Promotion of Critical Thinking Dispositions Amongst Intensive Care Registered Nurses Through Utilization of High-Fidelity Simulation

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Abstract

Background: Critical thinking is considered an essential component to sound nursing practice. Whereby critical thinking dispositions, or habits of the mind, are considered to be the foundation for effective critical thinking, the literature suggests that this concept has lacked in development and assessment, particularly within critical care nurses. High-fidelity simulation (HFS) has the demonstrated potential to meet this need.

Purpose: The purpose of this study was to evaluate the use of high-fidelity simulation for the promotion of critical thinking dispositions of intensive care unit registered nurses.

Methods: A quasi-experimental study took place over two weeks in a tertiary academic medical center where a convenience sample of adult critical care registered nurses was taken. Participants completed the California Critical Thinking Disposition Inventory (CCTDI) prior to the high-fidelity simulation and again upon completion to evaluate overall change in critical thinking and individual dispositions.

Results: 22 nurses participated in this study. Overall CCTDI scores significantly increased after participation in the HFS, with four of the seven subscales displaying statistically significant increases as well. There were found to be no significant relationships between measured demographics and overall CCTDI. Within the subscales, significant relationships were found between truth-seeking and years as a critical care nurse, open-mindedness, age, and years as a registered nurse, as well as, systematicity and certification status.

Discussion: Participation in a single high-fidelity simulation showed a positive impact on overall critical thinking dispositions of practicing critical care nurses, as well as, the majority of the dispositional components. This is the first identified study to demonstrate such an effect. The significance of this could foster development of transition-to-practice and continuing education programs to improve critical thinking, clinical judgment, and ultimately improve patient outcomes.

Keywords: critical thinking, critical thinking dispositions, nursing, simulation, critical care

Promotion of Critical Thinking Dispositions Amongst Intensive Care Registered Nurses Through Utilization of High-Fidelity Simulation

Critical thinking is considered an essential component of professional nursing, necessary for professional accountability, as well as safe, quality-driven nursing care (Scheffer & Rubenfeld, 2000). In 2008, the American Association of Colleges of Nurses (AACN) issued new recommendations for baccalaureate competencies to assure high quality and safe patient care. These recommendations came in response to a movement amongst the National Academy of Medicine [formerly Institute of Medicine (IOM)], Agency on Healthcare Research and Quality (AHRQ) and the Robert Wood Johnson Foundation that nurses are not adequately prepared to provide the highest quality and safest care possible (IOM, 2004). There appeared to be a lack in translating developed competencies to bedside care. Critical thinking was the first core competency recommended, highlighting that critical thinking is the foundation for sound clinical judgment and decision making. There have been calls from leading health organizations and prominent nursing researchers to find new ways of developing and accessing critical thinking within the nursing profession (IOM, 2010; Benner, Sutphen, Leonard, & Day, 2010).

Background

Critical Thinking

The concept of critical thinking dates back more than 2500 years ago to the Greek philosopher Socrates. Evolving over time, much of the early work on critical thinking revolved around defining the concept (Dewey, 1938; Ennis, 1962; Watson & Glaser, 1980; Facione, 1990; Paul & Elder, 2010). Within the nursing literature, the most cited definition is that of the American Philosophical Association's (APA) Delphi Report (Turner, 2005). The APA's international effort to define critical thinking, led by Dr. Peter Facione, stated that critical thinking is a "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which the judgment is based" (Facione, p.3, 1990). This definition was produced by a qualitative research Delphi methodology, in which a panel of forty-six experts on critical thinking, philosophy and education, convened in reaching consensus on the definition.

The effective critical thinker, according to this definition, is "habitually inquisitive, honest in facing personal bias, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit" (Facione, p. 3, 1990). There are certain cognitive skills necessary to engage in this purposeful manner of thinking. These skill are interpretation, analysis, evaluation, inference, explanation, and self-regulation. The internal motivation to utilize the skills of critical thinking are driven by a set of attributes, or dispositions. The seven critical thinking dispositions identified by the Delphi panel include: inquisitiveness, open-mindedness, systematicity, analyticity, truth-seeking, maturity, and confidence in critical thinking. These affective dispositions are necessary for the foundation and flourishment of critical thinking skills (Facione, 1990).

Facione's definition continues to dominate within nursing literature today due to two validated and well-established instruments to measure both dispositions and skills: the California Critical Thinking Skills Test (CCTST), and the California Critical Thinking Disposition Inventory (CCTDI).

With an accepted definition of critical thinking, researchers began to inquire how nurses critically thought, develop methods to improve critical thinking, and understand the significance it brought to the profession. Traditional pedagogical approaches to teaching students critical thinking rely on passive learning strategies such as lecturing on definitions and theoretical frameworks. There exists, however, a disconnect between these styles of teaching, and becoming an effective critical thinker as a practicing nurse. In a large, multi-cite study of nearly 11,000 nurses, del Bueno reported only 35% of newly graduated nurses met critical thinking and clinical judgment expectations of their employers (2005). In the aptly titled report, *A Crisis in Critical Thinking*, del Bueno believed that this is likely the result of the emphasis placed on traditional content-based education rather than a focus on, or use of, the application of knowledge (2005). Nurse educators became encouraged to incorporate learner-active teaching approaches (Wangesteen, Johansson, Bjorkstrom, & Nordstrom, 2010), particularly as academic success and level of satisfaction with nursing education became correlated with a student's ability to critically think (Kim, Moon, Kim, Kim, & Lee, 2014; Pitt, Powis, Levett-Jones, & Hunter, 2015). Active-learning styles of case scenarios, problem-based learning, and concept mapping developed into well-established methods. Meta-analytical results demonstrated significant improvements in a student's critical thinking scores, all of which were demonstrated by the CCTDI (Hong & Yu, 2017; Yue, Zhang, Zhang, & Jin, 2017; Kong, Qin, Zhou, Mou, & Gao, 2014).

A 2008 assessment of critical thinking of over 2,000 newly graduated and experienced nurses, found that 25% of participating nurses were unable to recognize the presented clinical problem, safely prioritize care and implement independent nursing interventions (Fero, Witsberger, Wesmiller, Zullo, & Hoffman, 2009). Consistently demonstrated however, was the relationship between years of experience and critical thinking; those with more years in practice had statistically significant higher critical thinking measurements (Fero et al., 2009; Feng, Chen, Chen, & Pai, 2010; Lang, Beach, Patrician, & Martin, 2013).

What significance does it bring in understanding the critical thinking of practicing nurses? Critical thinking allows nurses to recognize changes in patient conditions, perform independent nursing interventions, anticipate orders and prioritize care (Buerhaus, 2005). This translates into effective decision making, directly affecting patient care outcomes (Shoulders, Follett, & Eason, 2014). A nurse's ability to critically think reflects in their competence, clinical judgment, and ability to impact patient safety (Buerhaus, 2005).

In the intensive care unit, the relationship between critical thinking, independent action and patient safety is integral. Critical care is an increasingly complex environment, inundated with new technologies, managing multiple competing priorities while caring for patients with both complex and unstable medical conditions (Swinney, 2010). There are several key reasons why critical thinking is essential in the intensive care: 1) the ability to interpret new data, 2) accurately define new problems, 3) communicating important points about the new problem accurately, 4) anticipating needed nursing and medical interventions, 5) analyzing of outcomes to determine progress towards stability/healing, 6) building knowledge of nursing practice, and 7) building rapport within the healthcare team (Swinny, 2010).

Research that examines critical thinking attributes of intensive care nurses and how to develop and assess such skills and/or dispositions is lacking. Oermann identified clinical scenarios, questioning, conferences and context-dependent test items as potential ways to enhance critical thinking within the nursing population (1998). Expanding upon that list, Shoulders et al. (2014), named problem-based learning, concept making, techniques of thinking aloud, storytelling, self-directed learning formats, interdisciplinary rounds, developing clinical practice guidelines, case reviews and continuing education. Missing within this list of potential ways to assess and develop critical thinking of intensive care nurses is the use of high-fidelity simulation.

High-Fidelity Simulation in Nursing

Simulation technologies have been used in nursing education for decades. A simulation is any activity that mimics the reality of a clinical environment and is designed to demonstrate procedures, decision-making, and critical thinking through techniques such as role playing, and the use of devises (Jeffries, 2005). Simulation-based education allows students the opportunity to practice their critical thinking, decision-making and clinical skills without compromising a patient's well-being (Kim, Park, & Shin, 2016). The level of simulation is based upon the fidelity of the simulation used with fidelity being equated to realism. How close to realistic recreation the simulation approaches is typically associated with the integration of technology. High-fidelity simulators are usually life-sized computerized manikins with realistic anatomical structures that can display data and interact in real-time (Kim et al., 2016).

High-fidelity simulation allows for the opportunity for participants to apply knowledge and theoretical concepts within an active learning environment. Simulation-learning has been shown to increase learning motivation and to develop situated cognition practices ultimately preparing for clinical practice (Jeppesen, Christiansen, & Frederiksen, 2017). Simulations have also consistently demonstrated improvements in participants self-rated confidence, competence, knowledge, and skills (Jeppesen et al., 2017; Yuan, Williams, Fang, & Ye, 2012; Cook et al., 2011). Given the concern for a large portion of newly graduated nurses lacking essential behaviors related to safe and competent nursing practice, the use of high-fidelity simulation appears to meet the need for experiential learning experiences (Hee-Ok & Insook, 2016).

As evidence accumulates surrounding the use of high-fidelity simulation for a range of clinical outcomes, application of the usefulness of simulation within professional nurses has expanded. Several studies within the past three years have examined simulation-based training for intensive care unit nurses and their associated outcomes. In an integrative review, Boling and Hardin-Pierce found that simulation is effective at improving clinical knowledge and provider confidence in critical care environments (2016). High-fidelity simulation was shown to enhance clinical judgment as well as critical care knowledge amongst neonatal intensive care nurses (Letcher, Roth, & Varenhorst, 2017). A pilot study utilized high-fidelity simulation for critical care nurse orientation displayed promising results. High ratings of simulation effectiveness on participants self-reported learning were observed (Boling, Hardin-Pierce, Jensen, & Hassan, 2017).

Understanding the consistently demonstrated benefits of simulation learning amongst nursing students, the promise of simulation within the critical care environment and the vital necessity of being an effective thinker, this study proposes a combination of all three components. The purpose of this study is to evaluate the use of high-fidelity simulation for the promotion of critical thinking amongst intensive care unit registered nurses. The specific study question being asked is: Is high-fidelity simulation an effective method for the promotion of critical thinking dispositions amongst intensive care unit registered nurses?

Review of Literature

A literature search was performed within CINAHL, OVID Medline, Web of Science, PubMed, and ERIC databases to include the previous 10 years, January 2007 to July 2017. The following search terms were used: “high-fidelity simulation” OR “simulation” AND “nursing” OR “critical care nursing” OR “critical care” AND “critical thinking.” Initial search results yielded 327 studies.

Review of literature inclusion criteria of studies were: 1) use of high-fidelity simulation as primary simulation method, 2) the study of simulation methods directed on currently practicing nurses and nursing students, 3) study design of experimental, quasi-experimental, or mixed methods, 4) primary or secondary outcomes related to simulation effect on measured critical thinking outcomes, 5) studies published in English only. Exclusion criteria included 1) studies which included medical students, physicians or other healthcare professionals, 2) studies that were qualitative in design, and 3) studies that did not report outcomes regarding simulation effects on critical thinking. After reviewing studies for relevancy, duplicity, and those that met the inclusion criteria, thirteen studies were included for full review.

In review of these thirteen studies, the shared characteristics among them include the definition of critical thinking used, theories or conceptual frameworks, simulation design characteristics, methods used and results.

Critical Thinking Definition

Seven studies utilized either the exact definition or variations of, the APA Delphi Report definition. Five reported the exact definition of critical thinking as a “purposeful, self-regulatory judgment” (Facione, p.3, 1990; Shin, Ma, Park, Ji, & Kim., 2015; Shinnick & Woo, 2013; Maneval et al., 2012; Wood & Toronto, 2012; Ravert, 2008). One study (Goodstone et al., 2013) utilized a variation of this and only one study spoke specifically to critical thinking dispositions (Chiang & Chan, 2014).

Two studies utilized less commonly used definitions of critical thinking (Schubert, 2012; Brown & Chronister, 2009). Fero et al. (2010) made an individual summative assessment regarding critical thinking, based upon previous landmark researchers. Three studies (Ahn & Kim, 2015; Shin & Kim, 2014; Sullivan-Mann, Perron, & Fellner, 2009) did not articulate a definition for critical thinking.

Theoretical or Conceptual Frameworks

Seven of the thirteen studies utilized either a theory or conceptual framework in their study design, however the theories were varied. Two studies (Shin et al., 2015; Shin & Kim, 2014) utilized Tanner's Clinical Judgment Model, two studies (Chiang & Chan, 2014; Ravert, 2008) utilized Kolb's Theory of Experiential Learning, and two studies (Brown & Chronister, 2009; Sullivan-Mann et al., 2009) used Benner's Theory of Novice to Expert.

Six studies (Ahn & Kim, 2015; Goodstone et al., 2013; Shinnick & Woo, 2013; Maneval et al., 2012; Schubert, 2012; Wood & Toronto, 2012) did not reference a theoretical framework for the basis of their study design.

Simulation Design Characteristics

Only two studies (Ahn & Kim, 2015; Shin & Kim, 2014) offered detailed explanation of simulation scenario development. Both used the NLN/Jeffries Simulation Framework (2005). The pediatric courseware used by Shin et al. (2015) is the same as what is described in the 2014 study by Shin and Kim, and repeat description of scenario development was not provided. Both studies outlined their simulation development via each of the NLN/Jefferies Simulation Framework constructs, with the study completed by Ahn and Kim offering the greatest detail.

The remaining ten studies focused on aspects of the scenario development and/or the scenario itself. The depth of the descriptions varied greatly and there was no standardization of which components were spoken to. None of these ten studies referenced a framework for scenario development.

Overall, the simulation characteristics between the thirteen studies varied immensely. The majority of the simulations allowed participants to prioritize care and intervene, with only two studies (Goodstone et al., 2013; Wood & Toronto, 2012) stating that their scenarios were assessment-based only. Nine studies explicitly spoke to the topic of the scenario, with cardiac-focused scenarios being the most common. Two studies (Shin et al., 2015; Shin & Kim, 2014) developed scenarios on the care of pediatric patients, only one scenario (Ahn & Kim, 2015) explored topics and care specific to intensive care patients. One study utilized prepackaged scenarios from a simulation software (Sullivan-Mann et al., 2009).

The number of simulation sessions ranged from one to fourteen, with the most studies employing 1-3 sessions. Simulation lengths were also diverse, ranging from ten minutes to three hours. Two-hour sessions were the most common, though seven of the thirteen studies did not specify simulation lengths (Shin et al., 2015; Shin & Kim, 2014; Chiang & Chan, 2014; Shinnick & Woo, 2013; Maneval et al., 2012; Schubert, 2012; Sullivan et al., 2009).

Methods Used

Study design. Regarding study design, six studies (Ahn & Kim, 2015; Maneval et al., 2012; Wood & Toronto, 2012; Brown & Chronister, 2009; Sullivan-Mann et al., 2009; Ravert, 2008) employed experimental designs. Shared objective characteristics of these six studies were aimed at evaluating critical thinking outcomes of simulation in comparison to other methods. Comparison methods included lectures, case studies, or video vignettes.

The remaining seven studies (Shin et al., 2015; Shin & Kim, 2014; Chiang & Chan, 2014; Goodstone et al., 2013; Shinnick & Woo, 2013; Schubert, 2012; Fero et al., 2010) employed quasi-experimental methods in which outcomes of critical thinking were evaluated prior to and post simulation experiences.

Setting and sample.

The majority of the studies were conducted in the United States (Goodstone et al., 2013; Schubert, 2012; Wood & Toronto, 2012; Fero et al., 2010; Sullivan-Mann et al., 2009; Brown & Chronister, 2009; Ravert, 2008), with the remaining studies conducted in either Korea (Ahn & Kim, 2015; Shin et al., 2015; Shin & Kim, 2014) and Hong Kong (Shinnick & Woo, 2013; Chiang & Chan, 2014). Study sample sizes varied from 26 (Maneval et al., 2012) to 237 (Shin et al., 2015). All but two studies (Maneval et al., 2012; Schubert, 2012) sampled undergraduate nursing students. No studies examined practicing critical care registered nurses.

Instruments used.

Six of thirteen studies utilized the CCTDI or a culturally-adapted version of the CCTDI (Shin et al., 2015; Shin & Kim, 2014; Chiang &Chan, 2014; Wood &Toronto, 2012; Fero et al., 2010; Ravert, 2008) to measure of critical thinking. The Health Science Reasoning Test (HSRT) was the second most common instrument, used by four investigators (Goodstone, 2013; Shinnick & Woo, 2013; Maneval et al., 2012; Sullivan-Mann et al., 2010). Use of the HSRT for the purpose of measuring critical thinking skills of both nursing students and nursing professionals has recently been challenged as to whether it is the correct instrument for the desired outcome. Producers of the HSRT strongly recommend the use of the CCTDI as a companion to the HSRT. The remaining studies (Ahn & Kim, 2015; Schubert, 2012; Brown & Chronister, 2009) measured critical thinking with three different instruments; the Korean nursing students' critical thinking tendency, the learning transfer tool and the ECG SimTest respectively.

