CLINICAL REASONING IN NURSING STUDENTS

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of the Requirements for the Degree
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in
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by
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ABSTRACT

CLINICAL REASONING IN NURSING STUDENTS

by

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Nursing students are expected to learn an enormous amount of information, implement interventions and evaluate patient outcomes in their few years of nursing school. Nursing students have limited experiences in the clinical setting to refine their clinical reasoning skills. In the clinical setting, patients leave the hospital sooner due to limited reimbursements while others are so sick that the student might not get a chance to learn from the experience due to the acuity and fast pace of the assignment. Simulation can provide students with a very similar experience to the real patient setting, thus allowing them time to consider and apply their knowledge. This study looked at whether simulation experience assisted the nursing student in recognizing the salient features of a patient scenario as evidenced by a focused assessment tracked by the Clinialedonline.com© computer program using a septic patient case study. The post-test scores would suggest that this research question was supported by the pass rates. The computer program allowed the nursing students to be evaluated on their understanding of
assessment and implementation of appropriate interventions for the septic patient. Through the use of the interactive program, the participants were required to evaluate lab data, clinical presentation and current orders before choosing from a number of different treatment options such as fluid, antibiotics, vasopressors and steroids. This process showed that the nursing students improved their ability to evaluate and implement the nursing process which requires clinical reasoning skills. Clinical reasoning develops with mental models that incorporate experience from patients; simulation provided a model of ideal care of the septic patient for the nursing students to correctly assess and treat patients using the sepsis bundle of treatment elements.
CHAPTER I

INTRODUCTION

Nursing students are expected to learn an enormous amount of information, implement interventions and evaluate patient outcomes in their few years of nursing school. According to the Carnegie study, nursing faculty provide students with situated coaching and knowledge but this does not necessarily translate to application of the information in practice (Benner, Sutphen, Leonard, & Day, 2010, p. 31). Nursing students have limited experiences in the clinical setting to refine their clinical reasoning skills. In the clinical setting, patients leave the hospital sooner due to limited reimbursements while others are so sick that the student might not get a chance to learn from the experience due to the acuity and fast pace of the assignment. Simulation can provide students with a very similar experience to the real patient setting, thus allowing them time to consider and apply their knowledge. The Carnegie study recommended that nursing education: “shift from an emphasis on critical thinking to an emphasis on clinical reasoning and multiple ways of thinking that include critical thinking” (p. 84). Clinical reasoning skills develop while a nurse is taking in multiple streams of information such as patient responses to interventions, consideration of co-morbidities and developing care plans towards a particular outcome. This cannot be accomplished in a classroom lecture setting where the learner is not applying knowledge (Knowles, 1973). Simulation offers
students the ability to practice exactly how to respond to changes in a patient condition and thus develop the reasoning skills needed for their eventual nursing practice.

Background

Simulation of clinical scenarios using high fidelity mannequins has many advantages compared with practice in the actual clinical setting, including: no threat to actual patients, active learning can occur, errors can be corrected and discussed immediately, and communication, teamwork, and delegation can be incorporated into many scenarios (Medley & Horne, 2005). This experience allows the students to interact using their prior knowledge and start forming problem solving abilities (Wotton, Davis, Button, & Kelton, 2010). It has been hypothesized that simulation can lead to the development of clinical reasoning skills. In a literature review by Cato, Lasater and Peeples (2009), many qualitative studies show students feel more confident after participating in simulations that include debriefing, however, there are few quantitative studies that measure whether the student gained skill in clinical reasoning (Lasater, 2007).

Clinical reasoning skills are important for the competent nurse in bedside practice. Developing these skills in the nursing student is a complex issue for several reasons. These reasons include: limited clinical placements, a shortage of experienced faculty to observe students in those settings, and very little time to give effective feedback for the student to formulate problem-solving skills. Clinical reasoning is a complex thought process that includes cognitive strategies, information recall, and the ability to make clinical decisions in problem resolution to achieve patient outcomes.
(Forsberg, Georg, Ziegert, & Fors, 2011). While there are limitations to clinical placements and therefore, less time to build reasoning skills, simulation can provide students with time to apply knowledge and receive prompt feedback from faculty.

Clinical reasoning is difficult to assess and there are few tools such as rubrics based on competence that are available (Cato, Lasater & Peeples, 2009; Lasater, 2007). Other tools to assess clinical reasoning are reflective writing or focused articulation (Murphy, 2004). The Creighton Simulation Evaluation Instrument was developed and tested by faculty and has been further tested for validity and reliability. The Creighton Simulation Evaluation Instrument shows promise as a tool for evaluating students but it is not known if it has been widely adopted in nursing schools (Adamson et al., 2011; Dillard et al., 2009).

Assessing clinical reasoning is difficult because of the variability in practice that can lead to positive health outcomes. A meta-analysis of studies measuring critical thinking in nursing found the majority of scores did not improve despite specific interventions (Murphy, 2004). Since that time, many innovations in computerized programs have been developed such as in-depth case studies with monitor readings that respond to interventions and virtual patients that are based on real cases. In medical education the United States Medical License Exam (USMLE) utilizes software that is programmed to recognize and analyze over 2500 actions; the inputs to the program by the examinee are measured against responses from real clinical encounters (Kreiter & Bergus, 2009).
Critical Thinking and Sepsis

One disease process that requires advanced clinical reasoning skills is sepsis. Sepsis is a syndrome described as the body’s overwhelming inflammatory response to infection, which can lead to organ failure, abnormal bleeding, clotting, and eventually, death. Sepsis is diagnosed in 750,000 patients per year with a mortality rate as high as 50% (Society of Critical Care Medicine, 2012). As many as 500,000 patients per year admitted to hospitals with septic shock come through the Emergency Department (ED) (Wang, Shapiro, Angus, & Yealy, 2007). Although sepsis has a high mortality rate, the interventions to save patients are simple: early identification, rapid infusion of fluids to oxygenate the body tissues affected by inflammation and early administration of antibiotics.

Sepsis is a multi-organ disease process that is further complicated in patients with co-morbidities such as diabetes, end-stage renal disease, and cardiac history. Nurses need to be able to rapidly identify and advocate for treatments for septic patients. Patients can decompensate unless they receive large amounts of fluid when they are in fulminant septic shock and it takes strong clinical reasoning skills to determine whether the patient is responding to treatment or if they need more fluids. Simulation with septic patients can help develop these clinical reasoning skills in nursing students so they can carry this knowledge forward into their clinical practice.

Nurses need to recognize subtle changes in the criteria that qualify a patient for sepsis inclusion. Having clinical reasoning skills will help the nurse determine the salient features of a patient presentation which will help them advocate for the appropriate orders. Patients who start at a lactate level as low as 1.0 mg/dL can progress
quickly to a lactate greater than 4 mg/dL and it becomes harder to catch up with the progressive organ damage that is occurring at the cellular level. Nurses need well-developed clinical reasoning skills to build on their existing knowledge due to the high level of critical thinking involved with this type of patient. For example, treatment for congestive heart failure and renal failure is limited fluid administration but septic patients require massive fluid boluses, sometimes up to 20 liters of crystalloids. The nurse must understand that the patient needs this fluid to survive sepsis and the congestive heart failure or renal damage can be managed and later corrected by a skilled intensivist.

Statement of the Problem

In order for nursing students to practice the application of their knowledge, they should be taught in a style that most closely mimics real practice (Knowles, 1973). Nurses need the clinical reasoning skills to help patients with sepsis so they receive the appropriate interventions as quickly as possible. Research on simulation supports this style of education as being more effective for the adult learner than passive lecture style (Cato, Lasater & Peeples, 2009). Knowles’ adult learning theory states that the andragogical teacher creates an environment for learning by providing processes and resources for learners to acquire information and skills (Knowles, 1973). As opposed to pedagogy where information is told to the learner and the teacher evaluates what was learned, andragogy helps the learner identify his or her own learning needs and to self-evaluate what they have learned. A classroom setting where a nurse can work with a simulated patient experience can help the nurse develop his or her critical thinking in an environment where it is safe to make mistakes and ask questions without compromising a
Nurses can have a good understanding of the pathophysiology of sepsis but this does not necessarily translate into the clinical reasoning skills needed in difficult patient cases. Many hospitals offer lecture style classes that focus on early identification and rapid treatment of sepsis. This helps many nurses recognize patients in severe sepsis or septic shock but the early signs of sepsis can be more elusive. The hyperdynamic phase of sepsis includes a bounding pulse, fever and a stable blood pressure. If the nurse is not suspicious of infection, these symptoms can be overlooked until the patient starts to decompensate. The use of simulated patient scenarios via computer programs or simulation style classrooms can aid the nurse in working through these patient scenarios. As the nurse learns what symptoms to focus on, s/he develop his or her clinical reasoning skills in determining the salient features of a patient case. This can lead them to advocating earlier for a patient and potentially saving a patient from significant morbidity and mortality. A simulation setting can be produced to lead the nurse down a pathway of a decompensating patient; if the nurse does not perform certain interventions in a timely manner, the mannequin can show signs of severe shock and even death. Learning that takes place in a simulated environment helps nurses develop their thought processes as they are active participants in the scenario, not passive recipients of a lecture. Nurses can practice advocating for patient needs with a physician model so they develop this
important skill for the real clinical area. Research done on the learning environment of simulation and specific pathologies such as sepsis will be beneficial in determining the best way to help nurses provide the best care for these patients.

