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Development of Nursing Staff Education for Central Line Maintenance

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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Walden University
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Abstract

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MS, Grand Canyon University, 2012

BS, College of Charleston, 1995

Project Submitted in Partial Fulfillment

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Doctor of Nursing Practice

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Abstract

Patients with cancer who receive bone marrow transplants (BMT) are at increased risk for central line-associated blood stream infections (CLABSI), a serious complication leading to increased costs, length of stay, and even death. Recognition of an increased CLABSI rate at one BMT unit in the southwestern United States prompted development of an evidence-based staff development education program to improve nurses' knowledge of central line maintenance and CLABSI prevention practices. Guided by Lewin change theory, the program was developed based on a nurse-led analysis and synthesis of the evidence, and a formative evaluation of the educational program conducted by a 3-member expert panel made up of the BMT director, a BMT clinical nurse specialist and vascular access team member. The review confirmed the lack of standardized evidence-based guidelines for central venous catheter care, that any patient who has a central line is at risk for CLABSI, and BMT patients are at particular risk due to frequency of catheter manipulation. Findings reinforced the need for the recommendations to educate nurses in BMT settings on evidence-based central line practices, evaluate knowledge gained, and audit practice techniques post education. The social change implication of this DNP project will be the potential decrease in healthcare costs, length of stay, and mortality associated with central line infections when nursing staff are provided an educational program that aims to improve their knowledge and skills of evidence-based central line care and CLABSI prevention practices.

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Dedication

I dedicate this DNP project to my husband, Vincent Farley, my sons, Kendrick and Ryan, my niece Sabrina Rivera, and my daughter-in-law Angelina Jones-Farley who provided encouragement in times of frustration and supported me throughout this work.

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Section 1: Nature of the Project

Introduction

Healthcare-associated infections (HAI) continue to represent ongoing patient safety concerns on a national level (Centers for Disease Control and Prevention [CDC], 2016). To measure the incidence of HAIs, the CDC's National Healthcare Safety Network uses standardized infection ratios (SIRs; CDC, 2019). The SIR tracks HAIs over time and is adjusted for the differences in facilities and patient populations (CDC, 2019). The ratio is calculated by comparing the number of HAIs to the number predicted using national baseline data (CDC, 2019). One HAI that continues to receive national attention is central line-associated bloodstream infections (CLABSI). CLABSI is defined as the presence of a laboratory-confirmed bloodstream infection occurring at least 48 hours after catheter insertion (Haddadin & Regunath, 2018).

CLABSIs can be severe and can prolong hospital stays and increase healthcare costs (CDC, 2019). The cost of a CLABSI is approximately $46,000 per case (Haddadin & Regunath, 2018). Approximately 250,000 bloodstream infections are reported annually, with the majority of the cases due to the presence of central lines (Haddadin & Regunath, 2018). Based on the organism responsible for the bloodstream infection, length of stays can be prolonged 7 to 14 days (Haddadin & Regunath, 2018), and can result in death (CDC, 2011). The mortality rate reported by the CDC was 12% to 25% of reported CLABSI cases (CDC, 2011). These statistics indicated the importance of finding strategies to reduce CLABSI across all healthcare settings.

Incidents of CLABSIs are rising in the United States but could be prevented. The CDC (2017a) reported that the 2015 SIR was 0.603, which represented a 21.8% increase in CLABSI data from 2014. The Office of Disease Prevention and Health Promotion (ODPHP, 2018) called for a 50% decrease in the previous SIR target of 1.0, thus setting a new benchmark at 0.5 in 2016. The majority of these infections can be prevented by using current evidence-based central line practices (CDC, 2016; Haddadin & Regunath, 2018). The U.S. Department of Health and Human Services recommended further action be taken at various healthcare levels to eliminate infections (CDC, 2016). Some recommendations to decrease CLABSI include meticulous hand hygiene, minimizing device use, sterile technique when required, and staff education on infection prevention measures (Babcock, 2015).

During cancer treatment, it is important to decrease the risk of infection. For oncology patients, CLABSI can lead to life threatening sepsis (Page, Tremblay, Nicholas, & James, 2016). A subspecialty of oncology, bone marrow transplant (BMT), involves the transplantation of stems cells to treat diseases such as lymphoma, multiple myeloma, and leukemia (Brown, 2010). Transplant treatment compromises the immune system (Page et al., 2016), which increases the risk of opportunistic infections. Infections can occur from either viral, bacterial, or fungal pathogens (CDC, 2017b). Fungal infections pose the highest risk during the transplant process and can result from the presence of a central line catheter (CDC, 2017b). For stem cell recipients, fungal infections can be mild but can also be deadly (CDC, 2017b). Nursing care of BMT patients must incorporate

current strategies that minimize the risk of serious infections such as sepsis, which can develop from CLABSI.

One of the primary goals of transplant care is infection prevention. Registered nurses (RNs) play an essential role in achieving this goal (Garbin, Silveira, Braga, & Carvalho, 2011). To decrease the risk of infections, the CDC (2015) recommended educating healthcare staff on the indications for insertion and maintenance of central line catheters. The nature of this DNP project was to develop an education program for RNs on a BMT unit in the United States that was experiencing an increase in CLABSI. The education program provided information of evidence-based central line maintenance and CLABSI prevention practices to reduce infection rates. The potential positive social change implications of this DNP project are improved nursing practice of catheter maintenance, including infection prevention strategies and standardization of evidence-based central line care. The improved practice of central line care may lead to a sustained reduction of CLABSI, increasing positive patient outcomes on the BMT unit.

Problem Statement

Despite the emphasis on CLABSI prevention strategies in recent years, these infections continue to occur (The Joint Commission [TJC], 2012). This preventable HAI (TJC, 2012; CDC, 2016) causes patient harm and is a burden on the healthcare system due to the costs associated with a CLABSI diagnoses. Nurses working in oncology units, specifically BMT, should have knowledge of best practice for assessing and maintaining central line catheters, troubleshooting complications, and adhering to CLABSI prevention

strategies (Thompson-Mackey, 2017). Knowledge of current central line infection prevention strategies can decrease CLABSI on the BMT unit.

Though the focus of this DNP project was central line care and CLABSI reduction on a BMT unit, it was important to note that any patient with a central line is at risk for CLABSI (Marschall et al., 2014). CLABSI results from inconsistent adherence to evidence-based central line practices when performing catheter care (Conley, 2016; Hakko et al., 2015); thus, in this DNP project, I incorporated the importance of complying with current central line practices. Following evidence-based strategies during insertion and maintenance of central lines can reduce the risk of infection (Haddadin & Regunath, 2018). Ideally, the information in this project could transfer to other units with heightened CLABSI risk because compliance with implemented infection control practices is necessary to decrease the risk of CLABSI.

Local Nursing Practice Problem

Maintaining hemostasis is difficult during the transplant process because BMT patients experience fluid, electrolyte, and blood level fluctuations. This requires BMT nurses to access central lines multiple times a day to provide necessary infusions (Zakhour, Chaftari, & Raad, 2016) to maintain proper hydration, balance electrolytes, and provide hematological needs. This frequent manipulation is one of the sources of CLABSI for the BMT patient (Johnson & Grossman, 2013). BMT RNs should have knowledge of the various complicated aspects of transplant care (Neumann, 2017), including central line maintenance and CLABSI prevention practices.

A recent increase in CLABSI on the BMT unit at my practicum site was due to failure to implement consistent, evidence-based strategies for central line nursing care. According to BMT leadership at the practicum site, nursing care did not reflect current evidence-based catheter care, which prompted the need to find strategies to improve nursing practice of central line care. One strategy to improve practice of central line catheter care was nursing staff development through the use of education. Alkilany (2016) maintained that participation in evidence-based central line education on catheter care and infection prevention may reduce CLABSI, resulting in a decrease in healthcare costs and length of stay associated with central line infections. Therefore, I developed an evidence-based educational program of central line maintenance and CLABSI prevention practices for the BMT unit.

The educational program included annual assessments of central line practices to ensure compliance post education. Literature revealed the importance of periodically assessing nursing knowledge of central line care (CDC, 2015; Beltran, Schroeder, Smith, Marnocha, & Friess, 2015; TJC, 2017a) This DNP educational program may improve nurses' knowledge of central line maintenance and influence adherence to CLABSI prevention strategies on the BMT unit.

Local Relevance

According to BMT leadership at the practicum site, three factors affect nursing care on the BMT unit that required attention. First, BMT staff RNs and float RNs worked on the BMT unit without the benefit of receiving comprehensive education on evidence-based central line practices due to staffing constraints. Second, the float RNs' limited

experience with central line dressing changes and troubleshooting line patency was also a factor that affects the care of BMT patients. Third, according to BMT leadership at the practicum site, facility policy required the vascular access team (VAT) to perform central line maintenance on all units except BMT and Neonatal Intensive Care Unit, which limited the float RN's exposure to central line care. Thus, while float RNs routinely deferred central line maintenance practices to the VAT, this was not an option on the BMT unit. These various factors affecting nursing care on the BMT unit revealed the need to review nursing central line practices on this unit.

A central line surveillance team periodically performs nursing practice audits on the BMT unit. The surveillance team consists of the director, two clinical managers, and the clinical nurse specialist who works on the BMT unit. A central line audit performed focuses on central line practices. The BMT clinical nurse specialists (CNS) compiles the surveillance team's audit results and generates a central line audit report. The report revealed nursing practice not consistent with evidence-based practice and/or facility policies. Varied nursing practice and inconsistent use of evidence-based strategies for CLABSI prevention were noted when flushing catheters, cleaning catheter hubs, and changing central line dressings. These areas were identified by the central line surveillance team as nursing practices that require staff education.

Another concern on the BMT unit was the increase in CLABSI on the unit, which prompted a meeting at the practicum site to review CLABSI data and strategies to reduce infections. In collaboration with the infection control coordinator, the nursing quality outcomes coordinator at the practicum site compiled BMT SIR data and presented

findings to the Central Line Optimization Steering Committee in April 2018. According to the infection control coordinator's report at the practicum site, data used to compile the report were retrieved from the internal quarterly infection reports from Quarter 2 2016 to Quarter 2 2017. The PowerPoint presentation revealed a steady increase in CLABSI indicated by the BMT SIR, which increased from 0 in Quarter 2 of 2016 to 3.01 in Quarter 2 of 2017.

According to BMT leadership at practicum site, the CLABSI increase was associated with a rapid expansion of the unit to meet the growing needs of the transplant population. Expanding patient beds on the BMT unit required additional nursing staff to provide transplant care. Leaders at the practicum site hypothesized that with the increase in new staff RNs and float RNs, who were not familiar with BMT and/or aspects of central line care for this patient population, the CLABSI rate failed to meet or fall below the national SIR benchmark of 0.5 (ODPHP, 2018). According to BMT leadership at practicum site, the failure to adhere to the national standard requires immediate attention to identify strategies to decrease the infection rate.

RNs are expected to practice using the best evidence to maintain patient safety and quality of care (American Nurses Association, 2018). Healthcare organizations must promote the execution of evidence-based practice to decrease the variation in practice and improve patient outcomes (Stevens, 2013). Improving nursing practice on the BMT unit may result in a CLABSI decrease. Knowledge of positive patient outcomes that result from evidence-based nursing care may empower nurses to encourage adherence to implemented evidence-based strategies.

Significance of Doctoral Project

The significance of this doctoral project to nursing practice is the improvement of evidence-based care delivery of central line care to decrease CLABSI. Delivery of quality patient-centered care based on current evidence is the focus of today's healthcare system (Melnyk & Fineout-Overholt, 2011). It is widely known that better patient outcomes result from consistent nursing practice based on the best evidence (Evangelista, Vosburg, Libman, & Jones, 2017).

The quality of patient care increases when RNs perform interventions based on proven strategies that promote patient safety. Healthcare organizations must advocate for the use of evidence-based practice among clinicians and provide adequate resources to support implementation (Melnyk & Fineout-Overholt, 2011). Knowledge of central line evidence-based processes improves nursing practice of catheter care, which is significant as patients may receive better quality of care. The doctoral project involved creating an educational program that may improve nurses' knowledge of evidence-based central line maintenance and CLABSI prevention to improve the quality of care on a BMT unit.

Purpose

The purpose of this doctoral project was to improve nursing practice of central line care for BMT patients. Specifically, I sought to improve nurses' knowledge of central line maintenance and CLABSI prevention practices by developing an evidence-based central line program on a small BMT unit. Improving patient outcomes on the BMT unit by decreasing CLABSI rates may empower nurses to continue to practice central line care using the best evidence.

Meaningful Gap

The varying central line maintenance practices and the lack of evidence-based central line care among RNs who practice on the BMT unit represented the gap in practice. Improving nurses' knowledge of evidence-based central line practices through education was necessary to develop consistency of nursing practice of central line care on this unit. This doctoral project addressed the need for evidence-based central line nursing practice care.

Practice Focused Questions

1. Can an evidence-based staff development education program improve nurses' knowledge of central line maintenance and CLABSI prevention practices on a small BMT unit in the United States?

2. Can improvement in nurses' knowledge of evidence-based central line maintenance and CLABSI prevention practices lower the BMT unit's CLABSI rates?

Addressing the Practice Gap

Practice gaps are identified as the difference between current practice and evidence-based practices (Agency for Healthcare Research and Quality [AHRQ], 2014). This doctoral project addressed the practice gap by presenting an educational program that may improve consistency of evidence-based central line nursing practice on the BMT unit to prevent CLABSI. Proper care of central line catheters used for supportive care is vital to decrease the risk of infection in this vulnerable patient population. Staff education may occur on the BMT unit incorporating float RN staff, resulting in the translation of knowledge gained to other nursing units within the facility.

Nature of the Doctoral Project

Sources of evidence for this doctoral project included a literature search related to current central line catheter practices. Evidence was obtained from the Cumulative Index to Nursing and Allied Health Literature and PubMed, which are databases provided by the Walden University Library. Regulatory agencies and professional organizations were also used to locate evidence-based practice guidelines. These included the American Nurses Association (ANA), the CDC, the AHRQ, and the TJC.

Organizing and Analyzing the Evidence

To organize this doctoral project, an evaluation table developed by Melnyk and Fineout-Overholt (2011) was used to provide a visual representation of the various levels of evidence of articles reviewed. This table helped with the analysis and synthesis of information for this doctoral project. Input was welcomed from stakeholders on the BMT unit. The complexity of oncology care requires interprofessional teamwork and collaboration for a successful project implementation (Bohnenkamp, Pelton, Rishel, & Kurtin, 2014)

Concise Statement

The knowledge gained from participation in the staff development central line program may improve nursing practice of evidence-based central line care, which may reduce CLABSI on the BMT unit. This may promote consistent care of central line maintenance and CLABSI prevention strategies. Studies indicated that education focused on central line maintenance practices result in the reduction of CLABSI and improve patient outcomes (Beltran et al., 2015; Humphrey, 2015; Marschall et al., 2014; Royer,

2010). The education program will be used for initial staff education and annually for a refresher for all RN staff who care for BMT patients to maintain best practice. Initial and reinforcement education of central line practices may sustain a reduction in CLABSI (Royer, 2010).

Significance

The stakeholders pertinent to this project were the administration, the oncology management team, and the nursing staff, including medical-surgical float staff, who frequent the BMT unit, and BMT patients. These stakeholders were impacted in various ways. The oncology management team have gained an education program to improve central line care and nursing practice on the BMT unit. Nursing practice on the BMT unit may consist of safe, evidence-based nursing care, which will improve transplant outcomes leading to shorter patient stays and less complications.

Potential Contributions

Using evidence-based strategies to reduce the incidence of CLABSI contribute to better patient care outcomes. Education should be provided to all nurses practicing central line care. Beltran et al. (2015) found that experienced nurses were unfamiliar with evidence-based central line practices. The potential contribution of this DNP project is the decrease in avoidable central line infections experienced by BMT patients. This can lead to lead to fewer treatment delays resulting in reduced patient costs, and length of stay that results from CLABSI.

Transferability

The knowledge gained through participation in the DNP central line education can increase the quality of care on the BMT unit as well as the primary medical-surgical units staffed by the float RNs at the practicum site. Float RNs who frequent the BMT unit should be able to share knowledge of evidence-based central line practices on their home units, thus encouraging their colleagues to model current central line practices. This can improve central line practices throughout the facility. The facility will be able to provide the evidence-based education program to all units staffed with RNs who care for patients with central lines.

Positive Social Change

Clinical decisions based on evidence can influence patient outcomes and reveal an organization's commitment to promote safety and quality. Using an evidence-based approach when delivering care is required as healthcare consumers have an expectation of receiving high quality care (AHRQ, 2018). Nursing practice supported by evidence increases the quality of care and decreases avoidable harm to patients (White & Dudley-Brown, 2012). Strategies that influence change and improve patient outcomes can have a positive effect on patient satisfaction, organizational culture, and the performance of nursing care (Braithwaite, Herkes, Ludlow, Testa, & Lamprell, 2016). For effective clinical outcomes, nursing clinical reasoning and judgement must be based on current evidence.

In this DNP project, I focused on the improvement of nursing care of central line catheters with the goal of reducing central line infections on the BMT unit. As nurses

gain awareness of current strategies for central line maintenance and CABSI prevention, a more proactive rather than reactive approach to catheter care may result. When nurses practice using the full extent of education and training, patients receive purposeful and efficient care. Empowering nurses to make informed clinical decisions when performing central line care promotes social change. Positive social change includes enhancement of clinical expertise of central line maintenance for CLABSI reduction, meeting consumer expectations of cost-effective high quality nursing service care delivery.

Summary

CLABSI continues to be an obstacle for transplant patients. For the BMT patient, careful adherence to infection control practices is needed to minimize CLABSI. The gap in practice on the BMT unit was the lack of consistent evidence-based central line practices by RN staff, which led to an increase in CLABSI. Staffing demands contributed to this gap in care as the BMT unit's number of patient beds increased rapidly to meet community needs for transplant care. The influx of float RNs and new BMT RNs hired to manage staffing constraints resulted in varied central line practices observed during a central line audit conducted on the BMT unit. Improving nurses' knowledge of how to maintain central lines and prevent CLABSI was necessary to promote consistent practice on the BMT unit and reduce infection rates. Initial and annual education may ensure that nurses gain and maintain knowledge of current evidence-based central line practices to provide safer care. A central line education program was developed in collaboration with various stakeholders on the BMT unit to address the practice gap. Oncology and BMT expertise was welcomed during project development. In the next section, I discuss the

background and context, concepts, and relevance to nursing practice as well as the role of the DNP student and the team in project development.

Section 2: Background and Context

Introduction

CLABSI continues to be an obstacle in healthcare today. Approximately 41,000 patients are affected each year by central line-associated infections, and 1 in 4 patients die each year (ANA, n. d.). Central line infections can occur because of contamination from health care personnel and the patient's skin flora (Yeral et al., 2015), making infection prevention the number one strategy in overcoming poor patient outcomes. The BMT patient population is vulnerable to infection from the use of central lines for treatment and support (Dombecki, Vercher, Valyko, Mills, & Washer, 2017) increasing the risk of CLABSI, so it is essential to implement strategies to improve catheter care. According to BMT leadership at the practicum site, BMT nurses spent most of their shift managing central lines without the opportunity of formal education in central line care. This has resulted in inconsistent central line practices on the BMT unit.

The purpose of this doctoral project was to educate BMT nursing staff and float staff regarding evidence-based central line practices and CLABSI prevention techniques to decrease the CLABSI rate occurring on the BMT unit. Staff education is essential to decreasing morbidity, mortality, and expenses associated with catheter-related infections (Sacks, Diggs, Hadjizacharia, Green, Salim, & Malinoski, 2014). The practice focused questions are as follows:

1. Can an evidence-based staff development education program improve nurses' knowledge of central line maintenance and CLABSI prevention practices on a small BMT unit in the United States?

