by the set of items?

- a. Yes _____
- b. No, please explain _____

3. Are the items and the instruction for responding to the items clear?

- a. Yes _____
- b. No, please explain _____

4. Should only items be added or deleted?

5. Do you have any idea for revision?

Name: _____

Content Validity of Neonatal Resuscitation Confidence Tool			
Content validity expert (name) _____			
<p>Assess the relevancy of each item for the confidence of neonatal resuscitation? 1 = not relevant 2 = somewhat relevant 3 = quite relevant 4 = very relevant</p>			
How confident are you in...	Relevancy	Delete item	Edit item
1. Resuscitating an apneic neonate with no heart rate			
2. Anticipating and planning a resuscitation			
3. Assuming the leadership role in a neonatal resuscitation			
4. Communicating effectively during a neonatal resuscitation			
5. Delegating the workload during a neonatal resuscitation			
6. Assisting management of a newborn if meconium is present and the neonate is not breathing			
7. Calling for help as needed			
8. Preparing for a resuscitation of a 25 week gestation newborn			
9. Recognizing the need to suction			
10. Maintaining professional behavior during a neonatal resuscitation			
11. Recognizing the need to use positive pressure ventilation			
12. Evaluating the effectiveness of positive pressure ventilation			
13. Recognizing when to administration oxygen during a resuscitation			
14. Performing chest compressions			
15. Documenting on Neonatal Resuscitation Record			
16. Resuscitating an infant when the parents are asking difficult questions			
17. Working as a team player during a resuscitation			
18. Assisting with the intubation of a neonate			
19. Communicating with the father during a difficult resuscitation			
20. Assessing the need for an umbilical catheter			
21. Preparing an epinephrine dose for a 3 kg infant			
22. Assisting in inserting an umbilical catheter			
23. Initiating a debriefing with the resuscitation team following a resuscitation			

Appendix L: Demographics

Demographic Questionnaire

Date _____ Code # _____

What area(s) do you currently work in?
(check all that apply)

- NICU
- Delivery Suite
- Rural Hospital
- Other _____

How long have you worked in an NICU or
delivery suite (including rural)? _____ years

How many neonatal resuscitations requiring
positive pressure ventilation, have you
performed in the past 24 months?

- zero
- 1-4
- 5-9
- 10-19
- 20 +

In your opinion how many of the above
resuscitations had a poor outcome for the
neonate? _____

What is your level of education?
(check all that apply)

- Respiratory Therapist Diploma
- Nursing Diploma
- Bachelor's of Nursing
- Perinatal/Neonatal Certification
- Midwifery
- Master's Degree
- Doctorate

How many NRP courses have
you completed in your career? _____

Appendix M: Script

Script for Megacode Using Low-Fidelity Manikin

We're here to do your Megacode Evaluation.

You are being evaluated on Initial Step, Positive-Pressure Ventilation, and Chest Compressions.

You will also be evaluated on Intubation and Medication Administration.

This means that you are required to draw up the correct dose of epinephrine and label it for administration via the endotracheal tube and/or umbilical venous catheter.

In just a moment, I'll give you basic information about the baby you've been called to take care of.

When you begin the resuscitation, work quickly and efficiently as if this were a real baby and a real resuscitation.

You can talk while you work, but don't let it slow you down. It's what you do in real time that I'll evaluate.

The baby does not have a pulse or change color, so you'll have to ask me for additional information. I won't tell you how the baby is doing until you ask, and I won't give you hints about what to do next. This is because part of the evaluation is knowing when to look for specific signs, and how to proceed quickly. If you require an assistant, indicate that you need another person to help you. The assistant will know how to perform resuscitation but will not begin an intervention until you direct him or her to do so.

Do you have any questions?

Please demonstrate how you would prepare for the baby's birth. Prepare all equipment as you would for a real delivery. Tell me when you're ready to proceed. If necessary, you may ask me additional detail about the pregnancy and labor.

Script for Megacode Using High-Fidelity Manikin

We're here to do your Megacode Evaluation.

You are being evaluated on Initial Step, Positive-Pressure ventilation, and Chest Compressions.

You will also be evaluated on intubation and medication administration.

This means that you are required to draw up the correct dose of epinephrine and label it for administration via the endotracheal tube and/or umbilical venous catheter.

In just a moment, I'll give you basic information about the baby you've been called to take care of.

When you begin the resuscitation work quickly and efficiently as if this were a real baby and a real resuscitation.

You can talk while you work, but don't let it slow you down. It's what you do in real time that I'll evaluate.

The baby has a pulse and changes color, so you will not be given any additional information or hints about what to do next. This is because part of the evaluation is knowing when to look for specific signs, and how to proceed quickly. If you require an assistant, indicate that you need another person to help you. The assistant will know how to perform resuscitation but will not begin an intervention until you direct him or her to do so.