Results

Only two studies (Ahn & Kim, 2015; Shinnick & Woo, 2013) reported that there were no statistically significant gains in critical thinking after a simulation intervention. Both studies compared high-fidelity simulation to a second method. Ahn and Kim (2015) compared the use of high-fidelity simulation and lectures/case studies for the development of critical thinking of nursing students. While there was no significant difference between the two groups, the simulation group demonstrated higher scores on average. Shinnick and Woo (2013) employed a single group pre- and post-simulation evaluation of critical thinking of nursing students and did not find any significant gains in critical thinking as assessed by the HSRT. While there was no mention of the length of the simulation, and debriefing and post-test evaluation occurred at least an hour after conclusion of simulation, the authors speak to a single session as their significant limitation.

Six studies reported mixed findings, dependent upon individual study aims. Shin et al. (2015), found that overall critical thinking significantly increased after three exposures to simulation, though a single exposure showed no significant gains. Goodsone et al. found that both high-fidelity simulation and instructor written case studies increased critical thinking skills significantly, however, there was no difference found between the two groups as measured by the HSRT (2013). Maneval et al. had similar findings, with overall critical thinking scores increasing significantly, with simulation group achieving greater gains though again, there was not a statistically significant difference between groups (2012). Wood and Toronto found no significant differences between the post-test critical thinking scores of two groups of nursing students, but did see a significant increase in CCTDI scores for those students exposed to high-fidelity simulation (2012). Brown and Chronister demonstrated no significant differences between the overall ECG SimTest score between those students who incorporated simulation in their ECG learning versus those students who did not (2009). However, second semester students did show significant differences in overall ECG SimTest scores as well as in all subcategories of the test. It is also important to consider that for many of these studies that examined the effectiveness of simulation compared to other methods, their control groups continued to be under routine nursing education. Within this compilation of mixed findings, there is evidence to suggest high-fidelity simulation interventions displays trends of improved critical thinking measurements.

Five studies (Shin & Kim, 2014; Chiang & Chan, 2014; Schubert, 2012; Fero et al., 2010; Ravert, 2008) resulted in all statistically significant improvements regarding critical thinking after their simulation intervention.

Gaps Within the Literature

This review identified several gaps within the literature. There is dissonance between the definition of critical thinking used, the guiding theoretical framework, and the instrument used to measure based upon the definition. Through the use of the APA Delphi report definition, the conceptual framework of the disposition towards critical thinking and the CCTDI, this study will be consistent in its approach to measuring critical thinking dispositions. The heterogeneity of simulation design characteristics is a second demonstrated gap in the literature. The use of a simulation conceptual framework instills a process-based method to simulation research, allowing for clear delineation of what the scenario encompasses as well as for future reproducibility. This current research study will also address the dearth of literature on critical thinking amongst professional nurses while being the first to report on the use of simulation for the promotion of critical thinking dispositions within the critical care nursing population.

Conceptual Frameworks

The disposition toward critical thinking (Facione, Giancarlo, Facione, & Gainen, 1995) served as the conceptual framework guiding this research study. Dispositions towards critical thinking is described as a characterological profile which is frequently reflected in theoretical characterizations of critical thinking (Facione et al., 1995). Based upon the APA Delphi report, critical thinking is defined as a purposeful, self-regulatory judgment process that results in an individual's ability to make decisions within a given context (Facione, 1990). Recognizing the impact that an individual's intellectual affective characteristics have on their utilization of critical thinking is an important concept. In order for an individual to fully engage in the cognitive skills of critical thinking, nurturing the dispositions toward critical thinking was crucial (Facione et al., 1995). "A strong overall disposition toward critical thinking is integral to ensuring the use of critical thinking skills outside the narrow instructional setting," (Facione et al., pg. 3, 1995). There are seven dispositions towards critical thinking: inquisitiveness, open-mindedness, systematicity, analyticity, truth-seeking, critical thinking self-confidence, and maturity. In the explanation of each of the dispositions, Facione, Facione and Giancarlo (2000) consistently makes reference to how these dispositions would be exemplified within the nursing profession which allows for adaptation as an adequate conceptual framework for this study. See Table 2 for an explanation of each of the subscales and its applicability to the nursing profession.

The conceptual framework that guided the simulation development and delivery was the National League of Nursing/Jeffries Simulation Framework. This framework was developed to meet a gap in the simulation literature, where simulation practices required an organized, systematic way of conducting research (Jeffries, 2005). The simulation framework is composed of five major elements and associated factors: teacher, student, education practices, simulation design characteristics and outcomes (Figure 1).

Unlike teachers in a traditional classroom learning experience, the simulation facilitator provides learner support through the simulation and leads the debriefing session (Jeffries, 2005). It is not expected that the facilitator has expert abilities in simulation design, use of simulation technologies or scenario set up.

The student factors are influenced by program preparation, age, and level of experience. It is expected that participants be self-directed and motivated regarding their own learning experiences during the simulation (Jeffries, 2005).

There are several educational practices identified within the Jeffries' framework: active learning, feedback, student-facilitator interaction, collaborative learning, high expectations, diverse learning and time on task (Jeffries, 2005). This particular simulation incorporated elements of each of the seven principles through the simulation design characteristics.

The element of simulation design must be appropriate for learning objectives and desired learner outcomes; arguably the most significant component of this framework. There are five components of simulation design: objectives, fidelity, complexity (problem-solving), student support (cues) and debriefing.

Objectives define the desired learner goals for the simulation. The objectives should be clearly written and explained in conjunction with designated roles and time frames prior to participation in the simulation (Jeffries, 2005).

Fidelity is equated to the realism of the simulation design, and in the selection of high-fidelity simulation, the simulation experience should mimic clinical reality as closely as possible.

This can be achieved by designing the simulation to be evidence-based with established validity (Jeffries, 2005).

Complexity (problem-solving) reflects the level of uncertainty within the simulation. Either high or low levels of uncertainty can be established with as little or as much relevant information given to the participants to provide opportunities to problem solve the clinical scenario (Jeffries, 2005).

The variable of student support (cues) is a wide encompassment of concepts that are vital to the simulation design as they assist the participant in their assessment and problem solving through the scenario (Groom, Henderson, & Sittner, 2014). Cues may include observations, statements from the simulator, assessment data, laboratory and radiographic data, and patient response or lack of a response to an intervention (Cohen, Cragin, Wong, & Walker, 2012; Gillespie & Patterson, 2009; Langewitz et al., 2010). Orientation to the simulated learning experience, a concept called prebriefing, is also considered student support and has been linked to improved clinical performance (Harris, 2011).

As the simulation design is the most crucial element of this framework, the debriefing component of simulation design is where the work of the entire learning activity cumulates. The debriefing activity should reinforce the positive aspects of the experience, encourage reflective learning strategies allowing the learner to think critically upon the experience and discuss the relevant clinical interventions for future practice (Jeffries, 2005).

The final component of the NLN/Jeffries framework is related to the outcomes of the simulation activity. Jeffries identifies knowledge, skill performance, learner satisfaction, self-confidence, and critical thinking as potential outcomes. Focusing on critical thinking, Jeffries references the APA Delphi Report Definition and the use of the California Critical Thinking Disposition Inventory.

Methods

Definition of Terms

Fidelity. The realism of a simulation, with levels of fidelity describing the technology level and technical features of the simulator (Jeffries, 2007). There are three levels of simulation: low-level, medium-level, and high-level.

Simulation. Activities that mimic the reality of a clinical environment and are designed to demonstrate procedures, decision-making, and critical thinking through techniques such as role playing, and the use of devises (Jeffries, 2005).

Critical thinking. Purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which the judgment is based (Facione, p.3, 1990).

Critical thinking dispositions. A set of intellectual characteristics, attributes or "habits of the mind" that refer to the set of attitudes that allows someone to become the ideal critical thinker. These habits of the mind are: inquisitiveness, open-mindedness, systematicity, analyticity, truth-seeking, maturity and confidence of critical thinking (Facione et al., 1995).

Research Design

This study was a quasi-experimental one group, pretest-posttest design.

Setting

Recruitment took place within a 600-bed, tertiary academic medical center. The simulation scenario took place in an unoccupied room within the Thoracic-Cardiovascular Post-

Operative Intensive Care Unit. The rooms within any of the intensive care units (ICU) of the hospital are identical, with layout and equipment characteristic of standard ICUs. Other equipment necessary for the scenario included: SERVO-i Mechanical Ventilator (Maquet Holding B.V. & Co. KG, Germany), and HAL S3101 Wireless and Tetherless Patient Simulator (Gaumard Scientific, Miami, FL, USA).

Sample

A convenience sample of staff registered nurses of all five adult intensive care units was taken over a six-week period between October and December 2017. Inclusion criteria for participation included: primary job role as staff nurse and full or part-time employment status. Exclusion criteria for participation included: per diem employment status, staff nurses currently on unit-orientation, travel nurses, and nurses who do not spend at least fifty percent of their job duties in patient care.

Based on the three studies that conducted a sample power analysis (Ahn & Kim, 2015; Shin & Kim, 2014; Shinnick & Woo, 2013) the average effect size of the three studies was used. A sample size of 49 participants was planned based on a moderate effect size of 0.40, power of 0.80, and a significance level of 0.05.

Protection of Human Subjects

Approval of this study protocol was sought by the Institutional Review Board at the University of Virginia, with protocol number UVA IRB-SBS #2017-0480. Consent was obtained prior to simulation participation with emphasis that all collected data will not be used, in any way, for job performance review and will stay confidential. All data obtained from the CCTDI was anonymous beyond demographic data as outlined above.

Procedures

Simulation scenario development and characteristics. Simulation development occurred over a 15-week period between September to December 2017. The clinical topic of acute respiratory distress syndrome (ARDS) was chosen. ARDS has the potential to develop in any patient, regardless of the underlying etiology, allowing for a diagnosis that could be seen in any intensive care unit. ARDS is characterized by the acute onset of bilateral, inflammatory pulmonary infiltrates, unrelated to a cardiogenic process, that leads to respiratory failure and refractory hypoxemia (Abou & Dogham, 2016; Walkey, Summer, Ho, & Alkana, 2012). Two master-prepared respiratory therapists functioned as content experts in the development of the scenario. A certified health simulation educator functioned as the simulation construct expert.

All three individuals, in addition to the primary author (AA), met several times to test the manikin-ventilator interface. The manikin chosen is not manufactured with the unique capability to interact with ventilators in real-time. The goal was to manipulate both the simulator and ventilator so that the ventilator could sense spontaneous breaths and the natural plateau pressures of the manikin. Once this was established as possible, subsequent sessions established tidal volumes, ventilatory ratios, and positive end-expiratory pressure (PEEP) values so that realistic respiratory mechanics were read and translated by the ventilator. Final development sessions focused on establishing the necessary settings to consistently reproduce desired ventilatory alarms. Three simulation dry-runs were conducted two weeks prior to data collection to establish timing and fluency of moving through the simulation scenario.

The scenario content was developed during this 15-week period as well. Content validity was established through agreement of the respiratory therapies as well as an acute care nurse practitioner (KG). Edits were made to enhance complexity, ensure ARDS interventions were evidence-based, and all supplemental student support cues (laboratory values and arterial blood gases) were appropriate. The step-wise management interventions completed within the scenario, use of sedation/analgesia, increases in PEEP, neuromuscular blockading agents, recruitment maneuvers and bi-ventilatory mechanical ventilation approaches are recommended within the supportive measures of ARDS treatment (Alessandri, Pugliese, & Ranieri, 2018; Walkey et al., 2012). See Figure 3 for material provided during debriefing scenario regarding role and timing of such therapies. See Appendix A for outline of the simulation scenario.

Simulation design characteristics were defined as follows:

Objectives. The primary objective was for participants to engage in critical thinking. Secondary objectives were to: 1) recognize the clinical presentation of acute respiratory distress syndrome (ARDS) via Berlin definition diagnostic criteria, 2) assess and intervene to various mechanical ventilator alarms, 3) articulate rationale for changes in ventilatory management as it relates to ARDS, and 4) understand treatment rationale for managing ARDS.

Fidelity. Fidelity of the simulation was ensured through utilization of intensive care unit patient rooms, along with the high-fidelity patient simulator. This manikin allowed for real-time interaction with the mechanical ventilator, medication administration, and vital sign response. All supplemental medical equipment (chest tube, urinary catheter, central and peripheral access) were set-up with realistic functionality that allowed the participants to have complete assessments, further enhancing the real-life interaction between simulated patient and participating nurse.

The structure of the simulation allowed for participants to investigate and engage freely with the simulation environment. Limited clinical information was presented initially. Additional clinical information was dispersed throughout the simulation, mimicking the progression of care of a real patient (Jeffries, 2005).

Complexity. The clinical topic of this simulation centered around the clinical progression of a multi-trauma patient that experienced respiratory and systemic complications ultimately leading to respiratory failure and ARDS. Patients often present with tachypnea, dyspnea, restlessness, agitation, tachycardia with a decrease in oxygenation displayed via pulse oximeter and arterial blood gas analysis. Management is hallmarked by low tidal volume ventilation and application of positive end-expiratory pressure to mediate the inflammatory process of tissue damage, and pulmonary edema which decrease the potential for oxygenation.

ARDS carries a high hospital mortality rate, at 40%. The diagnosis is clinically challenging due to the nonspecific symptomology of the condition encompassing a broad differential (Walkey et al., 2012). The bedside nurse is a critical component in early identification of a patient through consistent assessments, synthesis of clinical data, and ongoing communication with the healthcare team. Treatment is largely supportive and success of various treatment options depends primarily on the severity of the condition once recognized, placing great significance on early detection (Walkey et al., 2012).

This complex scenario was constructed with high levels of uncertainty, but with high levels of relevant information. Via the history of present illness, clinical assessment information, arterial blood gas results, and chest x-ray information, all necessary information was presented to participants within the scenario for the diagnosis of ARDS. However, given the high level of uncertainty regarding the etiology of the simulated patient's deterioration, the relevant information presented could, and often was, attributed to various differentials. This level of complexity was chosen to allow for several opportunities for participants to critically reason through the scenario.

Cues. Various student support elements were encompassed within this scenario design. A period of pre-briefing lasting ten minutes was conducted prior to the start of the scenario. Elements of this pre-briefing included: introduction to the simulation environment, opportunity to engage freely with the manikin and the simulated environment, creation of a non-judgmental space centered around learning and an opportunity for clarifications and questions. The scenario schema was also presented, where the primary investigator role-played the resident and respiratory therapist if it was decided that the participants requested additional support. Participants were requested to think aloud.

Throughout the scenario, student support cues of laboratory information and diagnostic imaging were presented. The assistance of the scenario resident or respiratory therapist was offered only if all participants in the scenario felt it necessary. The assistance offered was done via a line of Socratic questioning. No direct guidance towards a decision or simulation treatment modality was given; participants were allowed an opportunity to openly explore potential etiologies of the patient decline and treatment decisions. Decisions were based on their clinical assessments, presented scenario information and understanding of the clinical situation.

Regardless of treatment decisions, the scenario was designed in such a way that the patient would continue to ultimately decline, requiring aggressive rescue therapies outlined in the management of ARDS. The purpose of this was to ensure exposure to advanced therapies. The scenario ended when the participants suggested any of these: proning, high-frequency ventilation or extra corporeal membrane oxygenation.

Debriefing. Per the NLN/Jeffries Simulation Framework, debriefing followed immediately upon scenario completion. The debriefing occurred within the same room as the simulation, where participants were provided chairs surrounding a white board. Debriefing was structured in style, and the method used was Debriefing for Meaningful Learning (DML). This particular method was chosen as it has been demonstrated to be an effective method of debriefing allowing for review of patient care, fostering meaningful learning and most importantly, cultivating critical thinking (Dreifuerst, 2015).

DML employs the use of worksheets to explore the phases of this method. This was modified through the use of a white board where the debriefing facilitator (AA) wrote participant responses. This ensured visual learning opportunities and employed conceptual mapping practices, allowing for visualization of the relationship among assessments, decisions, and outcomes (Dreifuerst, 2015; Pesut, 2004). Socratic questioning then employed to guide participants through the six phases of DML: engage, explore, explain, elaborate, evaluate and extend.

During the engage phase of DML, the simulation concluded where the debriefing facilitator gathered participants to debrief. Participants were given a moment to express emotions regarding the scenario, unload the experience of the simulation scenario, and then asked to engage in the process of reflective debriefing.

In the explore phase of DML, Socratic questioning was continued to uncover the participant's thinking (Dreifuerst, 2015). Specific questions were asked regarding what occurred during the scenario, what were the primary problems the patient experienced, and what clinical symptoms or assessment findings supported the diagnosis. Concepts and themes amongst answers were written on the whiteboard, and opportunities to discover relationships between assessment findings, decisions, actions, and outcomes were explored. Assumptions and associated actions, whether correct or incorrect, were explored so that these mismatches in reasoning could be addressed to provide a consistent foundation for the extend phase of DML

(Dreifuerst, 2015). The explore phase of DML moves seamlessly with the explain phase of DML, where articulation of thought processes was done.

During elaboration, the opportunity to emphasize existing nursing knowledge and concepts was done. This was accomplished again via Socratic questioning which pulled together key themes and concepts that surfaced during the explore phase. Reflecting back to participant-highlighted concepts solidified the objectives of the simulation experience. Through questioning, participants had time to synthesize the material during the simulation experience and debriefing, emphasizing links in nursing knowledge and future application (Dreifuerst, 2015).

Evaluating what went well and what did not go well during the scenario followed. Attention was given to specific moments in the scenario. Strengths in communication or evident moments of conclusion in thought were highlighted to frame the experience in a positive, meaningful manner. Then, the questions of "what could be improved upon?" and "how could that be accomplished?" was posed to move towards the extension phase of DML.