Significance to Nursing

Nursing students are faced with acutely ill patients in their clinical learning environment who stay less time in the hospital due to recent changes in reimbursement. The new graduate nurse must be able to quickly assess, analyze, and plan for the patient who may be experiencing a complication or change in condition that warrants an intervention. This research project will provide greater understanding of the role of simulation and online instruction in undergraduate nursing education, provide outcome data on a computer program to evaluate clinical reasoning and determine if nursing students can recognize the salient features of a septic patient and provide correct interventions.

Theoretical Framework

For this research study, Benner’s concept of novice to expert will be used to describe the progress of the nursing students. Benner applied the Dreyfus Model of Skill Acquisition to nursing and found that nurses progress in their performance levels in Figure 1.

Figure 1. Progress of nurse’s performance levels.
The novice nurse has no experience with situations and is primarily task-oriented. The advanced beginner has experienced enough real situations to be able to recall meaningful situational components. In order to start recognizing patterns, the advanced beginner must have prior experiences to start forming meaningful connections. The competent nurse has typically been on the job for two to three years and can see his or her actions in the scope of a long range process of goals for a patient. They are consciously aware of their plans and can manage the many contingencies of clinical nursing. They are able to deliberately plan their work in order to be efficient and organized. Nurses at this level benefit from simulation training to enhance their clinical reasoning skills. The proficient nurse perceives situations as a whole instead of components and they are comfortable when the unexpected occurs in a patient’s plan. A proficient nurse is able to find meaning in nuances of patient presentations and can apply clinical reasoning skills to solve problems quickly. The expert nurse has an intuitive grasp of a situation and can find the salient features in a patient presentation in which to make a plan for the patient’s care. This nurse may be unable to describe how he or she works or thinks because it has become second nature. Expert nurses can be encouraged to write exemplars of patient scenarios for the less experienced nurse to learn from in a teaching environment (Benner, 1982).

This study will involve nursing students in their novice to advanced beginner phase in a simulation course. The simulation course includes multiple scenarios including clinical issues, ethical dilemmas and patient teaching that are designed for the students to learn from with their classmates in a teamwork setting. During this fifth semester capstone simulation class, the students will participate in a sepsis scenario. The students
will be evaluated on their ability to focus their assessment skills to recognize the salient features of a septic patient requiring timely intervention. A computer program will be used to assess clinical reasoning related to sepsis. The program records the time for each student to move through four computerized patient scenarios to assess whether the students are able to apply their clinical reasoning skills before and after participating in a sepsis scenario.

Purpose of the Study

This study will evaluate whether simulation leads to an improvement of times on a computer program (ClinicalEdonline.com©) that could show an increase in clinical reasoning skills. The results of this study may give insight as to whether time spent in simulation leads to students being able to find the salient features of a clinical scenario. This study will assist other nursing faculty in the development of valuable simulations and in the use of ClinicalEdonline.com© or other case study based computer programs to measure the progress of clinical reasoning skill development in nursing students. Forty students from four sections of a capstone simulation class will review the sepsis module from ClinicalEdonline.com© then complete two case studies on the ClinicalEdonline.com© program specific to sepsis. They will then take part in a sepsis scenario during their simulation class. The students will be given two more case studies from the ClinicalEdonline.com© program. Data will be gathered as to how much time was spent on the case studies before and after the simulation exercises. The results of these data can be used to show whether the student identified salient information more quickly which might show an increase in clinical reasoning abilities.
Research Question

Nursing students need experiences and feedback that provide them the foundation to start building their clinical reasoning skills. This study will examine the use of simulation and a computer program to evaluate changes in senior nursing students’ skills to recognize salient features of a septic patient. The research questions are:

“Does simulation experience lead to increased clinical reasoning abilities as measured by a faster time to complete a post-test after three sepsis simulation scenarios?

“Does simulation experience assist the nursing student in recognizing the salient features of a patient scenario as evidenced by increased pass rates for a focused assessment tracked by the ClinicalEdonline.com© computer program using a septic patient case study?”

Definitions

Clinical Reasoning

A complex cognitive process that uses formal and informal thinking strategies to gather and analyse patient information, evaluate the significance of this information and weigh alternative actions. Core essences of this concept include cognition, metacognition and discipline-specific knowledge. …Clinical reasoning is dynamic, expansive and recursive, as information, interventions and alternative actions are considered or discarded at multiple cognitive entrance points (Simmons, 2010, p. 1155).

Focused Assessment

An examiner's evaluation of the disease or condition based on the patient's subjective report of the symptoms and course of the illness or condition and the examiner's objective findings, including data obtained through laboratory tests, physical
examination, medical history, and information reported by family members and other health care team members (Elsevier, 2009, heading: assessment).

**Salience**

The components of a patient situation that are relevant and essential for the nurse or student to recognize, analyze and intervene to assist the patient in their health outcome (Benner, Sutphen, Leonard & Day, 2010).

**Sepsis**

A syndrome characterized by an overwhelming systemic response by the body to infection, which can rapidly lead to organ failure and, ultimately, death. Sepsis may cause multiple organs in the body to fail and trigger the onset of both abnormal clotting and bleeding. It can strike anyone but is most likely to develop from infection associated with pneumonia, trauma, surgery, burns, or conditions such as cancer and AIDS (Society of Critical Care Medicine, 2012).

**Simulation**

The reproduction of the essential features of a real-life situation. The process can be used with low or high fidelity mannequins but should include a means to provide feedback to the student for using correct or incorrect interventions leading to consequences to aid the student in developing critical thinking. The simulation experience is greatly enhanced when followed by guided reflection or debriefing, led by a skilled and knowledgeable instructor (Medley & Horne, 2005).
Qualifications of the Researcher

This researcher is a Certified Emergency Nurse who has been teaching sepsis to ED nurses for four years. The researcher uses lecture, simulation, and case studies for education as a unit-based Clinical Nurse Educator for two EDs in Northern California. In the role of Clinical Nurse Educator, this researcher serves on the hospital’s Regional Sepsis Committee, has attended multiple sepsis conferences, acted as a Clinical Trial Coordinator for Eli Lilly for drotrecogin alpha (Xigris), lectured to System level ED directors regarding rapid identification and bundle implementation of sepsis protocols, and serves as a content expert on sepsis for the hospital electronic medical record build. This researcher is co-teaching a simulation class at a baccalaureate nursing school in Northern California and also has experience running simulations for ED nurses in a teaching hospital in the San Francisco Bay Area. Starting in 2011 the researcher was a lecturer for a new nurse graduate program and utilized Knowles’ Theory of adult learning to engage the nurses with the use of unfolding case studies, concept mapping, and reflective writing.

Transitional Statements

Developing clinical reasoning skills will assist nursing students as they transition from nursing school to the practice environment. Simulation offers nursing students the opportunity to build these skills in a safe environment where they can receive immediate feedback from faculty. The next chapter will review the literature regarding concepts of clinical reasoning, simulation studies, and sepsis.
CHAPTER II

LITERATURE REVIEW

Nursing students need the time to incorporate the knowledge they have learned in nursing school and practice implementation in a safe environment. Simulation offers an environment where scenarios can be developed that allow the student to interact with a high fidelity mannequin that responds to interventions. This environment also provides a dialogue with the mannequin (through an instructor’s voice) so the student must respond verbally to the patient and consider patient responses to interventions. During these scenarios and the debriefings that follow, nursing students are given the opportunity to develop clinical reasoning skills. This can be measured in a computer program where the speed in which a student moves through a sepsis scenario can be measured to show the student is recognizing the salient features of a patient presentation. Sepsis is a time-sensitive syndrome where life-saving treatments must be given as soon as the process is identified. Morbidity and mortality for sepsis can be dramatically decreased when nurses have the knowledge and clinical reasoning skills to treat these patients efficiently.

Review of the Literature

A review of the literature was performed to gather the latest theories in clinical reasoning, simulation and the advancements in the treatment of sepsis. The
literature was reviewed for relevant articles to the research question: “Does simulation experience lead to increased clinical reasoning abilities as measured by a faster time to complete a post-test after three sepsis simulation scenarios?” and, “Does simulation experience assist the nursing student in recognizing the salient features of a patient scenario as evidenced by increased pass rates for a focused assessment tracked by the ClinicalEdonline.com© computer program using a septic patient case study?”