2. Can improvement in nurses' knowledge of evidence-based central line maintenance and CLABSI prevention practices lower the BMT unit's CLABSI rates?

In Section 2 of this project, I describe the theory that framed the project and the relevance of a central line education program to nursing practice. The local background, context, and my role in the project are also discussed.

Theory

The project was guided using Lewin's change theory (Lewin, 1947). This theory addresses human systems and group dynamics (Nursing Theories, 2011). The group of nurses working on the BMT unit did not consistently provide central line care using the best evidence. Lewin's change theory addresses the driving forces to move people toward change (White & Dudley-Brown, 2012). Changing prevention practices that are not consistent with current practice recommendations is necessary for patient safety. Educating nursing staff to change previous central line practices to reflect current best practice can promote consistent central line maintenance practices on the BMT unit.

Lewin's theory supports the notion that when individuals are involved in the discussion of change, they are more inclined to change their behavior (White & Dudley Brown, 2012). Stakeholders were encouraged to get involved with the development of the central line maintenance program. This can be beneficial when reeducating nursing staff to consistently practice central line care based on the best evidence on the BMT unit.

Lewin's Change Theory

Lewin (1947) identified three phases of the reeducative process: unfreezing, changing, and refreezing. During the unfreezing phase, the recognition of the need to

change old habits may be realized (Lewin, 1947). Forces that serve as barriers to change are addressed during the unfreezing phase. The changing phase represents Lewin's reeducative process, with the goal of introducing new processes (Lewin, 1947). During the reeducative phase of this project, BMT nurses learned current central line practices and infection prevention techniques. The refreezing phase establishes the new change represented by adherence to the new processes put into place (Lewin, 1947). This final stage can be represented by a change in practice behaviors on the BMT unit.

Clarifying Terms

The following terms are defined according to their use in the doctoral project:

Catheter related blood stream infections: The presence of bacteremia originating from an intravenous catheter (Gahlot, Nigam, Kumar, Yadav, & Anupurba, 2014).

Central line associated blood stream infection (CLABSI): An infection that occurs when bacteria or other germs enter the patient's central line and then enter the bloodstream (Johns Hopkins Medicine, n.d.).

Central line bundles: Evidence-based interventions for patients with intravascular central catheters that, when implemented together, result in better outcomes than when implemented individually (Institute of Healthcare Improvement [IHI], 2012a).

Central venous catheter (CVC): A thin, flexible tube that is inserted into a vein, usually below the right collarbone, and guided (threaded) into a large vein above the right side of the heart called the superior vena cava (National Cancer Network, n. d.).

Healthcare associated infection (HAI): Infections that patients get while receiving treatment for medical or surgical conditions (ODPHP, 2017).

Tunneled catheter: A central line catheter passed under the skin to a separate exit point. This helps stabilize the catheter for long term use (American Cancer Society, 2018).

Vascular access team (VAT): A team of RNs and/or allied health professionals who have extensive specialist knowledge, skills, and competence in effective patient assessment, bedside device insertion, and maintenance and care of central lines (Shawyer, 2016).

Relevance to Nursing Practice

One of the primary roles of nursing is the maintenance of central lines (Macklin, 2010). Central venous catheters (CVCs) are accessed multiple times a day (TJC, 2012) on BMT units for maintenance intravenous fluids, chemotherapy, biotherapy, antibiotics, blood products, and various intravenous medications. Nursing care of BMT patients is complex because of the many infusions that are necessary to sustain life. During periods of chemotherapy-induced neutropenia, these patients are susceptible to infection (Page et al., 2016). The increased risk of infection requires extensive fundamental nursing skills and knowledge (Brown, 2010) of the care and maintenance of central lines and the importance of compliance with central line practices (Page et al., 2016).

Brief History and Scholarship

No one single intervention can reduce CLABSI, resulting in various evidence-based strategies currently in use by health care organizations. Sacks et al. (2014) argued that standardizing evidence-based practices at the bedside can be challenging. At the practicum site, different central line models of care exist. Conley, Buckley, Magarace,

Hsieh, and Pedulla (2017) mentioned that interventions not based on evidence are a result of practices that are not defined or standardized. According to the BMT leadership at the practicum site, the VAT team did not provide catheter maintenance practices on the BMT unit because of the complexity of the transplant process. The VAT team does, however, provide catheter insertion and maintenance practices for the rest of the facility, excluding the Neonatal Intensive Care Unit, which involves a complex patient population. Because no single intervention can decrease CLABSI, different approaches have been recommended, such as VAT teams, standard operating procedures (SOP), and central line bundles. All interventions require staff training and education.

Some acute care hospitals use central line teams, referred to as VAT, to standardize central line practices in efforts to decrease CLABSI (Harnage, 2012; Johnson, Synder, Strader, & Zamora, 2017). Either RNs or registered respiratory therapists staff VAT teams trained in central line catheter care. CLABSI reduction was associated with VAT team implementation. Johnson et al. (2017) reported a decrease in CLABSI after the implementation of a VAT team staffed by registered respiratory therapists in an Arizona hospital system. Harnage (2012) confirmed a CLABSI reduction in a California hospital after a nurse-led VAT team implementation of a central line bundle. Central line bundles are evidence-based interventions to insert and maintain central lines (IHI, 2012a). According to Harnage, a 7-year period with zero CLABSI resulted from the implementation of a central line bundle, and the key to sustaining CLABSI reduction is staff education and commitment. Staff education and training, as

well as adherence to implemented central line practices, are necessary for CLABSI reduction.

Current State and Recommendations

Education was the theme when discussing CLABSI reduction. Guerin, Wagner, Rains, and Bessesen (2010) hypothesized that educating nurses about the importance of meticulous central line maintenance practices, including cleaning the hub postinsertion, may reduce CLABSI. Guerin et al. developed a training program consisting of a nurse-led central line bundle focusing on hands-on training of central line care techniques. The bundle components included daily insertion site inspections, site care and dressing changes (when needed), documentation of catheter need, application of Chlorhexidine gluconate-impregnated sponge, hand hygiene, and scrubbing the hub for fifteen seconds. A significant decrease in CLABSI was reported postimplementation (Guerin et al., 2010). Educating nurses on postinsertion catheter care is essential in reducing the risk of CLABSI.

Central line education and readily available quick reference resources are essential when providing care of patients with central venous catheters. Nursing education has addressed how to access central lines, flush lines, and change central line dressings while following infection control practices for patient safety. Devi, Ghai, Vir Singh, and Puril (2017) maintained that education and adequate staffing lead to CLABSI reduction. Devi et al. reviewed nursing practice of central lines in Intensive Care Units (ICU) and found inconsistent nursing practice during the performance of central line dressing changes, the cleaning of access ports prior to use, and hand hygiene. Also found

were inadequate nurse-patient ratios and a lack of written guidelines or in-service education related to infection prevention (Devi et al., 2017). This prompted the development of an SOP, which addressed evidenced-based interventions to prevent catheter infections (Devi et al., 2017). Postimplementation of the protocol development resulted in a positive practice change on the ICU unit (Devi et al., 2017). Nursing staff education and access to written guidelines for a quick reference of central line practices is beneficial for safe catheter care.

Central line education programs can provide the necessary resources for CLABSI prevention. Humphrey (2015) developed a central line education program to address an increase in CLABSI occurring in an ICU. According to Humphrey, a hands-on education session was included with educational material in the central line program. Humphrey found that of the 64 participants, 95% did not know proper flushing techniques, and 91% did not know which central line connectors to use. Humphrey concluded that understanding which central line connectors to use and how to flush them are fundamental to proper central line maintenance. Humphrey's educational intervention included a pretest followed by central line maintenance education and a posttest to assess knowledge gained. Humphrey reported a significant improvement ($p = .0001$) in central line maintenance knowledge with the increase of the mean score of 4.6 on the pretest to 8.4 post education. Humphrey recommended initial and ongoing participation in evidence-based nursing education to increase nurses' knowledge of central line care.

CLABSIs can be reduced when nurses are educated on infection prevention practices. A pre-intervention-postintervention survey study addressed the impact of

nursing central line education (Dumyati et al., 2014). The educational content developed by Dumyati et al. (2014) focused on central line maintenance prevention techniques. The results of the preintervention survey indicated that only 20% of nurses understood the importance of properly cleaning connector hubs. The educational content included a computer-based education module containing information on hand hygiene, needleless connectors, central line dressing changes, tubing changes, and daily assessments of the need for a central line catheter (Dumyati et al., 2014). Dumyati et al. reported a positive outcome with a 50% decrease in CLABSI related to an increase in nurses' knowledge and performance of central line practices. Nursing staff engagement and nursing education of central line maintenance care using the best evidence was recommended for the reduction of CLABSI (Dumyati et al., 2014). Research indicated education played a role in increasing adherence to organizational strategies to decrease CLABSI (Beltran et al., 2015; Dumyati et al., 2014; Humphrey, 2015; Marschall et al. 2014; O'Grady et al., 2011; Shrestha, 2013).

Strategies and Standard Practices

Nursing staff education is a vital component of central line maintenance. Beltran et al. (2015) discussed the importance of formal education of CLABSI preventative measures to improve nursing practice of central line care. Beltran et al. recommended education that incorporates didactic instruction and skill demonstration to increase knowledge of central line care. Marschall et al. (2014) recommended that acute care hospitals should require staff education for insertion and maintenance of central lines

consistent with practice guidelines. O'Grady et al. (2011) also recommended nursing staff education as a strategy to decrease CLABSI.

To sustain current practice of CLABSI preventative measures, nurses should comply with standardized infection control practices and established guidelines (O'Grady et al., 2011). Standard central line maintenance practices include the use of central line practice audits, checklists, and bundled care (AHRQ, 2018). The BMT unit at the practicum site incorporated bundle components for central line maintenance practices and performed periodic practice audits to monitor nursing care of central lines.

Advancing Nursing Practice

To advance nursing practice in central line care and maintenance, the DNP staff development education program covered the importance of consistent evidence-based nursing central line practices on the BMT unit. Shrestha (2013) discussed the importance of central line education in the reduction of the risk of complications in critically ill patients. As BMT is a specialty unit with vulnerable patients, nursing staff education is vital to reduce the risk of transplant complications.

Participation in the central line staff development program may allow BMT nurses to gain the knowledge necessary to apply current best practice to bedside care. This program may also be utilized in other facilities across the health care system allowing for central line practice consistency throughout the entire organization. This action will further advance nursing practice of central line maintenance.

Local Background and Context

Central line infection rates have been an issue on the BMT unit. The quarterly infection control reports of the BMT SIR data revealed an increased SIR three times greater than the national benchmark of 0.5 (ODPHP, 2018). This was reflected in 2017 BMT Quarter 2 infection control report. The increase in infection rates raised concerns of nursing practice of central line maintenance on the BMT unit. In response to the increase in CLABSI the BMT leadership revealed the need to develop a training program to increase nurses' knowledge of central line maintenance and CLABSI prevention to improve for successful transplant outcomes.

Institutional Context

The BMT unit at the practicum site is associated with a health care system located in an urban area. The majority of the patient population is White non-Hispanic (United States Census Bureau, 2018). As greater than 12,000 residents in Arizona lost their lives to cancer in 2016, health care systems that treat oncology patients collaborate with state agencies to reduce the cancer burden (Arizona Department of Health, n. d.).

With a strong mission to improve health and well-being, the practicum site was committed to reducing current CLABSI rates. The organizational leadership's immediate response to the increase in CLABSI was the development of a central line steering committee for which I had the opportunity to participate in several meetings. One of the objectives of the steering committee was to evaluate whether CLABSI was occurring at time of insertion or post insertion. This information was relevant to the doctoral project as educational content included information from the steering committee findings. The

quick “call to action” addressing the increase in CLABSI rates was consistent with the organization’s commitment to its current mission, vision, and values.

State and Federal Context

The hospital system is required to report CLABSI data to the Centers for Medicare and Medicaid Services (CMS, 2013). This mandatory reporting requirement can have a financial impact on the organization as CMS no longer reimburses hospitals for CLABSI. The DNP program educational content provided current organizational CLABSI rates and CMS requirements to stress the importance of adhering to evidence based central line maintenance practices.

A TJC accreditation requirement is to utilize evidence-based preventative steps to decrease central line infections (TJC, 2019). Varying nursing practice of central line care on the BMT is not consistent with TJC requirements. This was relevant to the DNP project as RNs that care for BMT patients would learn how to maintain central lines using the best evidence incorporating CLABSI prevention practices.

Role of the DNP Student

As a DNP student my role in this project was to develop an evidence-based educational program to improve nurses’ knowledge of central line practices on a small BMT unit in the U. S. I accomplished this by conducting a literature search, appraising and synthesizing the evidence, reviewing central line practice guidelines, meeting with stake holders, and encouraging input from the project team. This was consistent with DNP Essential VIII which focuses on, “designing, implementing, and evaluating

therapeutic interventions based on nursing science…" (American Association of College of Nursing, 2006, p. 16.).

Professional Context and Relationship to Project

I have been an oncology nurse for 10 years. Working on BMT units, I quickly learned how serious CLABSI are to immunocompromised patients. I understand the complexity of care necessary for this patient population through experiences gained when caring for BMT patients. Education is vital to ensure sufficient knowledge and skills are acquired to care for this patient population. As a DNP student, I wanted to participate in improving BMT patient outcomes and the BMT unit at the practicum site has given me that opportunity. I do not have a previous relationship with the practicum site**.** This site is where I was able to secure a preceptor.

Motivation for Project

My motivation for this project was my commitment to patient safety and quality of care. My goal was to improve care delivery for BMT patients by developing a central line maintenance education program based on current best practice for nurses working on the BMT unit. This program was developed using current central line maintenance practices and specifically adapted for the BMT unit. The program contained a PowerPoint presentation incorporating three modules related to central line practices and CLABSI prevention. Included was a skill demonstration of a dressing change, and a central line flush.

Potential Biases

It is essential to conduct and report research data accurately and without bias. Šimundić (2013) defines bias as an intentional or unintentional deviation from the truth during data collection, data analysis, interpretation, and publication. Potential causes of bias should be recognized and reported as possible limitations (Šimundić, 2013). For this DNP project, the potential bias was my strong belief that only BMT RNs should perform central line maintenance and CLABSI prevention techniques for transplant patients. Float RNs were tasked with working on the BMT unit due to staffing shortages. BMT patient care is highly specialized (Browne, 2016) and ideally, only trained oncology nurses should care for this vulnerable patient population. Though I supported a model of care that entailed specialized training for BMT nurses, I understood that the rapid growth of the unit made that challenging. Along with that understanding, the development of the project was driven by current evidence related to RNs performing central line care and all work was reviewed by my preceptor to minimize bias.

Role of the Project Team

A collaborative team was established to provide ongoing support and guidance during the development of the DNP project. The team consisted of the BMT Director, the BMT Clinical Nurse Specialist (CNS), and a representative from the VAT team. The BMT Director and the CNS have extensive knowledge of transplant care, and the VAT team member specialized in central line insertion and maintenance. These individuals have clinical expertise of central line maintenance and infection control practices**.**

The CNS was an essential member of the team functioning as the DNP mentor. The CNS evaluated my progress towards project completion and made recommendations when needed. The role of the CNS was to collaborate on various aspects of the DNP project to assist me in developing a successful evidence-based central line program.

How Project Team Will Be Used and Presenting Information

I coordinated with the BMT leadership to set up a meeting with the project team. The team attended a PowerPoint presentation outlining the background, gap in practice, and literature search results which led me to develop a central line staff development education program. Sharing this information was important as the team will be implementing the education.

Project Team Sharing and Time Line

The project team and I will attended a scheduled meeting prior to project completion. The team was given time at the meeting to offer their comments and suggestions toward the final project. I reviewed the feedback, provided clarification, and adjusted content based on team input. The project was be finalized once those steps were completed.

Summary

Numerous strategies have been implemented in the last decade to decrease the healthcare burden of CLABSI. Most studies that have examined methods to decrease CLABSI have occurred in ICUs even though CLABSI affects various patient care units. As CLABSI can occur merely from a patient's own skin flora, BMT patients with low immune responses are at higher risk. The purpose of this project was to improve nurses'

knowledge of central line care with the goal of minimizing CLABSI on a small BMT unit in the U. S. To accomplish this, an evidence-based central line education program was developed using a team approach. The team consisted of the BMT Director, the CNS and a member of the VAT team. Team members collaborated with the DNP student by offering their expertise, guidance, and support. During a scheduled team meeting, members reviewed the completed project and made recommendations. The DNP student reviewed recommendations and finalized the project. In the next section, the sources of evidence used for the literature search as well as the nature and relevance of the data were be discussed. Information related to the systems used to record, track, organize, and analyze the evidence was also provided.

Section 3: Collection and Analysis of Evidence

Introduction

CLABSI continues to be a healthcare concern accounting for thousands of infections each year in the United States (CDC, 2017a). For BMT patients, this HAI can be severe and lead to death due to ineffective immune responses resulting from cancer treatment. BMT nursing staff must be knowledgeable of the critical aspects of transplant care in order to minimize infection risks (Mayo Clinic, 2018; Memorial Sloan Kettering Cancer Center, 2018). The purpose of this project was to improve nursing practice of central line maintenance and CLABSI prevention practices by developing an evidence-based central line education program on a small BMT unit.

In this section, the practice problem is restated, and I further discuss the purpose and approach to the practice-focused questions. The sources of evidence are listed, including specific databases, key search terms, and search engines that were used in the development of this project. I also explain how the literature was synthesized and analyzed, which included processes that were used to record, track, and organize the evidence.

Practice-Focused Questions

A small BMT unit in the United States had an increase in CLABSI, which prompted BMT nursing leadership to audit nursing practice of central line maintenance. The audit revealed varying central line maintenance practices among nursing staff not consistent with current evidence. The increase in CLABSI, the varying practice observed, and the lack of a formal education program of central line maintenance practices were

factors that created a practice gap. These factors led to the development of the following practice focused questions: (a) Can an evidence-based staff development education program improve nurses' knowledge of central line maintenance and CLABSI prevention practices on a small BMT unit in the United States? (b) Can improvement in nurses' knowledge of evidence-based central line maintenance and CLABSI prevention practices lower the BMT unit's CLABSI rates?

Clarifying Purpose and Approach

The purpose of this doctoral project was to improve nursing practice of central line care on a BMT unit. A staff development education program was designed to teach nursing staff effective clinical approaches for catheter maintenance based on current evidence. This educational strategy aligned with the practice-focused questions by addressing infection rates and presenting evidence-based central line practices, including CLABSI prevention. The overall goal was to advance nursing practice of catheter care and infection prevention to decrease CLABSI.

Sources of Evidence

Multiple databases were used to search the literature for the development of the educational project to address the practice focused questions. Literature was obtained from e-journals provided by the Walden University Library database of online sources. An Internet search for professional nursing organizations along with federal and state regulatory agencies was performed to obtain current evidence-based nursing practice guidelines for central line care.

There was a substantial amount of information on central line practices, resulting in thousands of records when performing the literature search. It was necessary to use key search terms to narrow the search. To narrow the search, only articles in the English language between 2012 and 2018 were reviewed. To further narrow the search to a more manageable level, the Walden Library Boolean operator AND was used to combine the following key search terms: *CLABSI, catheter-related bloodstream infection, central venous catheter, nursing education, central line care, BMT, central lines, bone marrow transplant, neutropenia, infection, specialty nursing, and central line maintenance.*

Identifying Sources of Evidence

An exhaustive search was executed by narrowing down the total number of records chosen that fit the search criteria and addressed the practice-focused questions. The search was comprehensive and only included peer reviewed journals. The Cumulative Index to Nursing and Allied Health Literature, Cochrane Library, PubMed, and MEDLINE were the databases used. These databases were provided by the Walden University library.