Concluding with extension, participants were asked to assimilate what was learned from the scenario to their current practice as intensive care nurses. Participants were asked to extend their thinking, to anticipate future decision making when faced with similar clinical situations (Dreifuerst, 2015).

Instruments. Demographic information was collected using an investigator-developed Demographic Information Questionnaire. Demographics measured included age, gender, years practicing as professional nurse, years practicing as an intensive care nurse, certification status (Yes/No). Participants were allowed to write in which certification they held.

The California Critical Thinking Disposition Inventory (CCTDI) was used to measure baseline and post-intervention critical thinking scores. This is a discipline-neutral instrument that measures internal motivation toward critical thinking, or rather, the disposition to use or not to use one's reasoning and reflective judgment when solving problems (Facione, Facione, & Giancarlo, 2001). The CCTDI is a 75-item Likert style attitudinal survey (Facione et al., 2001) that has seven subscales, each designed to measure a critical thinking habits of mind; truth-seeking, open-mindedness, analyticity, systematicity, confidence, inquisitiveness, and maturity (Facione et al., 2001). Each subscale has 9-12 items which are interspersed throughout the instrument.

The instrument uses a 6-point Likert scale in which 1 = strongly agree and 6 = strongly disagree. Total CCTDI scores range from 70 to 420, with subscales scores ranging from 10 to 60. A total score above 350 indicates a strong disposition towards critical thinking, 280-450 a positive inclination, 210-279 indifference, and scores below 210 indicating a significant weakness towards practicing critical thinking (Facione et al., 2001). A score of 30 and below on any of the scales indicates a weakness in relation to the given attribute, a score of 40 indicates average or indifference towards the attribute, and scores above 50 indicates strength of that given attribute (Facione, Facione, & Sanchez, 1994).

Alpha reliabilities for the seven individual scales range from .71 to .80, with an alpha reliability of .91 for the entire instrument measuring overall disposition towards critical thinking (Facione et al., 2001). Cronbach alphas have established overall reliability between .8 and .9 when utilized in nurses of various inpatient practice settings (Profetto-McGrath, Hesketh, Lang, & Estabrooks, 2003). Smith-Blair and Neighbors (2000) validated it within the critical care nursing population with a Cronbach alpha of .87 overall. This instrument was used with permission from Insight Assessment, Inc. Refer to Table 2 for a description of the subscales.

Delivery of simulation. Participating nurses were asked to participate on their own time. Each simulation session had three slots available so the designated roles of charge nurse, primary nurse, and secondary nurse were filled. Simulation sessions ran with as little as one participant or as many as three. Several recruitment strategies were employed. Recruitment flyers (see Figure 2) were placed in all the intensive care units, in person recruitment was completed, food was provided on each day there was a simulation, and gift cards of the amount of $10.00 to a local coffee shop were provided to those participating. Additionally, a raffle for a $300.00 gift card which was chosen at the end of the study period.

Upon arrival to the simulation, informed consent was obtained, the Demographic Information Questionnaire and the pre-test CCTDI were completed. When all session participants were finished, participants were guided into the simulation environment and simulation pre-briefing was completed. An opportunity to address questions and concerns was given prior to simulation start. Simulation scenario time frames varied between 30-40 minutes in length, dependent upon necessary student cues. Debriefing followed once participants arrived at conclusive therapy suggestions. Immediately following debriefing, participants completed the post-test CCTDI.

The delivery of the simulation in its entirety lasted 75-90 minutes, with time variation dependent upon participation's fluency within the scenario. All five simulation constructs were adhered to in each singular delivery.

Primary outcomes. The primary outcome of this study was the change in total critical thinking and individual disposition scores.

Secondary outcomes. The secondary outcome was to examine the potential existing relationships between critical thinking dispositions scores and age, gender, years practicing as professional nurse, years practicing as an intensive care nurse, and certification status.

Data Analysis Plan

Data analysis was performed using IBM SPSS Statistics for Mac version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics on age, gender, years practicing as professional nurse, years practicing as an intensive care nurse, and certification status were run. The pre-and post-test means of the overall CCTDI scores and the seven subscale scores were computed for each individual. Paired t-tests were performed comparing the change of overall CCTDI score as well as change of the seven subscale scores. Pearson's correlation was performed to investigate potential correlations between the continuous variables and change in overall CCTDI, the seven subscales and demographics. Mann-Whitney U was completed for the same purposes with the categorical variables. All tests were two-sided at the $\alpha=0.05$ level of significance. There was no missing data.

Results

Twenty-two nurses participated in the study. The participants were predominantly female (91%), with a mean age of 29 years, 4.6 years of professional nursing experience and nearly 3 years of critical care nursing experience. All five adult critical care units were represented with the majority being from the Surgical-Trauma Intensive Care Unit (31.8%). The majority of the participants held certification (72.7%), with the Critical Care Registered Nurse (CCRN) certification being the most popular (54.5%). See Table 3 for full demographic characteristics.

Mean overall CCTDI scores before and after the simulation were 325.68 ± 23.71 and 334.86 ± 22.92, respectively. Change in overall CCTDI scores increased significantly by 9.18 points ($t = 3.453$, $p = .002$, 95% CI [3.452, 14.71]). Four categories of critical thinking dispositions, truth-seeking, inquisitiveness, systematicity, and confidence in reasoning, increased significantly after simulation participation. The categories of open-mindedness, analyticity, and maturity of judgment displayed an increasing trend, but were not statistically significant. See Table 4 for full results.

No significant correlations were found between the demographics of gender, age, years practicing as a registered nurse, years practicing as an intensive care registered nurse, home intensive care unit, or certification and overall CCTDI change. Amongst the subscales, there were significant correlations between change in: truth-seeking and years an intensive care nurse ($r= .559$, $p= .007$), change in open-mindedness and increase in age ($r = .514$, $p = .014$) as well as, increase in years practicing as a registered nurse ($r = .454$, $p = .034$), change in systematicity and being certified in any nursing specialty ($r = .543$, $p = .009$).

Discussion

Post-test overall critical thinking disposition scores increased after participation in a single high-fidelity simulation, and were overall positively inclined towards critical thinking. Similar findings of increased overall CCTDI scores after nursing student simulation participation were also reported by others (Shin et al., 2015; Shin & Kim, 2014; Chiang & Chan, 2014; Wood & Toronto, 2012). However, this study found significance after only a single, one-hour session. This is in contrast to studies that found no significant change in CCTDI after a single simulation session (Shin et al., 2015; Chiang & Chan, 2014), and studies that by design had multiple simulation sessions (Shin & Kim, 2014; Wood & Toronto, 2012). Furthermore, this increase was shown to be statistically significant though only half of projected sample size was reached.

The methods of this study may provide several explanations for this significant increase in CCTDI scores. One explanation is the consistency in which definitions of critical thinking and critical thinking dispositions were applied to both conceptual framework and instrument choice. This process characteristic was found in two similar studies that demonstrated significant increases in total disposition scores after HFS; however, sample sizes were much larger at 237 (Shin et al., 2015) and 132 (Chiang & Chan, 2014).

A second potential explanation is the use of the NLN/Jeffries Simulation Framework to guide simulation development and implementation. This framework was developed to fill a gap in simulation and provide an organized, systematic way of conducting simulation research (Jeffries, 2005). However, utilization of theoretical frameworks guiding simulation experiences has been slow to evolve and become adapted (Groom et al., 2014). In fact, only two studies (Shin et al., 2015; Shin & Kim, 2014) in this literature review described the use of a framework to build their scenarios.

To increase standardization and reproducibility of simulation exercises, simulations should be grounded in theory and guided by frameworks, where through a rigorous simulation design, desired objectives can be met (Groom et al., 2014; Ahn & Kim, 2015). Particular use of the NLN/Jeffries Simulation Framework capitalizes on this concept, where the core constructs, particularly the simulation design characteristics, represents the evolving methodology of simulation-based education in health care (Groom et al., 2014). Several elements of the NLN/Jeffries Simulation Framework have been adopted as best practices by the International

Nursing Association for Clinical Simulation and Learning (INACSL) (INACSL, 2016) and most likely contributed to the findings of this study.

Lastly, only a moderate effect size of 0.40 was used in this study's power analysis calculation. The effect size could in fact larger than 0.40, allowing for significance of the simulation effects on critical thinking dispositions to be found, even in this small sample size.

Four subscales showed statistically significant gains from pre- to post-test scores: truth-seeking, systematicity, confidence in reasoning, and inquisitiveness. Regarding all subscales but one, participant's mean scores, in both pre-test and post-test, were positive towards critical thinking. Mean pre-test inquisitiveness scores were strongly positive towards critical thinking, and remained strongly positive upon post examination.

The largest change was in the truth-seeking subscale, which had the lowest mean pre-test disposition score (42.18 ± 4.85). Eighteen percent of participants transitioned from being ambivalent towards this disposition to positively inclined. See Figure 4 for subscale distributions. Similar findings were shown where truth-seeking had the lowest mean subscale score (Wood & Toronto, 2012; Fero et al., 2010), and saw significant change after simulation intervention (Wood & Toronto, 2012). Furthermore, in multiple critical thinking disposition surveys of both practicing nurses and nursing students, truth-seeking was consistently demonstrated to be the lowest mean subscale score (Mahmoud & Mohamed, 2017; Wangensteen et al., 2010; Profetto-McGrath et al., 2003; Profetto-McGrath, 2003).

The truth-seeking subscale targets intellectual curiosity (Facione et al., 2001), where there is a desire for the most comprehensive understanding of a situation, even if it challenges one's preconceived notions or beliefs (Facione et al., 1995). It has been suggested that traditional, lecture-based pedagogical approaches could account for this within surveys of nursing students, where students learn passively, and do not have the opportunity to explore differing explanations to material presented (Wangensteen et al., 2010; Profetto-McGrath et al., 2003). This could explain the low truth-seeking pre-test score given the relatively novice experience of this study's particular sample.

Another consideration could also be the varied methods of continuing education and updates in evidence-based practices within the different intensive cares, again which are typically passive in the form of online modules or emails, limiting nurse's opportunity to challenge old knowledge and considered a hindrance by some to critical thinking (Tedesco-Schneck, 2013). It is desirable that practicing critical care nurses display stronger inclinations towards this particular disposition, that they are encouraged to have honest and objective pursuits of inquiry as this knowledge can translate into patient care through. It is encouraging that use of high-fidelity simulation impacts truth-seeking significantly. Impacting it to the extent that it did in this study might be explained via the simulation design characteristics of complexity, cues, and debriefing.

Systematicity followed, where post-test assessments saw an increase in those aligned strongly positively by nearly 14%. Described as striving to approach problems in a disciplined, orderly, and systematic way is likely to factor into the individual's approach in all higher order thinking processes (Facione et al., 1995). Systematicity was also found to be increased in several other studies after simulation intervention (Shin et al., 2015; Shin & Kim, 2014; Chiang & Chan, 2014). Enabling critical care nurses to exercise organized thought processes and approaches towards unfamiliar clinical scenarios allows for the orderly collection of data to synthesize potential patient changes. This in turn, could translate to improved clinical judgments.

Confidence in reasoning was the third subscale that changed significantly between pre- and post-test. This is regarded as the habitual tendency to trust one's reflective thinking ability to solve problems and make decisions (Facione et al., 1995). Participant's scores doubled the pre- and post-test from 27.3% to 50% of those aligned positively or strongly positively towards this disposition. Of the studies that reported subscale results, Chiang & Chan (2014) was the only to report a statistically significant increase within of reasoning confidence, while all others (Shin et al., 2015; Shin & Kim, 2014; Wood & Toronto, 2012) saw a trend of increasing scores. In an integrative review of seventeen studies assessing the use of high-fidelity simulation on continuing education of critical care providers, twelve studies saw a significant increase in self-confidence measurements (Boling & Hardin-Pierce, 2016). However, this study used a validated instrument to measure confidence versus self-report, adding to the understanding of critical thinking processes.

Pre-test mean inquisitiveness, or intellectual curiosity (Facione et al., 1995), of participants was the highest scoring subscale, a finding shared by several others (Wangensteen et al., 2010; Fero et al., 2010; Profetto-McGrath et al., 2003; Profetto-McGrath, 2003). Participants remained strongly positive towards inquisitiveness post-simulation. Similar findings of significant increases of inquisitiveness were reported (Shin et al., 2015; Shin & Kim, 2014). Interestingly though, nine percent of individuals scores decreased upon post-test, from strongly expressing to positively expressing this disposition. Chiang and Chan (2014) reported a similar finding, where nursing students experienced a significant decrease in level of inquisitiveness after two separate exposures to high-fidelity simulation. This particular finding could be due to the clinical topic of ARDS which the simulation scenario was based upon. In debriefing participants regarding this topic, there were varying levels of individual knowledge. Some participants were simply familiar with the diagnosis, while others had extensive knowledge which could explain why some might be less inclined to further learning. However, since individual knowledge of this topic was not tested, no correlations could be explored, this is merely speculative. This finding could also be due to the learning environment of high-fidelity simulation, and the nature of being assessed (Chiang & Chan, 2014); participants might not be motivated for further learning beyond the formal debriefing period and completion of study participation. Indeed, higher score of inquisitiveness have been positively correlated to higher levels of research utilization (Wangensteen et al., 2010; Profetto-McGrath et al., 2003) which can ultimately influence practice standards and patient outcomes. Further study is needed to explain the effect of high-fidelity simulation on inquisitiveness.

Though changes in subscales of open-mindedness, analyticity, and maturity in judgment were not statistically significant, all displayed an increase in mean post-test scores after participation in simulation. Where this study did not find significant changes, other studies did in these subscales (Shin et al., 2015; Shin & Kim, 2014; Chiang & Chan, 2014; Wood & Toronto, 2012). This simply could be a limitation of this study's small sample size, the makeup of demographic characteristics and the fundamental difference of practicing nurses versus student nurses studied. Furthermore, there were found to be no significant correlations between any of the demographics and change in total critical thinking disposition scores. The existing literature agrees with this finding (Wood & Toronto, 2012; Chiang & Chan, 2014; Shin & Kim, 2014; Shin et al., 2015). Looking more broadly at an examination of various assessment methods of critical thinking and nursing, relationships can be found, particularly between higher critical thinking scores and older age (Ludin, 2018; Shinnick & Woo, 2013; Wangensteen et al., 2010; Martin, 2002). Again, this study's small sample size and homogenous distribution of ages, being that nearly 80% of the sample was between 24-29 years old, may have affected the ability to explore potential meaningful relationships.

Several significant relationships were found between subscale and demographics. Change in truth-seeking was positively correlated with years as an ICU RN, a finding that was shared by newer survey studies of critical thinking of ICU RNs (Ludin, 2018; Yurdanur, 2016). Stated previously, this subscale targets intellectual curiosity, and it could be suggested that as a nurse develops towards intermediate and expert levels of practice, the level of understanding also develops. They have both the desire and the ability to understand and synthesize complex pieces of information regarding their patient.

Change in open-mindedness scores were positively correlated with as both age and years of RN practice. The ability to be open-minded, or the tendency to allow others to voice viewpoints and act with tolerance in face of differing opinions (Facione et al., 1995), could be considered something that older, more experienced clinicians can practice efficiently given their varied experiences. This relationship could also exist as simulations were conducted in group settings, where participants were placed in a situation where difference of opinions could arise, and open-mindedness could be exercised.

Finally, the change in the subscale of systematicity was positively correlated with holding certification in a nursing specialty. The ability to approach problems in a disciplined, orderly fashion regardless of knowledge of the potential issue at hand (Facione et al., 1995) could be something learned through the process of systematic preparation for certification, or could be a habit that indicates a certain individual is more likely to pursue certification.

Limitations

There are multiple limitations of this study. First, the quasi-experimental, single group, pre-test post-test design lacks a randomized control comparison group. This reduces internal validity of the study and did not allow for confounding factors to be controlled. Furthermore, sampling bias should be considered as sample size was obtained via convenience sampling methods. While a power analysis was completed, the small sample size, with homogenous demographic characteristics, limits the generalizability of these findings. In addition to generalizing findings, the small sample size most likely impacted certain findings, such as correlations, where there simply were not enough participants to explore relationships between demographics and scores. The length of the simulation posed a significant limitation to recruitment. Subjects were asked to participate on their own time, outside of work, and was frequently stated to be the main reason individuals did not want to participate in this study.

Practice Implications

Several practice implications regarding the promotion of critical thinking in critical care nurses are relevant to the study. First, the relationship between critical thinking and clinical judgment can further be explored. Critical thinking is recognized as essential to developing comprehensive clinical judgment, and safe delivery of patient care. Benner posits that a nurses' ability to critical think and make accurate clinical judgments develops predominantly through experience (1984). High-fidelity simulation offers experience opportunities. Particularly, the opportunity for repeated exposures to rare, but high-stakes clinical situations where it is essential a nurse has exemplary critical thinking and clinical judgment skills. If critical care nurses do not develop critical thinking, a delay in patient treatment potentially resulting in serious, life-threatening consequences could occur (Fero et al., 2009).

