Teaching Infection Prevention using Concept Mapping Learning Strategies

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Executive Summary

Infection prevention challenges are encountered in all hospital settings. Daily clinical interactions frequently expose nurses to microorganisms that can result in healthcare-associated infections (HAIs) for a patient. The relationship between infections as a result of healthcare and susceptible patients has long been understood and although HAIs are preventable, they continue to be a peril to today’s patients. Previous healthcare research has indicated that recognition by nurses regarding the importance of HAI prevention strategies is inconsistent (Siegel, Rhinehart, Jackson, Chiarello, & the Healthcare Infection Control Practices Advisory Committee, 2007). Lack of adherence to infection prevention strategies was also identified as a concern for graduate nurses participating in the Intermountain Healthcare Urban South Region registered nurse residency program. As a result, this quality improvement infection prevention educational intervention was planned in collaboration with the Intermountain Healthcare Urban South Region residency program coordinator and infection preventionist.

The quality improvement project describes the addition of a concept mapping learning strategy for infection prevention education of novice graduate nurses enrolled in the RN residency program. The project objective was to evaluate the use of a concept mapping learning strategy as an educational intervention to improve novice graduate nurses’ critical thinking and prioritization skills regarding infection prevention. Results of the project indicate that the learning strategy intervention had a positive effect in improving novice graduate nurses’ critical thinking, prioritization of nursing assessments and interventions related to infection prevention, and retention of infection prevention nursing care knowledge.
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Guidelines for the prevention of healthcare associated infections (HAIs) are well-established in the healthcare setting and yet research regarding the frequency of infections indicates that healthcare-associated infections (HAIs) continue to present a grave threat to patients. Multiple initiatives to decrease the risk of HAIs have been implemented in the national and local arenas. Quality improvement research regarding the effectiveness of these implementations is an ongoing endeavor for healthcare leaders. A persistent concern of healthcare leaders and providers alike is the compliance of healthcare givers with infection prevention standards of practice at the bedside.

Discussion with the program director of Intermountain Health Care (IHC) Urban South Region (USR) registered nurse (RN) program indicated a similar concern regarding inconsistency of HAI prevention strategies among the facility’s novice nurses. Therefore, a research question was raised: What effect will the addition of a concept mapping learning strategy have on a novice graduate nurse’s critical thinking and prioritization of nursing interventions related to infection prevention?

In October 2012 the concept mapping learning strategy project was implemented with novice graduate nurses participating in the IHC USR RN residency program. Following the initial intervention an after-action review process evaluated the impact of the learning strategy. The review process included the use of concept mapping learning strategies by graduate nurses for two weeks following the initial educational presentation. Statistical testing involved concept map pre- and post-scoring and correlation testing to determine interrater reliability. Novice graduate nurses were asked to complete a concept map for one patient each work week for two weeks post the concept mapping learning strategy. After two weeks of using the concept-
mapping tool, the nurses’ knowledge was evaluated with further post-testing. (For a complete outline of the proposal time frame (see Appendix A.) The goal of the program was to optimally improve critical thinking, improve prioritization of nursing care, and improve application of strategies used to prevent healthcare associated infections.

**Review of Literature**

**Search Strategy**

An extensive search of the literature was completed in the Cinahl, PubMed, and ERIC databases. Multiple combinations of the following search terms were used: concept map, nursing, care map, infection control, infection control compliance, personal protective equipment use, standard precaution compliance, contact isolation, infection control communication, nurses, infection control checklist, infection prevention residency nursing education, CAUTI prevention, graduate nurse and workforce, novice nurse and clinical decision making, critical thinking skills, hospital orientation, and novice nurse transition. Clinical trials, systematic reviews, meta-analyses, guidelines were searched for, in addition to educational information regarding concept mapping. The internet was also searched for guidelines related to infection prevention and educational reports regarding concept mapping. Data were evaluated for value to the current study based upon reliability of results and generalizability of findings to the project research question.

**Healthcare Associated Infections**

Healthcare associated infections (HAIs) are those infections that are not present when the patient is admitted to the hospital, become evident 48 hours following admission, or are acquired during hospitalization but become clinically evident following discharge (Mirza, 2012). HAIs are thought to be the greatest threat faced by hospital patients and although the infections are
preventable, about 1.7 million patients in the United States (U.S.) experience HAIs each year. Approximately 99,000 of those patients die of complications related to the HAI. The resulting financial burden of HAIs is felt to be about $28 billion to $33 billion each year (U.S. Department of Health and Human Services [USDHHS], 2010, p. 1).

The relationship between HAIs and susceptible patients was first noted by Semmelweis in the 1840s when the lack of handwashing was linked with the occurrence of puerperal fever among childbearing women. The discovery of Semmelweis related to the importance of handwashing and cleanliness is recognized as the foundation of infection prevention practices. In the United States, the practice of infection prevention is founded upon the Joint Commission for Accreditation of Hospitals (JCAHO) and the Centers for Disease Control and Prevention (CDC) guidelines. Basic principles of infection prevention involve the following: CDC standard precautions, hand hygiene, isolation precautions, environmental cleaning, and surveillance (Friedman & Sexton, 2012).

In spite of advanced technology and medical understanding, the challenges of HAIs remain a significant concern among healthcare providers and their patients. According to Siegel et al. (2007) the adherence of healthcare personnel to recommended infection prevention practices is limited and compliance with universal precaution guidelines range from 43% to 89%. Authors of the report comment that adherence is conditional upon the practice being assessed. For example the appropriate use of gloves ranged between 15% to 82% with increased reports of glove use during arterial blood gas draws and resuscitation efforts (Siegel et al., 2007, p. 45). A review of the literature by Gammon, Morgan-Samuel, and Gould (2006) indicates that healthcare practitioner compliance with handwashing guidelines is within a range of 27-86%, with a mean of 52% (p. 164).
Infection Prevention Research and Recommendations

In a landmark report involving a systematic review of the literature prepared for the U.S. Department of Health and Human Services Agency for Healthcare Research and Quality (AHRQ), Ranji et al. (2007) indicate that quality improvement studies regarding the prevention of hospital acquired infections are needed. The report focuses on infection prevention strategies for the four types of infections that have been shown to account for approximately 80% of HAIs. These include surgical site infections (SSI), central line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP), and catheter-associated urinary tract infections (CAUTI) (Ranji et al., 2007, p. 19).

Multiple preventive interventions have been researched for each type of HAI. Examples include the appropriate provision of antibiotics, hand hygiene, glycemic control, and avoidance of preoperative shaving. Personal protective equipment use, aseptic catheter care, standardized protocols and guidelines, sedation vacation, peptic ulcer disease prophylaxis, deep vein thrombosis prophylaxis, wound management, surveillance activities, and patient positioning have also been researched. Educational research has involved interventions such as early ventilator weaning, oral hygiene, pathogenesis and epidemiology, nutrition assessment, respiratory exercises, and patient mobilization. To reduce the prevalence of CAUTI, computer-based reminders have been posted to prompt clinicians to remove urethral catheters early and nurses have been empowered to remove unnecessary catheters according to pre-specified indications (Ranji et al., 2007; Saint et al., 2009).

Ranji et al. (2007) indicate that although multiple research studies were published prior to 2007, poor methodological quality of many of the studies resulted in inconclusive evidence. Unfortunately, research findings have not consistently validated a reduction in infection rates or
improved clinician compliance with infection prevention interventions. Their summary did suggest however that several promising strategies warranted additional research. Recommendations included further research regarding clinical practices such as appropriate antibiotic administration; checklist documentation during invasive procedures; hand hygiene; reduction of urinary catheter use through clinician reminders, automatic stop orders, and nurse empowerment to remove unnecessary catheters; and educational interventions to improve preventive practices and overall patient care. It is also suggested that more research regarding improving clinical practice adherence to preventive intervention policies be completed (Gammon, Morgan-Samuel, & Gould, 2007).

Credible research and data collection is crucial to overcoming the challenges associated with hospital derived infections. An example of one such study involves the implementation of a daily goals checklist in the Genesys Regional Medical Center (GRMC) Intensive Care Unit (ICU) (Khorfan, 2008). In 2005, the epidemiology department at GRMC began to voluntarily report HAI data related to VAP and CLABSI. At this time they also formed a quality improvement leadership team to oversee goals to improve patient care quality, decrease patient length-of-stay, morbidity and mortality, and improve communication and safety measures.