Evidence gathered for this DNP project consisted of current practice guidelines and peer reviewed articles related to central line care, infection control practices for central line care, CLABSI, and nursing staff education. Examples of professional journals used to search peer-reviewed articles were the American Society of Clinical Oncology, Journal of Nursing Education and Practice, Nursing Standard, Infusion Nurses Society, Journal of Infusion Nursing, Journal of Infection Control, American Journal of Infection Control, Clinical Infectious Diseases, Journal for the Association of Vascular Access, and

the International Journal of Critical Illness and Injury. Information for current practice guidelines were obtained from the AHRQ, CDC, CMS, IHI, ODPHP, and TJC.

Relationship to Purpose

Evidence-based central line maintenance practices were obtained from the various databases mentioned above. The sources used to address the practice focused questions represented the best evidence retrieved between 2012 and 2018 from healthcare organizations in relation to nursing staff education and strategies to decrease CLABSI. The sources provided information for the development of the staff development central line maintenance education program.

Addressing Practice-Focused Questions

To address the practice-focused questions, I was reliant on central line maintenance guidelines and primary evidence. I used the Melnyk and Fineout-Overholt evaluation table developed in 2007 (Melnyk & Fineout-Overholt, 2011). An evaluation table is a visual representation of a literature review and provides a means to weigh the evidence (Melnyk & Fineout-Overholt, 2011).

Ethical Considerations

To maintain ethical requirements, it is essential to ensure that no organizational proprietary, sensitive, or confidential information is disclosed within doctoral project work (Walden University, 2019). The identity of the doctoral project site was kept private. To maintain the organization's privacy, all project documents reflected a generalized location and were unidentifiable to any specific organization. This project was literature based; therefore, there were no human subject ethical implications. Also, in

accordance with the Walden University Staff Education Manual instructions (Walden University, 2019), I obtained institutional review board approval prior to creating the Staff Development Central Line Education Program.

Analysis and Synthesis

The staff development central line project was an educational program that required peer-reviewed journal articles reflecting high levels of research evidence. Examples of high-level evidence identified by Melnyk and Fineout-Overholt (2011) include systematic reviews of a randomized controlled trial (RTC), an RTC that is well designed and/or a meta-analysis. With this in mind, I used the most significant and well-conducted research to develop the central line education program.

The use of high-level evidence and verifiable methods to analyze and synthesize research evidence promotes research integrity. The National Institutes of Health (2018) defined research integrity as maintaining honesty, accuracy, efficiency, and objectivity during the research process. These concepts were vital for the development of a strong evidence-based educational program.

Tools Used to Record, Track, and Organize Evidence

An evaluation table developed by Melnyk and Fineout-Overholt (2011) was used to record, track, and organize the evidence (see Appendix A). The table displayed the author, date, research question, study design and method, sample characteristics, major variables, findings, data analysis, and the level of evidence. This table was an invaluable tool used to compare and contrast the various sources of evidence**.**

A critical appraisal is another research tool that was used to evaluate the evidence. Melnyk and Fineout-Overholt (2011) defined a critical appraisal as a process of evaluating a study to determine its worth. Various steps should be followed when conducting a critical appraisal to identify the applicability, validity, and reliability of research study results (Melnyk & Fineout-Overholt, 2011).

Analysis and Procedures

I conducted a literature review and selected the highest sources of evidence to support the importance of improving nurses' knowledge of central line maintenance and CLABSI prevention practices. The research studies selected were entered into the Melnyk and Fineout-Overholt (2011) evaluation table with the appropriate information recorded under each column. To determine the applicability, validity, and reliability of each study, I performed a critical appraisal using the information entered in the table as recommended by Melnyk and Fineout-Overholt. I combined, contrasted, and interpreted the evidence by reviewing the interventions, outcomes, and conclusions. The findings obtained through synthesis provided key points and inferences of strategies to address the practice-focused questions consistent with Melnyk & Fineout-Overholt recommendations. According to Melnyk and Fineout-Overholt, synthesis involves the determination of what knowledge was gained and how it would be applied to practice. After completion of the evaluation and synthesis process, the study findings relevant to the DNP project reflecting the strongest evidence were used to develop the central line education program.

Summary

This DNP proposal was developed to address an increase in central line infections on the BMT unit at the practicum site. A comprehensive literature search was performed to address the practice focused questions. Sources of evidence were obtained from peer reviewed nursing journals and were maintained using verifiable methods. Integrity of the evidence was maintained during collection, analysis, and synthesis of data obtained from peer reviewed articles. The Melnyk and Fineout-Overholt (2011) evaluation table was used for analysis and synthesis data and included the level of evidence for each peer reviewed journal article. The table was easy to navigate with a legend for identification of abbreviated terms. Information in the evaluation table assisted in making decisions regarding what information should be used to develop the education program. In the next section, the findings, unanticipated limitations, strengths, and potential implications for positive social change are discussed. I also discuss the recommended implementations, evaluation procedures, contribution of the project team, and the strengths of the DNP project.

Section 4: Findings and Recommendations

Introduction

Responsibilities of healthcare organizations are to provide safe and effective patient care. These concepts are measured by adverse events that may cause patient harm and contribute to mortality (Joshi & Berwick, 2014). CLABSI is an example of an HAI that causes harm and increases mortality risks (Haddadin & Regunath, 2018). This largely preventable HAI (CDC, 2016; Haddadin & Regunath, 2018; ODPHP, 2018; TJC, 2012) threatens patient safety in ICU settings (Valencia et al., 2016) and non-ICU settings such as oncology and BMT (Page et al., 2016). RNs responsible for care and maintenance of central lines should be knowledgeable of CLABSI prevention techniques (Conley, 2016) to foster safe and effective patient outcomes.

To minimize the risk of CLABSI, especially for transplant patients that are susceptible to infection, evidence-based central line education is required. Sacks et al. (2014) emphasized the importance of educating RNs on central line practices to minimize CLABSI. This was consistent with the understanding that RNs may be in a better position to actively contribute to CLABSI reduction when educated on central line practices based on the best evidence (Beltran et al., 2015; CDC, 2015; Haddadin & Regunath, 2018; Humphrey, 2015; Marschall et al., 2014; Royer, 2010). With this in mind, a central line education program was developed and tailored for adult learners with some knowledge of central line practices for a small BMT unit in the United States.

When designing a staff development program for a nursing unit, it was important to assess what educational areas need to be addressed. For this DNP project, that

assessment was made by the BMT leadership after observation of inconsistent practice of central line care coupled with an increase in CLABSI. After determining the basis of the content, it was important to know the audience to be able to choose a teaching strategy that would be effective. With multiple generations in the healthcare system today, determining an appropriate teaching modality can be challenging (White & Dudley-Brown, 2012). The central line program plan was delivered using a few different teaching strategies to meet various learning styles (see Appendix B). Strategies included lecture using PowerPoint, video, and skill demonstration using a low fidelity simulation manikin.

Local Problem and Practice Gap

It was necessary to provide structured education of central line care to improve knowledge of evidence-based catheter maintenance and CLABSI prevention practices. The local practice problem on the BMT unit was an increase in CLABSI. On BMT units, central lines deliver life-sustaining care and treatment requiring RNs to have clinical knowledge of catheter care (Abu Sharour, 2018; Camp-Sorrell & Matey, 2017; Dombecki et al., 2017; Thompson-Mackey, 2017; Shrestha, 2013). Due to a rapid increase in transplant patient admissions on the BMT unit, new RN employees and float RNs with limited or no oncology experience staffed the BMT unit.

A gap in practice existed due to varying central line practices performed by RNs on the BMT unit. This variation has led to the lack of consistent evidence-based central line care resulting in an increase in CLABSI. This prompted the immediate need to address the practice gap.

Purpose and Practice-Focused Questions

The purpose of this DNP project was to improve practice of central venous catheter care among RNs working on a BMT unit through participation in the educational program. The practice-focused questions were as follows: (a) Can an evidence-based staff development education program improve nurses' knowledge of central line maintenance and CLABSI prevention practices on a small BMT unit in the United States? (b) Can improvement in nurses' knowledge of evidence-based central line maintenance and CLABSI prevention practices lower the BMT unit's CLABSI rates?

Sources of Evidence and Analytical Strategies Used

Sources of evidence used to determine current strategies for central line care and CLABSI prevention were obtained from peer-reviewed published research, national agencies, and professional nursing organizations. Expert opinions from members of the project team also provided valuable information during project development. Together, these sources supplied a wealth of information regarding evidence-based central line practices and were used to develop the central line program.

After choosing evidence-based peer reviewed articles, a critical appraisal was conducted. The evaluation table (Melnyk & Fineout-Overholt, 2007) was used to list, organize, and manage the appraised articles (see Appendix A). Using a rating system for hierarchy of evidence (Melnyk & Fineout-Overholt, 2011), the levels of evidence were determined and added to the evaluation table. The completed table allowed a visual picture to compare and contrast and weigh the evidence. These various tools were used to select the best evidence (Melnyk & Fineout-Overholt, 2011) to develop the central line

program. Along with the research-based information used in the evaluation table, the project team offered expert opinions regarding central line care and CLABSI prevention practices. National agencies such as the AHRQ, CDC, IHI, and TJC were also used to compile evidence-based strategies for central line maintenance and CLABSI prevention (AHRQ, 2018; CDC, 2015; IHI, 2012b; TJC, 2019). The evidence-based approaches for central line care and CLABSI prevention were gathered from these sources to develop the educational program content. Some of the visual images incorporated in the program content were taken and provided by a project team member to show current central line devices used on the BMT unit.

Findings and Implications

An extensive literature review of central line practices and CLABSI prevention was conducted to evaluate, compare, and contrast evidence to support the practice focused questions (see Appendix A). This review provided valuable information necessary to determine which evidence-based strategies developed for safe and effective care of central venous catheters including CLABSI prevention were to be incorporated in the central line program. Additionally, practice guidelines and recommendations from national agencies (AHRQ, 2018; CDC, 2015; IHI, 2012b; TJC, 2019) and expert opinion from the project team helped to narrow down specific strategies to incorporate into the education content.

With the many resources for central line maintenance and CLABSI prevention, the review revealed that central venous catheter care is not standardized (Sacks et al., 2014) and that practices not based on current evidence can result from the lack of

standardization (Conley et al., 2017). Conley (2016) found that nurses were requesting standardized practices based on evidence and that the lack of standard central line care was observed and even questioned by patients. Due to the lack of standardization of central line practices, it was crucial to review all strategies offered from peer-reviewed research studies, current practice guidelines, and expert opinions.

The literature revealed that CLABSI is a complication associated with the use of central venous catheters (Conley, 2016; Dombecki et al., 2017; Gahlot et al., 2014; Velasquez Reyes, Bloomer, & Morphet, 2017; Zakhour et al., 2016) and can lead to undesirable patient outcomes in any care setting (Marschall et al., 2014). To monitor complications on a national level, mandatory reporting of CLABSI is required, and no further reimbursements are provided for patients diagnosed with CLABSI (CMS, 2013). Also, the criteria for hospital accreditation now include the requirement to use evidence-based practice approaches to minimize infections (TJC, 2019). Other organizations also recommended that the delivery of nursing care be based on the best evidence for better outcomes (AHRQ, 2018; ANA, 2017; IHI, 2012b). Considering these requirements and the continued occurrence of central line infections (CDC, 2017a; Harnage, 2012) with a mortality rate of 1 in 4 annually (ANA, 2017), strategies for CLABSI reduction remain a priority.

One of the key findings of the evidence review was that any patient with a central line is at risk for CLABSI (Marschall et al., 2014). Because RNs frequently access central lines (TJC, 2019) as one of their primary roles (Macklin, 2010) for supportive care, it is important to be knowledgeable of current evidence-based central line practices. In

addition, knowing that oncology/BMT patients experience low immune systems further increasing the risk of CLABSI (Alkilany, 2016; Conley, 2016; Dombecki et al., 2017; Page et al., 2016; Zakhour et al., 2016), extensive nursing knowledge of central line practices (Brown, 2010) is required. Along with the mere presence of a central line catheter, the frequency of catheter manipulation (Zakhour et al., 2016) further contributes to an increased risk of CLABSI, especially for BMT patients (Johnson & Grossman, 2013). This finding led to the recommendation that only trained oncology nurses should care for transplant patients with central lines (Mayo Clinic, 2018; Memorial Sloan Kettering Cancer Center, 2018; Neumann, 2017; Thomas-Mackey, 2017) due to the highly specialized nature (Bohnenkamp et al, 2014; Browne, 2016) of this patient population and the frequency of catheter manipulation. The critical nature of a BMT patient is similar to an ICU patient, and Marschall et al. (2014) mentioned that limiting float nurses in ICU was a recommendation gathered from expert opinion when discussing postinsertion care of central lines. Though these were recommendations, due to staffing constraints, float RNs are still required to work on the BMT unit. This is another reason why all nurses working on the BMT unit should be educated on evidence-based central line care and infection prevention. This led to the notion that any nurse who cared for a patient with a central line must be knowledgeable of central venous catheter practices (Abu Sharour, 2018; CDC, 2015; Evangelista et al., 2017; O'Neil et al., 2016; Page et al., 2016; Velasquez et al., 2018)). This thought was consistent with the CDC recommendation of educating healthcare staff on the indication for catheter use, insertion and maintenance techniques, and proper infection control techniques (CDC, 2015).

Another key finding of the evidence review and organizational information review was that when RNs participate in structured central line education (Arizona State Board of Nursing, 2015) incorporating content on how to perform dressing changes, catheter flushing techniques, the importance of aseptic technique, using sterile technique when required, the importance of the consistent use of evidence-based strategies, and adhering to bundled components, infection rates decrease. Gahlot et al. (2014) went a bit further by recommending that for infection reduction, healthcare workers should be educated and trained in standardized insertion and maintenance practices as well as participate in continuous quality improvement.

Also reflected in the literature was the various evidence-based educational approaches available to deliver central line education. Examples of educational modalities for teaching central line practices and CLABSI prevention were PowerPoint (Beltran et al., 2015), education modules (Abu Sharour et al., 2018; Blot, Bergs, Vogelaers, Blot, & Vandijck, 2014; TJC, 2019), traditional lecture format (Blot et al., 2014; Conley, 2016; Dumyati et al., 2014; Shrestha, 2013; TJC, 2019), hands-on training (TJC, 2019), simulation (Beltran et al., 2015; Page et al., 2016; TJC, 2019), and online (TJC, 2019), which can be accomplished in single sessions, multiple sessions, and/or annually. These teaching modalities have shown a significant reduction in CLABSI postintervention (Abu Sharour et al., 2018; Beltran et al., 2015; Blot et al., 2014; Conley, 2016; Dumyati et al., 2014; Humphrey, 2015; Shrestha, 2013).

Educating nursing staff using a multidimensional approach as observed with bundle care components for insertion and maintenance of central lines was also an

effective strategy in reducing CLABSI (Blot et al., 2014; CDC, 2011; Dumyati et al., 2014; Guerin et al., 2010; IHI, 2012a; Jaggi et al., 2013; O'Grady et al., 2011; O'Neil et al., 2016; Sacks et al., 2014; TJC, 2019; Zakhour et al., 2016). Examples of bundled components for central line maintenance are daily review of the need for CVC, documentation of removal, the use of needleless connectors or sterile end-caps, sanitizing access ports, proper dressing change procedures, hand hygiene, aseptic technique when required, using closed infusion systems, scrubbing the hub, and prompt removal (CDC, 2018; TJC, 2019). These approaches were not standardized and were tailored to each organization that utilizes bundle components. According to BMT leadership, the unit incorporated similar bundle components for central line maintenance consistent with the CDC and TJC recommendations and include hand hygiene, chlorhexidine-based antiseptic, daily line assessment and documentation, chlorhexidine impregnated sponge, scrub the hub for 15 seconds, dressing changes every Sunday and as needed, removal of gauze dressing every 48 hours and place and antimicrobial sponge, and the use of positive pressure valve/caps on every lumen.

Another key finding was the importance of the surveillance of central line practices post education. Auditing nursing practice of central line care was also an essential aspect in ensuring compliance of evidence-based central venous care and CLABSI prevention practices. Surveillance audits (CDC, 2017a; Jaggi, et al., 2013; Marschall et al., 2014; O'Neil et al., 2016; Page et al., 2016; Valencia et al., 2016; Zakhour et al., 2016) and annual training (Dumyati et al., 2014) of central line practices are measures indicated in the literature for continued compliance to sustain reduction of

CLABSI. The CDC also recommended careful monitoring of central line techniques by assessing staff knowledge and compliance with established evidence-based guidelines (CDC, 2015).

Limitations

A limitation was that many studies related to central line care and maintenance are conducted in ICU settings (Blot et al., 2014; Devi et al., 2017; Gahlot et al., 2014; Guerin et al., 2010; Jaggi et al., 2013; Sacks et al., 2014; Shrestha, 2013; Velasquez et al., 2017). There is a need for additional CLABSI research in non-ICU settings (Conley, 2016; O'Neil et al., 2016). Another limitation was the lack of standardization across studies regarding central line strategies including bundle care components. This made it difficult to choose which set of strategies were appropriate for the BMT unit. Because of this limitation, the elements for CLABSI reduction and central line care were tailored for the unit using current guidelines that were consistent with established BMT and facility policies.

Implications Resulting From Findings

The implications gathered from study findings were that though infection rates have decreased over the years, CLABSI continues (Scheithauer et al. 2014) and measures must be taken to minimize the risk of this potentially harmful HAI. RNs working with immunocompromised patient populations must be knowledgeable of the importance of being educated on safe catheter practices. Findings suggested that education on strategies to decrease CLABSI were beneficial in reducing central venous catheter infections (CDC, 2015; Evangelista et al., 2017) and should be implemented. To accomplish this, a

fundamental awareness of the problem should be addressed with RN staff on the BMT unit. The potential risk factors for CLABSI should be discussed as well as the importance of following evidence-based guidelines for safer patient care. Another important implication was the use of bundle care components recommended by the CDC which has been successful in the reduction of CLABSI (CDC, 2018). Also implied by the study findings was the need for staff surveillance audits and periodic education for consistent performance of evidence-based practices. Elements of these findings were incorporated in the staff education program.

Possible Implications to Social Change

Patients receive the best care when nurses use evidence-based interventions when performing care. The staff development central line program encompassed current information based on the best evidence of central venous catheter care and CLABSI prevention techniques (see Appendix C). Knowledge gained may empower nurses to provide consistent catheter care based on current peer reviewed research and practice guidelines resulting in improved patient outcomes.

Recommendations

Recommendations for the practicum site were to (a) provide initial and annual training (CDC, 2015; Beltran et al., 2015; Dumyati et al., 2014; Humphrey, 2015; Royer, 2010) and evaluation (Oermann & Gaberson, 2017) using the staff development central line program for all RNs working on the BMT unit; (b) continue to participate in staff surveillance (AHRQ, 2018), and consider using peer audits (Conley et al. 2017) to periodically review central line practices; (c) provide immediate feedback of RN

performance of central line care and infection control practices (Blot et al., 2014; CDC, 2015; Jaggi, et al., 2013); (d) share BMT monthly CLABSI rates with RNs (Jaggi et al., 2013); (e) review literature and evidence-based guidelines annually; and (f) conduct a program evaluation (Oermann & Gaberson, 2017) to determine if revisions are needed based on new evidence. These proposed recommendations were provided to the BMT leadership as part of the program plan and were presented in a team meeting.

The proposed training included three modules using various teaching modalities to improve RN knowledge of evidence-based central line practices (see Appendix C). The modules covered information about the background of CLABSI, strategies to minimize the risk of infection, and central line maintenance practices. This eight hour educational event included a pretest followed by central line education. Upon completion of the training, participants would take a posttest to evaluate knowledge gained which concludes the educational session.