An on-line search using the terms: clinical reasoning, critical thinking, nursing students, simulation, sepsis, and evidenced-based practice was performed in the research database CINAHL, Google Scholar and PubMed. An additional search was performed to find evaluations and tools related to measuring clinical reasoning and knowledge gained in simulation. Studies were reviewed for relevance to the combined ideas of simulation and clinical reasoning; articles were also reviewed for recency although classical articles were also included. This section is divided into literature about clinical reasoning and measurement tools, then literature about simulation is explored.

Clinical Reasoning

In a concept analysis article, Simmons (2010) described clinical reasoning as a guide for nurses to assess, assimilate, retrieve and/or discard components of information that are salient to patient care. She described this skill as unique to registered nurses and important for the best care of the patient who is facing shorter hospital stays, higher acuity and continual advances in technology (Simmons). A history of the development of the concepts of clinical reasoning seems to start with the Information Processing Theory where decision-making is multidimensional, cyclical and pieces of information can be
added or subtracted for consideration (Simmons). Benner’s work of novice to expert as she applied Dreyfus’ Model of Skill Acquisition fits the concepts of clinical reasoning well; the higher levels of proficiency demand the clinical reasoning and judgment skills that nurses develop with experience. Simmons’ article described the antecedents and components of clinical reasoning which include: cognition, domain-specific knowledge, inference, information processing and experience (Simmons). This article provided a descriptive theory of clinical reasoning in nursing that defined the term and gave a broad view of the components necessary for this skill.

New computer learning programs attempt to meet the recommendations set forth by the Carnegie Foundation, the Robert Wood Johnson Foundation with the Institute of Medicine in changing how we educate new nurses. Computer programs can emphasize visual, audio and interactive patient cases to develop clinical reasoning skills. Programs may consist of different components:

Programs may consist of the following programs: lessons, cases and virtual rooms. Lessons can be video or text information that the student can learn at their own pace. Cases are meant to engage the learner to use the knowledge that have just reviewed. Virtual rooms can show monitors, lab data, patient history, and response to nursing interventions. The student sees the results of their interventions immediately so they can adjust and build their clinical reasoning skills. The virtual rooms encourage constant re-evaluation of the patient after each intervention which helps reinforce the subject matter.

Instruments that measure clinical reasoning in the literature are scarce. A study conducted on medical students combined knowledge with case studies where the students actively participated in problem-solving cases to determine a diagnosis
In this study, second-year medical students were taught using these four steps each week with a new diagnosis: 1) associate the symptom with the organ system, 2) establish a clinical database, 3) develop analytic clinical reasoning ability, and 4) practice clinical reasoning applying both analytic and nonanalytic strategies. The authors felt this was a good process to develop clinical reasoning skills based on the positive comments from the students in their course evaluation. The authors also used the Script Concordance Test which measures clinical reasoning at the beginning and end of the course to determine improvements in this skill. They found an increase in clinical reasoning skills that was statistically significant (Jacobsen et al., 2010). The limitations to this study are the small sample size (n less than 30) but it was performed over a two year class term and the design for the instructors was very clear with a well-developed plan (Jacobsen et al., 2010).

The Outcome-Present State Test Model of Clinical Reasoning (OPT) is a process that helps nursing students develop clinical reasoning skills. This was developed in 1998 by Pesut and Herman and used by Bartlett, Bland, Rossen, Kautz, Benfield, and Carnevale (2008) with nursing students on a psychiatric case study. The sample of 43 nursing students was comprised of undergraduates in their psychiatric-mental health nursing course. The OPT model was taught along with a clinical reasoning web. The students had to formulate a nursing diagnosis and create a plan for the patient to move from the current state of health to the desired (outcome) state (Bartlett et al., 2008). Next, the students used the OPT model on their assigned patients in the clinical setting over a four-week period and were given feedback by faculty each week. The students completed a case twice during the semester. Results showed statistical significance for improvement.
in the use of the tool. Limitations to this study include not actually measuring clinical reasoning, the OPT is merely a process by which students think about a patient or case and one third of the students did not actually master the use of the OPT (Bartlett et al., 2008).

A study using virtual patients on a computer program showed positive attitude responses from the students in terms of developing clinical reasoning skills (Forsberg et al., 2010). This program gives the students a case history, labs, physical exam data and imaging test results; the students must then come up with a diagnosis and treatment plan. Prior to giving each patient scenario, the instructor goes into the case and identifies the questions, tests and procedures that are most important per case, which is not visible to the students. The computer program measures how many of the important features the student chooses against the instructor’s choices. The study was performed on 77 undergraduate nursing students over three nursing courses at two universities. This is very similar to the ClinicalEdonline.com© program design but it did not look at the speed in which the students progressed through the cases. There were two testing sites; at one site all the students passed the case while some students failed at the second site creating a lot of variance for this study that was not addressed (Forsberg et al., 2010). This study primarily evaluated students’ opinions of the use of the computer program and did not compare whether the students became more proficient over time in their clinical reasoning skills (Forsberg et al., 2010).

Reflective thinking and journaling are a way for instructors to gain insight into students’ thinking processes. A study was conducted on nursing students to gain an understanding of the levels of clinical reasoning occurring after clinical experiences
(Murphy, 2004). The authors’ objective was to determine whether instruction in the use of focused reflection and articulation would aid in the development of clinical reasoning. Four groups of first semester nursing students and their instructors in a community college program were assigned to a control or treatment group. Two of the cohorts received the focused teaching while two groups received no intervention. The intervention was given as a two-hour workshop and reinforced throughout the semester. Next, the instructors for all the cohorts measured the students’ ability to comprehend, prioritize and accurately choose a nursing diagnosis from written patient assessments using the Assessment and Analysis Instrument. This tool was found to be reliable across instructors using Cronbach’s alpha at 0.90 and provided a measurement of the knowledge in use by the students. The “high” clinical reasoners were able to describe the events in ways that match Benner’s model. They reported their attitudes towards the learning experience and the lessons they learned. In contrast, the “low” clinical reasoners reported the skills they performed and the sequence of steps that occurred during their clinical time. This was an interesting study that was able to differentiate between high and low clinical reasoners based on the context of their journals. In reading through some of the examples from the journals, the “high” clinical reasoners have clear direction with their patient’s goals and can readily identify the issues the patients is experiencing while the “low” clinical reasoners merely list the steps they followed such as a series of physician orders throughout the shift. The author found that students should be encouraged to journal about their experiences but also be directed to link theory and knowledge to their practice to help develop their problem-solving skills (Murphy).
Simulation

The use of simulation in teaching can be found in the literature as early as the 1940s in various industries such as diving, aircraft and military (Wilford & Doyle, 2006). Simulation has become more advanced as technology has progressed and gained momentum in teaching medical and nursing students. A simulated teaching environment is meant to mimic the real patient setting as closely as possible. This can be done in many ways including patient models, teaching with a mannequin in an empty patient room or with task trainers for skill acquisition. One form of simulation is the use of high fidelity mannequins that respond to interventions and can respond to verbal interactions via an instructor in a control booth. The advantages for students are: a place to practice nursing skills while receiving immediate feedback from faculty, time to practice communication and teamwork skills, and there is no threat to actual patient safety. This mode of teaching can lead to the progression of clinical reasoning skills due to the active learning that is occurring and the feedback process of debriefing. Many students reported high levels of satisfaction with the process of simulation (Dillard et al., 2009). Due to the issues of limited clinical placements and the time limits of faculty interaction with students in these placements, simulation is becoming a good substitute for assisting nursing students in the process of developing mental representations required for pattern recognition and clinical reasoning (Wotton et al., 2010).

Wotton, Davis, Button, and Kelton propose high fidelity simulation can help students develop clinical reasoning skills through enhanced cognitive, associative and autonomous skills (2009). In developing scenarios for simulation, the authors of this study included the following components in their scenarios: signs and symptoms specific
to a particular disease, and scenarios progressed in a similar fashion but at a faster pace than is actually seen in the clinical setting. The authors also gave cues that increased in complexity as the scenarios progressed, cues increased in intensity if students missed low-intensity cues, students were expected to collaborate with each other, and the authors included aspects of legal and ethical considerations specific to the cases (Wotton et al., 2010). Next, the authors gave 300 third semester nursing students an evaluation form to ascertain the students’ perceptions of the experience. Statements were followed by a five-point Likert scale and included:

I enjoyed working with SimMan®, simulation provided and maintained an appropriate level of challenge, sessions were relevant to what I was learning, at times I felt lost as we worked through the simulation, feedback sessions were helpful in developing rationale for action and responses to patient. (Wotton et al., 2010, p. 635)

They were also asked three open-ended questions: “What were the most positive aspects of working with SimMan?,” “What areas of working with SimMan do you feel need to be improved?,” and “What did you learn from being involved with this patient?” (Wotton et al., 2010). The results showed favorable responses to the experience: over 90% of students enjoyed their experience across three scenarios. In addition, 94.7% of the students felt their attention was maintained throughout the scenarios; they felt the need to constantly analyze, interpret and respond to cues as reported in their open-ended questions (Wotton et al., 2010). In the feedback from the debriefing sessions, students felt this process confirmed management of patients’ problems, helped them develop rationale for actions and assisted in understanding reasons for medications and fluid management (Wotton et al., 2010). This was a well-developed study that provided nurse educators with information on how to develop effective simulation scenarios. This includes: timely
and specific use of debriefing sessions, providing a means for collaboration amongst the students during the scenario to develop their teamwork skills, and providing cues that increased in intensity to accommodate students who missed low-intensity cues.