Secondly, the use of high-fidelity simulation could find meaning in both transition-to-practice programs for graduate critical care nurses, as well as, continuing education programs. Implementing successful methods to expedite the development of critical thinking in new both new and experienced nurses has the potential to improve patient safety, nurse job satisfaction, leading to improved recruitment and retention of competent nurse professionals (Shoulders et al., 2014). This is particularly vital as patient safety cannot be compromised due to changes in workforce trends, where turnover rates are as high as 28% within the first year of nursing (Nursing Solutions Inc., 2018). While formal transition-to-practice programs have demonstrated improvements in retention (Rush, Adamack, Gordon, Lilly, & Janke, 2013), examination of the role of integrating high-fidelity simulation is warranted.

Future Recommendations and Conclusion

This study addressed a gap in the study of the effect of high-fidelity simulation on the disposition of critical care nurses critical thinking. While this study has implications for how to restructure orientation programs for practicing nurses to mature critical thinking, clinical judgment, and clinical decision-making, there are several opportunities for future investigation.

First, the design and conduct of studies aimed at practicing critical care nurses that recruits larger sample sizes would allow analysis of correlation between demographic characteristics and critical thinking dispositions or skills. Second, conducting randomized studies that compare high-fidelity simulation to other established methods of promoting critical thinking such as problem-based learning or case studies, could help to establish the true effectiveness of high-fidelity simulation. Retention of the effects of high-fidelity simulation on critical thinking dispositions should also be examined. Multiple studies cited that either multiple exposures of simulation were necessary to obtain desired effects but the optimal dose, timing, or need for repetition of high-fidelity simulation are not known. Future studies should aim to measure the relationship between the critical thinking abilities of practicing nurses, participation in simulation and improved patient outcomes.

In summary, the participation of practicing critical care nurses in a single high-fidelity simulation showed a positive impact on overall critical thinking dispositions of practicing critical care nurses, as well as, a majority of the seven dispositional components. The design and use of a simulation based in the NLN/Jeffries Simulation Framework and the alignment of the study concept, critical thinking dispositions, with a validated measure contributed to the outcomes of this study. The findings of this study in the critical thinking dispositions of practicing nurses adds to the body of knowledge of critical thinking and supports the value of further study with larger, randomized samples. Finally, demographic and workforce trends in the retention of critical care nurses and the national priority for safe and optimal patient outcomes, dependent on nurses' critical thinking and clinical judgment, calls for the examination of innovative education models, such as high-fidelity simulation, implemented in this study.

References

Abou, F., & Dogham, R. (2016). Impact of Using Simulation on Critical Care Nursing Students' Knowledge and Skills of Acute Respiratory Distress Syndrome. *Journal of Nursing and Health Science, 5*(5), 28-42.

Ahn, H., & Kim, H. Y. (2015). Implementation and outcome evaluation of high-fidelity simulation scenarios to integrate cognitive and psychomotor skills for Korean nursing students. *Nurse Education Today, 35*(5), 706-711. doi:10.1016/j.nedt.2015.01.021 [doi]

Alessandri, F., Pugliese, F., & Ranieri, M. (2018). The Role of Rescue Therapies in the Treatment of Severe ARDS. *Respiratory Care, 63*(1), 92-101.

American Association of Colleges of Nursing. (2008). *The essentials of baccalaureate education for professional nursing practice.*Washington, DC.: American Association of Colleges of Nursing.

Benner, P., Sutphen, M., Leonard, V., & Day, L. (2010). *Educating nurses: A call for radical transformation*. San Francisco, CA: The Jossey-Bass.

Benner, P. (1984). From novice to expert: Excellence and power in clinical nursing practice. *AJN the American Journal of Nursing, 84*(12) Retrieved from http://journals.lww.com/ajnonline/Fulltext/1984/12000/FROM_NOVICE_TO_EXPERT__EXCELLENCE_AND_POWER_IN.27.aspx

Boling, B., Hardin-Pierce, M., Jensen, L., & Hassan, Z. U. (2017). Evaluation of a high-fidelity simulation training program for new cardiothoracic intensive care unit nurses. *Seminars in Thoracic and Cardiovascular Surgery, 28*(4), 770-775. doi:S1043-0679(16)30154-X [pii]

Boling, B., & Hardin-Pierce, M. (2016). *The effect of high-fidelity simulation on knowledge and confidence in critical care training: An integrative review* doi:http://dx.doi.org.proxy.its.virginia.edu/10.1016/j.nepr.2015.10.004

Brown, D., & Chronister, C. (2009). The effect of simulation learning on critical thinking and self-confidence when incorporated into an electrocardiogram nursing course. *Clinical Simulation in Nursing, 5*(1), e45-e52. doi:10.1016/j.ecns.2008.11.001

Buerhaus, P. I. (2005). Six-part series on the state of the RN workforce in the united states. *Nursing Economic$, 23*(2), 58-60, 55.

Chiang, V. C., & Chan, S. S. (2014). An evaluation of advanced simulation in nursing: A mixed-method study. *Collegian (Royal College of Nursing, Australia), 21*(4), 257-265.

Cohen, S. R., Cragin, L., Wong, B., & Walker, D. M.Self-efficacy change with low-tech, high-fidelity obstetric simulation training for midwives and nurses in mexico. *Clinical Simulation in Nursing, 8*(1), e15-e24. doi:10.1016/j.ecns.2010.05.004

Cook, D.A., Hatala, R., Brydges, R., Zendejas, B., Szostek, J. H., Wang, A. T., . . . Hamstra, S. J. (2011). Technology-enhanced simulation for health professions education: A systematic review and meta-analysis. *JAMA, 306*(9), 978-988. doi:10.1001/jama.2011.1234 [doi]

del Bueno, D. (2005). A crisis in critical thinking. *Nursing Education Perspectives, 26*(5), 278-282.

Dewey, J. (1938). In Kappa Delta Pi (Ed.), *Experience and education* Simon and Schuster.

Dreiferst, K. (2015). Getting started with Debriefing for Meaningful Learning. *Clinical Simulation in Nursing, 11*(5), 268-275. doi: https://doi.org/10.1016/j.ecns.2015.01.005

Ennis, R. (1962). A concept of critical thinking. *Harvard Educational Review, (32)*1, 81-111.

Facione, P. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. the Delphi report: Research findings and recommendations*. Washington, DC: American Philosophical Association.

Facione, P., Facione, N., & Giancarlo, C. (2000). The disposition toward critical thinking: Its character, measurement and relation to critical thinking skill. *Informal Logic, 20*(1), 61-84.

Facione, P., Facione, N., & Giancarlo, C. (2001). *California critical thinking disposition inventory test manual.* Milbrae, CA: California Academic Press.

Facione, N. C., Facione, P. A., & Sanchez, C. A. (1994). Critical thinking disposition as a measure of competent clinical judgment: The development of the California critical thinking disposition inventory. *The Journal of Nursing Education, 33*(8), 345-350.

Facione, P., Giancarlo, C., Facione, N., & Gainen, J. (1995). The Disposition Toward Critical Thinking. *Journal of General Education, 44*(1), 1-25.

Feng, R. C., Chen, M. J., Chen, M. C., & Pai, Y. C. (2010). Critical thinking competence and disposition of clinical nurses in a medical center. *The Journal of Nursing Research : JNR, 18*(2), 77-87. doi:10.1097/JNR.0b013e3181dda6f6 [doi]

Fero, L. J., O'Donnell, J. M., Zullo, T. G., Dabbs, A. D., Kitutu, J., Samosky, J. T., & Hoffman, L. A. (2010). Critical thinking skills in nursing students: Comparison of simulation-based performance with metrics. *Journal of Advanced Nursing, 66*(10), 2182-2193. doi:10.1111/j.1365-2648.2010.05385.x [doi]

Fero, L. J., Witsberger, C. M., Wesmiller, S. W., Zullo, T. G., & Hoffman, L. A. (2009). Critical thinking ability of new graduate and experienced nurses. *Journal of Advanced Nursing, 65*(1), 139-148. doi:10.1111/j.1365-2648.2008.04834.x [doi]

Gillespie, M., & Peterson, B. L. (2009). Helping novice nurses make effective clinical decisions: The situated clinical decision-making framework. *Nursing Education Perspectives, 30*(3), 164-170.

Goodstone, L., Goodstone, M. S., Cino, K., Glaser, C. A., Kupferman, K., & Dember-Neal, T. (2013). Effect of simulation on the development of critical thinking in associate degree nursing students. *Nursing Education Perspectives, 34*(3), 159-162.

Groom, J. A., Henderson, D., & Sittner, B. J.NLN/Jeffries simulation framework state of the science project: Simulation design characteristics. *Clinical Simulation in Nursing, 10*(7), 337-344. doi:10.1016/j.ecns.2013.02.004

Harris, M. (2011). Simulation-enhanced pediatric clinical orientation. *Journal of Nursing Education, 50*, 461-465.

Hee-Ok, P., & Insook, L. (2016). Enhancing critical thinking through simulation problem-based learning in nursing education. *Indian Journal of Science and Technology, 9*(37) doi:http://dx.doi.org/10.17485/ijst%2F2016%2Fv9i37%2F101758

Hong, S., & Yu, P. (2017). Comparison of the effectiveness of two styles of case-based learning implemented in lectures for developing nursing students' critical thinking ability: A randomized controlled trial. *International Journal of Nursing Studies, 68*, 16-24. doi:S0020-7489(16)30244-9 [pii]

INACSL Standards Committee (2016, December). INACSL standards of best practice: Simulation^SM Simulation design. Clinical Simulation in Nursing, 12(S), S5-S12. http://dx.doi.org/10.1016/ j.ecns.2016.09.005

Institute of Medicine. (2010). *The future of nursing: Leading change, advancing health.* (). Washington, DC: The National Academies Press.

Jeffries, P. R. (2005). A framework for designing, implementing, and evaluating simulations used as teaching strategies in nursing. *Nursing Education Perspectives, 26*(2), 96-103.

Jeffries, P. R. (2007). *Simulation in nursing education: From conceptualization to evaluation.* (2nd ed.). New York, New York: National League of Nursing.

Jeppesen, K. H., Christiansen, S., & Frederiksen, K. (2017). Education of student nurses - A systematic literature review. *Nurse Education Today, 55*, 112-121. doi:S0260-6917(17)30108-9 [pii]

Kim, D. H., Moon, S., Kim, E. J., Kim, Y. J., & Lee, S. (2014). Nursing students' critical thinking disposition according to academic level and satisfaction with nursing. *Nurse Education Today, 34*(1), 78-82. doi:10.1016/j.nedt.2013.03.012 [doi]

Kim, J., Park, J., & Shin, S. (2016). Effectiveness of simulation-based nursing education depending on fidelity: A meta-analysis. *BMC Medical Education, 16*(1), 152. doi:10.1186/s12909-016-0672-7

Kong, L. N., Qin, B., Zhou, Y. Q., Mou, S. Y., & Gao, H. M. (2014). The effectiveness of problem-based learning on development of nursing students' critical thinking: A systematic review and meta-analysis. *International Journal of Nursing Studies, 51*(3), 458-469. doi:10.1016/j.ijnurstu.2013.06.009 [doi]

Lang, G. M., Beach, N. L., Patrician, P. A., & Martin, C. (2013). A cross-sectional study examining factors related to critical thinking in nursing. *Journal for Nurses in Professional Development, 29*(1), 8-15. doi:10.1097/NND.0b013e31827d08c8 [doi]

Langewitz, W., Heydrich, L., Nubling, M., Szirt, L., Weber, H., & Grossman, P. (2010). Swiss cancer league communication skills training programme for oncology nurses: An evaluation.

Journal of Advanced Nursing, 66(10), 2266-2277. doi:10.1111/j.1365-2648.2010.05386.x [doi]

Letcher, D., Roth, S., & Varenhorst, L. (2017). Simulation-based learning: Improving knowledge and clinical judgment within the NICU. *Clinical Simulation in Nursing, 13*(6), 284-290.

Ludin, S.M. (2018). Does good critical thinking equal effective decision-making among critical care nurses? A cross-sectional survey. *Intensive & Critical Care Nursing, 44*, 1-10.

Mahmoud, A.S., & Mohamed, H.A. (2017). Critical thinking disposition among nurses working in public hospitals at port-said governorate. *International Journal of Nursing Sciences, 4*(2), 128-134.

Maneval, R., Fowler, K.A., Kays, J. A., Boyd, T. M., Shuey, J., Harne-Britner, S., & Mastrine, C. (2012). The effect of high-fidelity patient simulation on the critical thinking and clinical decision-making skills of new graduate nurses. *Journal of Continuing Education in Nursing, 43*(3), 125-134. doi:10.3928/00220124-20111101-02 [doi]

Martin, C. (2002). The theory of critical thinking in nursing. *Nursing Education Perspectives, 23*(5), 243-247.

Nursing Solutions, Inc. (2018). *2018 national health care retention and RN staffing report.* NSI Nursing Solutions, Inc.

Oermann, M. H. (1998). How to assess critical thinking in clinical practice. *Dimensions of Critical Care Nursing: DCCN, 17*(6), 322-327.

Paul, R., & Elder, L. (2010). *The miniature guide to critical thinking concepts and tools.* Dillon Beach: Foundation for Critical Thinking Press.

Pesut, D.J. (2004). Reflective clinical reasoning. In L. Hayes, H. Butcher & T. Boese (Eds), *Nursing in Contemporary Society* (pp. 146-162). Upper Saddle River, NJ: Pearson Prentice Hall.

Pitt, V., Powis, D., Levett-Jones, T., & Hunter, S. (2015). The influence of critical thinking skills on performance and progression in a pre-registration nursing program. *Nurse Education Today, 35*(1), 125-131. doi:10.1016/j.nedt.2014.08.006 [doi]

Profetto-McGrath, J. (2003). The relationship of critical thinking skills and critical thinking dispositions of baccalaureate nursing students. *Journal of Advanced Nursing, 43*(6), 569-577.

Profetto-McGrath, J., Hesketh, K.L., Lang, S., & Estabrooks, C.A. (2003). A study of critical thinking and research utilization among nurses. *Western Journal of Nursing Research, 25*(3), 322-337.

Ravert, P. (2008). Patient simulator sessions and critical thinking. *The Journal of Nursing Education, 47*(12), 557-562.

Rush, K.L., Adamack, M., Gordon, J., Lilly, M., & Janke, R. (2013). Best practices of formal new graduate nurse transition programs: an integrative review. *International Journal of Nursing Studies, 50*(3), 345-356.

Scheffer B.K., & Rubenfeld. M. (2000). A consensus statement on critical thinking in nursing. *Journal of Nursing Education, 39*(8), 352-9.

Schubert, C. (2012). Effect of simulation on nursing knowledge and critical thinking in failure to rescue events. *Journal of Continuing Education in Nursing, 43*(10), 467-471.

Shin, H., & Kim, M. J. (2014). Evaluation of an integrated simulation courseware in a pediatric nursing practicum. *The Journal of Nursing Education, 53*(10), 589-594. doi:10.3928/01484834-20140922-05 [doi]

Shin, H., Ma, H., Park, J., Ji, E. S., & Kim, D. H. (2015). The effect of simulation courseware on critical thinking in undergraduate nursing students: Multi-site pre-post study. *Nurse Education Today, 35*(4), 537-542. doi:10.1016/j.nedt.2014.12.004 [doi]

Shinnick, M. A., & Woo, M. A. (2013). The effect of human patient simulation on critical thinking and its predictors in prelicensure nursing students. *Nurse Education Today, 33*(9), 1062-1067. doi:10.1016/j.nedt.2012.04.004 [doi]

Shoulders, B., Follett, C., & Eason, J. (2014). Enhancing critical thinking in clinical practice: Implications for critical and acute care nurses. *Dimensions of Critical Care Nursing: DCCN, 33*(4), 207-214. doi:10.1097/DCC.0000000000000053 [doi]

Smith-Blair, N., & Neighbors, M. (2000). Use of critical thinking disposition inventory in critical care orientation. *The Journal of Continuing Education in Nursing, 31*(6), 251-256.

Sullivan-Mann, J., Perron, C. A., & Fellner, A. N. (2009). *The effects of simulation on nursing students' critical thinking scores: A quantitative study* doi:http://dx.doi.org/10.1053/j.nainr.2009.03.006

Swinny, B. (2010). Assessing and developing critical-thinking skills in the intensive care unit. *Critical Care Nursing Quarterly, 33*(1), 2-9. doi:10.1097/CNQ.0b013e3181c8e064 [doi]

Tedesco-Shneck, M. (2013) Active learning as a path to critical thinking: are competencies a roadblock? *Nurse Education in Practice, 13*(1), 58-60.

Turner, P. (2005). Critical thinking in nursing education and practice as defined in the literature. *Nursing Education Perspectives, 26*(5), 272-277.

Wangensteen, S., Johansson, I. S., Bjorkstrom, M. E., & Nordstrom, G. (2010). Critical thinking dispositions among newly graduated nurses. *Journal of Advanced Nursing, 66*(10), 2170-2181. doi:10.1111/j.1365-2648.2010.05282.x [doi]

Walkey, A., Summer, R., Ho, V., & Alkana, P. (2012). Acute respiratory distress syndrome: Epidemiology and management approaches. *Clinical Epidemiology*, *4*, 159-169.

Watson, G., & Glaser, E. (1980). *Critical thinking appraisal manual*. New York, New York.: Harcourt, Brace & Jovanovich.