It was important to use a variety of teaching methods in attempts to meet the diverse learning styles of RNs working on the BMT unit. A learning style is how a learner interprets, organizes and determines how to use information assimilated (Chick, 2019). The education program content included visual, auditory, and tactile methods of instruction such as lecture, visual aids, video, and hands on. Another important factor to consider when facilitating the delivery of the educational content is how to evaluate whether learning outcomes were achieved (Oermann & Gaberson, 2017).

There were several techniques available to evaluate learning (Oermann & Gaberson, 2017). A number of studies informed that one of the ways to evaluate nurses'

knowledge prior to and after participating in the central line program is to use a pretest/posttest design (Abu Sharour et al., 2018; Beltran et al., 2015; Conley, 2016; Conley et al., 2017; Dumyati et al., 2014; Evangelista et al., 2017; Page et al., 2016; Shrestha, 2013). The DNP staff development program contained a written multiple-choice pretest (see Appendix D) and posttest (see Appendix E) to evaluate nursing knowledge. It was recommended that if the practicum site chooses to use the program on an annual basis that this evaluation process continue to gauge whether knowledge was retained over time. Along with evaluating nursing knowledge, the CLABSI rate must also be evaluated. It was recommended that BMT leadership continue to track the CLABSI rate consistent with their current policy.

Surveillance of central line practices is essential to determine staff adherence to infection control practices. Evidence suggested the use of ongoing central line audits (AHRQ, 2018). Conley et al. (2017) defined this concept a bit further by designating peer review audits which resulted in 100% compliance with dressing change policy sustained over a nine month period. Peer review audits were recommended to encourage compliance and may help to sustain evidence-based infection control practices.

Providing immediate feedback when observing central line practices is necessary when discussing techniques that are not consistent with evidence-based practice (Blot et al., 2014; CDC, 2015; Jaggi, et al., 2013). It was recommended that the BMT unit incorporate performance feedback directly after observations of central line maintenance practices. This may promote consistent practice of central line care.

Keeping BMT RN staff abreast of the CLABSI rates on the transplant unit was also recommended. By displaying the CLABSI rate and providing positive patient outcomes on a monthly bases (Jaggi et al., 2013) BMT RNs may be encouraged to continue to perform evidence-based central line catheter care. This recommendation may help sustain consistent central line maintenance practices as well as a sustained reduction in CLABSI rates.

The final recommendations were to review the literature and evidence-based guidelines annually and revise program content when needed. Healthcare is dynamic and evidence continually evolves (Melnyk & Fineout-Overholt, 2011) resulting in the possibility of new processes and procedures for central line care and CLABSI prevention. To reflect current central line practices it is essential to evaluate the central line education program to ensure that content is current and evidence-based (Oermann & Gaberson, 2017).

Contribution of the Doctoral Project Team

The BMT Director, a CNS, a member of the VAT team and I made up the DNP project team. Team members were knowledgeable of current evidence-based central line maintenance and infection control practices. The team worked well together and collaborated in person and via email. Team meetings were held on a regular basis to review the status of the DNP proposal and the education planning. The CNS was always quick to respond to my questions and offered suggestions and recommendations.

Team Roles

It was important that central line practices were tailored for the BMT unit considering the patient population. Due to the lack of standardization, multiple strategies for catheter care and infection prevention were presented to the team. The role of team members was to work together to gain a consensus of which evidence-based strategies were appropriate for the BMT unit. Team members offered feedback providing expert opinion, constructive criticism and recommendations. Since the team will be implementing the program, it was vital that their recommendations were considered. Along with reviewing the literature, the practicum site policies were also reviewed and discussed with the team.

Process Summarized

The BMT central line policies and the VAT team policies at the practicum site were reviewed to compare and contrast central line insertion and maintenance techniques. Minor inconsistencies were found and discussed with the team**.** As RNs on the BMT unit did not insert central lines, there were some variances in central line maintenance practices. To assess dressing change techniques, the VAT team member and BMT CNS demonstrated a central line dressing change. Differences were related to the use of personal protective equipment (PPE) donned during the procedure. This laid the ground work for further review of evidence-based approaches for PPE procedures during central line care.

Another instance where the team was asked to provide input was during a one hour meeting about the float RNs that worked on the BMT unit. There was a concern

about the float RNs lack of knowledge of central line maintenance practices including line type. This led to a team discussion of the importance of including instruction about central line type during the staff development central line education. This educational activity was deemed valuable by team members with the consensus that all RNs would benefit from this knowledge and would be added to the educational content.

Module Development

Education content for each module included information from peer reviewed articles, national guidelines, BMT policies and procedures, and expert opinion from the project team. The first module consisted of definition of terms (CDC, 2019; Gahlot et al., 2014; Healthypeople.gov, 2017; IHI, 2012b; Johns Hopkins Medicine, n. d.; National Cancer Network, n. d.) and the background of CLABSI and infection prevention statistics (AHRQ, 2018; AHRQ, 2019; CDC, 2015; Healthypeople.gov, 2017) which included the burden on healthcare and threat to patient safety. This was vital when laying the groundwork for the importance of improving knowledge of catheter care and infection prevention. This module also mentioned the National Patient Safety Goals (TJC, 2017b), the national CLABSI benchmark (ODPHP, 2018) and the BMT CLABSI SIR data. The BMT CLABSI data added transparency in relation to whether or not the BMT unit was meeting national requirements. Another vital piece of information provided in this module was how CLABSI was diagnosed (Haddadin & Regunath, 2018) and the signs and symptoms of infection (Dombecki, 2017; TJC, 2012, Yeral et al., 2015). To actively engage participants during Module one there were two interactive question and answer slides developed which covered the pathogenesis of CLABSI (TJC, 2012; Yeral et al.,

2015) and why it was essential to provide care based on the best evidence (Alkilany, 2016; American Nurses Association, 2018; Haddadin & Regunath, 2018; Melnyk & Fineout-Overholt, 2011).

The second module developed for this project discussed the types of central lines (Beltran et al., 2015; CDC, 2014; Camp-Sorrell & Matey, 2017; Cope, 2017), CLABSI prevention guidelines (Beltran et al., 2015; CDC, 2018; Guerin et al., 2010; Hopper & Moss, 2010; IHI, 2012b; Simko, 2012; TJC, 2019), and the importance of patient involvement in safety practices (Thompson-Mackey, 2017). This module added a video, hands demonstration and a group discussion to further enhance the variety of teaching strategies used in module one which included auditory and visual aids such as facilitator guided instruction using PowerPoint. The video was a refresher of the sterile gloving technique. After viewing the video, participants would practice sterile gloving while being audited by their peers as literature revealed that peer audits were beneficial and may encourage compliance (Conley et al., 2017). The group discussion focused on types of central lines used on the BMT unit. Each group would answer questions related to the type of line, whether it was a long term or short term catheter, what could be the line be used for, whether it could be tunneled, and if the line could be placed at the bedside. Each group would then provide that information to the class. Module two ended with a discussion of the importance of patient teaching regarding catheter care and signs and symptoms of infection. As with module one, the content was developed from a variety of sources including site policies and procedures.

The last module relied heavily on BMT policies and procedures as well as a couple of sources from peer reviewed research. This module covered central line dressing change components including types of dressings (Camp-Sorrell & Matey, 2017), when to change, and how to flush (Beltran et al., 2015). The central line flush content covered syringe sizes, flush volumes, flush solutions, troubleshooting patency. Also covered were what was considered, “always events”. These events included hand hygiene, identifying patients using two identifiers, assessing the catheter insertion site for infection, infiltration and patency, and documentation of the appearance, flush amount and patency of central lines (Beltran et al., 2015; Camp-Sorrell & Matey, 2017). Once this module was complete the facilitator would demonstrate a central line dressing change and flush on a static simulation manikin and all participants would perform a return demonstration. During this non-graded activity, the facilitator would provide immediate feedback of participant performance. Immediate feedback is essential (Blot et al., 2014; CDC, 2015; Jaggi et al, 2013) in improving performance and sustaining consistent practices.

Once the modules were complete, the team agreed that prior to teaching the educational content, it was important to assess prior knowledge of central line care and infection prevention. This was consistent with the literature review in terms of how to evaluate whether knowledge was gained after instruction (Abu Sharour et al., 2018; Beltran et al., 2015; Conley, 2016; Conley et al., 2017; Dumyati et al., 2014; Evangelista et al., 2017; Page et al., 2016; Shrestha, 2013). A pretest (see Appendix D) and posttest (see Appendix E) were created using the content from each module.

Team Meeting

When the literature review and the content meetings with the team were complete, the education plan proposal was developed. I met with the project team and presented a PowerPoint explaining the background of the issue, the results of the literature review and, the proposed central line staff development educational program plan. During the one hour meeting, the team had time to review. After reviewing the feedback, no changes were indicated and the project was finalized and presented to the BMT leadership.

Plans to Extend Project

Though this staff development central line education program was developed at the request of the BMT unit it may also benefit nursing students. As an adjunct clinical instructor and full time nursing professor, I know that nursing students have limited basic knowledge of central line maintenance and CLABSI prevention practices. In addition, clinical placement is sometimes difficult and nursing students may have limited exposure to settings that admit patients with central lines (Aloush, 2019) resulting in the absence of experiential learning. Along with lecture and group discussions, the program would provide nursing students the opportunity to practice central line maintenance and infection prevention skills such as sterile gloving, central line dressing changes, and central line flushes. With this in mind, my plan is to propose the use of this education program at the university level to increase nursing student's knowledge of central line care so they are better prepared when entering the workforce.

Strengths and Limitations of the Project

One of the strengths of the DNP project was the support from the project team and the facility. The practicum site embraces students and has been very accommodating. Another strength of the project was the amount of literature related to central line care and infection prevention. Not only was there an abundance of peer reviewed articles but there were national guidelines as well as professional organizations that provided a wealth of information regarding strategies to reduce CLABSI.

One of the limitations of the project was though CLABSI can occur in any setting, many of studies were published in ICU settings. More research should be conducted in non-ICU settings. Another limitation was that national guidelines developed from study outcomes were not all within the last 6 years. Many strategies currently in place have been so for ten years and no one strategy reduces CLABSI. This was one of the barriers to the literature search. Many authors cited CLABSI information from previous studies that were more than six years old. The shear amount of strategies in place and the lack of standardization is also a limitation. In terms of the staff development central line program, CLABSI reduction and central line maintenance content is modeled from national guidelines, peer review studies revealing significant results regarding CLABSI reduction and nursing knowledge attainment, and consistent with the practicum site policies also considering the BMT unit's policies and procedures.

Continued research is recommended considering the lack of standardized central line care and maintenance techniques mentioned in the literature. The standardization of central line practices within a healthcare facility that utilizes float RNs is essential in

maintaining patient safety. Nursing staff education of CLABSI prevention is also important to reduce preventable central line infections. It is recommended that all RNs involved in central venous catheter care have knowledge of central line maintenance and CLABSI prevention techniques.

Section 5: Dissemination Plan

Introduction

The purpose of this doctoral project was to improve nursing practice of central line maintenance and CLABSI prevention techniques on a small BMT unit. The project was developed in collaboration with a small project team. Team members consisted of experts in transplant care and central line insertion and maintenance practices. The finalized project was delivered to the BMT leadership.

Audiences and Venues Appropriate for Dissemination

Though the staff development central line program was developed for the BMT unit, it is appropriate for any unit that admits patients with central lines. Program content encompasses basic nursing central line practices and infection prevention techniques. As the care of central venous catheters is within a RNs scope of practice (Arizona State Board of Nursing, 2015), the staff development program would be beneficial for initial training and reinforcement of RN knowledge of evidence-based central line practices. Along with improving RN knowledge of central line practices, dissemination is equally important. By sharing research findings that resulted in positive outcomes, similar research questions can be resolved that may foster new inquiries (Williams & Cullen, 2016). The collective efforts to resolve healthcare issues may enhance patient safety and uphold healthcare consumer's expectations of high quality care.

Additional venues to disseminate the central line program are conferences, seminars, and/or staff events. An abstract, poster board (Sherman, 2010; Williams & Cullen, 2016), or oral presentation are strategies that can be used to share findings. As a

nursing professor at a local university, I will be discussing the central line education program and presenting a poster board during a faculty meeting in January 2020. I will propose that the education program be used in the undergraduate nursing program. Also, being active in nursing simulation, I will apply to submit a poster board presentation during the next annual Arizona Simulation Network conference in 2020, adding a simulation exercise proposal using the concepts presented in the central line program.

Analysis of Self

As I reflect on my journey throughout my nursing career, it is evident that I am committed to improving nursing practice in a variety of areas. I continually stay abreast of changes in my practice area by spending time in the clinical environment, facilitating student learning at local hospitals, reading professional journals, and attending conferences related to oncology, simulation, and nursing education. I am also an active member of the Arizona Nursing Association, which allows me to network with colleagues in my area learning about new evidence-based projects, processes, and/or procedures.

As a novice university professor, I decided to continue my education to gain additional knowledge of nursing practices, such as leadership, health policy, and evidence-based practice. This decision led me to Walden University where I was accepted into the Doctorate of Nursing Practice program. This endeavor has renewed my passion for nursing and has fostered an interest in health teaching at a higher level as currently I teach undergraduate nursing courses.

During my time at Walden University, I have improved in the areas of research, writing, leadership, communication, and my understanding of a nurse's role in health policy. I am now an active member on the health policy committee for my local nurses' association. I review active bills in the legislature on an annual basis and provide summaries of the bill's content and make recommendations as to whether the nurses association should support or just monitor a bill. This exciting opportunity has opened new doors for me within the nursing community as I have met advanced practice nurses who are passionate about health policy. Through networking with this wonderful group of nurses, I will seek out additional opportunities within my local nurses' association to be a part of shaping the future of nursing.

Role as a Practitioner

As a practitioner, I gained new insight into the importance of evidence-based practice and need for standardization of nursing practices. When searching the literature, it was evident that the lack of standardization effects nursing practice can result in poor patient outcomes. This was seen with the increase of CLABSI at the practicum site. I hope the project is successful in improving nursing knowledge of central venous catheter care as well as standardizes central line practices on the BMT unit. I have been more vocal regarding the need for nurses to turn to the literature when seeking answers for clinical inquiries to improve practice.

Role as a Scholar

As a novice scholar, I look forward to continuing to participate in scholarly work to assist nurses in providing efficient, effective, evidence-based care. As a nursing

educator, my short term goal is to present this project to my colleagues to share current strategies for central line care. This is important as student learning must be based on current evidence-based practice. A long term goal is to continue to research and implement evidence-based practices in the area of nursing education incorporating nursing simulation. This would include publishing outcomes post-implementation of new practices developed to enhance the process of educating nursing.

Role as Project Manager

As a project manager during this project, I found that I was unprepared to lead a team. It took a while for me to become comfortable communicating with the team. Though I knew the team members prior to this project, each time we met, I was quite nervous. It took several meetings for me to become more comfortable presenting information and responding to questions.

Along with feeling unprepared, I found scheduling time for the team to meet to be challenging. Team members had different schedules making this task difficult. One way to determine everyone's availability was to compare their monthly schedules and put on a calendar. This visual display made it easier to request meetings. After a while, I felt comfortable in the role of a project manager.

Project Completion

I was excited to enter the project completion phase. I worked hard compiling information, comparing and contrasting central line interventions, and developing an educational program. Though I was happy to reach this stage, it became a little overwhelming when completing the education program, meeting with team members, and

working on the draft, all at the same time. There were a few challenges during the project completion phase that I had to overcome.

Challenges and Solutions

One of the main challenges at the beginning of this journey was the lack of knowledge of the research process. Without strong research skills, it was difficult to effectively choose, critique, and synthesize peer-reviewed articles. This resulted in a lot of time wasted on broad literature searches. A solution for this problem was to spend a few weeks with a librarian. A librarian at the practicum site assisted me with learning how to conduct a more efficient search of library databases. This was beneficial as search results became more purposeful yielding articles that provided pertinent information to address the practice-focused questions.

The process of critiquing and synthesizing information was also difficult. I was not strong in this area, which resulted in the gathering of multiple articles that did not obtain data significant to the practice-focused questions. Though I took a research-related course during my Master's program, I was not prepared for this endeavor. One solution was to review research-related books to refresh my knowledge of how to critique and synthesize information (Melnyk & Fineout-Overholt, 2011; White & Dudley Brown, 2012). Another solution was to use a tool to assist me in comparing and contrasting information retrieved from the various databases. The Melnyk and Fineout-Overholt (2011) evaluation table was chosen to manage the volume of information retrieved and provided a visual representation of the information chosen to support the practice-focused questions.

Scholarly writing was the most difficult part of this journey. To improve in this area, I obtained a writing mentor. I met with the mentor periodically during project development. Sentence structure, paragraph development, and APA were discussed. I also participated in Walden University writing center courses. Course facilitators provided immediate feedback on a weekly basis on revisions of the proposal draft. Participation in these courses lessened the reiterative process as my writing improved. I highly recommend that all doctoral students enroll in Walden writing center courses as well as work with a mentor.

Insights Gained on Scholarly Journey

This journey has been tough but rewarding. During this program, not only did I improve in the area of research and scholarly writing, but I gained insight into what it takes to develop a nursing research proposal. My determination and commitment to myself and the nursing profession, frequent visits with my mentor, and support from my family and colleagues were encouragements needed for program completion.

My ultimate goal now is to empower nurses with the tools needed to provide safe care based on the best evidence. By devoting my time to researching current evidence-based strategies for nursing care, I hope to standardize care and improve practice. I am in a better position to meet this goal as I have improved in the areas of scholarly writing, research, leadership, and project management as a result of participation in this project.

Summary

To summarize, patient safety and quality of care is of the utmost importance in healthcare today. The knowledge that CLABSI is preventable should signal practitioners

to review current evidence-based strategies for central line care and infection prevention. A consensus from much of the literature reviewed for this project suggested that education of line care and infection prevention is instrumental for CLABSI reduction.

The staff development central line education program was designed to improve nursing practice of catheter care which in turn may result in CLABSI reduction on a small BMT unit. A literature review was initiated yielding evidence that education was vital in improving nursing knowledge of catheter care and infection prevention which may translate to CLABSI reduction. The eight hour evidence-based course contained concepts such as, dressing changes, flushing techniques, scrubbing the hub, the importance of hand hygiene, sterile procedures, and types of lines. Along with lecture, there were hands-on activities so RNs could become familiar with the types of lines used on the BMT unit and could practice sterile gloving, a central line dressing change using sterile technique, and a central line flush.

Also, included in the central line program was a pre and posttest to evaluate knowledge gained after completion of the education program. Evaluations assist facilitators in identifying RNs that may need additional education to meet the desired outcome. It was recommended that the program be used for initial and ongoing training to reinforce evidence-based central line practices. Also, recommended was the continual assessment of current evidence-based central line practices to ensure that the program content was always current. Healthcare is dynamic resulting in processes that change often due to evidence-based research.

Standardization of central line care on the BMT unit results from ensuring that all RNs providing transplant care are using recommended central line practices. It was suggested that periodic audits of central line maintenance and CLABSI prevention techniques were continued to sustain practices acquired or reinforced by participation in the central line program. This action would also identify RNs that may need remediation.

Education is the key to improving central line care and this program is appropriate for any location where RNs care for patients that have central venous catheters. This program also may contribute to the advancement of nursing practice by empowering RNs to play an active role in maintaining patient safety, decreasing length of stay, and minimizing costs due to CLABSI. These concepts are essential for improving patient safety and quality of care of transplant patients.