Nursing faculty at one nursing school in Florida compiled a process for instruction for the use of simulation with undergraduate nursing students (Medley & Horne, 2005). They recommend the following: determine the content best taught in simulation, develop the learning objectives, replicate environment and equipment as closely as possible, use video camera recording for discussion in debriefings, and include a debriefing conference where critical thinking and reflection can occur (Medley and Horne). If the simulation center has the resources, a unit of 4-6 patients can be set up to work on skills such as time management, delegation and prioritization to help the student in the higher level aspects of nursing required for the real clinical setting (Medley and Horne). This article was well-developed by experienced simulation instructors and provided a clear strategy for implementation of the process for instruction (Medley and Horne).

Instruments for evaluating students’ progression of their clinical reasoning skills are lacking (Lasater, 2007). One commonly used tool is the Lasater Clinical Judgment Rubric which incorporates “effective noticing, interpreting, responding, and reflecting” along a scale labeled: beginning, developing, accomplished, and exemplary. This rubric has been validated and found reliable between raters; it measures behavior of the students which allows the instructor to provide specific feedback. Lasater has posited that the common language used in this tool could be transferred to feedback given in the real clinical setting. This tool is a necessary part of simulation to standardize evaluation
of students and represents a substantial addition to the genre of simulation in teaching. In
a review of three studies of the Lasater Clinical Judgment Rubric rater selection, rater
training and data collection were found to affect reliability results (Adamson, Gubrud,
Sideras, & Lasater, 2012). The authors of this study recommend that students should not
be evaluated on a single instrument scale but the scale has shown enough reliability to be
used as one component of overall student assessment.

Noting the lack of quantitative measurement tools, a group of instructors at
the Creighton School of Nursing developed a Simulation Evaluation Instrument (Todd,
Manz, Hawkins, Parsons, & Hercinger, 2008). There are four categories and the students
are given points for each observed behavior. These categories are: assessment,
communication, critical thinking, and technical skills; students are given 0 points for “did
not demonstrate competency” or 1 point for “demonstrates competency.” The observed
behaviors are scored and divided by the number of observed items; in this way, missed
items do not count against the student (Todd et al., 2008). The authors tested the tool for
inter-rater reliability and both students and faculty were given evaluations to complete on
whether they felt the tool measured what was intended, if it was easy to use, and whether
it would help in evaluating student performance (Todd et al., 2008). Study limitations
include a small sample size at one site with only two sections of students in a BSN
program, but the tool can be easily transferred to other nursing programs which makes it
very valuable in the field of simulation.

Simulation has been shown to assist nursing students and professionals in
other disciplines in the progress of developing clinical reasoning skills. Students like this
type of active learning and appreciate the time with faculty to receive feedback that helps
them hone their understanding of complex processes in nursing (Cato, Lasater, & Peeples, 2009). Sepsis is a complex syndrome that requires a deep understanding of complex pathophysiology and the treatments and interventions necessary for positive patient outcomes. The next section of literature will explore this complexity.

Sepsis

Sepsis can be defined as infection plus organ dysfunction causing a systemic inflammatory response syndrome (Angus, 2010). Septicemia is confirmed when there is a positive blood culture although blood cultures are only positive for a source about 32% of the time even when infection is suspected. Mortality from sepsis is about 30% in the hospital setting. As more organs are affected, mortality increases and as age increases, mortality, despite the number of organs involved, also increases. The incidence of sepsis in the United States is approximately 300 cases per 100,000 resulting in about 215,000 deaths per year (Angus, 2010).

In the course of sepsis, a microbial toxin stimulates the release of cytokines such as tumor necrosis factor and Interleukin-I, which promote endothelial cell-leukocyte adhesion. In the classic work by Wheeler and Bernard (1999), it was found that this leads to the activation of the clotting cascade, a “leaky” endothelium, and the release of Interleukins 6 and 10 that further the inflammatory process. These three processes, left uncontrolled will lead to death. The clotting cascade uses up activated protein C and clogs small arterioles in organs. The clogging of organs combined with the leaky endothelium causes third spacing of fluids that decrease oxygenation to the tissues. Massive fluid boluses can increase oxygenation to the tissues as measured by central
venous oxygen saturation (ScVO2) monitoring devices. As ScVO2 values reach 70%, the patient has a better chance of survival. Central venous pressure (CVP) is another measure of fluid volume but has limitations if the patient has cardiomegaly, pulmonary hypertension or disseminated clots. These conditions will give a high CVP reading while the oxygenation can still be quite low. As mentioned before, blood cultures are only positive in septic patients 30% of the time that infection is suspected (Angus, 2010). Therefore, the current theory is that even though the antibiotics might have effectively treated the organism, the body is now in a state of uncontrolled and uninhibited inflammatory response. Lactic acidosis occurs from global ischemia and local or organ-specific ischemia. Treatment must occur with fluid before vasopressors to adequately oxygenate the tissues (Wheeler & Bernard, 1999).

In the history of treating hypotensive and distributive shock, a fluid bolus of 1000ml was usually given followed by vasopressors if ineffective. Due to the research of the last decade on sepsis, we now know that massive fluid boluses up to 20 liters of crystalloid should be given before even considering vasopressors. Also, research has shown that antibiotics must be given quickly in the treatment of sepsis; a delay of one hour can increase mortality by 7% (Kumar et al., 2006). In the management section of treating sepsis, corticosteroids and blood sugar management have also been found to be of major benefit to the septic patient (Vincent & Gerlach, 2004). Lactic acid values are gaining more favor in following the progress of the septic patient (Jansen, E., 2010; Nguyen et al., 2004). In the study by Nguyen et al., patients were given a goal of lactate reduction of 20% every two hours, which showed a decrease in mortality by 10%. This is a significant finding and shows the importance of constant monitoring and intensive
treatments for septic patients. This work can only be done by nurses at the bedside who understand the goals for septic patients and have the decision-making abilities to provide interventions as well as communicate these rapid changes to the multi-disciplinary team.

Sepsis is a difficult syndrome to identify and treat. Without the use of standardized order sets, physicians may treat the sepsis syndrome in a variety of ways (Focht, Jones, & Lowe, 2009). In 2002, the European Society of Intensive Care Medicine (ESICM) and the Society of Critical Care Medicine (SCCM) polled physicians to understand the views towards sepsis treatment. These societies learned that physicians found sepsis to mimic other disease processes and that a more specific definition would aid in the diagnosis and treatment of the syndrome. From this process, the ESICM, SCCM and International Sepsis Forum (ISF) created the “Barcelona Declaration” which explained the significance of the disease, the intent to create guidelines and the goal of a 25% decrease in sepsis mortality in five years. They created the “Surviving Sepsis Campaign” (SSC), which is focused on improving the diagnosis, treatment, and survival of sepsis. The declaration intended to accomplish this goal with the following:

- Awareness: increase awareness of healthcare professionals, governments, health and funding agencies, and the public of the high frequency and mortality of sepsis
- Diagnosis: improve the early and accurate diagnosis of sepsis by developing a clear and clinically relevant definition of sepsis and disseminating it to our peers
- Treatment: increase the use of appropriate treatments and interventions by disseminating the range of care options and urging their timely use
- Education: encourage the education of all healthcare professionals who manage sepsis patients by providing leadership, support, and information to them about all
aspects of sepsis management, including diagnosis, treatments and interventions, and standards of care

- Referral: recognize the need for clear referral guidelines that are accepted and adopted at a local level in all countries by initiating the development of global guidelines (Society of Critical Care Medicine, 2012).

According to Rivers’ original study (2001), a patient identified with sepsis who does not receive fluid in a timely manner can face a 17% increase in mortality. A concept called early goal directed therapy was developed from this study. Early goal directed therapy is an algorithm that is divided into two main parts based on time. First, the patient is identified with severe sepsis based on suspicion of infection, systemic inflammatory response syndrome (SIRS), and organ failure. There are many criteria that qualify a patient as having organ failure; one of the criteria is a lactate over 4 milligram/deciliter (mg/dL). Next the six-hour resuscitation bundle of the order set is started. This includes baseline labs including lactate, blood cultures before antibiotics, correct antibiotic administration within three hours of triage time (not the time the patient is identified with sepsis), a fluid bolus of 20ml/kg with continued fluid boluses until the central venous pressure (CVP) of 8 is reached, and measurement of the central venous oxygen saturation (ScVO2) with a goal of 70%. The following twenty-four hours is the management bundle, which includes fluid boluses to maintain the CVP and ScVO2, vasopressors if needed to maintain the blood pressure, corticosteroids, and blood sugar control within a narrow range (Rivers, E., 2001).