Wood, R. Y., & Toronto, C. E. (2012). Measuring critical thinking dispositions of novice nursing students using human patient simulators. *The Journal of Nursing Education, 51*(6), 349-352. doi:10.3928/01484834-20120427-05 [doi]

Yuan, H. B., Williams, B. A., Fang, J. B., & Ye, Q. H. (2012). A systematic review of selected evidence on improving knowledge and skills through high-fidelity simulation. *Nurse Education Today, 32*(3), 294-298. doi:10.1016/j.nedt.2011.07.010 [doi]

Yue, M., Zhang, M., Zhang, C., & Jin, C. (2017). The effectiveness of concept mapping on development of critical thinking in nursing education: A systematic review and meta-analysis. *Nurse Education Today, 52*, 87-94. doi:S0260-6917(17)30049-7 [pii]

Yurdanur, D. (2016). Critical thinking competence and dispositions among critical care nurses: a descriptive study. *International Journal of Caring Sciences, 9*(2), 489-495.

Zurmehly, J. (2008). The relationship of educational preparation, autonomy, and critical thinking to nursing job satisfaction. *Journal of Continuing Education in Nursing, 39*(10), 453-460.

Tables

Table 1.

Review of Literature Study Table

Source Country	Objective	Definition Framework	Design	Sample	Instrument	Session Number	Session Length	Result	Limitations
Ahn and Kim (2015) Korea	Using learning outcomes (including CT skills) to evaluate the students' simulation experience	Not specified	Two group post-test design	72 third year nursing students; group 1 = 35 group 2 = 34	KNSCTT[b] ↑scores = strong CT skills Cronbach's a = 0.80	1 session G1 = 2 scenarios simulation G2 = lecture and case scenarios	Each scenario = 2h	No statistically significant difference was found between the experimental and control groups in CT skills neither scenario 1 nor in scenario 2, though mean scores of experimental groups in both scenario	No CT definition or theoretical framework Convenience sample Cumulative effect of simulation not evaluated (more frequent exposures = increase in notable effects)

								were much higher.	
Shin et al. (2015) South Korea	Examine the effect of an integrated pediatric nursing simulation on students' CT abilities. Identify the effects of differing numbers of simulation exposures or "dosing" levels	Facione's (1990) Tanner's Clinical Judgment Model (2006)	Pre-post Simulation: Jefferies	237 undergraduate senior nursing students of 3 universities	YCTDT[a] ↑scores = strong CT skills Cronbach's a = 0.844 LCJR[f] Cronbach's a = 0.80-0.97	School A = 1 session; School B = 2 sessions; School C = 3 sessions	Not specified	Single exposure to the simulation resulted in no gain in CT; three exposure showed significant gains in CT; two exposures showed gains in CT, but not statistically significant. Overall, CT score significantly increased 4/7 domains increased (prudence, systematicity, healthy skepticism,	One group pre-post-test study design Different school curriculums and environments Differing clinical experiences amongst students

								intellectual eagerness)	
Shin and Kim (2014) South Korea	Examining the effect of integrated pediatric nursing simulation courseware on students' CT	No CT definition Tanner's Clinical Judgment Model (2006)	Pre-post Simulation: Jefferies	95 senior undergraduate nursing students	YCTDT[a] ↑scores = strong CT skills Cronbach's a = 0.844 LCJR[f] Cronbach's a = 0.80-0.97	3 sessions	Not specified	The CT score significantly increased by 6.27 points (p = .001). Five of the seven categories of CT significantly increased. 5/7 domains increased (intellectual eagerness, prudence, systematicity, intellectual fairness, skepticism) Positive correlation between CJ and CT	Does not define critical thinking One group, pre-post-test study design

Chiang and Chan (2013) Hong Kong	To evaluate the outcomes of advanced simulation for students regarding their CT disposition and skills	Facione's CT disposition (2000) Kolb's theory of experiential learning (1984)	Mixed-method Pre-post quantitative evaluation with validated tools Supplemental qualitative investigation	132 undergraduate pre-registration nursing students	CCTDI[d]/HCTSR[g]	3 HPS exposures	Not specified	There was a significant increase in overall CCTDI scores across T1and T3 (p = .000). Increase in analyticity and confidence. Decrease in inquisitiveness Increase in HCTSR scores between the three exercises	One group pre-post-test study design for quantitative measures
Goodstone et al. (2013) USA	To compare the effects of HFPS and instructor-written	Facione, Facione, Sanchez (1994) No theory specified	Two group pre-post	Associate degree nursing students; HFPS group = 20	HSRT[c]	14 sessions	3 hr.	Both groups showed an increase in CT skills (p = .001).	Convenience sample Small sample size and limited statistical power

	case studies on the developm ent of CT skills			Case study group = 22				No significant difference found between the two groups. Increase in HSRT for HFPS group not significant Increase in HSRT for case study group significant	The case control group did get HFPS exposure
Shinnick and Woo (2013) USA	To determine the effect of HPS on CT in prelicensu re nursing students Determine predictors of higher CT scores using 10	Facione's (1990) No theory specified	Pre-post	154 prelicensure nursing students	HSRT[c] Cronbach's a > 0.95	1 session	Not specifi ed	No statistically significant gains on CT CT skills "suitable for learning and developmen t."	Convenienc e sample Study design Baseline CT scores of 21, indicating a study population with strong foundation

	covariates suspected of influencing CT								Only one exposure Different HF clinical experiences Contamination of study content
Maneval et al. (2012) USA	To determine whether the use of HFPS in new nurse orientation improves critical thinking and clinical decision-making skills	Facione (1990) No theory specified	Two group pre-post, randomized	New graduate nurses; Exp = 13 Con = 13	HSRT[c] CDMNS[h] Cronbach's a = 0.83	6 sessions	Not specified	No statistically significant difference was found between the two groups Both showed increase in HSRT scores, with HFS showing greater gains Statistically significant	Correct definition and instrument to measure CT by? Small sample size Higher baseline HSRT (nearly 2 points above national norm) Lack of support

								increase in analysis	from nurse managers
Schubert (2012) USA	To determine whether simulation improved nurses' knowledge of failure to rescue events and CT	Turner (2005). No theory specified	Pre-post	58 staff nurses from four medical-surgical units	Learning transfer tool Reliability of 0.96 30 minutes to test	1 session	Not specified	A significant change in CT between pretest and posttest (p = .001) Not sustained over time	Newly developed test for use in measuring CT Tool takes 30 mins to complete Design
Wood and Toronto (2012) USA	Assessing the influence of human patient simulation on CT dispositions	Facione's (1990) No theory	Pre-post	85 baccalaureates nursing students Exp = 42 Con = 43	CCTDI[d] Cronbach's a = 0.91	1 session	2 hr.	No significant difference was found between the posttest scores of the two groups Experimental group did see a significant increase in	Tested simple psychomotor skills of clinical assessment for novice students (lowest mean age of all the studies, 19.4 years) – think Benner's

								CCTDI scores ($p < 0.05$). Truth-seeking and judiciousness increased	Homogeneity of sample Private 4 yr. institution Sample and design
Fero, O'Donnell, Zullo, Dabbs, Kitutu, Samosky and Hoffman (2010) USA	To examine the relationship between metrics of CT skills and performance in simulated clinical scenarios	Combined from Facione, Watson and Glaser, Paul, Landis and Ennis. Argyris' and Schon's theories of Action Espoused and Theory-in-Use	Quasi experimental, cross-over	36 nursing students; diploma = 14 ADN = 12 BSN = 10	CCTDI Cronbach's = 0.91 CCTST Reliability of 0.78-0.8 Kuder-Richardson-20 VTV/HFHS[i] Assessment Tool	1 session of HFHS and VTV	10 minutes each	Statistically significant relationship between overall HFHS performance and CCTDI scores.	Variation of clinical experiences Small sample size Singular performance in HFHS scenario

Sullivan-Mann, Perron, and Fellner (2009) USA	To investigate the effect of simulation teaching on the critical-thinking abilities	No definition Roy's Adaptation Model + Benner's Novice to Expert	RCT; 2x2 mixed model design	43 associate degree students; Exp = 27 Con = 26	HSRT[c]	Exp = 5 sessions Con = 2 sessions	Not specified	On the posttest, the experimental group answered significantly more questions than they did at pretest but although the control group improved, its change was not significant. Difference between the two groups was not significant Significant effects were found for deductive reasoning and analysis, significance	No critical thinking definition Sample size Influence and characteristics of clinical instructors

								between groups for analysis	
Brown and Chronister (2009) USA	To assess the effect of simulation activities on CT and self-confidence in an ECG nursing course	Assessment Technologies Institute (2003) Benner's Theory	Comparative, Correlative	140 senior baccalaureate nursing students	ECG sim test based on Health Education Systems conceptual framework	5 sessions	100 min	No significant differences were observed in the overall ECG SimTest score or the subcategories Second semester students had statistically significant differences in overall ECG SimTest scores, all subcategories	Exposures in clinicals over the weeks of the experiment Low simulation time, 30 minutes, less didactic time than control Validity and reliability of ECG SimTest to measure CT Is simulation the proper method for teaching of ECG rhythms?

Ravert (2008) USA	To determine whether measures of CT show differences between three groups (simulator, non-simulator, control) of BSNs	Facione's (1990) Kolb's learning styles	Pre-post	40 undergraduate students in 3 groups; Exp 1 (non-HPS) = 13 Exp 2 (HPS) = 12 Con = 15	CCTS[e]/CCTDI	5 sessions	1 hour	The HPS group and the non-HPS group both experienced a moderate effect in CCTDI scores while the control group experienced a large effect. However, the experimental groups experienced a larger effect size than the control group in the CCTST scores

[a] Yoon’s Critical Thinking Disposition Tool. 7 subscales: objectivity, prudence, systematicity, intellectual eagerness/curiosity, intellectual fairness, healthy skepticism, and critical thinking self-confidence

[b] Korean nursing students’ critical thinking tendency

[c] Health Science Reasoning Test. Interpretation, analysis, evaluation, explanation, and inference.

[d] California Critical Thinking Dispositions Inventory. 7 subscales: truth-seeking, open-mindedness, analyticity, systematicity, confidence, inquisitiveness, and maturity

[e] Californian Critical Thinking Skill

[f] Lasater Clinical Judgment Rubric

[g] Holistic Critical Thinking Scoring Rubric. Elements of analysis, interpretation, evaluation, inference, explanation and meta-cognition. Assesses disposition to pursue evidence and reason open-mindedly or fair-mindedly in order to reach good and objective decisions for complex problems.

[h] Clinical Decision-Making in Nursing Scale

[I] Video Taped Vignettes/High-fidelity Human Simulation Assessment Tool. Researcher-developed to assess simulation-based performance. Content validated.

Table 2.

California Critical Thinking Dispositions Inventory subscales – Components, Examples of Statements, Nursing Relevance

Subscale	**Component***	**Example of Statement****	**Relevance to Nursing+**
Truth-Seeking	Eager to seek the truth, courageous about asking questions, honest and objective about pursuing inquiry even if the findings do not support one's opinions or beliefs	It is never easy to decide between competing points of view	A truth-seeking nurse continually re-evaluates new information and evidence
Open-mindedness	Tolerant of divergent views with sensitivity to the possibility of one's personal bias	It concerns me that I might have biases of which I am not aware	Dispositional intolerance of divergent views might preclude effective nursing interventions
Analyticity	Alert to potentially problematic situations, anticipatory of potential consequences, and prizing the application of reason and the use of evidence even if the problem at hand turns out to be challenging and difficult	It bothers me when people rely on weak arguments to defend good ideas	Being analytical allows the nurse to connect clinical observations with her or his theoretical knowledge base, and to anticipate events likely to threaten the safety or limit health potential of a given patient
Systematicity	Disposition towards organized, orderly, focused and diligent inquiry	I always focus on the question before I attempt to answer it	Organized approaches are an indispensable part of clinical practice, and deficits in systematicity might particularly predispose a nurse to the possibility of negligence in practice

Confidence in Reasoning	Level of one's trust in one's own reasoning processes	I take pride in my ability to understand the opinions of others	An appropriate level of critical thinking confidence would be the desired trajectory of the nursing student to nursing clinician. Nurses who overrate their critical thinking abilities may act without adequate caution, while those whose critical thinking confidence is lower than actual critical thinking skills might be expected to demonstrate lack of leadership
Inquisitiveness	One's intellectual curiosity and one's desire for learning even when the application of the knowledge is not readily apparent	Learn everything you can, you never know when it could be handy	Considering that the knowledge base for competent nursing practice continues to expand, a deficit in inquisitiveness would signal a fundamental limitation of one's potential to develop expert knowledge and clinical practice ability
Maturity of Judgment	The mature critical thinking approaches problems, inquiry, and decision-making with a sense that some problems are necessarily ill-structured. Many times, judgments must be based on standards, context and evidence which preclude certainty	The best way to solve problems is to ask someone else for the answer	This disposition has particular implications for ethical decision-making, particularly in time-pressured environments

Note: [*]Sources: Facione, P., Facione, N., & Giancarlo, C. (2000). The disposition toward critical thinking: Its character, measurement and relation to critical thinking skill. *Informal Logic, 20*(1), 61-84. [**]Source: Facione, P., Facione, N., & Giancarlo, C. (2001). *California critical thinking disposition inventory test manual.* Milbrae, CA: California Academic Press. [+]Sources: Facione, N. C., Facione, P. A., & Sanchez, C. A. (1994). Critical thinking disposition as a measure of competent clinical judgment: The development of the California critical thinking disposition inventory. *The Journal of Nursing Education, 33*(8), 346-347.

Table adapted from Wangensteen, S., Johansson, I. S., Bjorkstrom, M. E., & Nordstrom, G. (2010). Critical thinking dispositions among newly graduated nurses. *Journal of Advanced Nursing, 66*(10), 2170-218

Table 3.

Demographics of Participants (N = 22)

Demographic Characteristics	N (%) or M ± SD
Gender	
Female	20 (91)
Male	2 (9)
Age	29.09 ± 4.88
RN Years	4.61 ± 3.04
ICU RN Years	2.93 ± 1.56
Home ICU	
STICU	7 (31.8)
TCVPO	5 (22.7)
MICU	5 (22.7)
NNICU	2 (9.1)
CCU	2 (9.1)
Certification Status	
Yes	16 (72.7)
No	6 (27.3)
Certification	
CCRN	8 (36.4)
CCRN + Other	4 (18.1)
CNL	2 (9.1)
CEN	1 (4.5)
ATCN	1 (4.5)

Note: One participant did not report home intensive care unit.

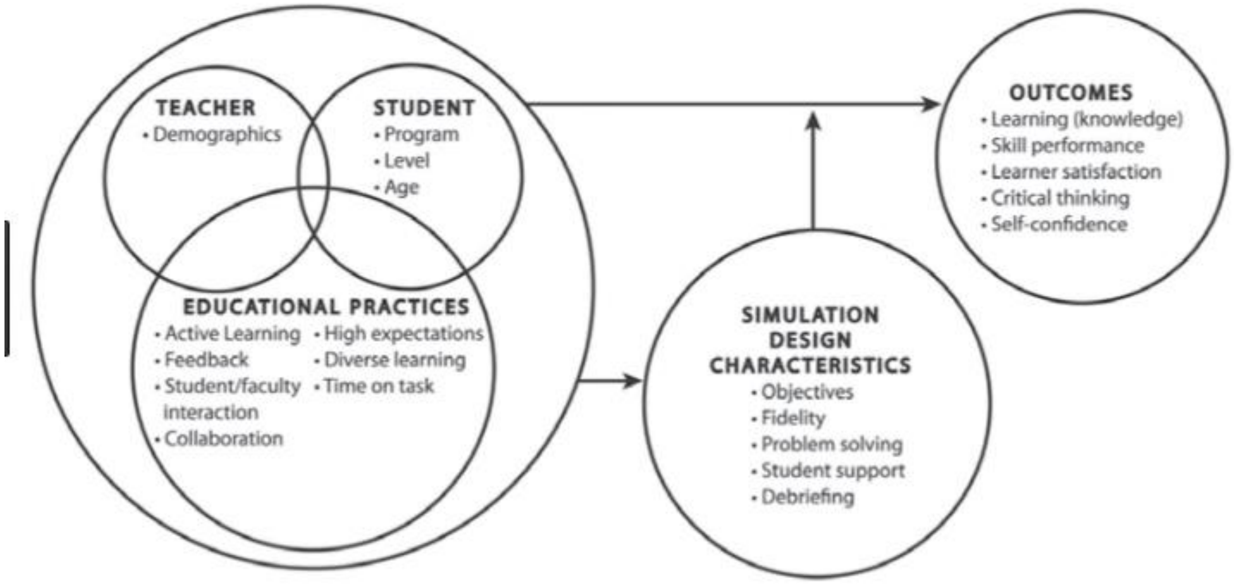
Table 4.

Comparison of Changes Between Pre- and Post-Test CCTDI Scores

CCTDI Scores	Pre-Test M ± SD	Post-Test M ± SD	*t*	p
Overall	325.68 ± 23.70	334.86 ± 22.92	3.452	.002*
Truth-Seeking	42.18 ± 4.85	44.59 ± 3.65	2.811	.010*
Open-Mindedness	46.77 ± 4.79	47.14 ± 4.89	0.748	.462
Inquisitiveness	52.14 ± 5.03	53.68 ± 4.70	2.364	.028*
Analyticity	45.86 ± 5.19	46.45 ± 5. 65	1.054	.304
Systematicity	44.55 ± 6.89	46.50 ± 5.86	2.543	.019*
Confidence in Reasoning	46.45 ± 4.52	47.95 ± 5.69	2.602	.017*
Maturity in Judgment	47.81 ± 3.50	48.55 ± 3.89	1.242	.228

Figures

Figure 1. *National League of Nursing/Jeffries Simulation Framework Model*



Note: Jeffries, P. R. (2005). A framework for designing, implementing, and evaluating simulations used as teaching strategies in nursing. *Nursing Education Perspectives, 26*(2), 96-103.