The GRMC improvement leadership team developed an infection prevention daily goals checklist to be completed each shift by intensive care physicians and nurses caring for ventilator-assisted patients and patients with central lines. All ICU team members, including nursing staff, respiratory therapists, pharmacists, allied health workers, house staff, and physicians were oriented to the intervention and a physician leader and executive team member reviewed the checklist daily.
Research data collected throughout the GRMC intervention showed a reduction in HAIs with rates much lower than the national mean. The GRMC quality improvement team recommended the daily goals checklist as a very effective tool in reducing HAI related to ventilator and central-line use. As a result of their success, GRMC leaders additionally implemented a daily goals checklist for deep vein thrombosis prophylaxis and peptic ulcer disease prophylaxis. They report 100% efficiency following checklist implementation. As expected with any new implementation, a few challenges are described that may occur during the implementation process. These include lack of adherence to processes, poor recognition of checklist value by some clinicians, and complaints regarding added paperwork. However, after sharing the resulting data with the staff and a review of the process, Khorfan (2008) indicates an increased willingness to implement the checklist process.

The concurrent use of several effective practices through care bundling has become a standard of practice for infection prevention strategies (Aboelela, Stone, & Larson, 2007; Institute for Healthcare Improvement [IHI], 2012). Care bundling has been shown to have a greater impact on the rates of infection in comparison to implementation of one infection prevention strategy at a time (Aboelela, Stone, and Larson, 2007; IHI, 2012). This approach is explained by the IHI (2012) as, “A way to describe a collection of processes needed to effectively care for patients undergoing particular treatments with inherent risks. The idea is to bundle together several scientifically grounded elements essential to improving clinical outcomes” (para. 2).

Care bundles involve the use of three to five infection prevention strategies packaged together as a cohesive unit. This infection prevention application is based upon the concept that transmission of disease is multi-factorial and several preventive practices are needed for greater
impact. Each element of the package is clearly defined and supported by research evidence (Aboelela, Stone, & Larsen, 2007). Multiple care bundles are suggested by the IHI; this strategy focuses on a wide range of infection prevention efforts including surgical site infections, ventilator-associated pneumonia, and urinary tract infections. An illustration is the urinary tract infection prevention bundle which includes practices such as daily assessing the need for an indwelling catheter, using sterile technique during catheter insertion, preserving a sterile closed drainage system, keeping the drainage system below the level of the bladder at all times, providing daily catheter hygiene, and securing the catheter to prevent repositioning (Kleinpell, 2009, para. 3).

**Ongoing Infection Prevention Efforts**

The effort to prevent and reduce HAIs by the AHRQ has continued. Since the report by Ranji et al. in 2007, AHRQ has supported many HAI projects throughout the nation. These projects have focused on barriers and challenges related to HAI prevention; accelerating change in healthcare organizations; HAI-related assistance tools; and identification, evaluation, and reduction of facility and community acquired methicillin-resistant staphylococcus aureus (MRSA) infections. Additional projects include the use of safety reporting systems in ICUs, reduction of CLABSI in ICUs using a comprehensive unit-based safety program, implementation of a national infection prevention toolkit, increasing efforts to decrease HAIs such as MRSA, Clostridium difficile, Klebsiella pneumonia, and antibiotic overuse (USDHHS, 2010).

In collaboration with the Department of Health and Human Services and other federal agencies, AHRQ has also worked to reduce HAIs and develop data collection instruments in support of Patient Safety Organizations. Fairly new entities, Patient Safety Organizations bring together clinicians and healthcare providers to identify and promote patient care safety concerns
and assemble and analyze patient safety data within a legally sheltered environment (USDHHS, 2010). As a result, additional research studies have been completed regarding HAIs and infection prevention strategies.

In 2010, the Association of State and Territorial Health Officials (ASTHO) and the CDC united their efforts to advance healthcare infection prevention at the state level and in 2011 they published the toolkit “Eliminating Healthcare-Associated Infections: State Policy Options” (Blumenstock et al., 2012, p. 7). Prepared by leading HAI experts, the toolkit offers assistance to senior policy makers as they prepare legal interventions and policies for HAI prevention. Various implementations are outlined in the toolkit such as “public reporting options, advisory councils, financial incentives and disincentives, and licensure and training requirements” (Blumenstock et al., 2012, p. 7).

Building upon the lessons learned during phase I of their collaborative efforts, ASTHO and the CDC published a report regarding the early impact of HAI policies in states. Various state HAI prevention efforts are documented in the report recently released in January 2012, “The Policies for Eliminating Healthcare-Associated Infections: Lessons from State Stakeholder Engagement.” Known as phase II of the ASTHO and CDC collaborative effort, the report relates the experiences of participating states as they work to reduce HAI within hospital facilities. Their summary of findings indicates that although public reporting of HAI is important, even more essential is a cultural change that will support the success and maintenance of HAI policies. Financial support is also needed for long-term sustainability of HAI programs (Blumenstock et al., 2012).

States participating in phase II of the project were supplemented through funding from the American Recovery and Reinvestment Act of 2009; however a growing concern among
participants is the availability of long-term funding resources. Members of the project also voiced the need for federal and state policy alignment, effective training programs with sufficient resources for implementation, validated data, and adequate guideline adherence incentives. When asked to summarize key steps for HAI program development, project participants indicated the following:

1. Organize a collaborative approach among policy-makers and multi-sector advisory councils to determine state goals and policies. Advisory councils should include representatives from patient and consumer advocacy organizations, quality improvement organizations, and infection prevention professionals.

2. Mandate public reporting of HAI rates. This includes rigorous processes for data validation and filing reports with the National Healthcare Safety Network (NHSN). Participants felt that mandated reporting raises awareness within the facility and the community and serves as the foundation of a statewide HAI prevention program.

3. Establish a set of initial focus. Infections of the greatest threat and/or greatest opportunity for successful improvement should be concentrated on first, with other infections addressed as the program progresses. Participants felt that this step was essential to keep the program focus manageable. (Blumenstock et al., 2012, pp. 11-12)

The success of a HAI reduction program was felt to be best measured by an increase in facility capacity, an increase in the number of certified infection prevention personnel, and greater level of participation in facility improvement programs. Although progress has been made in the reduction of HAI, much still needs to be done at the state and facility levels. In an effort to sustain current programs, ASTHO and CDC have identified future tasks as development of an outline reflecting stakeholder policy options and best practice advice, continued research
regarding the effectiveness of state HAI policies, and evaluation of CDC function and state support in sustaining HAI efforts (ASTHO, 2012).

**Utah State Infection Prevention**

An effort to reduce HAI continues at the state level. Most recently in the state of Utah, H.B 55: Health Care Associated Infections was signed into law at the close of the 2012 General Legislative Session. H.B 55 amended the Utah Communicable Disease Control Act and took effect on July 1, 2012.

H.B. 55 requires certain healthcare facilities to provide the Utah Department of Health with federally required HAI data submitted to the NHSN. It also instructs the Department of Health to prepare and publicly release an annual report on HAIs beginning May 1, 2013. This report is to include facility identification and comparative data. Data cannot be used as criminal, civil, or administrative proceeding evidence. Confidentiality measures are outlined in the bill as well as the protocol for release of specific medical and epidemiological information to healthcare providers (Draxler, 2012).

**Healthcare Provider Adherence to Infection Prevention Strategies**

Findings of the systematic review completed by Ranji et al., (2007) indicate that conclusions regarding improvement of adherence to infection prevention interventions are poor. As a result, they recommend that adherence to infection prevention practices and educational interventions be further researched in the future. In a systemic review of international literature, Gammon et al., (2007) also note that adherence to infection prevention strategies is less than optimal; however they suggest that compliance with infection prevention standards improves when a structured intervention is implemented. Differences in infection prevention practices are noted between observations of healthcare workers and healthcare worker self-report.
Interestingly, an increased length of health care experience has shown a negative adherence rate among physicians and nurses. The highest rate of infection prevention guideline adherence is seen with healthcare workers participating in educational interventions (Siegel et al., 2007).

**Highly effective infection prevention measures.** Two highly successful infection prevention measures used to avoid HAIs include hand hygiene and the appropriate use of urinary catheters. Most HAIs are spread through hands-on contact between the healthcare worker and the patient. Appropriate hand hygiene has long been considered the single most effective method of decreasing infections and yet unfortunately compliance with hand hygiene is substandard (Gould, Moralejo, Drey, & Chudleigh, 2011).

In an update to a Cochrane review completed in 2007, Gould, Moralejo, Drey, and Chudleigh (2011) evaluated short- and long-term interventions to improve hand hygiene compliance and the effect of hand hygiene on HAI rates. The number of research studies regarding promotion of hand hygiene is sparse with only four studies meeting the inclusion criteria for the update. Findings of the review did not provide a clear understanding of hand hygiene intervention effects. The authors remark however, that this should not be interpreted to suggest that education and interventions promoting hand hygiene should not be taken. Considering disease pathology and patient care, it is only logical that good hand hygiene is needed to disrupt the chain of infection. Based on this premise, Gould et al., (2011) recommend that educational and social marketing interventions to promote hand hygiene continue. They also comment that soundly designed studies evaluating hand hygiene interventions are needed in the future.