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Appendix A: Evaluation Table

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables Studied	Measurement	Data Analysis	Findings	Appraisal: Worth to Practice/Level of Evidence (LOE)
Abu Sharour, L. (2018). Oncology nurses' knowledge about central line catheter: Caring, complications, and applications among cancer patients – A cross-sectional study. Journal of Vascular Nursing, 36, 145-148. doi:10.1016/j/jvn.2018.04.002	None	Descriptive cross-sectional design - conducted to assess the knowledge of central line (CL) of oncology nurses -Self-reported survey in form of a knowledge based test on central venous catheter care (CVC), complications, and applications among cancer patients.	n=150 nurses -Setting: Different oncology units (surgical, medical, bone marrow transplant, pediatric, and adult outpatient clinics -Attrition rate: none	Nurses: --65 men --85 women --Ages 20 and above -Varying level of education: --40 diploma --102 bachelors --8 postgraduate -Years (yrs) of experience: --112 (1-3 yrs) --33 (4-8 yrs) --5 (8 yrs and above)	Chi-squared analysis was used to determine nurses' knowledge according to their level of education and knowledge to experience.	SPSS version 23 used for data analysis Difference in knowledge based on yrs of experience Relationship between nurses' level of knowledge and academic qualifications	Significant difference in nurses knowledge related to experience ($X^2 = 17.321$; $P = .000$) Significant difference in nurses knowledge related to academic level ($X^2 = 7.256$; $P = .03$)	(LOE: VI) Strengths: -Found high percentage of nurses with unsatisfactory knowledge of evidence-based catheter care. -Continuous education needed to for improved nursing practice of CVC care Limitations: - The study did not address the impact of educational intervention on infection rates.
Abu Sharour et al. (2018). Teaching module for improving oncology nurses' knowledge and self-confidence about central line	None	Descriptive cross-sectional, pretest-post quasi-experimental design	Intervention group: (n=50) Control group: (n=50)	Nurses: --26 men --74 women Mean age for Intervention	5-point Likert scale measuring self-confidence Likert Scale – valid and reliable with	SPSS version 23 used for data analysis -Independent *t*-test for homogeneity of participant	Independent *t*-test- There was no significant differences considering nurses'	(LOE IV) Strengths: Pretest-posttest design was effective in measuring

catheters caring, complication, and application: A pretest-posttest quasi-experimental design. Journal of Vascular Nursing, 36(4), 203-207 doi:10.1016/j/jvn.2018.07.05		Assessing effectiveness of education module based on Centers for Disease Control and Prevention (CDC) guidelines of central line catheter care on nurses' knowledge and self-confidence -structured questionnaire 20 multiple-choice	-Setting: Different oncology units (surgical, medical, bone marrow transplant, pediatric, and adult outpatient clinics Attrition rate: -none	group=27.1 yrs (SD =2.81) Mean age for control group=27.8 yrs (SD=2.91) Mean yrs of experience – experimental group = 3.1 (SD 0.81) Mean yrs of experience – control group =2.8 (SD 0.70)	Cronbach's alpha of 0.96	characteristics Paired *t*-test difference between pre- and post-test scores (measuring knowledge and self-confidence)	gender, age, yrs of experience, pretest knowledge and self-confidence Paired *t*-test – Significant difference between nurses knowledge pre and post intervention (t = -7.85, P = .001)	nurses knowledge of central line care Educational program improves nursing skills, safety, learning opportunities, and increases self-confidence. Limitations: The study did not address the impact of educational intervention on infection rates.
Alkilany, M. (2016). CLABSI during neutropenia among oncology adults post chemotherapy. *Middle East Journal of Nursing*, *10*(3), p. 25-27. doi:10.5742/mejn.2016.9287/	None	Systematic Review 10 quantitative studies consisting of 4 clinical trials, 4 descriptive correlational studies, and 2 reviews	Adult oncology patients post chemotherapy ages between 16 and 85. Attrition rate: N/A	Sample sizes ranged from 120-1076	CLABSI rate Examine knowledge of CLABSI during neutropenia	Information unavailable	Frequent respiratory and central line infections occurred in neutropenic patients CLABSI common during neutropenia and was associated with line placement, type of line, type of infusions.	(LOE V) Strengths: Reducing rates will decrease morbidity and healthcare burden. Limitations: Unknown which study produced these results.

Dumyati, G., Concannon, C., van Wijngaarden, E., Love, T. M., Graman, P., Pettis, A. M., &…Shelly, M. (2014). Sustained reduction of central line-associated bloodstream infections outside the intensive care unit with a multimodal intervention focusing on central line maintenance. *American Journal of Infection Control, 42*(7), 723-730. doi:10.1016/j.ajic.2014.03.353	None	Quality Improvement Quasi-experimental prospective pre/post intervention in three phases Impact of multi-modal intervention on CLABSI rates. Lecture format followed by an online training module now used for annual mandatory training. Nursing education on evidence-based CL bundle care incorporating education on: hand hygiene, dressing changes, needleless connectors, tubing change and assessment of CVC needs.	-Setting: 37 non-intensive care units (ICU) including medical surgical units and specialty units (oncology, bone marrow transplant) between 6 hospitals in Rochester, NY in 3 phases over 4 years Attrition rate: 2 hospitals dropped from study due longer meeting study criteria Only 90% of nurses on surveyed units completed the module. (No report as to why)	-200 nurses: Knowledge of central venous catheter practices assessed with survey CLABSI rates during each phase over 4 yrs.	Poisson regression used to compare CLABSI rates across study phases using rate ratios and 95% confidence ratios	Interrupted time series analysis (SAS version 9.2; SAS Institute, Cary, NC) P values for CLABSI rates across study phases computed by measuring the intervention as an ordinal variable. Used rate ratios and 95% confidence ratios	Statistical significance during and post-intervention -Phase 1 – baseline CLABSI data - 2.6/1000 line days (95% Cl, 2.2-3.0) compared to Phase 3 – 1.3/1000 line days = 50% reduction (*P* = .0179) Education improved nurses' knowledge of CL care and CLABSI decreased Post education-surveillance audits: Nurses' compliance of properly scrubbing hub >82% and the use of other bundled elements >90%	(LOE IV) Strengths: Data collected over 4 year period with multiple hospitals CLABSI reduction sustained Importance of standardizing central line policies and education Importance of patients receiving standardized are across facilities Lecture and training modules that are computer based were effective in this study Limitations: Quasi-experimental method – no control group.

Blot, K., Bergs, J., Vogelaers, D., Blot, S., & Vandijck, D. (2014). Prevention of central line-associated bloodstream infections through quality improvement interventions: a systematic review and meta-analysis. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America*, *59*(1), 96-105.10.1093/cid/ciu23	None	Systematic Review and Meta-Analysis of Quality Improvement interventions. The use of bundled approach and CL checklists Various modalities reported from a variety of studies: -education ---(lecture, educational modules) -training -feedback -clinical reminders	Adult ICU 41 studies from 1995-2012 Attrition rate: N/A	Meta-analysis of 6 interrupted time series studies Pre- and post-test	Random-effects analysis of pooled odds ratio (OR) confidence intervals	Interrupted time series studies revealed significant results 95% confidence intervals	41 Studies revealed significant CLABSI reduction OR, 0.39 [95% Cl, .33-.46]; P< .001 Meta-analysis of 6 interrupted time series studies revealed significant CLABSI reduction OR, 0.30 [95% Cl, .10-.88]; *P* =.03	(LOE I) Strengths: Quality improvement interventions decrease CLABSI Bundled care and checklists have a higher success rate. Limitations: n=33 studies that used an education intervention such as lecture, education modules, monthly sessions etc. but it is unknown which studies chosen utilized these methods.
Shrestha, R. (2013) Impact of educational interventions on nurses' knowledge regarding care of patient with central venous line. *Journal of Kathmandu Medical College, 2*(1), 28-30.	None	Pre-experimental study design. Pre-intervention, intervention, post-intervention	40 nurses from ICU Kathmandu Medical College Teaching Hospital Attrition rate: none	2 week educational intervention Pre- and posttest	Simple Random Sampling (Lottery) method	Descriptive Statistics Paired *t* test applied at 0.05% level	Pre-intervention knowledge score 14.75 with SD 2.37 Post-intervention knowledge score 16.80 with SD 5.51	(LOE IV) Strengths: Educational intervention increased nursing knowledge Limitations:

doi:10.3126/jkmc.v2i1							Significant difference between pre and post knowledge (P = 0.039) Regarding knowledge level a significant improvement (P = 0.001)	Does not reveal the educational model used
Page et al. (2016). Reducing oncology unit central line-associated bloodstream infections: Initial results of a simulation-based educational intervention. *American Society of Clinical Oncology, 12*(1), e83-e87. doi: 10.1200/JOP.2015.005751	None	Retrospective review over 6 months Pretest-Posttest design. 2 Part educational series Same 31 multiple choice question pre and post test Reviewed current standards and hospital policy Introduced audit tool post educational series	25 nurses Simulation based education Adult inpatient Hematology/ Oncology unit Participants were Oncology nurses Attrition rate: none	Identified knowledge deficit pre-intervention of central line standards of care Tailored intervention to meet needs Nursing competence CLABSI rates	CLABSI rate Nurses knowledge	CLABSI rate per 1000 CL days Two sample test $P <$ .05 being statistically significant	Pre-education: CLABSI rate 5.86/1000 CL days Post-education: CLABSI 3.43/1000 CL days After audits: CLABSI rate 1.42/1000 CL days Two-tailed pre and during education: (P =.3475) significant difference from baseline	(LOE VI) Strengths: Nursing staff education improves competence of central line care Limitations: Small study Audits were needed to continually improve competence and sustain central line evidence based practice techniques.

Conley, S. B. (2016). Central line associated bloodstream infection prevention: Standardizing practice focused on evidence based guidelines. *Clinical journal of Oncology Nursing, 20*(1), 23-26. doi:10.1188/16.CJON.23-26	None	Literature review and EBP implementation of proper dressing changes and port access.	Ambulatory setting. The Department of Clinical Education and Professional Development provided education and training.	Standardizing central line practice in an ambulatory setting focusing on aseptic technique.	Education intervention. A pre and posttest design was used and a lecture based educational intervention. Skill stations were also utilized to deliver and evaluate nursing practices.	Nursing knowledge was measured via posttest. CLABSI rates were measured. Compliance was monitored	There was 100% compliance 6 months post intervention. Quarter 2 infection rates decreased from 0.88 in 2013 from 1.39 in Quarter 3 of 2012	(LOE V) Strengths: sustained decrease in CLABSI post-intervention. Standardized practices complied with Limitations: Study did not include the pre-test/post-test information.
Conley, Buckley, Magarace, Hsieh, Pedulla. (2017). Standardizing best nursing practice for implanted ports. *Infusion Nursing Society, 40*(3), 165-174.doi:10.1097/NAN.0000000000000217	None	Literature Review and Guideline Review of nursing practice for implanted ports with implementation of EBP procedures. Implemented standardized port care based on EBP standards and guidelines for implanted port care.	CLABSI in oncology outpatient settings. (ambulatory care settings) Attrition rate: N/A	Implanted port access, dressings and flushing techniques	Education intervention. Posters, 90 minute training, skill demonstration of central line care and maintenance for all nursing staff along with question and answer sessions Pretest/post-test design Peer review audits	Nursing knowledge CLABSI rates Adherence to implemented procedures	**Sustained reduction** in CLABSI rates which decreased from 1.78 to 0.82. 100% compliance with dressing changes procedures post education	(LOE V) Strengths: Education, leadership, involvement, following EBP and audits can eliminate CLABSI Peer review audits showed compliance of dressing change procedures Limitations: Data analysis not specified

Scheithauer, S., Lewalter, K., Schroder, J., Koch, A., Hafner, H., Krizanovic, V., Nowicki, K., Hilgers, R. D., Lemmen, S. W. (2014). Reduction of central venous line-associated bloodstream infection rates by using a chlorhexidine-containing dressing. *Infection, 42(1)*, 155-159. doi:10.1007/s15010-013-0519-7	None	Non-randomized surveillance control trial looking at central line dressing containing chlorhexidine 1298 participants	Tertiary care center in Germany Comparing CLABSI rates between a medical ICU and a cardiology ICU over a 19 month period	Looking at the efficacy of chlorhexidine dressings for central line infection prevention	Compared control group against group using the chlorhexidine dressing Measured CLABSI rates	Used incident rate ratios (IRR) and 95% Cls Poison regression model	1.51 per 1000 central line days when using the chlorhexidine dressing (95% CL – 0.75-2.70) compared to 5.87 per 1000 central line days when not using the antiseptic dressing (93% CL – 3.93-8.43) (*p* < 0.0001) for CLABSI rates using the chlorhexidine dressing compared to the standard dressing	(LOE III) Strengths: Large study carried out over a 19 month period Revealed significant results using the chlorhexidine dressing Significant decrease in CLABSI when using the aseptic dressing compared to usint the standard dressing Limitations: Conducted in ICU units only
Yeral, M., Boğa, C., Oğuzkurt, L., Alişkan, H. E., Özdoğul, H., & Demiroğlu, Y. Z. (2015). Tunnelled central venous catheter-related problems in the early phase of haematopoietic stem cell transplantation	None	Retrospective Cross-Sectional study of stem cell patients looking at catheter related complications of tunneled central venous catheters (CVC)	Data compiled from 111 stem cell patients from May 2011 to January 2013 Study included 40 women and 71 men which	Catheter-related complications such as hemorrhage, infection, and thrombus All 111 patients had tunneled catheters	Number of catheterizations measured per 1000 catheter days	SPSS 17.0	There was a significant relationship between number of catheter days and rate of infection (p <0.05)	(LOE VI)) Strengths: Studied 111 transplant patients with tunneled catheters Though a small study found that the double

and effects on transplant outcome. *Turkish Journal of Hematology, 32*(1), 51-57. doi:10.4274/tjh.2013.0278			had a autologous stem cell transplant Attrition Rate: during the 100 day follow-up: -lost 2 patients due to complications and 3 patient's catheters were either taken out or came out.				Further studies were needed related to morbidity and catheter complications	lumen tunneled catheter was appropriate for stem cell transplants. Limitations: Though care of the catheter was the responsibility of a "catheter nurse", patients cared for the catheters at home. This would present a question of if an infection did occur, what was the source?
Sacks, G., Diggs, B., Hadjizacharia, P., Green, D., Salim, A., & Malinoski, D (2014). Reducing the rate of catheter-associated bloodstream infections in a surgical intensive care unit using the Institute for Healthcare Improvement central line bundle. *The American Journal of Surgery, 207*(6), p. 817-823.	None	Prospective before-after interventional cohort study with concurrent controls. Using checklists and bundled care to standardize central line practices to reduce CLABSI.	16-bed Surgical Intensive Care unit (SICU). 1141 patient equaling 3784 line days. Attrition rate: none	Implemented the Institute for Healthcare Improvement (IHI) central line bundle and used an insertion checklist to monitor adherence and to assess for daily needed of the catheter.	Computerized training module used with a post-examination requiring at least 90% to pass. -Lecture based education on CLABSI for nurses and physicians. -Checklist introduced to be used during	OpenEpi (statistics program used) Used mid-P exact tests and Byar methods to compare CLABSI rates per 1,000 catheter days Measured compliance	6 months post-intervention there was a 68% decrease in CLABSI rates -rate of CLABSI post intervention was statistically significant $P < 0.047$. Pre-intervention, CLABSI rate	(LOV II) Strengths: Length of the study. The baseline data was collected for a year and the study period was a year -Physicians and nurses that were involved in the insertion and maintenance of central lines were educated.

doi:10.1016/j.amjsurg.2013.08.041					insertion and daily catheter maintenance to standardize catheter maintenance.	with checklists	- 19 and post CLABSI rate - 3. -Control unit continued to have a high CLABSI rate.	-CLABSI can be decreased with adherence to standardized catheter care and daily assessment of catheter need. Limitations: Omitted patients with PICC lines and non-tunneled lines were not used in the SICU.
Devi, R, Ghai, S., Vir Singh, N., Puril, G. D. (2017). A methodological study to develop a standard operational protocol for nurses on central line catheter care of patients in selected intensive care units. *Indian Journal Of Critical Care Medicine*, *21*(8), 483-487. doi:10.4103/ijccm.IJCCM_261_16	None	Methodological review including 13 articles consisting of national guidelines, meta-analysis, and systematic reviews. Development of a central line Standard Operational Protocol (SOP)	Intensive care units Study carried out in 5 phases.	Improvement of central line care and infection prevention	SOP -Checklists --43 items	Cronbach's alpha for internal consistency reliability of checklists To reach a common consensus four Delphi rounds were completed.	Cronbach's alpha 0.749 indicating reliability of the checklist. Content validity (CVI) was utilized and all items on checklist were 100% except for one which was 85.4%.	(LOE III) Strengths: development of a checklist for an SOP Improved central line practices Standardizing central line catheter care including infection control and dressing changes SOP was available for a

								quick reference guide. Limitations: Only used in ICU
Evangelista, T., Vosburg, M., Libman, R., & Jones, T. (2017). 543: Decrease clabsi through central line re-education on the pediatric oncology and bone marrow transplant unit. *Biology Of Blood And Marrow Transplantation, 23*(Supplement), S484. doi:10.1016/j.bbmt.2016.12.589	None	Retrospective pre-test/post-test design	30 nurses Pediatric oncology patients Metropolitan children's hospital	Assess impact of a central line education program conducted over a two month period Addressing inconsistent catheter care Incorporated education on facility central line policy and incorporated a hands on skill demonstration	CLABSI rate Nursing knowledge	Information unavailable (Conference abstract)	Improvement in nursing knowledge and confidence observed in 93% of participants. CLABSI rate decreased by 50% over a 4 month period	(LOE VI) Strengths: The delivery of staff education may increase nursing knowledge of central line care Study showed a decrease in central line infections. Limitations: Complete study information not available in the U. S. regarding measured used for analysis.
Velasquez Reyes, D. C., Bloomer, M., & Morphet, J. (2017). Prevention of central line associated bloodstream infections in adult intensive care units: A systematic review. *Intensive*	None	Systematic Review (SR) of RTCs and observational studies Included interventions that were recommend by the CDC and IHI	Studies from adult ICU units Studies published between 2007-2016	Prevention and reduction of CLABSI strategies researched	CLABSI rate Central line bundles	CLABSI per catheter day Relative Risk (RR) 95% Confidence interval (CI)	Example of study finding for CLABSI per/catheter day w/bundle 24/1000 pre intervention RR 0.49 (0.24-0.98 CI) $p = 0.212$	(LOE I) Strengths: Positive outcomes reported with the following strategies: Education, aseptic technique,

and Critical Care Nursing, 43, 12-22. doi:10.1016/j.iccn.2017.05.006		Used Cochrane Effective Practice Organisation of Care Review Group (EPOC)	Resulted in 19 studies reviewed				12/1000 – 16/1000 during and post intervention RR 1.37 (0.65-2.89) $p = 0.413$ 5 studies reported CLABSI decrease per catheter day Of 4 studies, 2 significant results post education using IHI.	closed infusion systems, appropriate insertion site, extra staff, and early removal of lines. Limitations: On study did not report a CLABSI decrease
Hakko, E., Guvenc, S., Karaman, I., Cakmak, A., Erdem, T., Cakmakci M. (2015). Long-sustainability of zero central-line associated bloodstream infections is possible with compliance with care bundle elements. *Eastern Mediterranean Health Journal, 21*(4), 293-298. Retrieved from	None	4 year Cohort Observational study	13 bed Medical ICU in a 209 bed non-profit hospital	CLABSI prevention with bundled care and nursing education Over a 3 year period raised awareness and re-educated new nurses Promoted hand hygiene campaigns	Staff trained on bundle components which consisted of: 1.hand hygiene 2.avoiding femoral site for insertion 3.daily review of central line 4.site evaluation twice daily 5.transparent dressing intact until soiled	Measured compliance rates with bundle care components. Measured CLABSI rates by the number of CLABSIs divided by the number of central line days multiplied by 1000.	At end of 2010 with 100% compliance with bundle components, the CLABSI rate was 0. A negative correlation between compliance and CLABSI ($P < 0.0001$)	Strengths: Zero CLABSI 38 months post implementation Bundle care compliance and education showed a reduction in CLABSI Limitations: The notion that the zero CLABSI rate could be due to

ncbi.nlm.nih.gov/pubmed/26077525					Additionally: 1.Removal of lines placed in the emergency room within 24 hours 2.Aseptic technique, maximum barrier precautions, hand hygiene 3.use a dedicated line for total parental nutrition (TPN) 4.change TPN tubing in 24 hours			the use of short term catheters. The average mean catheter insertion time was 12.6 The study did not report specifics of the education provided to RNs
O'Neil et al. (2016). A central line care maintenance bundle for the prevention of catheter-associated bloodstream infection in non-ICU settings. Infection Control Hospital Epidemiology, 37(6), 692-698. doi:10.1017/icc.2016.32	None	Before and after trial Pre-intervention period = 3 months Follow-up period = 12 months	1250 bed teaching hospital 8 units -4 control and 4 intervention Non-ICU patients	CLABSI reduction Using staff educational bundle consisting of: dressing changes, hospital policy. Used visual aids, for catheter care, hub access, competency assessment, process monitoring, progress reports,	CLABSI rate Comparison of control and intervention group Dressings observed between groups using Chi Square tests looking to see if bundle care practices improved this practice area. Mann-Whitney U tests for CL	Catheter days/patient days t-tests Chi Square	IBM SPSS Version 21.0 R Statistical Software Version 3.2.3 Using AIRMA for Monthly CLABSI rates during study CLABSI decreased by 2.5% for intervention group (-2.5; 95% confidence interval (CI):	(LOE III) Strength: CLABSI reduction and better site care practices. Increase in dressing care technique compliance Positive association between CL site care and education of bundle components.