Based on Rivers’ original work (2001), early goal directed therapy for severe sepsis saves lives. Dr. Rivers showed in his study that patients identified with two or
more SIRS criteria (HR>90, temperature >38 or less than 36, respiratory rate >20, white blood cell count> 12,000) and one organ dysfunction (hypotension below systolic blood pressure 90mm Hg, creatinine >2.0, platelets <90,000, acute mental status change, PaO2/FiO2 ratio<300, bilirubin>2.0, lactate>4.0), and who received the appropriate antibiotics and fluid resuscitation to a goal of CVP>8 and/or ScVO2>70% had a significantly reduced mortality rate. He showed this by enrolling 263 severely septic patients into two arms of a randomized study. Of these patients, 130 were assigned to the group that received early goal directed therapy with early administration of fluids and hemodynamic monitoring. The clinicians were given an algorithm to follow in treating these patients to reach a CVP of 8 and an ScVO2 of 70% before switching to a vasopressor. The control group of 133 patients received the standard therapy at the time of the study, which was, delayed fluid administration and little or no hemodynamic monitoring. For those patients who received fluid in the six hours following sepsis identification, there was a decrease in mortality by 17% compared with the control group who received the same amount of fluid between seven and 24 hours. The most recent guidelines produced by the Surviving Sepsis Campaign (SSC) were released in 2008 (Dellinger, 2008) and provided very specific guidelines for the recognition and treatment of sepsis. These new guidelines include the early goal directed therapy as described by Dr. Rivers and add levels of recommendation for some of the elements in the 24-hour management bundle such as blood transfusion, steroid treatment and glycemic control. Many hospitals have adopted these guidelines and created order sets to meet the goals. The SSC also created “bundles,” a group of orders that could be easily followed to assist with success in meeting the guidelines. Based on Dr. Rivers’ study, the bundles are split
into the “resuscitation bundle” and the “management bundle.” The resuscitation bundle ends at the 6 hour mark when the goal of CVP>8 and/or ScVO2>70% should be met. Most of this first six hour bundle is focused on obtaining blood cultures, administering appropriate antibiotics, obtaining adequate intravenous or central line access and fluid administration.

Transitional Statements

The literature review provided a comprehensive understanding of the current knowledge about clinical reasoning and simulation. Clinical reasoning is required for students to progress in their ability to determine the salient features of a patient presentation. Simulation has been shown to be an effective teaching strategy where students can apply their knowledge. This allows them the time to incorporate their skills of assessment and skill implementation. Nursing students in simulation are also given the opportunity to develop clinical reasoning skills in a safe environment. Knowledge about the best way to treat sepsis is evolving constantly but the general pathophysiology remains the same for the nurse to understand in order to identify the syndrome and treat it quickly.

The next chapter will describe the methodology used to determine if a computer program will show an increase in speed of students identifying the salient features of a septic patient after being exposed to simulation scenarios and debriefing.
CHAPTER III

RESEARCH DESIGN

This study evaluated nursing students’ abilities to use clinical reasoning on a computer case study about sepsis after exposure to simulation of realistic septic patient scenarios. This chapter will review the research methodology, theoretical underpinnings, data collection and population studied. Ethical considerations will also be discussed.

Research Methodology

This study used descriptive quantitative single-case quasi-experimental design (Fawcett & Garity, 2009). This type of design was necessary because there was no randomization of the students but it did gather measurable data. This type of research is important for developing theories around how nursing students learn and can be repeated in other groups of students to evaluate effectiveness of simulation. This design was chosen by the researcher because the students were all enrolled and moving through their fifth semester capstone simulation course and were therefore a convenient sample. It was not possible to create a control and experimental group and offer an equal educational experience.

Theoretical Underpinnings

The theoretical basis for this study was Benner’s concept of novice to expert based on the Dreyfus Model of Skill Acquisition (Benner, 1982). Nursing students for this study were in their fifth and final semester and typically in their novice/advanced beginner
stage of skill acquisition during this semester. This study evaluated whether progress was made in their ability to use clinical reasoning to move through scenarios as measured by a computer program (Clinicaledonline.com©) after exposure to a septic patient in simulation.

Population

This study assessed clinical reasoning in 34 fifth semester nursing students attending a baccalaureate nursing program in Northern California. Data were gathered regarding age, gender, and whether they were a second degree student. They were also asked if they have worked in healthcare prior to the BSN program such as in the role of a Licensed Vocational Nurse (LVN), Certified Nursing Assistant (CNA), Emergency Medical Technician (EMT) or Paramedic.

Ethical Considerations

Students were informed at the beginning of the school semester that they would be asked to take part in a research study that would give them more education regarding the care of the septic patient. They were all instructed to complete the Clinicaledonline.com© coursework and scenarios but they could choose to have their individual pre- and post-tests removed from the study. Students who chose to participate were informed of any and all risks involved with the study and were told of their option to leave the study at any time. Students who chose to participate signed consent forms and were given the opportunity to ask questions. These consent forms were taken to a locked cabinet in the researcher’s home. They were also informed of any potential psychological stress or physical hazards per the Application for human subjects research
clearance form on the California State University, Chico (CSUC) Office of Research and Sponsored Programs website. The researcher ensured that the participants were protected under the regulations set forth by the CSUC Requirements for research using human subjects. The researcher requested an expedited exempt review due to the nature of the study. The study meets these qualifications per the following statement:

Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as research on regular or special education instructional strategies, comparison among instructional techniques, curricula, or classroom management methods. (California State University, Chico, 2012)

Data Collection

This study involved the use of the Clinicaledonline.com© computer program. Students read an on-line sepsis module in the computer program for about one hour prior to attending class. In class, they completed two Clinicaledonline.com© sepsis scenarios. The scenarios present a patient and the student analyzed the data by clicking on vital signs, lab values and other patient data. Next, they had to choose which nursing actions to perform from a menu of medications, fluids and other interventions. The Clinicaledonline.com© program has many scenarios for the students to practice; they were assigned the practice cases in the surgical Intensive Care Unit (SICU) portion of the program. The practice cases allowed the students to keep picking interventions until they were told they picked the correct medication and/or fluid. In the tests, the students were only allowed two choices before the program would stop them and give them feedback whether they passed or failed. All student data were kept confidential and only discussed with the thesis advisor and the nurse in charge of the computer program. This process of measurement is reliable in that it is recorded by a computer program which could not be
modified by the researcher. It is a valid tool to evaluate the accuracy at which the
students choose the interventions based on the Surviving Sepsis Guidelines.

Data Collection Procedure

In addition to the steps mentioned above, the students were given an overview
of the research study prior to being given the Clinicaledonline.com© computer program
link and password. They were asked if they wished to participate and then given the
consent form for signatures (see Appendix A. The computer program time was built into
their class time per the course instructor. Students not wishing to participate were not
penalized in any way relating to their grade or standing in the class or nursing program.
The data were printed and stored in a locked cabinet in the researcher’s home. Students
were offered water and restroom breaks as needed during the computer program time.
They were welcome to bring snacks as is allowed by the simulation center. Students were
not offered any type of monetary or gift reward as participation was built into the
coursework required by the instructor although it was not graded to accommodate any
students who did not wish to participate. The sepsis simulation was built and given to
students as a practice during the previous semester as a normal part of building new
scenarios for the simulation class with assistance from the course director. Therefore, the
simulation was validated on a similar group of nursing students.

There are four sections of the fifth semester simulation capstone class. Each
section was given Clinicaledonline.com© computer licenses and was taught by the
researcher as a group how to move through the program. The researcher demonstrated
how to use the program including how to assess all the patient information and provide
interventions including re-assessment of the patient. Next, the students were told to individually complete the SICU practice sepsis cases on their own. These cases were similar in the patient presentation and interventions necessary. This information was correlated with a license number and maintained by the Clinicaledonline.com© company. The students were allowed to bring their own computer or use the computers at the simulation lab. At the beginning of each class section, a short sepsis review was given by the researcher. The presentation included epidemiology, pathophysiology, treatments, complications, research and nursing practice. The presentation was given to help answer questions from the students from their pre-reading. After the students in the research study completed two pre-tests, they all participated in a sepsis simulation. There were three sections to the simulation, approximately three to four students were part of each section of the scenario, the remaining students watched from a different room via closed-circuit monitor. The scenarios can be found in Appendix C. All students participated in debriefing including questions such as, “What did you assess about the patient?” “How did you know if your intervention was working or not?” “How well did the nursing actions meet the treatment goals set by the Surviving Sepsis Campaign?” After a break from the simulation, the students completed two more Clinicaledonline.com© sepsis tests that were also similar to the first two cases in patient presentation and required interventions. This process took approximately 3 hours for each section to complete.