One of the most commonly seen and easily reducible HAI is catheter-associated urinary tract infections (CAUTI). It is estimated that each CAUTI costs about $600.00 and each case of
urinary tract-related sepsis costs approximately $2800.00 (Saint, Meddings, Calfee, Kowalski, & Krein, 2009, p. 877). Multi-modal interventions have been implemented by facilities to prevent CAUTIs and yet inaction on these preventive practices is common (Saint, et al., 2009). In 2008, the Centers for Medicare and Medicaid Services (CMS) declined further compensation for CAUTI in a quality improvement strategy to link payment for healthcare services with healthcare outcomes. This change in CMS policy came as a result of a Deficit Reduction Act of 2005 initiative which mandated the use of a “present-on-admission indicator” and a payment change for specific hospital acquired conditions (Saint et al., 2009, p. 879).

As a result of these changes some benefits have been recognized such as an increased focus on CAUTI, increased healthcare worker education regarding appropriate urinary catheterization indications, emphasis on removal of unnecessary catheters, and alternative interventions to urinary catheterization such as the use of condom catheterization and intermittent catheterization. Unfortunately, disadvantages such as an increase in laboratory facilitated urinalysis and urine culture collections, antibiotic treatment for asymptomatic bacteriuria, increased opportunity for fraud and coding complexity complications, and even reduced healthcare access for vulnerable patient populations such as the elderly were also identified (Saint et al., 2009, pp. 881-882).

It is interesting to note however that Healy, Spain, and Cromwell (2011) denote no significant difference in CAUTI rate among reporting states between 2007 and 2009 as a result of the CMS changes. Their research indicates that patients over 80 years of age were 44.7% more likely to experience a CAUTI and patients experiencing a 3-day difference in their anticipated length of stay were 39% more likely to experience a UTI associated with indwelling catheter use. Other patient characteristics were also found to contribute to CAUTI rates including gender
Creating a culture of safety. Creating a culture of safety and infection prevention guideline compliance involves multiple individual, managerial, and organizational interventions. These include managerial actions to improve patient and worker safety, participation of HCW in safety planning, personal protective equipment accessibility, group dynamics and behaviors, and socialization processes for new employees. Improvement of infection prevention practices will require continued organizational support, and prioritization of prevention interventions and integration into the culture of safety (Siegel et al., 2007).

It is important to note that social modeling may highly impact the safety and prevention practices of new hires, including adherence to infection prevention strategies (Olson, Grosshuesch, Schmidt, Gray, & Wipfli, 2009). A desire to “fit in” and anxiety related to negative social consequences may significantly impact the infection prevention behavior of new hires. Research suggests that organizational leaders should be aware of and carefully monitor cultural safety practices for possible effects upon infection prevention behaviors among newly hired employees (Olsen et al., 2009).

Novice graduate nurses. The transition from student nurse to the role of RN can be an intense and dynamic personal and professional experience for the graduate novice nurse. Adaptation and adjustment to new responsibilities and professional roles dominate the first few months of employment. Indeed, the first year of professional nursing service may be a time of confusion and discouragement associated with exhaustion and burnout as the novice nurse
struggles with lack of clinical knowledge and confidence, sociocultural adaptation, strains of workload, organization, and prioritization (Duchscher, 2008).

Because novice nurses have limited clinical experience and lack discretionary clinical judgment, they require rules to guide practice behaviors. Complex clinical decision-making is required and staff development programs should encourage nurses to systematically reflect on, compare, and review clinical judgments (Benner, 2001). Gillespie and Paterson (2009) suggest that social, cultural, political, ideological, historical, and physical influences shape a nurse’s decision-making; they conclude that the development of novice nurse decision-making skills is based on the learning atmosphere while a junior co-worker (p. 166).

In order to form the most appropriate judgment a nurse must be able to recognize cues regarding the clinical situation from patients, families and significant others, and other health care providers. Judgment must be open to change as clinical situations progress and nurses must be willing to seek consultation as needed. In addition, appropriate prioritization of concerns and nursing interventions is vital to determining the course of action. Optimal clinical decision-making requires the utilization of critical, systematic, creative, and anticipatory thinking (Gillespie & Paterson, 2009). Research of graduate nurse critical thinking abilities shows inconsistency in the identification and management of patient problems and incomplete reporting of patient information to physicians (St. Cyr & All, 2009).

To develop a sense of salience, Benner, Sutphen, Leonard, and Day (2010) suggest that apprenticeship to the health care team, community of practice, and patients and families is critical to the understanding and application of nursing knowledge. It is imperative for novice nurses to integrate learning through supervised practice, professional coaching from expert healthcare workers, reflection and articulation regarding practice in specific clinical situations,
and recognition of clinical priorities and demands. Assisting novice nurses as they progress through the stages of professional career development is important not only to master clinical skills and improve clinical decision-making; it is also critical to longitudinal job satisfaction and professional commitment (Duchscher & Myrick, 2008; Halfer, 2011).

In summary, the learning curve associated with new clinical practice is strenuous, if not intimidating. For this reason it is imperative that novice graduate nurses be integrated into the rigors of professional accountability through a prolonged orientation period such as that provided by an RN residency program. Residency programs provide opportunities for integrative learning and promote salience among novice nurses. In addition they create a work environment that empowers graduate nurses to provide optimal standards of care (Duchscher & Myrick, 2008; Benner et al., 2010). During the development of improved clinical reasoning, as the graduate nurse progresses from novice to expert, the use of concept maps may facilitate the assimilation of new knowledge and meaningful learning (Wood, 1992).

**Infection Prevention Education**

**Concept mapping learning strategy.** The theory and technique of concept mapping was originally presented by Joseph Novak as he completed research regarding children’s understanding of science. The theory of concept mapping is based on David Ausubel’s cognitive psychology premise that learning involves the assimilation of new ideas into the learner’s already established knowledge structure (Novak & Cañas, 2008).

In an attempt to illustrate a child’s discovery and learning process, Professor Novak developed the concept map (Novak & Cañas, 2008). This powerful tool has been recognized not only as an effective method of teaching and learning, but also as a method of evaluating the learning that has taken place. Novak and Cañas, 2008, indicate that the tool can also be
effectively used to compare a learner’s perceptions during learning and the related knowledge possessed by the learner pre- and post-instruction (p. 5).

The two main characteristics of concept maps are the hierarchical structure and the cross-links. Concept maps are constructed based upon a specific question or event that the learner is trying to understand. Areas of knowledge or concepts are organized in boxes or ovals on the map and cross-links represent relationships between represented knowledge concepts (see Appendix B). Specific events may also be identified on the map; however they are not included in the boxes or ovals as they do not represent specific concepts (Novak & Cañas, 2008).

Utilization of concept mapping as an educational strategy meets Ausubel’s conditions of meaningful learning, namely: presented learning material should be well-organized and described in terms and examples familiar to the novice, students must have previously learned knowledge that is related to the concepts being taught, and the apprentice or student must be willing to purposefully learn. Concept maps provide powerful methods of learning which can be used to promote long-term retention of meaningful learning, evaluate the effectiveness of learning, and identify the accuracy of thinking processes. Through the creation of concept maps knowledge is organized and structured in such a way that learners are empowered to use new learning in unfamiliar circumstances (Novak & Cañas, 2008).

**Usefulness in healthcare education.** Advantages of using concept maps can be applied to multiple healthcare scenarios. Utilization of concept maps has proven valuable in many areas of health care and nursing education. Although they have traditionally functioned as a method to conceptualize knowledge and learning, they have also been used for planning and evaluation of healthcare services. Additional benefits of concept mapping strategies have included the evaluation and prioritization of patient beliefs about coping with chronic illness, examination of

The benefit of using concept maps in nursing education has long been recognized. Through diagramming information regarding patient problems and treatments, nursing students and nurses alike are able to recognize poorly understood concepts, construct questions, and search for additional information. In other words, concept maps help learners identify his or her personal knowledge base and what needs to be learned in order to provide optimal patient care (Schuster, 2008, p. 3-4).

Multiple research studies involving various nursing student populations provide positive findings regarding the effectiveness of concept mapping as a nursing learning strategy. The concept mapping learning strategy has been used to educate students regarding relationships between medical/surgical patient status, clinical care, and prioritization of nursing interventions (Chen, Liang, Lee, & Lao, 2011) and to promote critical thinking and identification and implementation of nursing actions for patient with psychosis (Vacek, 2009). Dontje and Coenen (2011) used concept mapping techniques to explore the correlation between adult depression and standardized nursing terminologies. Maag, Buccheri, Capella, and Jennings (2006) used concept mapping to guide the design of a clinical nurse leader program. Although evidence supporting the theory that concept mapping increases student critical thinking and improves understanding is plentiful, only a few studies are described here.