Figure 2. *Recruitment Flyer*

Interested in being a part of a research study? Enjoy learning and exercising your critical thinking abilities in fun and exciting new ways?

Sign up now to participate in this simulation-based research study:

Is High-Fidelity Simulation an Effective Method for the Promotion of Critical Thinking Dispositions Amongst Intensive Care Registered Nurses?

Food is provided at all simulation sessions. All participants receive a $10 Starbucks gift card, as well as enter a raffle for $300 worth of gas and grocery gift cards.

Sign-up sheets are posted in the STBICU breakroom.

Primary Investigator: Affitin Anderson MSN, RN, CCRN
Faculty Advisor: Clareen Wiencek PhD, RN, ARNP, ACHPN

This study is for a Doctor of Nursing Practice scholarly project.

Questions? Email PI at aaa2qx@virginia.edu

UVA IRB-SBS #2017-0480

Figure 3. *Rescue Therapies for Severe ARDS*

RESCUE THERAPIES FOR SEVERE ARDS

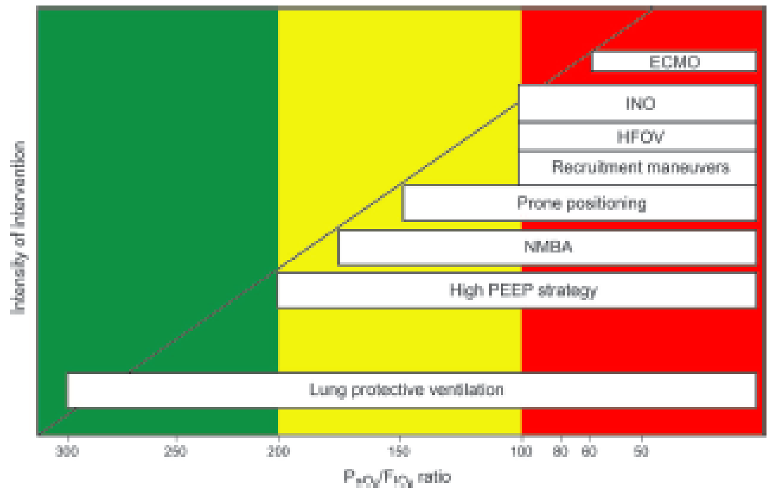
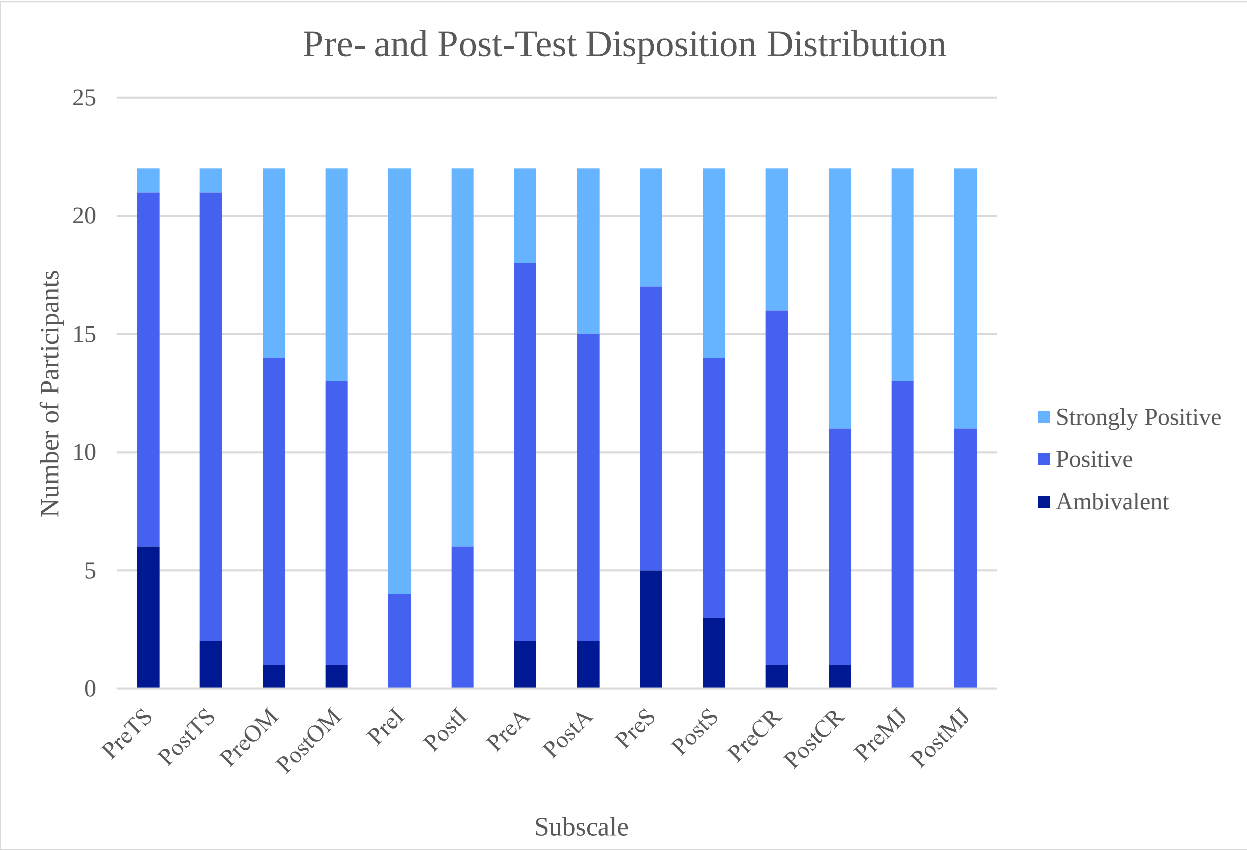


Fig. 1. Rescue therapy in increasing hypoxemia severity. Green indicates mild severity, yellow moderate severity, and red severe. ECMO = extracorporeal membrane oxygenation, HFOV = high-frequency oscillatory ventilation, INO = inhaled nitric oxide, NMBA = neuromuscular blocking agent.

Alessandri, F., Pugliese, F., & Ranieri, M. (2018). The Role of Rescue Therapies in the Treatment of Severe ARDS. *Respiratory Care, 63*(1), 94.

Figure 4. *Subscale Distributions*



Note: TS = truth-seeking, OM = open-mindedness, I = inquisitiveness, A = analyticity, S = systematicity, CR = confidence in reasoning, MJ = maturity in judgment.

Appendix A

Simulation Scenario

Case Information:

Designed for: Critical care RNs with any level of years of experience to assess critical thinking as it pertains to mechanical ventilation and ARDS management.

Estimated time: 75 min (includes pre-test, simulation, debriefing, and post-test)

Simulation Setting: TCVPO 4196

A. Pre-performance

1. Simulation Objectives:

   Upon completion of this high-fidelity simulation, participants will be able to:

   - Engage in critical thinking
   - Recognize the clinical presentation of ARDS via diagnostic criteria
     - Refractory hypoxemia via P/F ratio < 200 regardless of PEEP
     - Bilateral pulmonary infiltrates via CXR
     - Acute onset
     - Absence of left atrial hypertension
   - Assess and intervene to various ventilator alarms
   - Identify rationale for changes in ventilation management as it relates to ARDS
   - Understand treatment rationale for managing ARDS
     - High PEEP/Low FiO2
     - NMB
     - BiVentilation

- Proning

2. <u>Setup and Equipment:</u>

Environment: TCVPO, ICU

Manikin Set Up: In gown, flat in bed, intubated and connected to iServo ventilator. OGT in place. IV access: Right IJ TLC with CVP, 18 L AC, 18 R AC, R radial arterial line, L CT to wall suction.

Equipment: Ventilator, monitor, IV pole, IV channels, IV tubing, appropriate cables (including a line and CVP), TOF, chest tube and atrium, wall suction, CVP and aline setup, transducer holder, foley with urine.

Medications needed: NS MIVF, propofol, midazolam, fentanyl, NS bolus, cisatracurium.

3. <u>Participant Roles:</u>

Charge nurse, primary nurse and secondary nurse (max 3 RNs per session)

4. <u>Patient and Medical Information:</u>

<u>Demographics:</u>

Name: TM Uganda

Gender: M

Age: 35 years old

Ethnicity: Caucasian Height: 5’10” IBW: 77.6kg

<u>HPI:</u> Patient admitted s/p MVC. Patient was t-boned on the driver side and subsequently flipped his SUV. Patient was restrained, however, but found to be unconscious on location with a GCS of 8. Patient was intubated at the scene.

Upon assessment in the ER patient was found to have:

- L rib fractures 2-6
- L pneumothorax
- T4-T6 TP fracture
- Positive FAST exam

In the ER, the patient received 2 U PRBCs, 2.5 crystalloid, with placement of L chest tube. However, patient remained hemodynamically unstable and was taken to the OR for exploration of internal injuries given positive FAST exam.

In the OR, patient found to have grade 4 spleen laceration with splenic artery vascular injury. An open splenectomy was performed with repair of splenic artery. Patient's EBL was 1L. Patient was transfused an addition 2 U PRBCs, 1 pack PLTs, 1 FFP and 1L crystalloid intraoperatively. UOP during case was 700 mLs.

PMH: None

PSH: Appendectomy

Medications: No home medications

Hospital: Midazolam @ 2 mg/min

Fentanyl @ 100 mcg/min

NS @ 125 mL/hr

Pip/Tazo 3.75 g

5. Coordinator Overview:

Patient transferred out to the ICU postoperatively, intubated with 7.5 ETT at 24 lip. Patient was reversed and is currently sedated with infusions of midazolam and fentanyl. Patient was 99% sa02 with BVM ventilation and is subsequently placed on AC/VC TV 465, RR 16, PEEP 5, 1.0 FiO2.

Subjective data unavailable.

Objective data:

Labs: ABG, CMP, CBC with differential, Coags, Lactic Acid, HFP currently in lab.

Imaging: CXR post intubation available upon participant request.

Physical Examination:

- Neuro: Sedated on midazolam/fentanyl patient localizes to pain in BUE and withdraws to pain in BLE. Patient opens eyes to painful stimuli.
- CV: S1, S2, RRR, no MRG. Pulses +2 x 4 extremities.
- P: Intubated with 7.5 at 24 lip. No flail chest, with normal WOB. Coarse crackles in BUL, with diminished LLL and diminished coarse crackles noted in RML and RLL. There is a CT to the L side, noted to be to -20 cm wall suction, no air leak or pulsations.
- GI: OGT in place to LIS, belly flat soft, with midline surgical incision noted with dressing C/D/I.
- GU: Foley in place with yellow urine noted in collection bag
- Skin: Multiple bruises noted to bilateral chest/rib/flank area. Otherwise skin is warm and dry.
- Lines: RIJ TLC with CVP, R arterial line, bilateral AC PIVs.
- Drips: Midazolam at 2 mg/hr and fentanyl at 100 mcg/hr, NS at 125 mL/hr

Scenario begins as RNs begin to assess the patient.

Performance

<u>Step 1:</u>

- Patient has been transferred from OR to ICU post exploratory laparotomy and splenectomy

- VS: HR 105, BP 94/43 (60), RR 16, SaO2 97, Temp 37 CVP 6

– HALS BREATHING OFF

- Vent: AC/VC TV 465, RR 16, PEEP 5, 1.0 FiO2.

Step 2:

- After a minute or two of RN assessing patient, VS change:

- VS: ↑ RR (32), ↑ HR (112), ↓ BP (89/42 MAP 58), ↓ SaO2 (88-89%), temp 37, CVP 6 – TURN HALS BREATHING ON

RN to:

- Auscultate lung sounds: Coarse crackles in BUL, with diminished LLL and diminished coarse crackles noted in RML and RLL.

- Assess ventilator/patient

- Suction? Biting tube? Kink in line?

- Assess sedation/analgesia needs: patient is opening eyes spontaneously, grimacing, and localizing towards ETT. CPOT score of 4. Increase sedation accordingly.

- Assess temperature, consider blood reaction.

- Stop blood and flush with NS. Confirm patient BB# with what is on bag. Place all materials into plastic bag to send to lab.

- Notify RT/MD of findings

MD/RT:

- ABG

- *CXR*

- *Order NS bolus through IV line*

ABG: 7.47/30/23/189 P/F ratio: 189, patient already in moderate ARDS

CXR shows bilateral pulmonary infiltrates (hand CXR to participants)

Post-operative labs are back (hand lab slip to participants)

- *RT to increase PEEP from 5 to 10*

Step 3:

- Progressive tachypnea, triggering both the high RR alarm and peak pressure alarms, patient also becomes hypotensive again.

- VS: ↑ RR (32), ↑ HR (120), ↓ BP (88/43 (58)), ↓ SaO2 (89%), temperature 37, CVP 6 – TURN HALS BREATHING ON

- Vent: AC/VC TV 465, RR 16, PEEP 10, 1.0 FiO2

    - Vent alarms: High RR (MVE) and High PPeak (>30)

RN to:

- *Assess sedation/analgesia (patient opens eyes to painful stimuli, localizes to pain, does not follow commands)* CPOT of 1

- *Auscultate lung sounds: continues to have coarse/diminished lung sounds throughout*

- *Assess ventilator/patient*

    - *Suction? Biting tube? Kink in line? Mucous plug?*

- *Assess fluid status, CVP, UOP, PLR? RN to take into consideration increase in PEEP and volume status as well as known low H/H status*

- *Consideration of PE*

- *Notify both RT/NP:*

    - *Ask about PLR percentage increase percentage*

    - *Check CBC, lactate and ABG, Ddimer, get CXR*

If RN increases sedation, patient continues to be tachypneic, hypoxic, hypotense (88%)

NP to:

- *Order ABG*

- *Labs: D-dimer, lactate*

- *Discuss fluid status with RN (PLR decreased PPV < 12%)*

<u>Step 4:</u>

D-dimer mildy elevated at 1.0 ug/nL (normal less than < 0.5 ug/nL) , will not order CTAP however as likely elevated secondary to inflammatory state

Lactate at 1.8, and PLR affected SVV by < 12%, CVP 6 with PLR

ABG: 7.49/28/23/125, patient continues to exhibit worsening and refractory hypoxemia

Patient continues to be hypotensive trending downward to SBP of 85/39 (54).

RT/NP to:

- *Continue bolus*

- *Order norepinephrine to start at 4 mcg/kg/min*

- *Increase PEEP to 14 of AC/VC*

- *Order paralytics, cis bolus of (0.2mg/kg for 78 kgs) = 15.6 mgs and then drip starts at 3 mcg/kg/min.*

RN to:

- *Perform TOF*

- *Begin paralytics*

- *Reassess TOF after initiation of paralytic, patient will be ¼ twitches.*

VS stabilize (↓ HR to 101, BP 94/52 (66), RR set at 16 bpm per ventilator, SaO2 up to 94%) – TURN HALS BREATHING OFF

<u>Step 5:</u>

- Patient begins to set off Ppeak alarm and SaO2 will drop back down to 87%. Will continue to desaturate slowly, setting off monitor alarm, and pressure alarms.

- VS: HR 109, BP 99/55 (70), RR 16, SaO2 87% and will drop to 84% as RN assesses paralytics and alerts RT and NP – KEEP HALS BREATHING OFF, I WILL CHANGE VENT ALARMS

RN to:

- *Assess paralytics, TOF ¼, patient is adequately paralyzed.*

- *Notify RT/NP*

ABG: 7.4/41/23/112

RT/NP:

- *40 seconds at 40 PEEP for recruitment maneuver*

- *Place patient on BiVentilation*

VS: HR 101, BP 98/55 (69), RR 16, SpO2 89%

ABG: 7.30/55/23/78. Goal PaO2>60. P/F ratio: 78 indicating severe ARDS.

Patient will sit at 89%, RN to suggest final rescue therapies of proning/ECMO/HFOV, then scenario end.

Appendix B

DRAFT Manuscript for Publication Submission to *Nurse Education Today*.

Title Page

PROMOTION OF CRITICAL THINKING DISPOSITIONS OF INTENSIVE CARE REGISTERED NURSES THROUGH HIGH-FIDELITY SIMULATION: A QUASI-EXPERIMENTAL STUDY

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Abstract

Background: Critical thinking is considered an essential component to sound nursing practice. Whereby critical thinking dispositions, or habits of the mind, are considered to be the foundation for effective critical thinking, the literature suggests that this concept has lacked in development and assessment, particularly within critical care nurses. High-fidelity simulation (HFS) has the demonstrated potential to meet this need.

Objectives: The purpose of this study was to evaluate the use of high-fidelity simulation for the promotion of critical thinking dispositions of intensive care unit registered nurses.

Design: A one group, quasi-experimental pre-test, post-test design was used.

Settings and Participants: Sampling of adult critical care registered nurses from five intensive cares was taken from a 600-bed tertiary academic medical facility from October to December 2017.

Methods: Simulation scenario development occurred over a fifteen-week period, establishing content and construct validity with a team of experts. Participants completed the California Critical Thinking Disposition Inventory (CCTDI) prior to the high-fidelity simulation and again upon completion to evaluate overall change in critical thinking and individual dispositions.

Results: 22 nurses participated in this study. Overall CCTDI scores significantly increased after participation in the HFS, with four of the seven subscales displaying statistically significant increases as well. There were found to be no significant relationships between measured demographics and overall CCTDI. Within the subscales, significant relationships were found between truth-seeking and years as a critical care nurse, open-mindedness, age, and years as a registered nurse, as well as, systematicity and certification status.