				consolidating and standardizing CL maintenance location and supplies	duration for intervention group versus control and for positive versus negative CLABSI development CLABSI rate per month observed – used regression models- ARIMA errors		-5.3 – 0.4) and 1.1% for control group (-1.1; 95% CI, 2.1 – 0.1 43% decrease in CLABSI in intervention group For dressing change compliance the intervention group and control group were 100% (P = <.001; P = .001 respectively)	Limitations: CLABSI decrease not statistically significant
Beltran, M., Schroeder, J. A., Smith, C., Marnocha, S., & Friess, M. K. (2015). Assuring RN competency in central line catheter care. *Journal of Nursing Education and Practice, (5)*9, 110-115. doi:10.5430/jnep.v5n9p110	None	Pre-test/posttest design Competency based education using low fidelity simulation	9 ambulatory nurses -*n*=9, Ages 28-57, BSN prepared 5-33 years of experience. Setting: rural area, critical access hospital Over a three month period	Nursing knowledge of central venous catheter care. CLABSI rates 1 hour education sessions using a Power Point presentation and low fidelity simulation and participant demonstration	Education intervention Level of confidence of central line practices	Survey using Likert Scale measuring nurses' confidence Posttest scores improved post education.	Likert scale revealed increase in confidence post intervention -mean increase of 36% confidence in central line care	(LOE V) Strengths: Confidence levels sustained at 3 month follow-up. Limitations: Small sample size Only included outpatient nurses

Humphrey, J. S. (2015). Improving registered nurses' knowledge of evidence-based practice guidelines to decrease the incidence of central line-associated bloodstream infections: An educational intervention. *Journal of the Association for Vascular Access, 20*(3), 143-149. doi:10.1016/j.java.2015.05.003	Healthcare and Technology Synergy (HATS) Model	Pretest/posttest design Comparing nursing knowledge pre and post education	650 bed facility Medical Surgical ICU 64 ICU RNs participated	Measured knowledge of Central line care and maintenance using a questionnaire based pretest/posttest Education sessions were over a three day period Hands on educational intervention with a mannequin with various central lines	Education intervention with 16 question pretest and posttest	SPSS (IBM-SPSS Inc., Armonk, NY) Posttest scores improved post education	Significant increase in nurses knowledge of central line practices post education (P =.0001) (mean score for the pretest was 4.6 and posttest was 8.4)	(LOE V) Strengths: Relationship between central line education and knowledge gained Limitations: Small sample size Only included ICU nurses
Jaggi, N., Rodrigues, C., Rosenthal, V. D., Todi, S. K., Shah, S., Saini, N., … Radhakrishnan, K. (2013). Impact of an international nosocomial infection control consortium multidimensional approach on central line-associated rates in adult intensive care units in eight	None	Prospective before and after cohort study	16 Adult ICUs in 11 hospitals in 8 cities in India 35,650 patients	CLABSI prevention Interventions: 1.bundle 2.education 3.outcome surveillance 4.process surveillance 5. feedback of CLABSI rates 6. performance feedback	Random effects Poisson regression used to cluster CLABSI rates across time periods	Incidence rate ratio 95% confidence intervals	Significant reduction in CLABSI observed up to 36 months post intervention Pre-intervention: 6.4 CLABSIs/ 1000 CL days Post-intervention:	(LOE II) Strengths: 53% reduction in CLABSI over a 36 month period Large study using multiple interventions including education Limitations: unable to

cities in India. International Journal of Infectious Diseases, 17, e1218-e1224.doi:10.1016/j.ijid.2013.07.007							3.9 CLABSIs/ 1000CL days Incidence rate ratio: 0.47, 95% confidence interval 0.31 - 0.70; *p* = 0.0001	continue to quantify compliance due to funds Short baseline period (3months)
Dombecki, C., Vercher, J., Valyko, A., Mills, J., & Washer, W. (2017). Implementation of a central line-associated bloodstream infection (clabsi) prevention bundle for adult hematologic malignance and bone marrow transplant patients. *American Journal of Infection Control*, *45*(6). doi.10.1016/j.ajic.2017.04.166	None	Multi-disciplinary work group for Quality Improvement.	Determining bundle care components for hematologic malignancy and BMT patients	Intervention: Bundle components -1.daily patient hygiene using chlorhexidine -2.minimize accessing of lines by batching line draws -3.standardize central line practices -4.unit based CLABSI champion to encourage best practice.	To determine effectiveness of bundle intervention	Measured non-mucosal barrier injury (non-MBI) CLABSI rates per-catheter day on two units	BMT unit: reported a 41% decrease in CLABSI between Jan and July 2016. (1.0 vs 1.7 per 1000 CL days) Hemeonc unit: reported a 66% reduction in CLABSI (1.0 vs 2.9 per 1000 CL days)	(LOE V) Strengths: Decrease in CLABSI with the use of bundled care Multi-disciplinary intervention as there are many professionals that have direct contact with patient care Standardizing central line maintenance Limitations: 2nd ½ of year during the study CLABSI rates trended up and did not speculate why.

Harnage, S. (2012). Seven years of zero central-line-associated bloodstream infections. doi:10.12968/bjon.2012.2.1.Sup21.S6	None	Quantitative descriptive study design	Sutter Roseville Medical Center (SRMC) implemented bundle care with a dedicated vascular access team.	Intervention: Bundle components 1.Maximum barrier precautions upon insertion (cap, mask, gown) 2.peripherally inserted central catheters (PICC) using ultrasound during insertion 3.standardized central line dressing kit 4.zero displacement connectors 5.adherence to hub disinfecting prior to use 6. standardized flush protocol 7. monitoring line necessity and assess lines daily	Benefits of using bundled care and a dedicated nurse-led vascular access team	CLABSI rate	Zero CLABSI associated with the vascular access team insertions over a 7 year period Nurse-led vascular access teams are beneficial for CLABSI when adhering to SRMC bundle components	(LOE V) Strengths: 7 years with zero CLABSI attributable to a vascular access team insertion using bundle care. Limitations: Author's bias of the use of vascular access teams It is unknown if the vascular access team maintained all lines post-insertion No statistics were offered related to the rate of CLABSI prior to implementation.
Johnson, D., Synder, T., Strader, D., & Zamora, A. (2017). Positive influence of a dedicated vascular access team in an	None	Quality Improvement Project	501 bed acute care hospital	Use of a vascular access team (VAT) for CVC insertion care and	Evaluate the effectiveness of a dedicated vascular access team staffed by Registered	CLABSI rates measured Number of peripherally	Implementing the VAT team resulted in a decrease in CLABSI. From 2013 to	(LOE VI) Strengths: Reduction of CLABSI using a VAT team.

acute care hospital. *The Journal of the Association for Vascular Access, (22)*1, 35-37. doi:10.1016/j.java.2016.12.002				maintenance using the Institute of Health CVC care bundle	Respiratory Therapist	inserted central catheters (PICC) orders measured	2015 there was a decrease in CLABSI which went from 0.6/15004 line days to 0.34/14496 line days There was also a decrease in PICC orders.	A decrease in Peripherally inserted central catheters (PICC) and average wait times occurred with the implementation of a VAT team. Limitations:
Guerin, K., Wagner, J., Rains, K., & Bessesen, M. (2010). *Reduction in central line-associated bloodstream infections by implementation of a postinsertion care bundle. American Journal of Infection Control, 38*(6), 430-433. doi:10.1016./j.ajic.2010.03.007	None	Quasi-experimental study	Acute Care teaching hospital. Determining bundle care components for post-insertion central line care.	Utilized hands-on training with nursing staff demonstration. Bundled care consisted of: daily inspection, site care, documentation CHG-impregnated sponge, hand hygiene, and scrub the hub for 15 seconds.	To determine the effects of a post-insertion bundle on CLABSI rates	For statistical analysis used GraphPad InStat 3.0. Also used Fisher's exact test for the comparisons of proportions. . Measured CLABSI rates – per 1,000 catheter days Measured compliance with bundle components	There was a significant reduction in CLABSI post intervention. Bundle care compliance was already high pre-intervention and it remained high. (93%) CLABSI decreased from 5.7 per 1000 to 1.1 per 1000 catheter days. Catheter utilization	(LOE V) Strengths: CVC bundles reduce CLABSI Study was based on post-insertion High compliance with bundle components Limitations: Conducted at a single facility per author.

							proportion (P< .0001).	
Marschall, J., Mermel, L. A., Fakih, M., Hadaway, L., Kallen, A., O'Grady, N. P …Yokoe, D. S. (2014). Strategies to prevent central line-associated bloodstream infections in acute care hospitals. *Infection Control and Hospital Epidemiology, 35*(7), 753-771. doi:10.1086/676533	None	Practice Guidelines for CLABSI prevention. An Executive Summary incorporating expert opinion	Strategies to Prevent CLABSI in Acute Care Hospitals Preventative measures for post-insertion care:	CLABSI rates 1. Staff education 2. Appropriate nurse-patient ratios and limit float nurses in ICUs 3. Proper hub disinfectant 4. Remove non-essential VC lines 5. Hand washing 6. Continued evaluation of the best evidence of CVC care. 7. Quick removal of nonessential CVCs 8. CLABSI Surveillance in ICU and non-ICU setting			Continued evaluation of the best evidence in CVC care should continue to ensure current EBP guidelines are implemented and followed.	(LOE VII) Strengths: Continued compliance with current practice guidelines may reduce or even eliminate CLABSI Limitations: Though expert opinion, it is unknown what studies these results were generated from
Johnson, K., Grossman, A. (2013). Implementation and maintenance of practice guidelines to decrease central line associated	None	Practice Guidelines for assessing and maintain central lines for bone marrow patients.	Bone Marrow Transplant unit.	Practice council created guidelines for central lines to decrease manipulation times which included:	Determine the effectiveness of new central line practice guidelines Nursing education was	Measured CLABSI Rates	Pre-intervention CLABSI rate was 3.35/1000 patient days and post-intervention	(LOE V) Strengths: Reduction of CLABSI with limiting line manipulation

bloodstream infections by minimizing line manipulation. *Journal of Biology of Blood and Marrow Transplantation, 19*(2), s172. doi:10.1016/j.bbmt.2012.11.150				1. Continuous connection to IV even when showering, walking etc. 2. Nursing staff education 3. Provider education 4	provided via email and staff meetings and Physician education occurred during a Quality Improvement meeting.		CLABSI rate was 1.27\1000 patient days	Limitations: It was unclear what measures were used to ensure that all nurses received this information.
The Joint Commission. (2019). Preventing central line-associated bloodstream infections: Useful tools, An international perspective. Retreived from http://www.jointcommission.org/topics/clabsi_toolkit.aspx	None	Practice Guidelines for reduction of CLABSI	Bundle elements for insertion and maintenance of central lines from 7 different organizations	CLABSI rates Using bundled components to reduce CLABSI			Decrease in CLABSI due to the use of bundle elements	(LOE VII) Strength: Adherence to bundled care elements for central line insertion and maintenance is effective in CLABSI reduction. Limitations: Organizational data was compiled between 2004 and 2009
Babcock, H. M. (2015). *Infection Prevention Best Practices: IP and ARB*. Retreived from https://www.hhs.gov/sites/default/files/hi	None	Strategies for infection prevention (combatting the development and transmission of infection)	Bundle elements	Important to use care and maintenance bundles: Using infection			Bundled elements discussed were: 1.mimimizing device use and duration	(LOE VII) Strengths: Identified bundle elements but also discussed the importance of

lary-babcock-best-practices-012517.pdf				prevention bundles			2.hand hygiene prior to device access	infection prevention Limitations: PowerPoint presentation without references
Institute for Healthcare Improvement (2012a). How-to guide: Prevent central line-associated bloodstream infection. Retrieved from http://www.ihi.org/resources/Pages/Tools/HowtoGuidePreventCentralLineAssociatedBloodstreamInfection.aspx	None	Evidence-based care components for prevention of central line infections	Bundle elements	Using bundled components to reduce CLABSI			There were 5 components: 1. Hand hygiene 2. Maximal barrier precautions 3. Chlorhexidine skin antisepsis 4. Site selection 5. Daily review and prompt removal	(LOE VII) Strengths: Bundle elements align with several national agencies (IOM, AHRQ, CDC, and the Department of Health and Human Services' Partnership for Patients' initiative) Limitations: Originally designed for insertion practices in ICU.
O'Grady, N. A., Alexander, M., Burns, L. A., Dellinger, E. P., Garland, J., Heard, S. O., . . ., the Healthcare Infection Control Practices	None	Evidence-based recommendations for catheter-related infection prevention	Recommend various strategies to decrease CLABSI	CLABSI rates: Emphasis on: 1.education and training 2.maximal sterile barrier precautions			Various strategies including bundle care are recommended for prevention of catheter-	(LOE VII) Strengths: Very detailed information regarding strategies to

Advisory Committee (HICPAC). (2011). Guidelines for the prevention of intravascular catheter-related infections, 2011. doi:10.1093/cid/cir257				during insertion 3.using a >0.5% chlorhexidine skin prep with alcohol for antisepsis 4.avoid routine replacement of CVC 5. use antiseptic/ antibiotic impregnated short-term CVC and chlorhexidine impregnated sponge dressings if infection rate does decrease despite the use of the above practices.			related infection.	decrease CLABSI. Many professionals and national agencies took part in the development of these guidelines. Limitations: Guidelines were last reviewed in 2011.
Bohnenkamp, S. Pelton, N., Rishel, C. J., & Kurtin, S. (2014). Implementing evidence-based practice using an interprofessional team approach: Part two. Oncology *Nursing Forum, 41*(5), 548-	None	Quality Improvement Using Plan Do Study Act (PDSA) cycles for quality improvement implementation and evaluation.	Oncology, Gynecologic, and urology patients in a post-surgery inpatient unit.	Using EBP incorporating a team approach to care			Oncology patient population is complex and requires the use of EBP in daily practice and the collaboration of multiple disciplines to manage care.	(LOE VII) Strengths: The study showed that consistent involvement of oncology nurses in a collaborative effort with the healthcare team improves patient

550.10.1188/14.ONF.548-550		Importance of evidence-based practice (EBP) in Oncology to promote positive patient outcomes.						care. Also, the use of EBP along with continuous evaluation of patient outcomes improves care. Limitations: The study was conducted to improve the inconsistent use of sequential compression devices
Brown, M. (2010). Nursing care of patients undergoing allogenic stem cell transplantation. *Nursing Standard, (25)*11, p. 47-56. doi:10.7748/ns2010.11.25.11.47.c8405	None	Descriptive article of stem cell transplant patient's risks for infection.	Overview of allogeneic stem cell transplant	Analysis of nursing interventions to decrease risk of infection in stem cell transplant patients A review of various infections common in stem cell patients.			Stem cell patients are vulnerable to infection from decreased immune system from chemotherapy and radiation. Continued research is warranted to find infection reduction strategies.	(LOE VI) Strengths: Study found that extensive knowledge and skills of nursing staff is needed on BMT units Limitations: This is an older article but was used as it was one of the first articles chosen when this evidence-based review began
Neumann, J. (2017). Nursing challenges	None	Descriptive article of nursing	Overview of nursing care	Analysis of nursing			Nursing care of stem cell	(LOE VI)

caring for bone marrow transplantation patients with graft versus host disease. *Hematology/Oncology Stem Cell Therapy*, 10(4), 192-194. doi:10.1016/j.hemonc.2017.06.001		challenges of transplant care and the importance of nurse education.	of BMT patients.	intervention when caring for BMT patients experiencing graft versus host disease (GVHD).			patients is complicated. It is important that BMT nurses are educated and certified in the care of transplant patients.	Strengths: Nurses must be trained in BMT care including the coordination of care and the evaluation of therapy. Training and certification is essential. Limitations: Generalized information related to GVHD and challenges facing nursing caring for stem cell patients.
Centers for Disease Control and Prevention (2015). *Intravascular catheter-related infection (bsi): education, training, and staffing.* Retrieved from https://www.cdc.gov/infectioncontrol/guidelines/bsi/index.html	None	Guidelines for central line insertion and maintenance	Based on current evidence-based practice	Practice guidelines recommending education, training, staffing, proper selection of catheter and sites, infection prevention practices, hand hygiene, aseptic technique, skin prep, dressing regimens, cleansing,			Education, training, and proper staffing is effective in CLABSI reduction. Aspects of bundle components are discussed separately in the table as infection prevention techniques	(LOE V) Strengths: practice guidelines chosen from well-designed experimental studies as well as clinical and epidemiologic studies. Limitations: Elements under the recommended category II are

				securement devices, antimicrobial impregnated catheters and cuffs, antibiotic prophylaxis and ointments, performance improvements and bundled care were some areas covered in these guidelines.				only suggested such as types of dressings, when to change dressings, changing needless components, patient cleansing
Thompson-Mackey, H. (2017). Education, documentation, and legal issues for access devices. In D. Camp-Sorrell & L Matey (Eds.), Access device standards of practice: For oncology nurses (pp. 153-160). Pittsburgh, PA: Oncology Nursing Society	None	Standards of care for access devices	Related to nursing education, documentation, and legal issues of access devices	Recommends -nursing and patient education on the indications for device, type of central line access, symptoms of infection recognition, care and maintenance of central lines			It is essential that nurses are educated on aspects of central lines used on their units. It is also essential that patients are also educated on their central lines.	(LOE VI) Strengths: Provides current evidence-based information on indications of proper documentation, education, and legal issues of access devices based on the literature. Limitations: Other than the Institute of Medicine, there were no national agencies references in

								terms of standards of care.
Camp-Sorrell, D., & Matey, L. (Eds.). (2017). *Access Device Standards of Practices for Oncology Nursing*. Pittsburg, PA: Oncology Nursing Society	None	Standards of practice for access devices for Oncology Nursing	Discusses evidence-based central line insertion and maintenance practices	-Evidence-based insertion and maintenance approaches. -Information on types of lines, flushing techniques, documentation practices, importance of scrubbing the hub, aseptic technique, sterile technique when required.			Education on central line care techniques, pathogenesis, documenting procedures, types of lines, how to flush and draw blood, removal, importance of verifying placement, CLABSI prevention techniques.	(LOE-VII) Strengths: Standards of practice based on evidence-based information for various aspects of proper insertion and maintenance central line care Limitations: none
Arizona State Board of Nursing. (2015). *Advisory opinion central venous catheter insertion/removal for the adult population by registered nurses*. Retrieved from https://www.azbn.gov/documents/advisory_opinion/ao%20central%20line%20insertion%20by%20registered%20nurses.pdf	None	Advisory Opinion	Discusses RN scope of practice for insertion, maintenance and removal of central venous catheters.	Nursing educational instruction related to central line care.			RNs should have educational instruction on insertion, suturing, maintenance, removal, and tip placement verification.	(LOE VII) Strengths: Nursing board recommending RN education on central line insertion and maintenance based on expert opinions. Limitations: An advisory opinion