**Graduate nurse application.** Considering the steep learning curve associated with transition into the healthcare environment, novice graduate nurses may experience overwhelming clinical situations in which it is difficult to apply critical thinking and determine what nursing
action is priority (St. Cyr & All, 2009). The use of concept mapping has been shown to provide a method to assist graduate nurses with organization of thoughts, prioritization of actions, and application of nursing theory. It may also promote a sense of salience by facilitating critical thinking and reflection on clinical practice and prioritization as related to various clinical scenarios (Wilgis & McConnell; 2008; St. Cyr & All, 2009; Veo, 2010).

In a systematic review of the literature, Clayton (2006) examined research studies regarding the utilization of concept mapping as an active teaching strategy to help nurse educators prepare RN graduates to critically think and solve problems in various clinical settings. The author’s review and comparison of study results describes three major outcomes with the use of concept mapping. These include a positive effect on academic performance, improved critical thinking skills, and use of concept mapping as an appropriate teaching method (p. 202). Clayton (2006) suggests that further research regarding the use of concept mapping is needed to identify when concept maps should be used, how to assess and evaluate concept map use, and how to recognize the effect of concept maps on critical thinking.

The descriptive comparison study by Wilgis and McConnell (2008) examines critical thinking skills of graduate nurses in a hospital orientation program. Wilgis and McConnell (2008) describe concept mapping as “an analytical tool as well as a creative educational strategy used to help synthesize, organize, and prioritize data in a logical sequence” (p. 119). Participants in this small convenience sample of 14 graduate RNs were taught to use concept mapping as a tool to organize and prioritize patient health information and identify appropriate nursing diagnoses and interventions. Participant concept maps were scored pre- and post-intervention using an instrument developed by Schuster (2002). Mean scores of the pre- and post-concept maps indicated a significant difference, with post-concept map scores being considerably higher.
A paired sample t test \( t = -2.797; df = 13; p = .008 \) also showed significant improvement in post-concept maps (set alpha level of \( p = .05 \)) (Wilgis & McConnell, 2008, p. 123). Although limitations of the study must be taken into account, the improvement of concept map scores denote that use of concept mapping during a graduate nurse orientation program may be an inexpensive and effective method of improving critical thinking, organization, and nursing prioritization.

St. Cyr and All (2009) describe the use of a concept mapping learning strategy to improve clinical application of knowledge by graduate nurses in an orientation program. Implementation of the concept mapping intervention was founded on the author’s concerns regarding graduate nurses’ assessments using the Performance Based Development System (PBDS) developed by del Bueno. Areas of concern involved inconsistency by graduate nurses to identify and manage patient problems and report complete information to the physician. As a result a critical thinking session using concept mapping was implemented. Following an overview of concept mapping and map creation, the authors presented a patient scenario using video vignette. Discussion and map creation ensued with identification of body systems affected, nursing interventions, and anticipated physician orders. St. Cyr and All (2009) indicate that the learning strategy was so successful in improving critical thinking of graduate nurses that it continues to be an important component of the orientation program (p. 73).

Research by Veo (2010) involved use of the concept mapping learning strategy as a method of teaching nurses to apply theory to daily practice. It was employed in an effort to improve job satisfaction among nursing staff and give meaning to daily practice. Participants in the study were members of the hospital practice council. All participants were associate degree prepared RNs. The participants met for 1-2 hours each month for 4 months. During the first
session, a review of nursing theory was presented; this was followed by concept map integration during the second and third meetings. Session four involved a course review. A five-item Likert scale survey was administered pre- and post-intervention to evaluate participant’s opinions and understanding of nursing theory application. Participants were also interviewed regarding the experience. Due to limitations of the research the author was unable to make definitive recommendations. Based on positive interview responses however, the researcher suggested that concept mapping be further studied and considered for staff nurse development (Veo, 2010).

Concept mapping impact on knowledge retention. The effect of concept mapping learning strategies on memory retention has also been studied. Novak and Cañas (2008) indicate that long-term memory retention is significantly greater when using concept maps than that of rote learning unless the information is repeatedly rehearsed. Studies with persons of varying ages indicate significantly higher retention scores when concept mapping learning strategies are used (Kim & Olaciregui, 2008; Novak and Cañas, 2008; Robinson, Robinson, & Katayama, 1999).

Although much research using concept maps and memory retention has been done with varying populations, the research regarding concept mapping and memory retention with nurses is limited. Wood (1992) completed research with nursing students and other college students regarding Acquired Immune Deficiency Syndrome (AIDS). Using a computer-based concept mapping tool, Wood (1992) determined that students using concept map learning strategies demonstrated significantly better post-test scores on 18 of the 31 items tested. Wood (1992) suggested that the reason for improved scores is the result of facilitation of knowledge organization in a similar manner to that used by the human mind. This has also been confirmed by multiple authors (Robinson, Robinson, & Katayama, 1999; Kim & Olaciregui, 2008; Novak and Cañas, 2008).
In summary, concept mapping has been shown to be an effective learning strategy to improve knowledge retention, critical thinking, organization of care, and prioritization of nursing implementations among nurses. Although many studies have been completed regarding the effects of concept mapping on learning, additional research is needed to ascertain when concept mapping should be introduced, the effects of concept mapping on critical thinking and memory retention, and the use of concept mapping for staff development.

Overall Synthesis

Healthcare associated infections are one of the greatest healthcare risks currently challenging hospitalized patients. Although many HAIs are easily preventable, significant physical harm and considerable financial expenses are incurred at the hands of healthcare workers as a result of hospital related infections. Multiple healthcare initiatives and interventions have been employed in an effort to reduce the staggering morbidity and mortality rates associated with HAIs. Infection prevention implementations such as care bundling, good hand hygiene, appropriate urinary catheter use, educational interventions, and HAI prevention guidelines and checklists have been proven to decrease percentages of hospital related infections. Unfortunately, research has shown that compliance with infection prevention guidelines is less than optimal. Additional research is needed to determine the effects of educational interventions on healthcare worker adherence to infection prevention guidelines and the promotion of a culture of safety for patients and providers.

As newly hired employees with a fresh outlook on healthcare, novice graduate nurses are positioned to positively influence a culture of healthcare safety and infection prevention compliance. Likewise, concern related to negative social consequences may notably impact the infection prevention behavior of new hires. One method of facilitating the positive transition of
graduate nurses into the healthcare arena is through a residency program. It is suggested that residency programs provide opportunities for integrative learning and facilitate a work environment that empowers graduate nurses to provide optimal standards of care.

Concept mapping is one strategy used by educators to improve knowledge retention, critical thinking, organization, and nursing prioritization. Although the use of concept mapping learning strategies has been extensively studied, further nursing research is needed to determine the full extent of this approach to learning. The use of a concept map learning strategy is strongly encouraged by Intermountain Health Care as a method for nurses to organize patient care and recognize relationships between seemingly irrelevant or unconnected symptoms (Advisory Board Company, 2009, p. 40). Through the use of a concept mapping learning strategy, the author has provided further research evaluating the effects of this educational method on the clinical reasoning and infection prevention understanding of novice graduate nurses.

**Theoretical Framework**

Multiple theories apply to this quality improvement intervention. Probably the most foundational theory is Florence Nightingale’s Metaparadigm in Nursing. Florence Nightingale provided essential principles for implementing competent and effective nursing care. She felt that nurses should care for the patient as well as control the environment in order to promote health recovery. Nightingale encouraged environmental control as a method of disease prevention and health maintenance. Through control of the environment, she maintained that a patient’s physical and mental health status would improve (Potter & Perry, 2009; Current Nursing, 2011).

In addition to Florence Nightingale’s philosophy, the following applicable theories will be reviewed: The Health Belief Model; Theory of Planned Behavior; Patricia Benner’s Nursing
Theory of Skill Acquisition, Novice to Expert Model; and Ausubel’s Theory of Meaningful Learning.

**Health Belief Model**

The Health Belief Model was developed by Hochbaum, Kegels, Rosenstock, and Leventhal in the 1950’s in an attempt to understand certain patterns of behavior related to prevention or control of health problems. The theory defines cues to action and self-efficacy as important components of health-related activities, which are based on an individual’s personal perception of health risk, severity of disease, barriers to behavioral change, and benefits of new behavior (Efstathiou, Papastavrou, Raftopoulos, & Merkouris, 2011; Potter & Perry, 2009).

The health belief model has mainly been used to evaluate health-related behaviors such as weight management, immunization, and diabetes management. However, it has also been shown to be effective when measuring nursing and healthcare worker’s attitudes toward adherence to infection prevention strategies (Efstathiou et al., 2011).