Conclusions: Participation in a single high-fidelity simulation showed a positive impact on overall critical thinking dispositions of practicing critical care nurses, as well as, the majority of the dispositional components. This is the first identified study to demonstrate such an effect. The significance of this could foster development of transition-to-practice and continuing education programs to improve critical thinking, clinical judgment, and ultimately improve patient outcomes.

Keywords: critical thinking, critical thinking dispositions, nursing, simulation, critical care

Introduction

Critical thinking is considered an essential component of professional nursing, necessary for professional accountability, as well as safe, quality-driven nursing care (Scheffer & Rubenfeld, 2000). In 2008, the American Association of Colleges of Nurses (AACN) issued new recommendations for baccalaureate competencies to assure high quality and safe patient care. These recommendations came in response to a movement amongst the National Academy of Medicine [formerly Institute of Medicine (IOM)], Agency on Healthcare Research and Quality (AHRQ) and the Robert Wood Johnson Foundation that nurses are not adequately prepared to provide the highest quality and safest care possible (IOM, 2004). There appeared to be a lack in translating developed competencies to bedside care. Critical thinking was the first core competency recommended, highlighting that critical thinking is the foundation for sound clinical judgment and decision making. There have been calls from leading health organizations and prominent nursing researchers to find new ways of developing and accessing critical thinking within the nursing profession (IOM, 2010; Benner, Sutphen, Leonard, & Day, 2010).

Background

Critical thinking is defined to be a “purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which the judgment is based" (Facione, p.3, 1990). There are considered to be two components of being an effective critical thinking, the cognitive skills and dispositions towards critical thinking. Critical thinking dispositions are considered to be the internal motivation to utilize one's critical thinking skills. They are necessary for the foundation of critical thinking skills as well as their flourishment (Facione, 1990).

Traditional pedagogical approaches to teaching students critical thinking rely on passive learning strategies such as lecturing on definitions and theoretical frameworks. There exists, however, a disconnect between these styles of teaching, and becoming an effective critical thinker as a practicing nurse. In a large, multi-cite study of nearly 11,000 nurses, del Bueno reported only 35% of newly graduated nurses met critical thinking and clinical judgment expectations of their employers (2005). del Bueno believed that this is likely the result of the emphasis placed on traditional content-based education rather than a focus on, or use of, the application of knowledge (2005). Nurse educators became encouraged to incorporate learner-active teaching approaches (Wangesteen, Johansson, Bjorkstrom & Nordstrom, 2010) to effectively foster critical thinking development of practicing nurses.

Critical thinking allows nurses to recognize changes in patient conditions, perform independent nursing interventions, anticipate orders and prioritize care (Buerhaus, 2005). A nurse's ability to think critically translates into effective decision making, directly affects patient care outcomes (Shoulders, Follett, & Eason, 2014). In the intensive care unit, the relationship between critical thinking, independent action and patient safety is integral. Critical care is an increasingly complex environment, inundated with new technologies, managing multiple competing priorities while caring for patients with both complex and unstable medical conditions (Swinny, 2010).

Research that examines critical thinking attributes of intensive care nurses and how to develop and assess such skills and/or dispositions is lacking. Given the concern for a large portion of newly graduated nurses lacking essential behaviors related to safe and competent nursing practice, the use of high-fidelity simulation appears to meet the need for experiential learning experiences (Hee-Ok & Insook, 2016).

High-fidelity simulation allows for the opportunity for participants to apply knowledge and theoretical concepts within an active learning environment. A simulation is any activity that mimics the reality of a clinical environment and is designed to demonstrate procedures, decision-making, and critical thinking through techniques such as role playing, and the use of devises (Jeffries, 2005). Simulation-based education allows students the opportunity to practice their critical thinking, decision-making and clinical skills without compromising a patient's well-being (Kim, Park, & Shin, 2016). Simulations have consistently demonstrated improvements in participants self-rated confidence, competence, knowledge, and skills (Jeppesen, Christiansen, & Frederiksen, 2017; Yuan, Williams, Fang and Ye, 2012; Cook et al., 2011).

Understanding the consistently demonstrated benefits of simulation learning amongst nursing students, the promise of simulation within the critical care environment and the vital necessity of being an effective thinker, this study proposes a combination of all three components. The purpose of this study is to evaluate the use of high-fidelity simulation for the promotion of critical thinking amongst intensive care unit registered nurses. The specific study question being asked is: Is high-fidelity simulation an effective method for the promotion of critical thinking dispositions amongst intensive care unit registered nurses?

Theoretical Framework

The disposition toward critical thinking (Facione, Giancarlo, Facione, & Gainen, 1995) served as the conceptual framework guiding this research study. Dispositions towards critical thinking is described as a characterological profile which is frequently reflected in theoretical characterizations of critical thinking (Facione et al., 1995). Recognizing the impact that an individual's intellectual affective characteristics have on their utilization of critical thinking is an important concept. In order for an individual to fully engage in the cognitive skills of critical thinking, nurturing the dispositions toward critical thinking was crucial (Facione et al., 1995). . In the explanation of each of the dispositions, Facione, Facione, and Giancarlo (2000) consistently makes reference to how these dispositions would be exemplified within the nursing profession which allows for adaptation as an adequate conceptual framework for this study.

The conceptual framework that guided the simulation development and delivery was the National League of Nursing/Jeffries Simulation Framework. This framework was developed to meet a gap in the simulation literature, where simulation practices required an organized, systematic way of conducting research (Jeffries, 2005). The simulation framework is composed of five major elements and associated factors. The construction of this study's simulation scenario adhered to the five components of simulation design characteristics: objectives, fidelity, complexity, student support, and debriefing.

Methods

Study Design, Sample and Setting

This study was a quasi-experimental one group, pretest-posttest design. Recruitment took place within a 600-bed, tertiary academic medical center in Central Virginia. A convenience sample of staff registered nurses from all five adult intensive care units was taken.

Inclusion criteria for participation included: primary job role as staff nurse and full or part-time employment status. Exclusion criteria for participation included: per diem employment status, staff nurses currently on unit-orientation, travel nurses, and nurses who do not spend at least fifty percent of their job duties in patient care.

Based on the three similar studies that conducted a sample power analysis (Ahn & Kim, 2015; Shin & Kim, 2014; Shinnick &Woo, 2013) the average effect size of the three studies was used. A sample size of 49 participants was planned based on a moderate effect size of 0.40, power of 0.80, and a significance level of 0.05.

Simulation Scenario Development

Simulation scenario development occurred over a 15-week period. The scenario clinical topic of acute respiratory distress syndrome (ARDS) was chosen. ARDS has potential to develop in any patient, regardless of the underlying etiology where the bedside nurse is a critical component in early identification of ARDS through consistent assessments and synthesis of clinical data. Two master-prepared respiratory therapists and an acute care nurse practitioner (KG) functioned to establish content validity in the development of the scenario. A certified health simulation educator functioned as the simulation construct expert.

Objectives

The primary objective was for participants to engage in critical thinking. Secondary objectives were developed that focused on the recognizing and managing acute respiratory distress syndrome.

Fidelity

Fidelity of the simulation was ensured through utilization of intensive care unit patient rooms, along with the high-fidelity patient simulator. This manikin allowed for real-time interaction with the mechanical ventilator, medication administration, and vital sign response.

Complexity

This complex scenario was constructed with high levels of uncertainty, but with high levels of relevant information. Given this high level of uncertainty regarding the etiology of the simulated patient's deterioration, the relevant information presented could, and often was, attributed to various differentials. This level of complexity was chosen to allow for several opportunities for participants to critically reason through the scenario.

Cues

Various student support elements were encompassed within this scenario design including but not limited to: prebriefing, laboratory and diagnostic information, and role playing if assistance was required. No direct guidance towards a decision or simulation treatment modality was given; participants were allowed an opportunity to openly explore potential etiologies of the patient decline and treatment decisions. Decisions were based on their clinical assessments, presented scenario information and understanding of the clinical situation.

Debriefing

Debriefing followed immediately upon scenario completion. Debriefing was structured in style, and the method used was Debriefing for Meaningful Learning (DML). This particular method was chosen as it has been demonstrated to be an effective method of debriefing allowing for review of patient care, fostering meaningful learning and most importantly, cultivating critical thinking (Dreifuerst, 2015).

Data Collection Instruments

Demographic Questionnaire

Demographic information was collected using an investigator-developed Demographic Information Questionnaire. Demographics measured included age, gender, years practicing as professional nurse, years practicing as an intensive care nurse, certification status (Yes/No). Participants were allowed to write in which certification they held.

California Critical Thinking Disposition Inventory

The California Critical Thinking Disposition Inventory (CCTDI) was used to measure baseline and post-intervention critical thinking scores. This is a discipline-neutral instrument that measures internal motivation to use or not to use one's reasoning and reflective judgment when solving problems (Facione, Facione, & Giancarlo, 2001). The CCTDI is a 75-item Likert style attitudinal survey that has seven subscales, each designed to measure a specific disposition (Facione et al., 2001). Each subscale has 9-12 items which are interspersed throughout the instrument.

The instrument uses a 6-point Likert scale in which 1 = strongly agree and 6 = strongly disagree. Total CCTDI scores range from 70 to 420, with subscales scores ranging from 10 to 60. A total score above 350 indicates a strong disposition towards critical thinking, 280-450 a positive inclination, 210-279 indifference, and scores below 210 indicating a significant weakness towards practicing critical thinking (Facione et al., 2001). A score of 30 and below on any of the scales indicates a weakness in relation to the given attribute, a score of 40 indicates average or indifference towards the attribute, and scores above 50 indicates strength of that given attribute (Facione, Facione, & Sanchez 1994).

Alpha reliabilities for the seven individual scales range from .71 to .80, with an alpha reliability of .91 for the entire instrument measuring overall disposition towards critical thinking (Facione et al., 2001). Cronbach alphas have established overall reliability between .8 and .9 when utilized in nurses of various inpatient practice settings (Profetto-McGrath, Hesketh, Lang, & Estabrooks, 2003). Smith-Blair and Neighbors (2000) validated it within the critical care nursing population with a Cronbach alpha of .87 overall. This instrument was used with permission from Insight Assessment, Inc.

Simulation Implementation

Simulation implementation occurred over a two-week period. Each simulation session offered had three slots available for the designated roles of charge nurse, primary nurse, and secondary nurse. Simulation sessions ran with as little as one participant or as many as three.

After informed consent was obtained, participants completed both the Demographic Information Questionnaire and the California Critical Thinking Disposition Inventory. Simulation sessions began when all session participants completed each pre-simulation component. The delivery of the simulation in its entirety lasted 75-90 minutes, with time variation dependent upon participation’s fluency within the scenario. This included pre-briefing, scenario activities, and debriefing. Immediately following debriefing, participants again completed the CCTDI.

Data Analysis

Data analysis was performed using IBM SPSS Statistics for Mac version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics on age, gender, years practicing as professional nurse, years practicing as an intensive care nurse, and certification status were run. The pre-and post-test means of the overall CCTDI scores and the seven subscale scores were computed for each individual. Paired t-tests were performed comparing the change of overall CCTDI score as well as change of the seven subscale scores. Pearson's correlation was performed to investigate potential correlations between the continuous variables and change in overall CCTDI, the seven subscales and demographics. Mann-Whitney U was completed for the same purposes with the categorical variables. All tests were two-sided at the $\alpha=0.05$ level of significance. There was no missing data.

Results

Twenty-two nurses participated in this study. The participants were predominantly female (91%), with a mean age of 29 years, 4.6 years of professional nursing experience and nearly 3 years of critical care nursing experience. All five adult critical care units were represented with the majority being from the Surgical-Trauma Intensive Care Unit (31.8%). The majority of the participants held certification (72.7%), with the Critical Care Registered Nurse (CCRN) certification being the most common (54.5%). See Table 1 for full demographic characteristics.

Mean overall CCTDI scores before and after the simulation were 325.68 ± 23.71 and 334.86 ± 22.92, respectively. Change in overall CCTDI scores increased significantly by 9.18 points ($t = 3.453$, $p = .002$, 95% CI [3.452, 14.71]). Four categories of critical thinking dispositions, truth-seeking, inquisitiveness, systematicity, and confidence in reasoning, increased significantly after simulation participation. The categories of open-mindedness, analyticity, and maturity of judgment displayed an increasing trend, but were not statistically significant. See Table 2 for full results.

No significant correlations were found between the any of the selected demographics and overall CCTDI change. Amongst the subscales, there were significant correlations between change in: truth-seeking and years an intensive care nurse (r= .559, p= .007), change in open-mindedness and increase in age (r = .514, p = .014) as well as, increase in years practicing as a registered nurse (r = .454, p = .034), change in systematicity and being certified in any nursing specialty (r = .543, p = .009).

Discussion

Post-test overall critical thinking disposition scores increased after participation in a single high-fidelity simulation, and were overall positively inclined towards critical thinking. Similar findings of increased overall CCTDI scores after nursing student simulation participation were also reported by others (Shin et al., 2015; Shin & Kim, 2014; Chiang & Chan, 2014; Wood & Toronto, 2012). However, this study found significance after only a single, one-hour session. This is in contrast to studies that found no significant change in CCTDI after a single simulation session (Shin et al., 2015; Chiang & Chan, 2014), and studies that by design had multiple simulation sessions (Shin & Kim, 2014; Wood & Toronto, 2012). Furthermore, this increase was shown to be statistically significant though only half of the projected sample size was reached.

The methods of this study may provide several explanations for this significant increase in CCTDI scores. One explanation is the consistency in which definitions of critical thinking and critical thinking dispositions were applied to both conceptual framework and instrument choice. No study had congruency in all three of these components.

A second potential explanation is the use of the NLN/Jeffries Simulation Framework to guide simulation development and implementation. This framework was developed to fill a gap in simulation and provide an organized, systematic way of conducting simulation research

(Jeffries, 2005). However, utilization of theoretical frameworks guiding simulation experiences has been slow to evolve and become adapted (Groom, Henderson, & Sittner, 2014).

To increase standardization and reproducibility of simulation exercises, simulations should be grounded in theory and guided by frameworks, where through a rigorous simulation design, desired objectives can be met (Groom et al., 2014; Ahn & Kim, 2015). Particular use of the NLN/Jeffries Simulation Framework capitalizes on this concept, where the core constructs, particularly the simulation design characteristics, represents the evolving methodology of simulation-based education in health care (Groom et al., 2014). Several elements of the NLN/Jeffries Simulation Framework have been adopted as best practices by the International Nursing Association for Clinical Simulation and Learning (INACSL) (INACSL, 2016) and most likely contributed to the findings of this study.

Lastly, only a moderate effect size of 0.40 was used in this study's power analysis calculation. The effect size could in fact larger than 0.40, allowing for significance of the simulation effects on critical thinking dispositions to be found, even in this small sample size.

Four subscales showed statistically significant gains from pre- to post-test scores: truth-seeking, systematicity, confidence in reasoning, and inquisitiveness. Regarding all subscales but one, participant's mean scores, in both pre-test and post-test, were positive towards critical thinking. Mean pre-test inquisitiveness scores were strongly positive towards critical thinking, and remained strongly positive upon post examination.

The largest change was in the truth-seeking subscale, which had the lowest mean pre-test disposition score (42.18 ± 4.85). Eighteen percent of participants transitioned from being ambivalent towards this disposition to positively inclined. Similar findings were shown where truth-seeking had the lowest mean subscale score (Wood & Toronto, 2012; Fero et al., 2010), and saw significant change after simulation intervention (Wood & Toronto, 2012). Furthermore, in multiple critical thinking disposition surveys of both practicing nurses and nursing students, truth-seeking was consistently demonstrated to be the lowest mean subscale score (Mahmoud & Mohamed, 2017; Wangensteen et al., 2010; Profetto-McGrath et al., 2003; Profetto-McGrath, 2003). The truth-seeking subscale targets intellectual curiosity (Facione et al., 2001), where a desire for the most comprehensive understanding of a situation exists, even if it challenges one's preconceived notions or beliefs (Facione et al., 1995). It has been suggested that traditional, lecture-based pedagogical approaches could account for this within surveys of nursing students, where students learn passively, and do not have the opportunity to explore differing explanations to material presented (Wangensteen et al., 2010; Profetto-McGrath et al., 2003). This could explain the low truth-seeking pre-test score given the relatively novice experience of this study's particular sample.

Another consideration could also be the varied methods of continuing education and updates in evidence-based practices within the different intensive cares, again which are typically passive in the form of online modules or emails, limiting nurse's opportunity to challenge old knowledge and considered a hindrance by some to critical thinking (Tedesco-Schneck, 2013). It is desirable that practicing critical care nurses display stronger inclinations towards this particular disposition, that they are encouraged to have honest and objective pursuits of inquiry as this knowledge can translate into patient care through. It is encouraging that use of high-fidelity simulation impacts truth-seeking significantly. Impacting it to the extent that it did in this study might be explained via the simulation design characteristics of complexity, cues, and debriefing.

Systematicity followed, where post-test assessments saw an increase in those aligned strongly positively by nearly 14%. Described as striving to approach problems in a disciplined, orderly, and systematic way is likely to factor into the individual's approach in all higher order thinking processes (Facione et al., 1995). Systematicity was also found to be increased in several other studies after simulation intervention (Shin et al., 2015; Shin & Kim, 2014; Chiang & Chan, 2014). Enabling critical care nurses to exercise organized thought processes and approaches towards unfamiliar clinical scenarios allows for the orderly collection of data to synthesize potential patient changes. This in turn, could translate to effective clinical judgments.