Gahlot, R., Nigam, C., Kumar, V., Yadav, G., & Anupurba, S. (2014). Catheter-related bloodstream infections. *International Journal Of Critical Illness And Injury Science, 4*(2), 162-167. doi:10.4103/2229-5151.134184	None	Summary of risk factors for catheter-related bloodstream infections as well as the etiology, pathogenesis, how they are diagnosed and how to manage.	Discusses aspects of central venous care as it relates to the risks of infection.	Infection risk factors Education and strategies for infection reduction.			Education on risk factors, an understanding of pathogenesis of infection and strategies to decrease infection are important.	(LOE VI) Strengths: Very informative and provided evidence-based information on catheter-related bloodstream infections. Discussed routes of infection pertinent for nursing education of central line care. Limitations: General summary of catheter-related bloodstream infections
Valencia, C., Hammami, N., Agodi, A., Lepape, A., Herrejon, E. P., Blot, S. … Lambert, M.L. (2016). Poor adherence to guidelines for preventing central line-associated bloodstream infections (CLABSI): results	None	International survey of CLABSI prevention practices in ICUs	3407 responses received from 95 countries. ICU Nurses and physicians responded to the survey	Assessing items such as, whether respondents had CLABSI prevention guidelines, insertion site procedures, maintenance procedures, and dressing change			The authors noted that interest and awareness of CLABSI prevention was prevalent in the ICU setting. Improvement practices should occur	(LOE VII) Strengths: Large sample size in various locations Recognition that education is needed regarding CLABSI

of a worldwide survey. Antimicrobial Resistance and Infection Control, 5(49), 1-8.doi:10.1186/s/13756-016-0139-y 5, 49.				procedures, types of dressings, CLABSI rates, and compliance rates.			in the following areas: Daily assessment, barrier precautions, monitoring of central line practices	prevention techniques Limitations: Results were not differentiated between nurses and physician responses Heterogeneity of central line practices noted between countries which provided limited meaning per authors.
Haddadin, Y., & Requnath, H. (2018). *Central line blood stream infections (clabsi).* Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK430891/	None	Descriptive article of central line associated blood stream infections as well as how to evaluate and treat	Discussed etiology, epidemiology and pathophysiology of central line infections.	Insertion and maintenance prevention guidelines discussed.			Components of central line insertion and maintenance	(LOE VI) Strengths: Guidelines for post-catheter care consistent with multiple studies and national agencies. Limitations: This article provided general information regarding CLABSI
Zakhour, R., Chaftari, A., &	None	Literature review	Haematologic malignancies	Review of the various types	Infection prevention		The use of aseptic	(LOE V)

Raad, I. I. (2016). Catheter-related infections in patient with haematological malignancies: novel preventive and therapeutic strategies. *Lancet Infectious Diseases, 16*(11), e241-e250. doi:10.1016/S1473-3099(16)30213-4			and stem-cell transplant patients	of catheters used in oncology patient population Review of prevention and management of catheter-related infections	1.Education 2.Bundle care 3.-Antimicrobial catheters 4.Lock therapy		bundles, post insertion bundles, education, scrubbing the hub, antibiotic-coated catheters and audits after implementing bundle care may decrease catheter related infections in the oncology patient.	Strengths: The majority of articles reviewed were from Oncology, Infection Control, and Infectious Disease sources. Limitations: Some of the articles reviewed were more than 10 years old from the publication date.

Appendix B: Central Line Education Program Plan

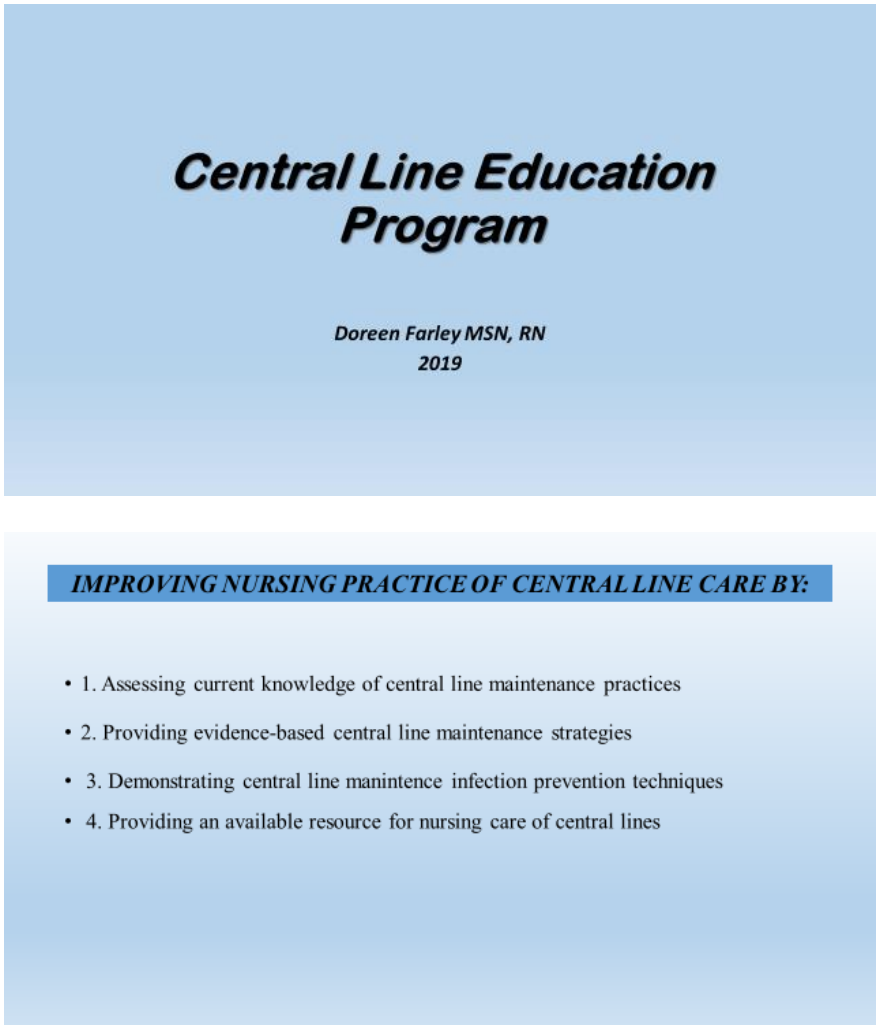
Time	Objectives	Content	Methods and Materials	Evaluation Method
0800-0820 20 min	Brief introduction and discussion of program plan for the day and administration of a 15 item multiple choice pretest.			
Module I CLABSI 0820-0850 30 min	Participant will be able to: 1. Define Central line associated bloodstream infection (CLABSI) 2. Define how CLABSI is determined 3. Describe the pathogenesis of CLABSI. 4. Identify the national benchmark for CLABSI 5. Identify current BMT CLABSI rate	The facilitator will discuss: 1. Background of (CLABSI) 2. Define CLABSI 3. How CLABSI is determined 4. Current national CLABSI benchmark and current BMT CLABSI rate. 5. Pathogenesis of CLABSI.	-Lecture using PowerPoint (PPT) -Visual aid	Multiple Choice test: # 1, 2, 3,
Module II A. Types of Central Lines 0850-0930 40 min	Participant will be able to: 1. Identify different types of central lines 2. Describe the difference between non-valved catheters and valved catheters 3. Describe the difference between non-tunneled and tunneled catheters	The facilitator will discuss: 1. Types of central lines used on the BMT unit 2. Valved vs. Non-valved 3. Tunneled vs. Non-tunneled	-Lecture using PPT -Class discussion on types of lines used on the BMT unit (20 minutes) -Group Activity: (hands on activity) Each group will receive a catheter and will have to identify the type of catheter and whether it is valved/non-valved, tunneled/non-tunneled. (20 minutes)	Multiple Choice test: # 4, 5, 6
Module II	Participant will be able to:	The facilitator will discuss:	-Lecture using PPT	Multiple Choice test:

B. Infection Prevention using Bundle Components for Central Line Maintenance Practices 0930-1015 45 min	1. List the bundle care components for central line maintenance. 2. Describe how to assess the insertion site 3. Identify how long to scrub the hub 4. Identify when sterile technique should be used during central line maintenance practices 5. Describe signs of infection 6. Explain the importance of patient involvement in safety practices	1. Importance of proper hand hygiene practices 2. Site assessment 3. Infection prevention techniques using bundle care: a. hand hygiene b. sterile technique when required c. chlorhexidine-based antiseptic d. chlorhexidine impregnated sponge e. scrub the hub for 15 seconds f. dressing changes every Sunday and as needed g. Removal of gauze dressing every 48 hours and placing an antimicrobial sponge h. Positive pressure valve/caps on every lumen. 4. Importance of patient involvement in safety practices.	-Video of sterile gloving -Group Activity: (hands on activity) Each individual will put on a pair of sterile gloves without breaking sterility. Peers will monitor each other putting on sterile gloves.	# 7, 8, 9
1015-1030 (15 minute break)				
Module III A. Central Line Dressing Change 1030-1130 1 hour	Participant will be able to: 1. Describe the different types of central line dressings used on the BMT unit 2. Identify when central line dressings should be changed on the BMT unit. 3. Identify two reasons a central	The facilitator will discuss: 1. Types of central line dressings available for use on the BMT unit 2. Dressing change procedures on the BMT unit 3. Reasons to change a central line dressing	-Lecture using PPT -Facilitator will demonstrate a central line dressing change, flush and cap change	Multiple Choice test: # 10, 11, 12

	line dressing should be changed on the BMT unit.			
1130-1200 (Lunch)				
Module III B. Central line flush 1200-1220 20 min	Participant will be able to: 1.Identify the minimum size syringe to use when flushing a central line and the rationale 2.Identify when central lines should be flushed and the volume to the flush 3. Identify what solution is used on the BMT unit to flush and maintain patency of central lines 4. Identify the process to take if the central line is no longer patent	The facilitator will discuss: 1. Syringe sizes for central line flush 2. Flushing solutions 3. Policy to follow when suspecting a central line is no longer patent.	-Lecture using PPT	Multiple Choice test: # 13, 14, 15
C. Central line dressing change and flush demonstration 1220-1330 1 hr 10 min	Participant will be able to: Properly demonstrate a central line dressing change and flush.	The facilitator will discuss: 1. Elements of a central line dressing change and flush	-Lecture using PPT -Skill Demonstration	Non-graded participant skill demonstration of central line dressing change and flush using a low fidelity simulation manikin. Immediate feedback on skill performance is recommended.
1330-1340 Question and Answer Session Prior to the Posttest				
Education Completed. Evaluation	Participant will be able to: 1.Complete the 15 item multiple	The facilitator will hand out the 15 question posttest.	-Written multiple choice posttest	Posttest to be administered after the question/answer session.

1340-1400 will conclude the educational event and participants will take a 15 question multiple choice posttest 20 min	choice posttest within 20 minutes			

Appendix C: Central Line Program Modules



CENTRAL LINE EDUCATION PROGRAM ESSENTIALS

- Pre-test / Post-test
- PowerPoint presentation
  - Incorporating visual aids, discussion, and hands-on activities
- Facilitator demonstration of:
  - CVC dressing change and flush

OBJECTIVES

- Participant will explain differences between various central lines discussed
- The participant will demonstrate central line care
  - Demonstrate flushing technique
  - Demonstrate dressing change
  - Demonstrate sterile gloving
- The participant will list safety practices for prevention of CLABSI
- The participant will complete a pre-test/post-test assessment

Module I

CENTRAL LINE ASSOCIATED BLOOD STREAM INFECTIONS (CLABSI)

- *Module I Overview*
  - Pretest / Introduction
  - Definition of terms
  - Healthcare Associated Infections / CLABSI
  - National benchmarks
    - Facility / BMT CLABSI rates (provided by facilitator)
  - Pathogenesis of CLABSI

Module I

COMMON TERMS DEFINED RELATED TO CENTRAL LINE CARE AND HEALTHCARE ASSOCIATED INFECTIONS.

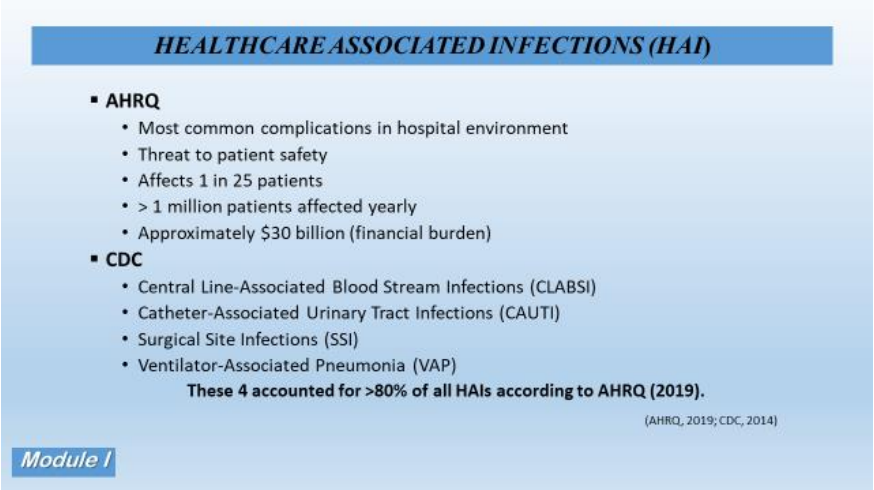
- **Healthcare associated infection (HAI)**
  - infections that patients acquire while receiving treatment for medical or surgical conditions (Healthypeople.gov, 2017).
- **Central venous catheter (CVC)**
  - thin, flexible tube inserted into a vein, usually below the right collarbone, guided (threaded) into large vein above the right side of heart (National Cancer Network, n. d.)
- **Central line**
  - intravascular catheter that terminates at or close to the heart or in one of the great vessels (for infusion, drawing blood, hemodynamic monitoring (CDC, 2017)

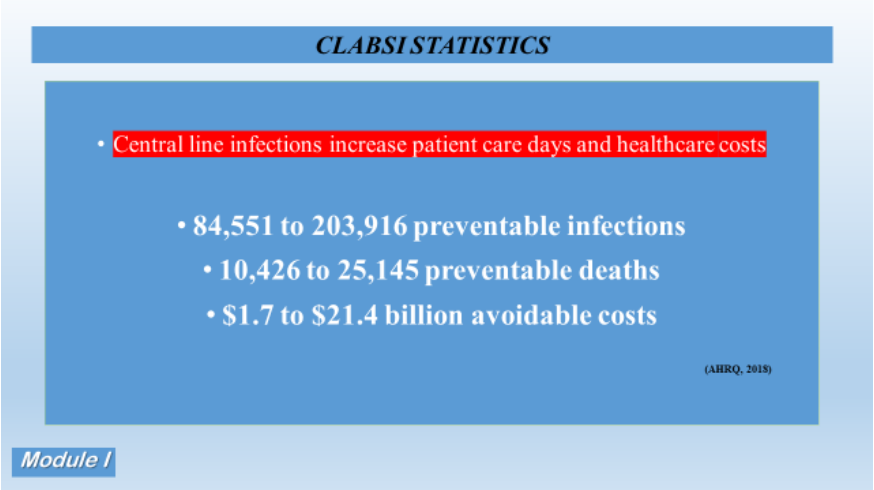
Module I

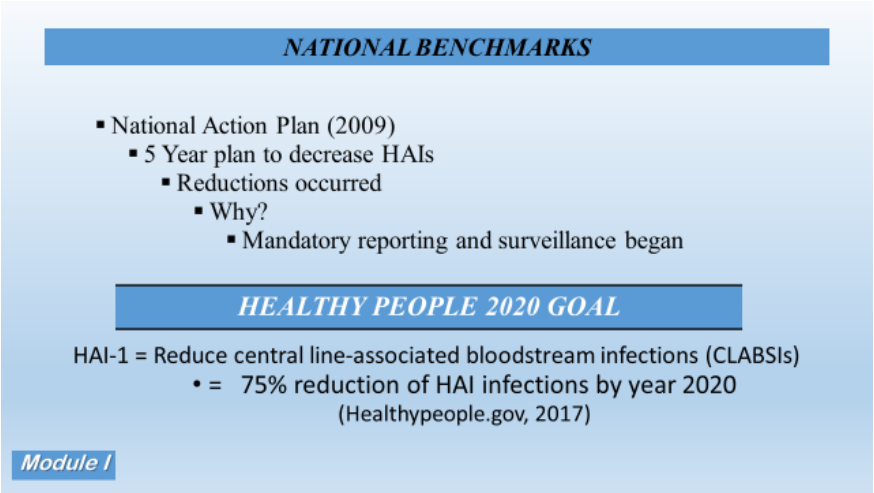
COMMON TERMS DEFINED RELATED TO CENTRAL LINE CARE AND HEALTHCARE ASSOCIATED INFECTIONS

- **Catheter related blood stream infections (CR-BSI)**
  - Is the presence of bacteremia originating from an intravenous catheter (Gahlot, Nigam, Kumar, Yadav, & Anupurba, 2014)
- **Central line associated blood stream infection (CLABSI)**
  - an infection that occurs when bacteria or other germs enter the patient's central line and then enter into their bloodstream (Johns Hopkins Medicine, n.d.).
- **Central line bundles**
  - group of evidence-based interventions for patients with intravascular central catheters that, when implemented together, result in better outcomes than when implemented individually (IHI, 2012)

Module I

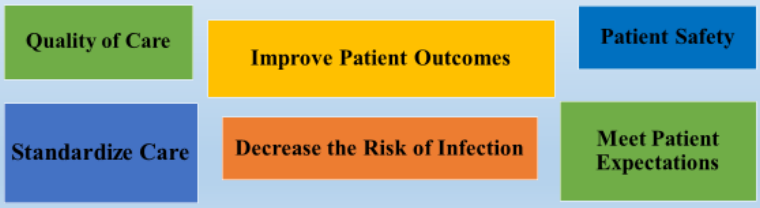

HEALTHCARE ASSOCIATED INFECTIONS (HAI)
AHRQ
Most common complications in hospital environment
Threat to patient safety
Affects 1 in 25 patients
> 1 million patients affected yearly
Approximately $30 billion (financial burden)
CDC
Central Line-Associated Blood Stream Infections (CLABSI)
Catheter-Associated Urinary Tract Infections (CAUTI)
Surgical Site Infections (SSI)
Ventilator-Associated Pneumonia (VAP)
These 4 accounted for >80% of all HAIs according to AHRQ (2019).
(AHRQ, 2019; CDC, 2014)
Module I


CLABSI STATISTICS
Central line infections increase patient care days and healthcare costs
84,551 to 203,916 preventable infections
10,426 to 25,145 preventable deaths
$1.7 to $21.4 billion avoidable costs
(AHRQ, 2015)
Module I


NATIONAL BENCHMARKS
National Action Plan (2009)
5 Year plan to decrease HAIs
Reductions occurred
Why?
Mandatory reporting and surveillance began
HEALTHY PEOPLE 2020 GOAL
HAI-1 = Reduce central line-associated bloodstream infections (CLABSIs)
= 75% reduction of HAI infections by year 2020
(Healthypeople.gov, 2017)
Module I

WHY IS IT ESSENTIAL TO PRACTICE CENTRAL LINE CARE USING THE BEST EVIDENCE????