**Theory of Planned Behavior**

The theory of planned behavior is applicable to many situations and can be used in combination with other theories and frameworks. This theory suggests that the intention to perform an act is the motivator for subsequent behavior. An individual’s intention to act is determined by three variables: attitude and perceived risks or benefits regarding the behavior, perception of positive or negative judgment by others, and the perceived obstacles associated with the act (Yardley, Miller, Schlotz, & Little, 2011). The strength of a person’s beliefs regarding action outcomes facilitates their ability to either overcome challenges associated with the action or prevent the behavioral change altogether. Application of the theory is generally
initiated through the use of focus-groups and qualitative assessment of factors influencing the variables (Whitby, McLaws, & Ross, 2006).

The health belief model and the theory of planned behavior are foundational to the proposed intervention with novice graduate nurses. The concept mapping learning strategy is intended to improve the nurses’ personal health beliefs, attitudes, and intention to act, which in turn are essential to facilitating adherence with infection prevention strategies and improving critical thinking.

**Theory of Novice to Expert**

Today’s new nurses must be prepared to maintain patient safety, practice accurately, and administer care in multiple settings. Because nurses are the gatekeepers of safe nursing practice and individual patient health, they require a vast knowledge base and exceptional skill level (Benner et al., 2010). Patricia Benner’s (2001) theory of novice to expert describes 5 levels of nursing development: stage 1: novice, stage 2: advanced beginner, stage 3: competent, stage 4: proficient, and stage 5: expert. The novice to expert theory suggests that a nurse progresses through each stage as they gain clinical knowledge and experience (Benner, 2001).

As recent graduates of a nursing program, the novice nurses involved in this research study are in stage 1 of Benner’s model. Benner’s theory will be used to guide the concept mapping learning strategy at an optimal level of understanding for the novice nurse. Identification of nursing knowledge will provide the foundational basis of the activity and direct the discussion to facilitate improvement in critical thinking and clinical reasoning of novice nurses.
Theory of Meaningful Learning

Ausubel’s Meaningful Verbal Learning and Subsumption theory provides the foundation of concept mapping. Ausubel suggests that the integration (or subsumption) of new ideas occurs through the assimilation of learning into the student’s already established knowledge base or cognitive structure. Two processes take place throughout the meaningful learning experience. These include the reception of new information, and discovery - as knowledge is rearranged and reorganized to allow cognitive application and problem solving (Clayton, 2006; Novak & Cañas, 2008).

Using Ausubel’s theory of meaningful learning, Novak and Gowan first introduced concept mapping in 1984. Novak and Cañas (2008) indicate one of the reasons concept mapping is such a successful learning tool is the facilitation of knowledge organization and structure. Very little is known about how our brains assimilate learning and store knowledge, but research has shown that the human brain organizes information in a hierarchal framework. Learning strategies that facilitate a hierarchal framework such as concept mapping, improve meaningful learning and retention (Novak & Cañas, 2008).

The novice nurse has little to no experience in many of their work situations. Each clinical situation may be new and the novice nurse relies upon remembering guidelines provided during school and job orientation (Benner, 2001). The use of a concept mapping learning strategy is a powerful method to assist novice nurses as they identify previously learned knowledge, clarify concepts, improve knowledge application, and strengthen critical thinking.
Methods

Sample and Setting

The concept mapping learning strategy educational intervention took place during October 2012. A small convenience sample of 16 participants was recruited from novice graduate nurses enrolled in the IHC USR RN residency program. The intervention took place in an IHC USR education department classroom which is housed in a free-standing building on the UVRMC campus, just north of the hospital. The total time allowed for the concept map learning strategy intervention was three hours. Participants were approached during the morning session of the residency program class and the principal investigator provided a brief description of the research study. Recruits were informed that participation was voluntary and would not affect employment status or residency program success. Of the 26 persons recruited for the study, 16 volunteered to participate. Informed consent was obtained and participants were asked to complete a demographics survey (see Appendix C). Study participants chose a four-digit number of their choice which was used to identify each of their concept maps. Participant names were used only to obtain consent; names were not linked to study numbers.

Procedure

Permission to complete the October 2012 study was obtained from IHC and the University of Utah Institutional Review Boards (IRB). Brigham Young University IRB also granted permission by deferral to the IHC IRB decision. Prior to implementing the October study, a pilot study with novice graduate nurses currently in the IHC USR RN residency program was completed June 2012. As a result of the pilot study, the following process modifications were made: case scenario information and concept map templates were color-coded to better facilitate concept map scoring, participant instructions were streamlined to improve
understanding of concept mapping, residency nurses were assigned to discussion groups after completing the demographics survey, and each group was provided with a specific section of the concept map to present.

Curriculum content. The content of the Concept Mapping Learning Strategy was based upon nursing assessments and interventions regarding infection prevention (see Appendix D for the curriculum content). Infection prevention education regarding hand washing and common HAIs was briefly presented by the infection prevention specialist prior to the concept mapping activity. An introduction to the concept mapping learning strategy was then presented by the principal investigator. Based on a case scenario provided, each participating graduate nurse was asked to develop a concept map which included the patient’s main diagnoses, medications and laboratory findings, critical nursing assessments and interventions, prioritization of nursing interventions, and connections between related systems and pathophysiological symptoms.

Concept map templates, written concept mapping instructions, and colored pencils were provided by the principal investigator for the activity. At completion of the activity, concept maps were gathered and group discussion regarding the case scenario ensued. All residency program nurses, via assigned groups, were invited to present various sections (based on pathophysiological systems) of the concept map. Connections between related systems and nursing intervention priorities were deliberated and infection prevention interventions discussed. Following the discussion, participants were asked to develop and submit a second concept map based on a similar case scenario.

To fully evaluate the usefulness of the concept mapping learning strategy, participants were also asked to complete and submit one concept map, involving a patient they were currently caring for, each week for two consecutive weeks. After two weeks of using the concept mapping
strategy, a final concept map based on an infection prevention case scenario was completed by participants during the residency program class.

**Case scenario description.** Three infection prevention case scenarios were used for the concept mapping intervention. Each case scenario was realistic and described a patient who had developed or was at high risk for developing an HAI such as CAUTI, pneumonia, and/or surgical site infection. The main diagnosis of the patients involved in the case scenarios included the repair of a hip fracture, an exploratory laparotomy and hemicolectomy following removal of an ileocecal polyp, and a traumatic brain injury patient with multiple fractures secondary to an automobile accident. The patient’s history, medications, vital signs, physical assessment findings, and laboratory and treatment results were provided for each scenario. Although the scenarios differed, the description of the scenario unfolded similarly and the same layout for the scenario content was used. This enabled study participants to find and evaluate information in a familiar format.

**Instrumentation**

The pre- and post-intervention concept maps were scored using a modified version of the Concept Map Grading Tool developed by Pamela Schuster (2002) (see Appendix E). The grading tool is based on the American Nurses Association (ANA) standards of nursing practice and is used to assess nursing critical thinking and patient care planning skills. Concept maps are graded by assigning points for the overall content of the map, analysis and prioritization of problems, and recognition of essential nursing care assessment and intervention standards. The tool is reported as reliable ($r > 0.70$) for evaluation of critical thinking, communication, and nursing interventions when the same educator teaching the course also grades the concept maps (Wilgis & McConnell, 2008, p. 122). Permission was granted by F.A. Davis Publishing to
modify and use the tool for the concept mapping learning strategies intervention. Generally the
tool is used to grade concept maps created by undergraduate nursing students with full access to
patient information and the ability to evaluate all of the patient’s healthcare data and response to
nursing interventions. Although a thorough representation of the patient’s health status was
described in each case scenario, it was not possible to include all patient data available to
healthcare providers in the clinical setting. As a result minor changes were made to the tool in
order to reflect scoring based on the limited amount of information provided in the case scenario.

The concept map grading tool scores map content based on the ANA standards of
assessment, problem analysis, and planning. An evaluation criterion was not used due to the
limitations involved in this educational setting. The concept map grading tool is divided into
three areas and sub-categories within each area: Assessment has 5 sub-categories, analysis of
problem involves 12 subcategories, and planning included 8 sub-categories. Each subcategory
was graded on a 3 point scale of 0, 1/2, or 1 point, for a maximum possible total score of 25
points.