Do you have any questions?

Please demonstrate how you would prepare for the baby's birth. Prepare all equipment as you would for a real delivery. Tell me when you're ready to proceed. If necessary, you may ask me additional detail about the pregnancy and labor.

Script for Practice Scenarios Using High-Fidelity Manikin

Welcome to NRP. We will start out with practice scenarios.

Simulation training allows you to learn and practice how to act and react in a real-life newborn encounter and not just in the classroom. Simulation in teams is a chance for you to make your mistakes in a safe environment, improve communication and improve our ability to work in a team.

It is important to understand that, to maximize the benefits of simulation for you and your colleagues, you must enter into the spirit of the story and act as if the newborn simulator is a real newborn. “Believing” the simulation and trying not to “break the illusion” will make it a much better learning experience.

The newborn will be both male and female, although they may look similar because you are working with a simulator. Each newborn has a different maternal history, gestational age, and weight, which will make them unique.

The SimNewB features, controlled by the instructor, allow you to assess and reassess relevant baseline vital signs, symptoms, and feedback of the newborn, such as the following:

- Vocal response (strong cry, grunting, weak cry)
- Movement (limp, tone, spontaneous movement)
- Spontaneous breathing//visible chest rise and fall
- CO₂ exhalation
- Cyanosis around the mouth
- Independent right and left lung sounds
- Bilateral and unilateral chest movement with mechanical ventilation
- Heart sounds
- Umbilical pulse
- Umbilical vein access for medication and fluid administration
- Insertion of gastric tube for stomach decompression
- Intubation ability – **Do not insert fluids into the airway**

You will need to simulate: inserting fluid in the airway, cutting the umbilicus, and turning on the warmer.

Each of you will take a lead role in resuscitation

The adult manikin represents the mother and an actor will represent a family member.

All participants in simulation often feel some degree of stress from the experience. This is because of a variety of factors (e.g. practicing in an unfamiliar setting, the uncertainty of the experience itself). Generally, this is harmless and actually may contribute to the learning experience.

When the actual simulation is over, a debriefing/guided reflection session will occur. You will receive feedback or your performance from your fellow students and myself. The debriefing also should be the time for you to get the answers to your questions and uncertainties that may have come up during the simulation itself.

Please try to refrain from asking questions or hints during the simulation and save them for the debriefing session.

In just a moment, I'll give you basic information about the baby you've been called to take care of.

When you begin the resuscitation work quickly and efficiently as if this were a real baby and a real resuscitation.

Verbalize your actions and work as a team.

Do you have any questions?

Script for Practice Scenarios Using Low-Fidelity Manikin

Welcome to NRP. We will start out with practice scenarios.

Simulation training allows you to learn and practice how to act and react in a real-life newborn encounter and not just in the classroom. Simulation in teams is a chance for you to make your mistakes in a safe environment, improve communication and improve our ability to work in a team.

It is important to understand that, to maximize the benefits of simulation for you and your colleagues, you must enter into the spirit of the story and act as if the newborn simulator is a real newborn. “Believing” the simulation and trying not to “break the illusion” will make it much better learning experience.

The newborn will be both male and female, although they may look similar because you are working with a simulator. Each newborn has a different maternal history, gestational age, and weight, which will make them unique.

The baby does not have a pulse or change color, so you’ll have to ask me for additional information. I won’t tell you how the baby is doing until you ask, and I won’t give you hints about what to do next.

The Manikin features include the following:

- Chest movement with mechanical ventilation
- Umbilical vein access for medication and fluid administration
- Insertion of gastric tube
- Intubation ability – **Do not insert fluids into the airway**

You will need to simulate: inserting fluid in the airway, cutting the umbilicus, and turning on the warmer.

The adult manikin represents the mother and an actor will represent a family member.

Each of you will take a lead role in resuscitation

All participants in simulation often feel some degree of stress from the experience. This is because of a variety of factors (e.g. practicing in an unfamiliar setting, the uncertainty of the experience itself). Generally, this is harmless and actually may contribute to the learning experience.

When the actual simulation is over, a debriefing/guided reflection session will occur. You will receive feedback on your performance from your fellow students and myself. The debriefing also should be the time for you to get the answers to your questions and uncertainties that may have come up during the simulation itself.

Please try to refrain from asking questions or hints during the simulation and save them for the debriefing session.

In just a moment, I’ll give you basic information about the baby you’ve been called to take care of.

When you begin the resuscitation work quickly and efficiently as if this were a real baby and a real resuscitation.

Verbalize your action and work as a time.

Do you have any questions?