Before we see the answers, write down some reasons why nursing care of central lines should be based on evidence?



NATIONAL BENCHMARKS

- **SIR**
  - Standardized infection ratios (SIR)
  - Tracks HAIs overtime and adjust for differences in facilities and patient populations
  - Compare # of HAIs to # of number predicted using national baseline data.
- **Benchmark**
  - 2015 SIR was 0.603 which represented a 21.8% increase in CLABSI data from 2014
  - ODPHP called for a 50% decrease in the previous SIR target of 1. setting a new benchmark at 0.5 in 2016 (ODPHP, 2018)

Last BMT SIR: _____

(CDC, 2018; ODPHP, 2018)

Module I

NATIONAL PATIENT SAFETY GOALS

- Education
- Policies consistent with current guidelines
- Monitor compliance
- Evaluate effectiveness
- Transparency of CLABSI data
- Checklists for insertion
- Standard protocols
- Hand hygiene
- Standard central line kits
- Standard barrier precautions
- Skin prep
- Proper catheter hub cleaning
- Routine evaluation of line need

Module I

(The Joint Commission, 2017)

HOW IS CLABSI DETERMINED ?

- Determined by the presence of a laboratory-confirmed bloodstream infection occurring at least 48 hours after catheter insertion.

(Haddadin & Regunath, 2018)

Module I

PATHOGENESIS OF CLABSI

Before we see the answers, write down some causes/routes of infection.

Patient's own skin flora

Healthcare worker's hands (Frequent manipulation of IV lines)

Connection sites

Inside vein traveling from a distant infectious location

Insertion site / Catheter hub

Contaminated fluids/medications

(Dombecki, 2017; TJC, 2012; Yeral, et al., 2015)

Module 2

CENTRAL LINE ASSOCIATED BLOOD STREAM INFECTIONS (CLABSI)

- Module II Overview – PART A
  - Types of central lines
    - Valved vs Non-valved
    - Tunneled vs Non-tunneled
    - Images of Central Lines
    - Implanted Ports
    - PICC (peripherally inserted)

Module 2

VALVED VS NON-VALVED CATHETERS

Valved	Non-Valved

• anti-reflux valve
  • prevents back flow of blood
  • prevents air from entering venous circulation
	• no anti-reflux valve

• heparin flush not required	• regular flushing needed
• no clamps	• Has clamps
	• unclamp prior to & after use

(Beltran et al., 2015)

Module 2

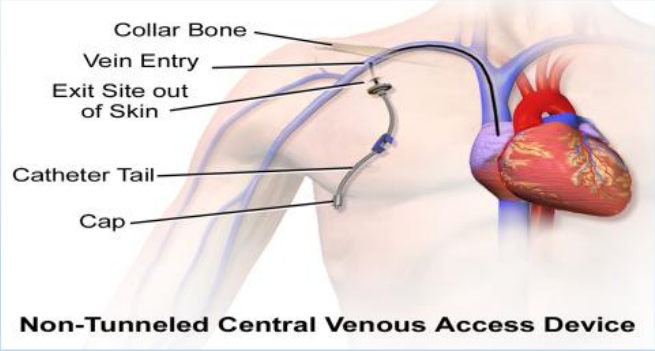
TYPES OF CENTRAL LINES

Tunneled	Non-Tunneled
• surgical insertion necessary	• can be placed at bedside
• long term (1, 2 or 3 lumens)	• short term (1, 2 or 3 lumens)
• use post placement confirmation	• use post placement confirmation
• risk of CLABSI and thrombosis	• higher risk of infection than tunneled
• Can be used for various types of IV infusions	• Can be used for fluid resuscitations & pressure monitoring

(Beltran et al., 2015; Camp-Sorrell, & Matey, 2017)

Module 2

IMAGE OF NON-TUNNELED CVC ENTRY POINT



Blausen.com staff (2014)

IMPLANTED PORT

Implanted Port

- surgical insertion necessary
- embedded under skin
- rubber septum / self-sealing
- Accessed with a non-coring needle
- long term use
- can be used for various types of IV infusions and blood draws

(Beltran et al., 2015)

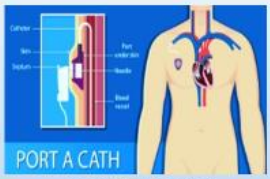


Image: Rumruay. (n.d.-a)

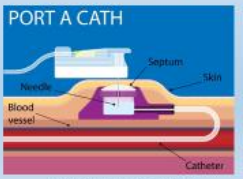


Image: Rumruay. (n.d.-b)

Module 2

PICC LINES

PICC LINES

- can be used for various types of IV infusions and blood draws
- long-term
- trained RN can insert and remove
- can be power injectable
- valved or non-valved
- can be placed at the bedside

(CDC, 2014, Copo, 2017).

(Byron, n. d.-a)

PICC line shown with anti-microbial patch, stabilization device and positive pressure cap

Module 2

WHICH LINE DO YOU HAVE?

- ***Group Activity***
  - ***When you receive the central line the group will answer the following:***
    - ***1. What type of line is it?***
    - ***2. Is it for short term or long term use?***
    - ***3. What can the line be used for?***
    - ***4. Is it a line that can be tunneled?***
    - ***5. Can the line be placed at the bedside?***

Module 2

CENTRAL LINE ASSOCIATED BLOOD STREAM INFECTIONS (CLABSI)

Module II Overview – PART B

- Infection prevention
  - Insertion site assessment
  - Catheter assessment
  - Signs and symptoms of infection
  - Bundle components
  - Hand hygiene / Scrub the hub
  - Maintaining Sterility
  - Sterile Gloving
  - Patient involvement in safety practices

Module 2

INFECTION PREVENTION

- ***Insertion site assessment***
  - Daily visual assessment of insertion site
    - Assess catheter insertion site area prior to every access and PRN
    - Assess for signs of infection

(practicum site facility policy)

- ***Catheter assessment***
  - Assess for cracks, leakage, kinking or pinching, and mechanical problems
  - Daily assessments of catheter need
  - Immediately notify provider or IV therapy team of any complications

(practicum site facility policy)

Module 2

POSSBLE SIGNS AND SYMPTOMS OF CENTAL LINE INFECTION

Before we see the answers, write down some signs and symptoms of infection.

(Haddadin & Regunath, 2018)

Module 2

INFECTION PREVENTION

- ***Bundle Components***
  - A set of interventions that when used together reduce the risk of CLABSI (IHI, 2012)
  - Many facilities use bundle care for central line insertion and maintenance practices
    - Not standardized
    - Tailored to unit needs

Module 2

INFECTION PREVENTION

The following techniques are required to reduce the risk of CLABSI.

1. hand hygiene
2. chlorhexidine-based antiseptic
3. daily line assessment and documentation
4. scrub the hub for 15 seconds
5. dressing changes every Sunday and as needed, along with valve/caps of all lumens
6. removal of gauze dressing every 48 hours and place an antimicrobial sponge
7. the use of positive pressure valve/caps on every lumen.
8. securement devices for PICCs
9. Transparent semipermeable dressing should be changed every 5 to 7 days
10. Dressings should be changed immediately if damp, loosened, or visibly soiled

Practicum site policy and procedures

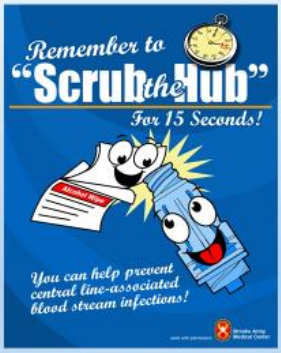
Module 2

INFECTION PREVENTION

- ***Hand Hygiene***

(Blaus, Bruce, 2017)

- ***Scrub the Hub***



(Brook Army Medical Center, n.d).

Module 2

MAINTAINING STERILITY – DECREASE RISK OF INFECTION

Before we see the answers, write down some components of how to maintain sterility during a sterile procedure such as a central line dressing change

Set up sterile field on a clean surface	Never turn your back on a sterile field	Touch sterile to sterile
Keep hands above the waist	Never reach over the sterile field	Keep all items above the waist

(Hopper & Moss, 2010; Medcom, 2010; Simko, 2012;)

Module 2

INFECTION PREVENTION

- ***Sterile Gloving***
  - During a central line dressing change, when is it necessary to don sterile gloves?
  - Please see below video for a refresher on sterile gloving. After viewing the video you will have a chance to practice sterile gloving.
  - ***https://youtu.be/96KT3tK045U***

Module 2

TEAMWORK IS ESSENTIAL FOR INFECTION PREVENTION

- ***Patient Involvement in Safety Practices***

  - It is essential to involve patients in their care
  - Knowing infection prevention practices is important for everyone
  - It is important that:
    - Patients are practicing purposeful hand hygiene
    - Patients are informed of the signs and symptoms of infection
    - Patients will inform RN if central line dressing is loose, soiled, wet, open
  - Also, teach patients about their central venous device using the "teach back method".

(Thompson-Mackey, 2017)

Module 2

Module 3

CENTRAL LINE DRESSING CHANGE

- ***Module III Overview – PART A***
  - Central line (CL) dressing change
    - Types of CL dressings
    - When to change CL dressing
    - Identify 2 reasons to change

Module 3

VARIOUS TYPES OF CENTRAL LINE (CL) DRESSINGS

(Rumruay, n. d.-c)

(Byron, n. d.-b)

Dressings should be changed **Every 7 days** per policy and as needed when:

1. Dressing is wet
2. Dressing is soiled
3. Dressing is loose

Do not reinforce dressings that are soiled, wet, or loose. Change the dressing.

Module 3

(Camp-Sorrell & Matey, 2017)

ESSENTIALS FOR CENTRAL LINE DRESSING CHANGE

Mask (RN & patient)

(Mahalec, n. d.)

Sterile Gloves

(Nastya, n. d.)

Hand Washing

(Blaus, Bruce, 2017)

Also, Use an anti-microbial dressing or patch

Common items found in a central line dressing kit below:

- -Mask
- -Sterile gloves
- -Occlusive dressing
- -Sterile gauze
- -Sterile Q-tip
- -Skin prep
- -Alcohol / Chlorhexidine
- -Sterile drape

CENTRAL LINE DRESSING CHANGE

Before we see the answers, let's see what you remember regarding when a central line dressing should be changed. Write down why a CL dressing should be changed and the rationale for each of your answers

Every 7 days per policy

When dressing is wet

If site does not contain a biopatch

When dressing is loose

When dressing is visibly soiled

If gauze dressing - change every 2 days

Module 2

CENTRAL LINE FLUSH

- *Module III Overview – PART B*
  - Syringe sizes
  - Flush volumes
  - Flushing solutions
  - Troubleshooting line patency issues
  - Always events

Module 3

CENTRAL LINE FLUSH

Syringe size:

- Use a 10 ml syringe
  - ***NO smaller***

When flushing remember to:

- Assess for signs of infiltration
- Aspirate for blood return
- Use the push-pause method
  - ***Creates turbulence to minimize blood and fibrin build-up***
- Maintain positive pressure if non-valved catheter
  - ***Clamp while syringe is still attached***
- NEVER FORCE FLUSH
- Do not "bottom out" syringe ***(Beltran et al., 2015)***

Module 3

FLUSING SOLUTIONS / TROUBLESHOOTING

Flushing

CVC type	Flushing solution	Lock solution	Frequency
PICC	0.9 NaCl (10ml per lumen) After blood draw: 0.9 NaCl (20ml per lumen)	Heparin 10 units/ml (3-5 ml each lumen)	Every 12 hours or after each use
Non-tunneled (NT) or Tunneled (T)	**NT** - 0.9 NaCl (10ml per lumen) **T** – 0.9 NaCl (10ml per lumen)	Heparin flush 10 units/ml (5 ml each lumen)	Every 24 hours or after each use
Groshong	Flush and lock with 0.9 NaCl (10ml per lumen)		Every 8 hours or after each use
Implanted port	0.9 NaCl (10ml per lumen) After blood draw: 0.9 NaCl (20ml per lumen)	Heparin 10 units/ml (5 ml each lumen)	Every 24 hours or after each use if needle left in place
		Heparin 100 units/ml (5 ml each lumen)	Every 4 weeks to lock port; If port de-accessed

Troubleshooting line patency ***(Beltran et al., 2015)***

Reposition the patient, have patient take a deep breath, have patient lift their arms over their head. Attempt to flush again. If works proceed and if not notify Vascular Access Team / Healthcare Provider. ***Follow hospital policy/procedure***

Module 3

ALWAYS EVENTS IN THE CARE AND MAINTAINTENCE OF CENTRAL LINES

- Always
  - Perform hand hygiene
  - Identify your patient with two identifiers
  - Assess site for:
    - Infection
    - Infiltration
    - Patency (brisk/sluggish)
  - Document
    - Appearance of site
    - Flush (amount and type)
    - Patency (brisk/sluggish)

Module 3

(Beltran et al., 2015; Camp-Sorrell & Matey, 2017)

CENTRAL LINE DRESSING CHANGE DEMONSTRATION AND PRACTICE

- *Module III Overview – PART C*
  - CL flush, cap change and dressing change demonstration
    - After facilitator demonstration
      - 1. Participant will complete CL dressing change
      - 2. Participant will complete flush and cap change

Module 3

QUESTION AND ANSWER SESSION PRIOR TO THE POSTTEST

Thanks for your participation in this educational event

After question and answer session please complete the posttest

Module 3

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Appendix D: Central Line Education Pretest

Choose the best answer:

1. Central line associated bloodstream infections (CLABSI) are largely preventable:	a. True b. False
2. The pathogenesis of CLABSI:	a. CLABSI can occur from the patient's own skin flora b. CLABSI can occur from contamination at the insertion site c. Can occur anywhere along the IV system due to line manipulation. d. All of the above
3. CLABSI is determined by:	a. The presence of an infection b. The presence of a fever greater than 101.5 c. The presence of an infection verified by a laboratory within 48 hours of insertion of a central line. d. The presence of an infection verified by a laboratory within 24 hours of insertion of a central line
4. What is one characteristic of a valved catheter?	a. A valved catheter does not have an anti-reflux valve b. A valved catheter has an anti-reflux valve. c. A valved catheter should always be unclamped prior to use. d. When not in use, a valved catheter must be clamped at all times.
5. Non-Tunneled catheters:	a. Have a higher rate of infection compared to tunneled catheters b. Are normally for short-term use c. Do not have a subcutaneous cuff to limit bacteria migration d. All of the above
6. Characteristics of Tunneled catheters:	a. A surgical procedure is required for insertion. b. Limits migration of microorganisms due to a Dacron cuff. c. Are long-term catheters d. All of the above
7. The CDC recommends scrubbing the hub:	a. At least 20 seconds if using alcohol wipes b. At least 30 seconds if using alcohol wipes c. At least 15 seconds if using alcohol wipes

	d. At least 30 seconds if using alcohol wipes
8. Elements of central line maintenance bundle care on the BMT unit consists of:	a. Hand hygiene b. Daily central line site assessment c. Scrubbing the hub d. Sterile technique when required e. All of the above
9. To maintain a sterile field:	a. Keep hands above the waist b. Never turn your back on a sterile field c. Only touch sterile to sterile d. A, and B e. A, B, and C
10. A central line dressing should be changed:	a. Every Sunday b. As needed if wet, soiled or loose c. Only on Sundays and should be reinforced if loose d. A and B
11. If a central line dressing is loose the RN will:	a. Change the central line dressing b. Reinforce the central line dressing c. Document and pass on to the next shift during bedside report. d. Document and immediately reinforce the central line dressing
12. During a central line dressing change, when is sterile technique required? :	a. When taking off the old dressing b. When cleaning the insertion site c. When applying the new dressing d. When changing the cap(s) e. B and C f. All of the above
13. The minimum size syringe to use when flushing a central line is a:	a. 20 ml syringe b. 10ml syringe c. 3 ml syringe d. 5 ml syringe
14. If RN suspects the central line lumen is not patent the RN will troubleshoot by:	a. Repositioning the patient and attempting to flush again using a 10 ml syringe. b. Assessing the central line lumen for an obstruction such as kinks in the lumen or closed clamps.

	c. Attempting to flush vigorously using greater pressure to dislodge suspected clots. d. A and B e. All of the above
15. The RN understands that at minimum, a central line should be flushed:	a. Before and after medication administration b. Using the push pause method c. Prior to and after blood draws d. A and B. e. A, B, and C

Appendix E: Central Line Education Posttest

Choose the best answer:

1. Central line associated bloodstream infections (CLABSI) are not preventable:	a. True b. False
2. The pathogenesis of CLABSI:	a. CLABSI can occur from the patient's own skin flora b. CLABSI can only occur from contamination at the insertion site c. Can only occur from contamination at the distal end of the intravenous (IV) tubing d. All of the above
3. CLABSI is determined by:	a. The presence of an infection during neutropenia b. The presence of a continual low grade fever c. The presence of an infection verified by a laboratory within 48 hours of insertion of a central line. d. The presence of an infection verified by a laboratory within 24 hours of insertion of a central line
4. What is one characteristic of a valved catheter?	a. A valved catheter does not have an anti-reflux valve b. A valved catheter has an anti-reflux valve. c. A valved catheter should always be unclamped prior to use. d. When not in use, a valved catheter must be clamped at all times.
5. Non-Tunneled catheters:	a. Have a lower rate of infection compared to tunneled catheters b. Have a higher rate of infection compared to tunneled catheters c. Have a subcutaneous cuff to limit bacteria migration d. All of the above
6. Characteristics of Tunneled catheters:	a. Does not require a surgical procedure for insertion. b. Does not contain a Dacron cuff to limit bacteria migration. c. Are long-term catheters d. Are short-term catheters
7. The RN should scrub the hub for:	a. At least 20 seconds if using alcohol wipes b. At least 30 seconds if using chlorhexidine wipes c. At least 15 seconds

	d. At least 30 seconds
8. Elements of central line maintenance bundle care on the BMT unit consists of:	a. Hand hygiene b. Daily central line site assessment c. Scrubbing the hub d. Sterile technique when required e. All of the above
9. Vital components to maintain a sterile field:	a. Only touch sterile to sterile b. Keep hands above the waist c. Never turn your back on a sterile field d. Never drop anything wet onto a sterile field e. All of the above
10. A central line dressing should be changed:	a. Only if wet, soiled or loose b. Only on Sundays c. Every Sunday and when wet, soiled or loose d. After the second time the dressing was reinforced
11. If a central line dressing is loose the RN will:	a. Document and change on Sunday b. Reinforce the central line dressing c. Document and reinforce the central line dressing d. Document and change the central line dressing
12. During a central line dressing change:	a. The RN is required to wear a mask b. The RN will clean the insertion site using sterile technique c. The RN will clean the insertion site using aseptic technique d. The RN will prime the new caps using aseptic technique e. A and C f. A, B, and D
13. The minimum size syringe to flush a central line lumen is a:	a. 20 ml syringe b. 10ml syringe c. 3 ml syringe d. 5 ml syringe
14. To assess for patency of a central line lumen the RN will:	a. Reposition the patient and flush again with a 10 ml syringe. b. Reposition the patient and flush using the push-pause method

	c. Assess the central line lumen for kinks in the line. d. Assess the central line lumen for closed clamps e. All of the above
15. Central line lumens should be flushed:	a. Using the push-pause method b. Prior to and after blood draws c. Prior to and after medication administration d. Once a shift only if medications are infusing. e. A, B, and C f. All of the above