**Interrater reliability per Generalizability Theory.** Reliability of the instrument for this
study was determined using Generalizability Theory. Considered to be a more robust test than
correlation testing, Generalizability Theory reflects the relationship between variables, evaluates
the dependability of the test scores, and identifies estimates of measurement error (Suen and Lei,
2007). Variance estimates and generalization comparisons are shown in Table 1.
Table 1

Variance Estimates between Participants (persons), Raters, and Time

<table>
<thead>
<tr>
<th>Component</th>
<th>Estimate</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Var(Person)</td>
<td>6.681</td>
<td>26.87</td>
</tr>
<tr>
<td>Var(Rater)</td>
<td>0.165</td>
<td>0.66</td>
</tr>
<tr>
<td>Var(Time)</td>
<td>10.079</td>
<td>40.53</td>
</tr>
<tr>
<td>Var(Person*Rater)</td>
<td>0.612</td>
<td>2.46</td>
</tr>
<tr>
<td>Var(Person*Time)</td>
<td>2.971</td>
<td>11.95</td>
</tr>
<tr>
<td>Var(Rater*Time)</td>
<td>0.641</td>
<td>2.58</td>
</tr>
<tr>
<td>Var(Person<em>Rater</em>Time)</td>
<td>3.718</td>
<td>14.95</td>
</tr>
<tr>
<td>Var(Error)</td>
<td>0.000</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>24.868</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Results of the variance estimates and generalization comparisons indicate that 26.87% of the variance in the concept map scores can be attributed to the unique qualities of each participant. Less than 1% (.66) of the variance can be attributed to the raters and 40% of the variance is attributed to the time the concept map was created (1st concept map, 2nd concept map, 3rd concept map). Variance attributed to the rater scores with regard to participant is 2.46% and 11.95% of the variance is attributed to changes in the participants over time. Changes in the rater over time accounts for 2.57% of the variance and 14.95% of the variance in map scores is attributed to rater scores per person over time. These results indicate that very little variance in the concept map scores can be attributed to raters; rather most of the variation is attributed to characteristics of the individual participant’s change in scores across time.
**Interrater reliability per paired t-test and Pearson correlations.** Table 2 below shows the average of concept map scores over time per rater. For the purposes of this discussion, concept map scores are identified as pre-intervention map: Map1; immediate post-intervention map: Map 2; and two-week post intervention map: Map 3.

Table 2

<table>
<thead>
<tr>
<th>Concept Map</th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater 1 Map 1</td>
<td>10.50</td>
<td>16</td>
</tr>
<tr>
<td>Rater 2 Map 1</td>
<td>8.97</td>
<td>16</td>
</tr>
<tr>
<td>Rater 3 Map 1</td>
<td>12.28</td>
<td>16</td>
</tr>
<tr>
<td>Rater 1 Map 2</td>
<td>16.88</td>
<td>16</td>
</tr>
<tr>
<td>Rater 2 Map 2</td>
<td>15.88</td>
<td>16</td>
</tr>
<tr>
<td>Rater 3 Map 2</td>
<td>17.13</td>
<td>16</td>
</tr>
<tr>
<td>Rater 1 Map 3</td>
<td>15.8</td>
<td>15</td>
</tr>
<tr>
<td>Rater 2 Map 3</td>
<td>15.8</td>
<td>15</td>
</tr>
<tr>
<td>Rater 3 Map 3</td>
<td>15.5</td>
<td>15</td>
</tr>
</tbody>
</table>

Paired t-tests and Pearson product moment correlations (r) were also examined to evaluate the variability of scoring between each of the raters with regard to the three different concept maps. Results are similar to those inferred by the concept map score means documented in Table 2. Table 3 presents information regarding the comparison of raters using paired t-tests and correlations.
Table 3

Comparison of Raters using Paired t-tests and Pearson Product Moment Correlations (r)

<table>
<thead>
<tr>
<th>Rater</th>
<th>Map 1</th>
<th>Map 2</th>
<th>Map 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t</td>
<td>r</td>
<td>t</td>
</tr>
<tr>
<td>1 vs. 2</td>
<td>1.867</td>
<td>.632***</td>
<td>1.417</td>
</tr>
<tr>
<td>1 vs. 3</td>
<td>-2.172**</td>
<td>.767***</td>
<td>-.470</td>
</tr>
<tr>
<td>2 vs. 3</td>
<td>-4.163**</td>
<td>.824***</td>
<td>-1.380</td>
</tr>
</tbody>
</table>

*p < .05, **p < .01, ***p < .001.

In Table 3, a nonsignificant t-test value indicates concept map score agreement by the two raters; a statistically significant t-test value indicates disagreement between the raters. Statistically significant positive correlations (r) indicates that higher scores associated with one rater was associated with higher scores from the other. It is interesting to note that the principal investigator who taught the class (rater 3), scored Maps 1 and 2 higher than the other two raters and Map 3 slightly lower. This may possibly be explained by the involvement of the researcher in the learning activity and the following class discussion. It could also be explained by the order of the map scoring by the researcher and personal fatigue, as Map 1 was scored last in the sequence by rater 3 only.

Although the means of the raters differed, the reliability of the instrument was supported by the Generalizability Theory analysis and the Pearson correlations. Minimal variance in the concept map scores was attributed to the raters with most of the variation being attributed to the characteristics of individual participants. Although the means of the raters differed, reliability of the instrument is valid.
Approach to Data Analysis

For this study, concept maps were scored by three raters: two experienced RNs not invested in the study, and the principal investigator who was also the instructor for the concept mapping class. RNs grading the maps were provided with a copy of each case scenario, a copy of the participant’s completed concept maps, and the grading tool. The principal investigator reviewed the scoring process with each of the RN raters, answered questions, and explained expectations. The researcher was also available to answer questions throughout the concept map scoring process. To reduce the possibility of bias, pre- and post-maps were not identified during the scoring. Data were analyzed using the Repeated Measures Analysis of Variance (RM ANOVA), the nonparametric equivalent to the ANOVA (the Friedman test), and paired t-tests.

Results

Participants

Sixteen newly licensed RN graduate nurses participated in the study. Ages of the participants ranged from 22 years to 37 years ($M = 27.8, SD = 5.18$). Fourteen of the 16 (87.5%) participants were female. All participants were currently working in medical/surgical areas including the emergency room, ICU, orthopedics, neurology, neuro and trauma rehabilitation, endoscopy, labor and delivery, mother/baby, and newborn ICU. Participants were graduates from both associate degree ($n = 12, 75\%$) and baccalaureate degree nursing programs ($n = 4, 25\%$). One participant also had a bachelor’s degree in psychology. Ten of the participants (62.5%) had experience as a patient care technician, six (37.5%) had experience caring for a homebound patient, and three (5.3%) participants did not have experience as a caregiver prior to their hire as a graduate RN.
Twelve (75%) of the participants had experience with concept mapping while in school. Previous experiences with concept mapping as described by the participants ranged from “Brief overview in nursing school” to “Used during nursing school clinicals.” Fifteen participants completed the study; one participant did not complete the final concept map due to long-distance barriers.

**Concept Map Scores**

Given that there were three raters scoring each concept map, the three scores were averaged to obtain a summary score for each participant. Mean scores for the entire group on the pre- and post-intervention case-scenario concept maps were calculated, compared, and evaluated using the RM ANOVA. Table 4 presents the means, standard deviations and F value (for time) for the three concept maps. These results indicate that the participants’ scores changed in a positive direction over time. There was a significant increase \((p = .001)\) in scores between Map 1 and Map 2 and a slight decrease between Map 2 and Map 3; the scores did not return to baseline however and the slight decline was not significant. The partial eta squared value indicated that 77.1% of variance in the concept map scores could be attributed to changes in scores across time.

Table 4

Means, Standard Deviations, and RM ANOVA Results for the Concept Maps across Time

<table>
<thead>
<tr>
<th>Concept Map</th>
<th>M</th>
<th>SD</th>
<th>(F_{(2, 13)}^{1})</th>
<th>P</th>
<th>(\eta^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map1</td>
<td>10.46</td>
<td>3.81</td>
<td>47.06</td>
<td>.001</td>
<td>.771</td>
</tr>
<tr>
<td>Map2</td>
<td>16.89</td>
<td>3.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Map3</td>
<td>15.70</td>
<td>3.16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)Because Mauchley’s test was nonsignificant \((p = .875)\), sphericity was assumed
Post-hoc tests were undertaken to determine the direction of the significant changes across time. These are presented in Table 5. The results indicate that concept map scores improved significantly between Maps 1 and 2. No significant change was noted between Maps 2 and 3. Figure 1 presents the visual changes of the concept map scores across time.

Table 5

Comparing the Three Maps Pre, Post and Two-weeks Post Intervention

<table>
<thead>
<tr>
<th>Measure</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map 1 vs. Map 2</td>
<td>620.817</td>
<td>1</td>
<td>620.817</td>
<td>77.610</td>
<td>.001</td>
</tr>
</tbody>
</table>

Estimated marginal means of scores is reflected in the profile plot below (Figure 1), showing the significant change between the scores of Map 1 and Map 2, and the lack of significant change between the scores of Map 2 and Map 3.
Figure 1. Visual Representation of Estimated Marginal Means of Scores. The significant change in scores of Map 1 and Map 2, and the lack of significant change in scores of Map 2 and Map 3 are illustrated.