After the four sections of nursing students completed the Clinicaledonline.com© cases and simulation, the researcher obtained the data from the Clinicaledonline.com© company.
Data Analysis

This study examined the pass and fail rates for the tests to see if learning occurred during the simulation and clinical reasoning skills improved as evidenced by an improvement of post-test scores after simulation. Statistical analysis included a chi square to analyze whether the post-test data is independent of the pre-test data. The researcher consulted with two doctorate-prepared Math professors to determine the appropriate statistical analysis for the research question.

Transitional Statements

This completes the research methodology section for this study. This information provided the researcher with the necessary steps to take to complete the research for this study. The next chapter will present the results of the data analysis.
CHAPTER IV

RESULTS

This chapter will present the findings from the pre-tests, simulation and post-tests on the topic of sepsis with fifth semester nursing students. The researcher studied the questions: Does simulation experience lead to increased clinical reasoning abilities as measured by a faster time to complete a post-test after three sepsis simulation scenarios? Does simulation experience assist the nursing student in recognizing the salient features of a patient scenario as evidenced by increased pass rates for a focused assessment tracked by the ClinicalEdonline.com© computer program using a septic patient case study?

The researcher was guided by the Benner method of skill acquisition and Knowles’ Adult Learning Theory during the simulation process.

Results

The study took place over a two week period. Students were shown the ClinicalEdonline.com© program and the consent was reviewed. All but one student signed the consent during the first week. During the second week, all four sections of the fifth semester simulation class took part in the simulations. All students who participated in the pre- and post-tests signed consent forms. Those students who did not sign consent forms still had access to the pre-reading and participated in the simulations.
Each section of the class (morning and afternoon over two days) took two pre-tests (before simulation) and two post-tests. Most of the students brought their own laptop computers, other computers were provided by the researcher and the simulation center. There was difficulty with the wifi system in the simulation center but this was resolved after the first group of students. A few pre- and post-tests were not recorded due to the wifi issues.

The students for each group had questions about the content they had read and reviewed over the previous week. The questions were about the amount of fluid administration, rationale for administering hydrocortisone and the timing of vasopressors. The researcher decided in order to assist the students’ understanding of the content to provide a short lecture on sepsis. A ten-minute video (Sepsis Emergency) was shown about identifying sepsis and the possible grave consequences when sepsis is not identified and treated rapidly (Sepsis Alliance, 2012). The content included identification of SIRS criteria, common order sets used in various hospital settings, and interventions based on the current Surviving Sepsis Campaign Guidelines (Jancin, 2012). This lecture lasted about 30 minutes and was given after the pre-tests were taken by the students.

Demographics

A page with instructions on how to access the computer program was given to the students in each class section during the week of consent. This paper also had a list of the practice cases and demographics. Students were instructed to return to class the following week with the completed page if they planned to take part in the research study. Only 24 of the 34 students who had signed consent returned their papers. The age
of the students ranged from 22 to 43 and the average age of the students was 26.7. All of the students who returned the demographic pages completed were female but there were four males in the class overall. Of the students who completed the demographics page, 19 students stated they completed all seven practice cases, one student stated she completed 5 cases, one student stated she completed 4 cases and two students declined to state how many practice cases they completed. Of the demographic pages completed, 14 of the students stated they had prior healthcare experience such as EMT, LVN, medical assistant or nursing assistant. None of the students who completed the demographics page were completing a second degree.

Times, and Pre- and Post-test Scores

Times were measured to address the first research question: “Does simulation experience lead to increased clinical reasoning abilities as measured by a faster time to complete a post-test after three sepsis simulation scenarios?” Students were given a card with a number to record their start and stop times for all pre- and post-tests. Although each student filled these out, the data are not accurate for the time spent on the tests. The difficulty with the wifi continued in all sections but eventually the test would load and the scores were recorded by the system. The researcher was able to check after each class section to see that the tests were being recorded. For many students, the tests took about five minutes to load but for others, the tests loaded more quickly. Some students were recording their start time when they started the pre- or post-test but some were recording their time when they launched the program so this would have included the five minutes of loading time. The researcher was circulating throughout the classroom to mitigate
wifi connection issues so the times were not recorded as accurately as possible. The computer program only recorded the time when the student completes the test. Therefore, the data were collected from the students but not recorded due to inaccuracy and the research question could not be answered due to the internet issues.

Computers were used to address the second research question, “Does simulation experience assist the nursing student in recognizing the salient features of a patient scenario as evidenced by increased pass rates for a focused assessment tracked by the ClinicalEdonline.com© computer program using a septic patient case study?” Two pre-tests were given before the simulation using the ClinicalEdonline.com© computer program. During the practice scenarios, the students can try as many interventions as they want and the program will allow them to keep choosing new interventions until they click “Finish Case.” In the pre- and post-tests, the computer program will allow the student to choose correct answers as long as needed but after two incorrect answers, the program will stop the student from choosing any more interventions and will automatically end the case. If the student has chosen the correct interventions, the computer will state, “Congratulations, you have chosen the right intervention.” If the student chooses two incorrect interventions, the program will state they failed and show them the correct interventions. In the data collection page of the computer program, the students’ results are listed only as “pass” and “fail,” there is no record of which interventions the student chose. All four tests were based on sepsis content with patients in a surgical intensive care unit on the computer program. The pass rates were only used if the student had a pre-test #2 recorded and at least one of the post-tests (Table 1).
Table 1

Pass Rates for Computer Simulation Pre- and Post-Tests

<table>
<thead>
<tr>
<th>% passing pre-test</th>
<th>% passing post-test #1</th>
<th>% passing post-test #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>100</td>
<td>72%</td>
</tr>
</tbody>
</table>

Statistical Analysis

Two Ph.D. statisticians were consulted for review of the statistics in this study. A chi-square analysis was used to examine the distribution of the pre-test result (pass or fail) to the post-test result for each student. The first pre-test (Mrs. Nile) was seen as a practice test case so that if students had not completed the practice cases in preparation for class, the first pre-test would serve as a practice for them to make sure they understood how to use the computer program. Therefore, only the pass/fail results from the second pre-test (Mrs. Mernard) were used in the statistical analysis. When the pre-test results were compared to the first post-test (Mr. Lopez), all students who passed the pre-test also passed the post-test. In addition, all nine of the students who had failed the pre-test passed the post-test. This suggests that the intervention of the simulation including brief lecture was effective. In comparing the pre-test to the second post-test (Mr. Otagwe), once again all of the students who passed the pre-test also passed the post-test. Of those students who had failed the pre-test, about 45% (5 out of 11) failed the post-test but about 55% (6 out of 11) passed the post-test. The chi-square test showed the distribution of the proportions who had passed/failed the post-test was dependent on the proportion of those who had passed/failed the pre-test ($p$-value = .002). This means the proportions of those who passed and failed were not distributed the same for the pre- and
post-tests. An examination of the data show that of the 11 students who failed the pre-test, 6 of them passed the post-test (55%). This result is not as good as the one for the first scenario when 100% of those who failed the pre-test later passed the post-test but it does indicate that slightly over half of them who failed were helped by the intervention for this more complicated second scenario. The two-proportion z test comparing the pass rates for the pre- and post-test showed that the pass rate for the post test was statistically significantly higher after the intervention than before the intervention ($p$-value $= .022$). That is, the intervention did lead to a higher pass rate and was successful.

The next chapter will explain the meaning of the results of the study for nursing education, nursing research and nursing practice. Many studies in simulation show positive results with increased confidence and skill acquisition in nurses (Kreiter & Bergus, 2009). However, based on a literature search, there are few studies with quantitative data that show increased clinical reasoning or a true change in nursing actions after simulation instruction.
CHAPTER V

DISCUSSION

Research has shown an increase in confidence in nursing student performance after simulation (Cato, Lasseter & Peeples, 2009). Researchers in the field of simulation recognize the need for further studies to determine whether clinical reasoning skills can be improved with the use of simulation as an instructional method.

Discussion

This research experiment set out to determine if simulation experience leads to increased clinical reasoning abilities as measured by a faster time to complete a post-test in time on the ClinicalEdOnline.com© computer program with a septic case study after students participate in simulation. This aspect was not able to be measured due to difficulties with the wifi computer system.

The second aspect of the study looked at whether simulation experience assisted the nursing student in recognizing the salient features of a patient scenario as evidenced by increased pass rates for a focused assessment tracked by the Clinialedonline.com© computer program using a septic patient case study. The post-test scores suggest that this research question was supported by the pass rates. The computer program allowed the nursing students to be evaluated on their understanding of assessment and implementation of appropriate interventions for the septic patient.
Through the use of the interactive program, the participants were required to evaluate lab data, clinical presentation and current orders before choosing from a number of different treatment options such as fluid, antibiotics, vasopressors and steroids. This process showed that the nursing students improved their ability to evaluate and implement the nursing process which requires clinical reasoning skills. Clinical reasoning develops with mental models that incorporate experience from patients; simulation provided a model of ideal care of the septic patient for the nursing students to correctly assess and treat patients using the sepsis bundle of treatment elements.