Confidence in reasoning was the third subscale that changed significantly between pre- and post-test. This is regarded as the habitual tendency to trust one's reflective thinking ability to solve problems and make decisions (Facione et al., 1995). Participant's scores doubled the pre- and post-test from 27.3% to 50% of those aligned positively or strongly positively towards this disposition. Of the studies that reported subscale results, Chiang & Chan (2014) was the only to report a statistically significant increase within of reasoning confidence, while all others (Shin et al., 2015; Shin & Kim, 2014; Wood & Toronto, 2012) saw a trend of increasing scores. In an integrative review of seventeen studies assessing the use of high-fidelity simulation on continuing education of critical care providers, twelve studies saw a significant increase in self-confidence measurements (Boling & Hardin-Pierce, 2016). However, this study used a validated instrument to measure confidence versus self-report, adding to the understanding of critical thinking processes.

Pre-test mean inquisitiveness, or intellectual curiosity (Facione et al., 1995), of participants was the highest scoring subscale, a finding shared by several others (Wangensteen, 2010; Fero et al., 2010; Profetto-McGrath et al., 2003; Profetto-McGrath, 2003). Participants remained strongly positive towards inquisitiveness post-simulation. Similar findings of significant increases of inquisitiveness were reported (Shin et al., 2015; Shin & Kim, 2014). Interestingly though, nine percent of individuals scores decreased upon post-test, from strongly expressing to positively expressing this disposition. Chiang and Chan (2014) reported a similar finding, where nursing students experienced a significant decrease in level of inquisitiveness after two separate exposures to high-fidelity simulation. This particular finding could be due to the clinical topic of ARDS which the simulation scenario was based upon. In debriefing participants regarding this topic, there were varying levels of individual knowledge. Some participants had simply familiar with the diagnosis, while others had extensive knowledge which could explain why some might be less inclined to further learning. However, since individual knowledge of this topic was not tested, no correlations could be explored, this is merely speculative. This finding could also be due to the learning environment of high-fidelity simulation, and the nature of being assessed (Chiang & Chan, 2014); participants might not be motivated for further learning beyond the formal debriefing period and completion of study participation. Indeed, higher score of inquisitiveness have been positively correlated to higher levels of research utilization (Wangensteen et al., 2010; Profetto-McGrath et al., 2003) which can ultimately influence practice standards and patient outcomes. More study is needed to explain the effect of high-fidelity simulation on inquisitiveness.

Though changes in subscales of open-mindedness, analyticity, and maturity in judgment were not statistically significant, all displayed an increase in mean post-test scores after participation in simulation. Where this study did not find significant changes, other studies did in these subscales (Shin et al., 2015; Shin & Kim, 2014; Chiang & Chan, 2014; Wood & Toronto, 2012). This simply could be a limitation of this study's small sample size, the makeup of demographic characteristics and the fundamental difference of practicing nurses versus student nurses studied.

Furthermore, there were found to be no significant correlations between any of the demographics and change in total critical thinking disposition scores. The existing literature agrees with this finding (Wood & Toronto, 2012; Chiang & Chan, 2014; Shin & Kim, 2014; Shin et al., 2015). Looking more broadly at an examination of various assessment methods of critical thinking and nursing, relationships can be found, particularly between higher critical thinking scores and older age (Ludin, 2018; Shinnick & Woo, 2013; Wangensteen et al., 2010; Martin, 2002). Again, this study's small sample size and homogenous distribution of ages, being that nearly 80% of the sample was between 24-29 years old, may have affected the ability to explore potential meaningful relationships.

Several significant relationships were found between subscale and demographics. Change in truth-seeking was positively correlated with years as an ICU RN, a finding that was shared by newer survey studies of critical thinking of ICU RNs (Ludin, 2018; Yurdanur, 2016). Stated previously, this subscale targets intellectual curiosity, and it could be suggested that as a ICU nurse develops towards intermediate and expert levels of practice, the level of understanding also develops. They have both the desire and the ability to understand and synthesize complex pieces of information regarding their patient.

Change in open-mindedness scores were positively correlated with as both age and years of nursing practice. The ability to be open-minded, or the tendency to allow others to voice viewpoints and act with tolerance in face of differing opinions (Facione et al., 1995), could be considered something that older, more experienced clinicians can practice efficiently given their varied experiences. This relationship could also exist as simulations were conducted in group settings, where participants were placed in a situation where difference of opinions could arise, and open-mindedness could be exercised.

Finally, the change in the subscale of systematicity was positively correlated with holding certification in a nursing specialty. The ability to approach problems in a disciplined, orderly fashion regardless of knowledge of the potential issue at hand (Facione et al., 1995) could be something learned through the process of systematic preparation for certification, or could be a habit that indicates a certain individual is more likely to pursue certification.

Study Limitations

There are multiple limitations of this study. First, the quasi-experimental, single group, pre-test post-test design lacks a randomized control comparison group. This reduces internal validity of the study and did not allow for confounding factors to be controlled. Furthermore, sampling bias should be considered as sample size was obtained via convenience sampling methods. While a power analysis was completed, the small sample size, with homogenous demographic characteristics, limits the generalizability of these findings. In addition to generalizing findings, the small sample size most likely impacted certain findings, such as correlations, where there simply were not enough participants to explore relationships between demographics and scores. The length of the simulation posed a significant limitation to recruitment. Subjects were asked to participate on their own time, outside of work, and was frequently stated to be the main reason individuals did not want to participate in this study.

Conclusion

This study addressed a gap in the study of the effect of high-fidelity simulation on the disposition of critical care nurses critical thinking. While this study has implications for how to mature critical thinking and clinical judgment, and restructure orientation and continuing education programs, there are several opportunities for future investigation.

First, the design and conduct of studies aimed at practicing critical care nurses that recruits larger sample sizes would allow analysis of correlation between demographic characteristics and critical thinking dispositions or skills. Second, conducting randomized studies that compare high-fidelity simulation to other established methods of promoting critical thinking such as problem-based learning or case studies, could help to establish the true effectiveness of high-fidelity simulation. Retention of the effects of high-fidelity simulation on critical thinking dispositions should also be examined. Multiple studies cited that either multiple exposures of simulation were necessary to obtain desired effects but the optimal dose, timing, or need for repetition of high-fidelity simulation are not known. Future studies should aim to measure the relationship between the critical thinking abilities of practicing nurses, participation in simulation and improved patient outcomes.

In summary, the participation of practicing critical care nurses in a single high-fidelity simulation showed a positive impact on overall critical thinking dispositions of practicing critical care nurses, as well as, a majority of the seven dispositional components. The design and use of a simulation based in the NLN/Jeffries Simulation Framework and the alignment of the study concept, critical thinking dispositions, with a validated measure contributed to the outcomes of this study. The findings of this study in the critical thinking dispositions of practicing nurses adds to the body of knowledge of critical thinking and supports the value of further study with larger, randomized samples. Finally, demographic and workforce trends in the retention of critical care nurses and the national priority for safe and optimal patient outcomes, dependent on nurses' critical thinking and clinical judgment, calls for the examination of innovative education models, such as high-fidelity simulation, implemented in this study.

References

Ahn, H., & Kim, H. Y. (2015). Implementation and outcome evaluation of high-fidelity simulation scenarios to integrate cognitive and psychomotor skills for Korean nursing students. *Nurse Education Today, 35*(5), 706-711. doi:10.1016/j.nedt.2015.01.021 [doi]

American Association of Colleges of Nursing. (2008). *The essentials of baccalaureate education for professional nursing practice.*Washington, DC.: American Association of Colleges of Nursing.

Benner, P., Sutphen, M., Leonard, V., & Day, L. (2010). *Educating nurses: A call for radical transformation*. San Francisco, CA: The Jossey-Bass.

Benner, P. (1984). From novice to expert: Excellence and power in clinical nursing practice. *AJN the American Journal of Nursing, 84*(12).

Boling, B., & Hardin-Pierce, M. (2016). *The effect of high-fidelity simulation on knowledge and confidence in critical care training: An integrative review* doi:http://dx.doi.org.proxy.its.virginia.edu/10.1016/j.nepr.2015.10.004

Buerhaus, P. I. (2005). Six-part series on the state of the RN workforce in the united states. *Nursing Economic$, 23*(2), 58-60, 55.

Cook, D.A., Hatala, R., Brydges, R., Zendejas, B., Szostek, J. H., Wang, A. T., . . . Hamstra, S. J. (2011). Technology-enhanced simulation for health professions education: A systematic review and meta-analysis. *JAMA, 306*(9), 978-988. doi:10.1001/jama.2011.1234 [doi]

Chiang, V. C., & Chan, S. S. (2014). An evaluation of advanced simulation in nursing: A mixed-method study. *Collegian (Royal College of Nursing, Australia), 21*(4), 257-265.

del Bueno, D. (2005). A crisis in critical thinking. *Nursing Education Perspectives, 26*(5), 278-282.

Dreiferst, K. (2015). Getting started with Debriefing for Meaningful Learning. *Clinical Simulation in Nursing, 11*(5), 268-275. doi: https://doi.org/10.1016/j.ecns.2015.01.005

Facione, P. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. the Delphi report: Research findings and recommendations*. Washington, DC: American Philosophical Association.

Facione, P., Facione, N., & Giancarlo, C. (2000). The disposition toward critical thinking: Its character, measurement and relation to critical thinking skill. *Informal Logic, 20*(1), 61-84.

Facione, P., Facione, N., & Giancarlo, C. (2001). *California critical thinking disposition inventory test manual.* Milbrae, CA: California Academic Press.

Facione, N. C., Facione, P. A., & Sanchez, C. A. (1994). Critical thinking disposition as a measure of competent clinical judgment: The development of the California critical thinking disposition inventory. *The Journal of Nursing Education, 33*(8), 345-350.

Facione, P., Giancarlo, C., Facione, N., & Gainen, J. (1995). The Disposition Toward Critical Thinking. *Journal of General Education, 44*(1), 1-25.

Fero, L. J., O'Donnell, J. M., Zullo, T. G., Dabbs, A. D., Kitutu, J., Samosky, J. T., & Hoffman, L. A. (2010). Critical thinking skills in nursing students: Comparison of simulation-based performance with metrics. *Journal of Advanced Nursing, 66*(10), 2182-2193. doi:10.1111/j.1365-2648.2010.05385.x [doi]

Groom, J. A., Henderson, D., & Sittner, B. J.NLN/Jeffries simulation framework state of the science project: Simulation design characteristics. *Clinical Simulation in Nursing, 10*(7), 337-344. doi:10.1016/j.ecns.2013.02.004

Hee-Ok, P., & Insook, L. (2016). Enhancing critical thinking through simulation problem-based learning in nursing education. *Indian Journal of Science and Technology, 9*(37) doi:http://dx.doi.org/10.17485/ijst%2F2016%2Fv9i37%2F101758

INACSL Standards Committee (2016, December). INACSL standards of best practice: Simulation[SM] Simulation design. Clinical Simulation in Nursing, 12(S), S5-S12. http://dx.doi.org/10.1016/ j.ecns.2016.09.005

Institute of Medicine. (2010). *The future of nursing: Leading change, advancing health.* (). Washington, DC: The National Academies Press.

Jeffries, P. R. (2005). A framework for designing, implementing, and evaluating simulations used as teaching strategies in nursing. *Nursing Education Perspectives, 26*(2), 96-103.

Jeppesen, K. H., Christiansen, S., & Frederiksen, K. (2017). Education of student nurses - A systematic literature review. *Nurse Education Today, 55*, 112-121. doi:S0260-6917(17)30108-9 [pii]

Kim, J., Park, J., & Shin, S. (2016). Effectiveness of simulation-based nursing education depending on fidelity: A meta-analysis. *BMC Medical Education, 16*(1), 152. doi:10.1186/s12909-016-0672-7

Ludin, S.M. (2018). Does good critical thinking equal effective decision-making among critical care nurses? A cross-sectional survey. *Intensive & Critical Care Nursing,* 1-10.

Mahmoud, A.S., & Mohamed, H.A. (2017). Critical thinking disposition among nurses working in public hospitals at port-said governorate. *International Journal of Nursing Sciences, 4*(2), 128-134.

Maneval, R., Fowler, K. A., Kays, J. A., Boyd, T. M., Shuey, J., Harne-Britner, S., & Mastrine, C. (2012). The effect of high-fidelity patient simulation on the critical thinking and clinical decision-making skills of new graduate nurses. *Journal of Continuing Education in Nursing, 43*(3), 125-134. doi:10.3928/00220124-20111101-02 [doi]

Profetto-McGrath, J. (2003). The relationship of critical thinking skills and critical thinking dispositions of baccalaureate nursing students. *Journal of Advanced Nursing, 43*(6), 569-577.

Profetto-McGrath, J., Hesketh, K., Lang, S., & Estabrooks, C. (2003). A study of critical thinking and research utilization among nurses. *Western Journal of Nursing Research, 25*(3), 322-337.

Scheffer B.K., & Rubenfeld. M. (2000). A consensus statement on critical thinking in nursing. *Journal of Nursing Education, 39*(8), 352-9.

Shin, H., & Kim, M. J. (2014). Evaluation of an integrated simulation courseware in a pediatric nursing practicum. *The Journal of Nursing Education, 53*(10), 589-594. doi:10.3928/01484834-20140922-05 [doi]

Shin, H., Ma, H., Park, J., Ji, E. S., & Kim, D. H. (2015). The effect of simulation courseware on critical thinking in undergraduate nursing students: Multi-site pre-post study. *Nurse Education Today, 35*(4), 537-542. doi:10.1016/j.nedt.2014.12.004 [doi]

Shinnick, M. A., & Woo, M. A. (2013). The effect of human patient simulation on critical thinking and its predictors in prelicensure nursing students. *Nurse Education Today, 33*(9), 1062-1067. doi:10.1016/j.nedt.2012.04.004 [doi]

Shoulders, B., Follett, C., & Eason, J. (2014). Enhancing critical thinking in clinical practice: Implications for critical and acute care nurses. *Dimensions of Critical Care Nursing: DCCN, 33*(4), 207-214. doi:10.1097/DCC.0000000000000053 [doi]

Smith-Blair, N., Neighbors, M. (2000). Use of critical thinking dispositions inventory in critical care orientation. *Journal of Continuing Education in Nursing, 31*(6), 251-256.

Swinny, B. (2010). Assessing and developing critical-thinking skills in the intensive care unit. *Critical Care Nursing Quarterly, 33*(1), 2-9. doi:10.1097/CNQ.0b013e3181c8e064 [doi]

Tedesco-Shneck, M. (2013) Active learning as a path to critical thinking: are competencies a roadblock? *Nurse Education in Practice, 13*(1), 58-60.

Wangensteen, S., Johansson, I. S., Bjorkstrom, M. E., & Nordstrom, G. (2010). Critical thinking dispositions among newly graduated nurses. *Journal of Advanced Nursing, 66*(10), 2170-2181. doi:10.1111/j.1365-2648.2010.05282.x [doi]

Wood, R. Y., & Toronto, C. E. (2012). Measuring critical thinking dispositions of novice nursing students using human patient simulators. *The Journal of Nursing Education, 51*(6), 349-352. doi:10.3928/01484834-20120427-05 [doi]

Yuan, H. B., Williams, B. A., Fang, J. B., & Ye, Q. H. (2012). A systematic review of selected evidence on improving knowledge and skills through high-fidelity simulation. *Nurse Education Today, 32*(3), 294-298. doi:10.1016/j.nedt.2011.07.010 [doi]

Yurdanur, D. (2016). Critical thinking competence and dispositions among critical care nurses: a descriptive study. *International Journal of Caring Sciences, 9*(2), 489-495.

Zurmehly, J. (2008). The relationship of educational preparation, autonomy, and critical thinking to nursing job satisfaction. *Journal of Continuing Education in Nursing, 39*(10), 453-460.

Tables

Table 1.

Demographics of Participants (N = 22)

Demographic Characteristics	N (%) or M ± SD
Gender	
Female	20 (91)
Male	2 (9)
Age	29.09 ± 4.88
RN Years	4.61 ± 3.04
ICU RN Years	2.93 ± 1.56
Home ICU	
STICU	7 (31.8)
TCVPO	5 (22.7)
MICU	5 (22.7)
NNICU	2 (9.1)
CCU	2 (9.1)
Certification Status	
Yes	16 (72.7)
No	6 (27.3)
Certification	
CCRN	8 (36.4)
CCRN + Other	4 (18.1)
CNL	2 (9.1)
CEN	1 (4.5)
ATCN	1 (4.5)

Note: One participant did not report home intensive care unit.

Table 2.

Comparison of Changes Between Pre- and Post-Test CCTDI Scores

CCTDI Scores	Pre-Test M ± SD	Post-Test M ± SD	*t*	p
Overall	325.68 ± 23.70	334.86 ± 22.92	3.452	.002*
Truth-Seeking	42.18 ± 4.85	44.59 ± 3.65	2.811	.010*
Open-Mindedness	46.77 ± 4.79	47.14 ± 4.89	0.748	.462
Inquisitiveness	52.14 ± 5.03	53.68 ± 4.70	2.364	.028*
Analyticity	45.86 ± 5.19	46.45 ± 5. 65	1.054	.304
Systematicity	44.55 ± 6.89	46.50 ± 5.86	2.543	.019*
Confidence in Reasoning	46.45 ± 4.52	47.95 ± 5.69	2.602	.017*
Maturity in Judgment	47.81 ± 3.50	48.55 ± 3.89	1.242	.228