Because the sample size was small \( (n = 15) \), the non-parametric equivalent of the RM ANOVA, the Friedman test, was used to compare the parametric and nonparametric results (Pett, 1997). These results confirmed those obtained from the RM ANOVA: based on median values, there was a statistically significant difference in the median scores for the concept maps across time in the same direction as the RM ANOVA \( (p < .001) \).

**Concept Map Learning Strategy Evaluation**

Qualitative information relating to the concept mapping learning strategy was also collected using the Concept Map Learning Strategy Evaluation (see Appendix F). Graduate nurse appraisal concerning the effectiveness of and satisfaction with the concept mapping learning
strategy was evaluated at the end of the study using the Concept Mapping Learning Strategy Evaluation questionnaire. Responses to the open-ended questionnaire provided qualitative data about graduate nurse perceptions regarding the use of concept maps for planning patient care, improving critical thinking, and prioritization of nursing interventions. Overall perception of the concept mapping learning strategy was positive. Eleven of the fourteen participants indicated that concept mapping helped them make connections between a patient’s symptoms and clinical data. Six of the participants indicated that they learned something new when they drew connecting lines between related symptoms, clinical data, and the pathophysiological system involved. Participant comments include, “Everything is intertwined and connected. I need to remember to stay focused on the entire picture instead of just the task at hand.” “It surprised me to realize how much – literally every system is interconnected. As well as how all the [pathophysiological] systems influence each other.” One participant disagreed with the use of connecting lines, “It’s just not how I learn best because it’s too much all over the place with connections.”

Ten of the study participants felt that concept mapping had helped them identify possible risks for HAIs and organize patient care. Comments included, “Yes, especially with pts who have foleys.” “Yes, unless you see the big picture you can overlook small things that can turn big.” “Yes, it did help prioritize and helped me think, ‘when I’m done with this problem, this is where I should focus my attention next’ even though I will be addressing multiple systems at the same time.” “Yes, it showed the big picture rather than just focusing in what’s happening right now.” Four participants did not feel concept mapping had helped them identify risks and organize patient care. A few of their comments included, “I can see how it might help some, but
I learn better with lists vs. maps.” “I feel I was so confused on the concept maps, infections were low on the list.”

Participants were also asked if they learned anything new about prioritization of nursing assessment and interventions as a result of the concept mapping learning strategy. Eight participants indicated yes. Their exact comments included, “Yes, thought about ABC and how to prioritize what is most important.” “Putting a # helped me think more about what is needed now.” “To be proactive in anticipating results/effects of interventions.” Comments from the five participants answering negatively to learning new prioritization strategies include, “Not as much as prioritizing as seeing the big picture.” “No, just how to organize info on a map.” “Not really, but I did like seeing the problems and meds being used to treat them in the same box instead of a list of meds and a list of problems.”

When asked if they would recommend the use of concept mapping to other nurses, seven participants said yes, one said no, four were unsure, and two did not answer. Reasons cited for recommending concept map use included, “Helps to see the whole picture, helps organize s/s, what’s going on.” “It helps as a new nurse to not be so focused instead seeing the broad picture.” “Because it helps you holistically visualize what physiologically is happening with patients, but time is always a realistic factor and a barrier to doing this.” Those not recommending the use of concept maps also commented: “Time! It is very time consuming.” “Everyone learns differently and functions differently.”

Regarding whether or not concept mapping helped participants identify changes they would make in the future, four answered yes. A few commented regarding the changes they will make: “When you can know an outcome for a pt that has a similar dx you are more inclined to make changes before they go bad. So of course it would help guide my care.” “Take the time to
look up meds and look for changes in the pt status.” “Try to look at labs and see what’s going on.” Four participants indicated that concept mapping did not help them identify changes they would make with future patients and one participant answered “maybe.” Their comments include, “I won’t deal with these situations where I work but I can use bits and pieces,” and “The change I will make is recognizing how interventions affect more than one system.”

Discussion

Results of the concept mapping learning strategy indicate that the intervention had a positive effect in improving novice graduate nurses’ critical thinking and prioritization of infection prevention nursing assessments and interventions. These findings are consistent with other concept mapping research showing that concept maps are powerful methods of learning which can be used to promote long-term retention of meaningful learning, evaluate effectiveness of learning, and identify the accuracy of thinking processes.

Study Risks and Limitations

The risk to study participants in this research was considered minimal as this was an educational intervention. Although the potential risks were minimal, participant identity disclosure and increased graduate nurse concerns regarding personal preparedness as they transition into nursing practice were a possibility. Limitations of the study included the small sample size, which was drawn from a convenience sample, and time constraints for teaching the process of concept mapping.

The researcher was also concerned that some resistance to the concept mapping learning strategy might occur. It was speculated that participant resistance might involve a lack of valuing for the educational strategy, decreased familiarity with concept map development, time constraints, and possible confusion during the learning session. One can also question if the
improvement in scores is related to an increased understanding of concept mapping. Based on their RN licensure however, the nursing care information required for each concept map was information that should be well known to the graduate nurse. The purpose of concept mapping is to organize and build upon previously learned information that is related to the concepts being taught. Therefore it is felt that the improvement in scores between the first two concept maps reflects improved understanding of relationships between medical and surgical patient status, infection prevention and required clinical care, and prioritization of nursing assessments and interventions.

**Conclusion and Recommendations**

Critical thinking and clinical reasoning are essential to the profession of nursing and prevention of HAIs. In this study concept mapping was used to educate students regarding relationships between patient status, clinical care, and prioritization of nursing interventions using realistic case scenarios of patients exhibiting signs and symptoms of HAIs. It is interesting to note that although there was a significant change noted between Map 1 and Map 2, the scores for Map 3 were not statistically different than those of Map 2. This finding may show that longer retention of meaningful learning was improved by the concept mapping intervention. Graduate nurse responses to the RN Residency Concept Learning Evaluation also suggest that concept mapping had a positive effect on the participant’s clinical reasoning, organization of care, and prioritization of care.

Although the Concept Mapping Learning Strategy showed improvement in critical thinking skills and prioritization of essential nursing assessments and interventions, the author recommends that further research is needed. Additional research is needed regarding educational strategies and interventions that promote nursing adherence to infection prevention standards and
a decrease in HAIs. Further research is also needed to determine effective evidence-based educational techniques that improve clinical reasoning and the resulting quality of care.

**Evaluation of Project**

The objective of the concept mapping learning strategy intervention was to evaluate the use of concept mapping as an educational intervention to improve novice graduate nurses’ critical thinking and prioritization skills in regards to patients with HAIs. Approval for the study was obtained through the IRB and the study was completed during October and November 2012. The effectiveness of the concept mapping learning strategy was assessed by comparing pre- and post-intervention concept map scores. Statistical test results indicated a significant improvement in graduate nurses’ critical thinking and prioritization of nursing assessments and interventions related to infection prevention between Maps 1 and 2, and retention of information between Maps 2 and 3.

Another project objective involved the development of an HAI prevention strategies reference guide to be used as a resource for residency program graduate nurses. The reference guide was not created due to policy changes within IHC and the resulting lack of need identified by the infection prevention specialist and the residency program director.

On November 20, 2012 the results of the concept mapping learning strategy intervention were shared and discussed with the IHC USR RN residency program coordinator and the IHC USR infection prevention specialist. Our meeting included a thorough discussion of the results and the impact upon the graduate nurses’ clinical reasoning and promotion of infection prevention. We also discussed possible changes to improve the effectiveness of the concept mapping intervention for future use with residency program participants. Additionally we reviewed ideas for the use of concept mapping with RNs throughout the USR in education.
infection prevention presentations. The infection prevention specialist is contemplating the use of this educational strategy in a current quality improvement project with ICU RNs to reduce CAUTI rates.

The final project objective was to disseminate study results through a poster or podium presentation and an article published in journals serving infection prevention nurses, medical/surgical nurses, or nurse educators. The author of this project, along with the IHC USR infection prevention specialist and the IHC USR residency program coordinator are planning to submit an abstract for a poster presentation at the Association for Professionals in Infection Control and Epidemiology (APIC) conference in June 2013. With more than 14,000 members, APIC is the leading professional association for infection preventionists (Association for Professionals in Infection Control and Epidemiology, 2012). The abstract for the poster presentation will be submitted prior to December 10, 2013. A journal article describing the project and results will also be submitted to the Journal of Infection Prevention or a nursing education journal for dissemination of results. Completion of this objective is anticipated in the future.