A short lecture prior to the simulations (after the pre-test but before the two post-tests) may have contributed to improvement of the post-test scores. However, although the protocol for fluid administration of 30ml/kg was heavily covered during lecture, none of the four sections of students asked for more than 1 Liter of fluid during their Situation, Background, Assessment and Recommendation (SBAR) report to the physician during the assessment phase of the simulation. In the subsequent scenarios, the patients did not improve their vital signs, CVP and ScVO2 values until after the second liter of fluid was given. The post-test scores show the improvement in choosing the right amount of fluid after the simulation which included debriefing. One student’s comments support this interpretation: “Because of the online training and practice scenarios I think I learned everything I needed to know. The lecture that was done beforehand helped as well. I think the major challenge was just remembering and applying everything we had learned!”
Limitations

This study was limited to one nursing school and the convenience sample of fifth semester students. Due to issues with the wifi computer system, the n is small for the recorded test scores. Many of the students had difficulty accessing the computer program to take the pre- and post-tests but eventually the system worked for most of the students. There are only 18 students for which there are recorded data; some scores were not captured in the post-tests.

Implications for Practice

In-depth knowledge and understanding is required for caring for a septic patient. Nurses should be given training in the sepsis treatment bundles and the rationale for the treatments in order to present the more applicable information to a physician for appropriate orders. Nurses need to be able to recognize the various stages of sepsis and whether the interventions of fluids and medications are working. Screening tools need to be in place in Emergency Departments, in-patient floors and Intensive Care Units to adequately recognize potential sepsis in all hospitalized patients. Early recognition and treatment can prevent morbidity and mortality but this must be part of the nurse’s assessment process. Computer programs can be built in to electronic health records that send an alert when enough criteria are met such as increased white blood cell count, increased temperature, heart rate and respiratory rate and whether antibiotics have been pulled from an electronic medication dispenser, such as Pyxis. Standardized order sets and hospital-wide “sepsis alerts” can help mobilize the appropriate staff and interventions for the patient with this time-sensitive syndrome.
Implications for Research

More research is needed in the form of robust experimental designs to further explore the improvement of clinical reasoning from simulation. Research is warranted in the potential for simulation to provide the student with a realistic approach to patient care. One student’s comments support continuing this style of education: “The last two scenarios required a more in depth assessment and reassessment of neurological/orientation status in order to see if interventions were working.”

A recent review of the literature provided more studies that evaluated the subjective experience of students and nurses. One study on participants showed improvement of self-confidence and satisfaction with a learning experience after simulation compared with computerized case studies (Arnold, Johnson, Tucker, Chesak, & Dierkhising, 2013). There continues to be a lack of objective research studies to show improvement of clinical reasoning skills in nursing after simulation education.

Simulation also supports students and practicing nurses working together as a team which is necessary in healthcare. The Institute of Medicine report on The Future of Nursing Education (National Academy of Science, 2010) states that healthcare professionals are educated in “siloes” and then suddenly they are all working together in the healthcare environment. Different healthcare professionals can come together in a simulated care environment to improve their teamwork and communication skills. A student during this study commented, “I think working as a team to get the best assessments done in a short amount of time is important in sepsis cases. Since it can be life threatening, and getting rapid treatment is important, teamwork and communication is vital.”
Implications for Education

Students appreciate the ability to practice their nursing actions until they feel they are doing them correctly. Nursing educators can assist students or practicing nurses with this process regardless of the teaching environment. Case studies and role-play can be done in classroom settings where the instructor can provide immediate feedback to help the nurse improve their communication and critical thinking skills.

In a previous simulation class taught by this researcher, if an error was made during simulation, the students often wanted to repeat the whole scenario so they would have a chance to correct their error. Between each stage of this sepsis simulation, the off-going nurse needed to provide a detailed SBAR shift report to the on-coming nurse. This student sums up some opinions noted in the student’s reflections: “Giving report is another aspect to nursing that I think students feel uncomfortable with, so practice can really help to gain confidence.”

Conclusion and Recommendations

This study set out to examine how students performed on a standardized test after simulation based on the topic of sepsis. The students’ post-test scores validate that the simulation intervention was helpful although there was a short lecture before the simulations which could have helped the post-test pass rates also. The questions and issues brought up during debriefing, especially that of fluid administration would lead this researcher to believe the simulated patient response was a more visual and effective teaching tool than the lecture. Students requested the appropriate intervention from the physician after the first debriefing and continued to monitor the patient for signs of
improvement during the second and third stages of the simulation. If the students were acting purely on lecture content, they would have asked for a larger amount of fluid in the first stage of the simulation but it was only after they could see the patient’s lack of response to a small amount of fluid that they requested the correct amount of fluid. This behavior was noted in all four class sections. Future research could repeat this study using a control group who received lecture versus the experimental group who participates in simulation, then testing both groups. It is recommended that a computer lab with internet capability be used for computer program testing.

Due to the positive post-test pass rates, simulation can be viewed as an effective teaching tool for developing and enhancing clinical reasoning. Nurse educators should be using simulation to assist nurses in developing assessment skills to be able to give an accurate picture of the patient to request orders from physicians. Simulation can also help nurses observe their interventions and whether the patient should be considered stable after an intervention or if the physician needs to be notified again. A student comment sums up the value of simulation best: “Just being familiar with sepsis and having the discussion and practice on it will really be beneficial. I am sure that I will encounter this at some point in my career and at least I will have had some kind of practice with it.”
REFERENCES
REFERENCES


Dillard, N., Sideras, S., Ryan, M., Carlton, K., Lasater, K., & Siktberg, L. (2009). A collaborative project to apply and evaluate the Clinical Judgment Model through simulation. *Nursing Education Perspectives, 30*(2), 99-104.


APPENDIX A
Consent to Participate in Research Study

California State University, Chico

Title: Clinical Reasoning in Nursing Students

Researcher: Jennifer Denno RN, BSN, CEN

Contact Information: 9413 Golden Drive, Orangevale, CA 95662, 916-988-1471, jydenno@comcast.net

Introduction:

You are being invited to volunteer as a subject in an evaluation being conducted at the (name removed for student identity protection) School of Nursing. This consent form provides you with the information you will need when considering whether to participate in this evaluation. All evaluation and research studies carried out at the California State University of Chico are governed by federal and state laws regulating human subjects’ research. If you decide to participate, you will be asked to sign this consent form which states that you have read the Summary of the Study, that any questions you have about the evaluation have been answered, and that you agree to participate. You will be given a copy of this form to keep for your records.

Summary of the Study:

This study is intended to evaluate clinical reasoning skills in fifth semester nursing students. Special focus will be on the septic patient and additional sepsis content will be
provided through a computer program (ClinicalEdonline.com©). You will receive instruction on using the computer program in class. You will then be asked to complete two case studies on the ClinicalEdonline.com© computer program. All students will participate in sepsis scenarios and debriefing. After the simulations, you will be asked to complete two more cases studies on the ClinicalEdonline.com© program. The computer work and simulation should take approximately three hours which is the normal class time. All identifying information will be removed from the final thesis write-up. Data from the scenarios completed by the students the ClinicalEdonline.com program will not be known by anyone but the researcher. This will not be a graded assignment and cannot affect your grade or standing in the class whether or not you choose to participate.

Study Risks

There are no physical or psychological risks to this study. Normal mental fatigue may occur similar to any study process. Water and restrooms will be provided; snacks are allowed in the simulation conference room.

Study Benefits

It is anticipated that the specific sepsis content will assist you in your understanding of the care of the septic patient. These benefits are not guaranteed by the researcher.

Costs, Funding and Compensation

There are no additional costs above tuition associated with the addition of this content and computer program. Time for completing the scenarios will be built into the course
curriculum. There is no funding associated with this study; the use of the ClinicalEdonline.com© program has been donated by Tom Ahrens. There is no compensation for participating in this study.

Confidentiality

Your confidentiality will be protected under the regulations of the Human Subjects federal, state and University laws and regulations. Your identifying information will be stored in a locked cabinet until the thesis work is completed and then all student information and scores will be destroyed.

Voluntary participation in, and withdrawal from, the study:

The decision whether to be in this evaluation is entirely up to you. Participation is voluntary. Although the ClinicalEdonline.com content and the simulations are a required part of your class, you may opt to not have your ClinicalEdonline.com scores included in the research data. You can refuse to participate, or withdraw from the evaluation at any time, and such a decision will not affect your relationship with the California State University, Chico and/or the School of Nursing, either now or in the future. Nor will a refusal or withdrawal of participation result in the loss of any other benefits to which you are otherwise entitled. Signing this form does not waive any of your legal rights.