**Clinical Significance and Project Conclusion**

Prevention of HAIs requires constant vigilance on the part of every member of the healthcare team. Although much has been done to reduce the occurrence of HAIs, further credible research and data collection are needed to overcome the challenges associated with hospital derived infections. The use of concept mapping as an educational method to improve clinical reasoning and infection prevention awareness is supported by the literature. The learning strategy has been shown to facilitate critical thinking and reflection on clinical practice, as well as assist graduate nurses with prioritization of nursing actions.
The concept mapping learning strategy and intervention was developed in response to infection prevention needs identified for the IHC USR RN residency program. Stakeholders in the intervention included novice graduate nurses, bedside nurse mentors, nurse educators, infection prevention nurse specialists, nursing administration, nurse practitioners, physicians, and the patient and family.

Through the concept mapping learning strategy, the author evaluated changes in graduate nurses’ ability to identify, synthesize, organize, and prioritize critical data related to infection prevention and the optimal care of patients. The clinical significance of this project may be difficult to determine within the constraints of the DNP program. The long-term effects of improvement in the critical thinking and clinical reasoning of a registered nurse is not easily measured. However, based upon the findings of the study, concept mapping education was shown to have a positive effect in improving novice graduate nurses’ critical thinking and prioritization of nursing assessments and interventions related to infection prevention.
References


Appendix A

Outline of Concept Mapping Learning Strategy Proposal and Study Timeframe
## Outline of Concept Mapping Learning Strategy Proposal and Study Timeframe

<table>
<thead>
<tr>
<th>Date</th>
<th>Study Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2012</td>
<td>Concept mapping learning strategy pilot study</td>
</tr>
<tr>
<td>July 2012</td>
<td>Submission of concept mapping learning strategy project proposal</td>
</tr>
<tr>
<td>July 2012</td>
<td>Defense of concept mapping learning strategy project proposal</td>
</tr>
<tr>
<td>August 2012</td>
<td>Submission of IHC and University of Utah IRB Applications</td>
</tr>
<tr>
<td>October 4, 2012</td>
<td>Concept mapping learning strategy intervention begins. Participants complete pre- and post-intervention concept map</td>
</tr>
<tr>
<td>October 4-11, 2012</td>
<td>Participants turn in first concept map for hospital patient</td>
</tr>
<tr>
<td>October 11-18, 2012</td>
<td>Participants turn in second concept map for hospital patient</td>
</tr>
<tr>
<td>October 18, 2012</td>
<td>Participants complete second post-intervention concept map</td>
</tr>
<tr>
<td>October 2012</td>
<td>Concept maps scored and statistical testing completed</td>
</tr>
<tr>
<td>November 2012</td>
<td>Submission of concept mapping learning strategy project results and recommendations</td>
</tr>
<tr>
<td>November 16, 2012</td>
<td>Final defense of concept mapping learning strategy project</td>
</tr>
</tbody>
</table>
Appendix B

Concept Map Example
Figure created by the author based on Advisory Board Company, 2009; Novak and Cañas, 2008; and Schuster, 2008.
Appendix C

Intermountain Health Care, Urban South Region

RN Residency Program Demographics Survey
Intermountain Health Care, Urban South Region

RN Residency Program Demographics Survey

This survey is for employees participating in the RN Residency Program. Please complete the survey prior to the infection prevention intervention class. Your answers will remain confidential. Please write in your study number at the top of the page - DO NOT put your name on the survey.

1. Please circle your gender: Male Female

2. What is your age? ______________________

3. What facility are you currently employed with?
________________________________________________________________________

4. What unit do you work on?
________________________________________________________________________

5. How many hours per week do you work?
   □ 1-20 hours per week ______________
   □ 21 – 40 hours per week _____________

6. What nursing program did you graduate from?
________________________________________________________________________

7. What is your highest level of education?
________________________________________________________________________
________________________________________________________________________

8. Have you had experience as a patient care technician (PCT)? If yes, how long did you work as a PCT?
________________________________________________________________________

9. Have you had experience as a caregiver for a homebound patient?
________________________________________________________________________

10. Have you had experience with concept mapping? Yes No
   a. If yes, describe your concept mapping experience:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Appendix D

Intermountain Healthcare, Urban South Region

RN Residency Curriculum: Infection Prevention Concept Mapping Learning Strategy
## RN Residency Curriculum: Infection Prevention Concept Mapping Learning Strategy

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Method</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0900-0915</td>
<td>Group demographics survey distributed Introduction to HAI</td>
<td>Paper/pencil, PowerPoint, hand hygiene scenario, &amp; YouTube video</td>
<td>Peggy, Karen</td>
</tr>
<tr>
<td>0915-0945</td>
<td>Introduction to Concept Mapping</td>
<td>Group work, 6 groups of 3 members and 2 groups of 4 members, Concept map template / pencil, Colored pencils, 11” X 17” papers for group presentations</td>
<td>Peggy</td>
</tr>
<tr>
<td>0945-1015</td>
<td>Discussion of patient scenario and map</td>
<td>White board concept map, Discussion</td>
<td>Peggy</td>
</tr>
<tr>
<td>1015-1040</td>
<td>Concept Mapping Part 2</td>
<td>Concept map template, pencils, Colored pencils</td>
<td>Peggy</td>
</tr>
<tr>
<td>1040-1100</td>
<td>Summary Discussion</td>
<td>Class discussion, Peggy, Karen, Christie</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Did you learn anything surprising when you drew connections between your patient’s symptoms or clinical data? What surprised you? Why?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Did you learn anything new about the patient’s condition or nursing needs as a result of this exercise? What did you learn?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Did this exercise help broaden your thinking about your patient’s potential co-morbidities or broader care needs?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Next time you care for patient with a similar diagnosis or symptoms, will you do anything differently as a result of this exercise? Why or why not? (Questions from: Advisory Board Company, 2009, p. 46).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assignment: Complete a concept map for 1 patient/week for the next 2 weeks. Select one of the most acute or complex patients you are caring for. Completed map is due at beginning of residency class for the next 2 weeks. You will be asked to complete a final concept map based on the case scenario provided during Residency class on October 18, 2012.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post class</td>
<td>Evaluate maps per evaluation guide</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E

Concept Map Grading Tool
## Concept Map Grading Tool

<table>
<thead>
<tr>
<th>Participant number____________</th>
<th>Hip fracture / Colectomy / TBI</th>
</tr>
</thead>
</table>

### Concept Map Grading Criteria

#### ANA Standard I: Assessment

<table>
<thead>
<tr>
<th>General survey of map (overall)</th>
<th>5 points possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most pressing assessments listed</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Logical (appropriate hierarchal order)</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Complex</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Prioritization listed</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Pertinent history listed</td>
<td>0 ½ 1</td>
</tr>
</tbody>
</table>

Total points /5

#### ANA Standard II: Problem Analysis

<table>
<thead>
<tr>
<th>Analysis of problem</th>
<th>12 points possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifies physiological problems</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Identifies psychological problems</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Identifies education needs</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Correctly identifies main health problem</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Correctly links problems together</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Abnormal assessment data in correct boxes</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Medications listed appropriately</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Key assessments listed appropriately</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Treatments indicated appropriately</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Laboratory/diagnostic tests listed appropriately</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Correctly prioritizes problems</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Labels nursing diagnoses</td>
<td>0 ½ 1</td>
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</tbody>
</table>

Total points /12

#### ANA Standard III, IV, V: Planning

<table>
<thead>
<tr>
<th>Nursing assessments &amp; interventions</th>
<th>8 points possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurological system</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Respiratory system</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Cardiovascular system</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Gastrointestinal system</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>GU system (renal)</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Skin</td>
<td>0 ½ 1</td>
</tr>
<tr>
<td>Psychosocial needs</td>
<td>0 ½ 1</td>
</tr>
</tbody>
</table>

Total points /8

Final score (out of 25 points) /25

Appendix F

Intermountain Healthcare, Urban South Region

RN Residency Concept Map Learning Strategy Evaluation
Intermountain Healthcare, Urban South Region

RN Residency Concept Map Learning Strategy Evaluation

Please complete this questionnaire after the concept mapping learning strategy. Your answers will remain confidential. Please DO NOT put your name on the survey. Thank you for your participation!

1. Did concept mapping help you make connections between your patient’s symptoms and clinical data? ________
   a. Did you learn anything new that surprised you when you drew connections? _____
   b. If so, what surprised you and why?

2. Did concept mapping help you identify possible risks for HAIs and organize patient care planning? Please comment:

3. Did you learn anything new about prioritization of nursing assessment and interventions as a result of this activity?

4. Would you recommend the use of concept mapping to other nurses? ________
   a. Why or why not?

5. Did concept mapping help you identify changes you will make in nursing interventions the next time you care for a patient with a similar diagnosis? _______
   a. If so, what changes will you make?

Questions adapted from Advisory Board Company, 2009.