Statement of consent:

I have reviewed the evaluation design outlined above and have had any questions I have about the evaluation answered to my satisfaction. I understand that my participation is
voluntary and that I can withdraw from the evaluation at any time without prejudice.

Signing this form does not waive any of my legal rights.

By signing below, you are indicating that this form has been explained to you, that you understand it, and any questions you have about the evaluation have been answered. You are indicating that you understand the ways the evaluation data may be used and how your privacy will be protected. By signing this form, you are agreeing to participate in the evaluation at this time only.

I ACKNOWLEDGE THAT I HAVE READ THE ABOVE EXPLANATION OF THIS EVALUATION THAT ALL OF MY QUESTIONS HAVE BEEN SATISFACTORILY ANSWERED, AND I AGREE TO PARTICIPATE IN THIS EVALUATION.

______________________________________ Signature of study volunteer

______________________________________ Printed name of study volunteer

______________________________________ Student number of study volunteer

Date _______________
APPENDIX B
Consent for Student Comments  
To be used in Thesis Paper

November 24, 2012

Thank you for your participation in the study “clinical reasoning in nursing students.” I would like to include some of your reflection comments in my thesis and potential nursing journal publication. Your name will not be given to me, Dr. Fox will only be forwarding comments to me. If you approve of your comments being published (this is a potential, not a guarantee that your comments will be used), please sign below.

Jennifer Denno RN, BSN, CEN

MSN Student

Name____________________________________________Date___________________

Signature________________________________________________________________
APPENDIX C
Sepsis Scenario-Chico, Clinical Reasoning Study

***A family member can be present during each stage, questions student actions just enough so the student has to explain what they are doing and why.

Stage 1

Assessment-Nurse is expected to identify severe sepsis based on:

A) suspicion of infection

B) SIRS criteria

C) Organ dysfunction

Call for MD and request orders, may push MD for extra fluid, will not be given more than 1 Liter

BP 90/60, HR 120, O2 sat 94%

Mannequin needs: IV saline lock in place, no fluid hanging yet. Foley in place. Nasal cannula and non-rebreather available. EKG leads, pulse ox and BP cuff available. Temp 101 on monitor.
Stage 2

Identification and treatment-mostly action/tasks

Nurse needs to do an assessment, run 1Liter of NS, give antibiotics, Motrin orally (pill or liquid cup), set up tray for central line

BP stays put at 90/60, HR 120

***Place central line on the patient chest and hang CVP line

Mannequin needs: EKG leads, BP cuff and pulse ox on mannequin. Temp 101 on monitor. Student will need to request/take vital signs as part of assessment. Nasal cannula and non-rebreather available. IV saline lock in place. NS 1000 bag available and pressure bag, antibiotics-3 partial fill bags

***After this stage ends, please take the 1000NS bag away and replace with empty 1000ml NS bag with tubing running to IV. Antibiotic partial-filled bags can be removed.

Stage 3

Assessment of not enough improvement of patient BP-should call MD for more fluid, possibly hydrocortisone, might ask for repeat lactate

BP starts at 90/60, HR 120

Mannequin needs: EKG leads, BP cuff and pulse ox on mannequin. Temp 99 on monitor. Nasal cannula and non-rebreather available. 1000NS bag available and pressure bag

Hydrocortisone available

As fluid is infusing, BP goes up to 106/80, HR down to 100.
***We will need to change bag to an empty so student can see the results of the fluid by this end of this part of the scenario. Updated CVP, ScVO2 and lactate can be given at this time.

Stage 1:

Patient scenario: Mr. Matsing, 84 year old male

Triage time 1619

Triage nurse report:

Situation: patient had foley placed at this hospital Thursday for urinary retention, they had a large amount of blood clots in catheter, today had a fever up to 102. Took a Tylenol at home at 1300. Background: Patient has a history of hypertension, diabetes and bladder cancer. He takes lantus, aspirin, atenolol, Lasix, Novolog, amlodipine, and benzapril. He has completed his chemo for his bladder cancer.


Recommendation: Patient has been placed in a treatment room for MD evaluation. Initial labs have been drawn but no results yet.

Action: Student will assess patient. Lab personnel to bring labs for stage 1 (below).
Student should report abnormal findings, state positive sepsis screen and request fluids.

MD gives the following orders:

NS bolus 1000ml

Levaquin 750 mg IVPB

Cefepime 2Gms IVPB

Vancomycin 1.75Gm IVPB

Motrin 800 mg PO

2 sets of blood cultures before antibiotic administration

Prep for central line placement

Student will read back orders, end of stage 1.

Debrief: focus on assessment, orders from MD

Stage 2

Student from first stage will give SBAR report to oncoming shift.

Action: Student will assess patient, hang fluid and antibiotics. Each antibiotic can go into a different port on the central line and one through the peripheral line. Fluid can run through the central line with one antibiotic. Extra student to bring CVP and ScVO2 values in middle of scenario after fluid has been running.
Student should note mild confusion from patient or family can mention patient seems to be getting confused, BP not increasing and HR not decreasing. Call to MD for more fluids. Should mention to MD that CXR is clear and ok to give more fluid.

Orders from MD:

1 Liter NS bolus

Hydrocortisone 75mg IV push q6 hours

Call MD back with repeat lactate,

Student should read back orders, end of stage 2.

Debrief: ok to give multiple antibiotics at once-cite latest guidelines from article.

Rationale for mentioning CXR and fluid. Why are we giving hydrocortisone? When should we ask for vasopressors?

Stage 3

Student to give SBAR report to oncoming shift. State which antibiotics have been given. Lactate has been drawn by lab.

Action: Student will assess patient. Give 2nd liter of fluid and administer hydrocortisone. Patient becomes less confused during scenario and family member notices this also.

Student should request new CVP, ScVO2 and lactate values-another student can bring these in after fluid has infused. (Empty bag can be hung and values given)

Student should call MD with new findings and updated patient status.
MD will order NS at 125ml/hr and repeat lactate in 6 hours.

Student will read back orders.
TABLE A1

*Mr. Matsing labs - Stage 1*

<table>
<thead>
<tr>
<th>Urine analysis</th>
<th>WBCs&gt;100, positive leuk Esterase</th>
</tr>
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<tbody>
<tr>
<td>Lactate</td>
<td>4.2</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Na 135</td>
</tr>
<tr>
<td></td>
<td>K 4.3</td>
</tr>
<tr>
<td></td>
<td>CL 100</td>
</tr>
<tr>
<td></td>
<td>Bicarbonate 28</td>
</tr>
<tr>
<td></td>
<td>Anion gap 11.3</td>
</tr>
<tr>
<td></td>
<td>Glucose 120</td>
</tr>
<tr>
<td></td>
<td>BUN 64</td>
</tr>
<tr>
<td></td>
<td>Creatinine 2.8</td>
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<tr>
<td>CBC</td>
<td>WBC 27.2</td>
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<tr>
<td></td>
<td>Hgb 7.7</td>
</tr>
<tr>
<td></td>
<td>Hct 23.4</td>
</tr>
<tr>
<td></td>
<td>Platelets 92,000</td>
</tr>
<tr>
<td>Blood cultures</td>
<td>Drawn, pending</td>
</tr>
</tbody>
</table>
TABLE A2

*Mr. Matsing Results Stage 2*

<table>
<thead>
<tr>
<th></th>
<th>Clear, no signs of infiltrate or cardiomegaly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest x-ray</td>
<td></td>
</tr>
<tr>
<td>CVP</td>
<td>3</td>
</tr>
<tr>
<td>ScVO2</td>
<td>45</td>
</tr>
</tbody>
</table>
TABLE A3

Mr. Matsing Stage 3 Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVP</td>
<td>8</td>
</tr>
<tr>
<td>ScVO2</td>
<td>75</td>
</tr>
<tr>
<td>Lactate</td>
<td>2.0</td>
</tr>
</tbody>
</table>
PARTICIPANT CONSENT FORM

Student Number: _______________

Thank you for participating in the Clinical Reasoning in Nursing Students Research Study.

The website address is: www.clinicaledonline.com

There is a tutorial with video on how to use the program. Complete the pre-reading online then move to the practice cases. Use the SICU cases.

Please keep track of how many practice cases you completed here:

<table>
<thead>
<tr>
<th>Practice case</th>
<th>Completed-Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Barn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Garden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Harp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mrs. Delores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mrs. Edward</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mrs. Frank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mrs. Iron</td>
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</tr>
</tbody>
</table>

VERY IMPORTANT!!!

Do NOT complete any of the post-tests. These will be completed in class the week of November 14/15.

Please bring your laptop and this paper to class on November 14/15.
If you have any questions or issues with the ClinicalED Online Program, please contact me asap: jydenno@comcast.net or 916-705-0627 (cell phone).

Jennifer Denno RN, BSN, CEN
MSN Student, California State University, Chico