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Improving Nurses' Knowledge to Reduce Catheter-Related Bloodstream Infection in Hemodialysis Unit

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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,
and that any and all revisions required by
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November 2015

Abstract

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MS, Jordanian University, 1998

BS, Baghdad University, 1981

Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Nursing Practice

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Abstract

Central venous catheters (CVCs) are commonly used as vascular access for patients who require hemodialysis. Infectious complications are a serious clinical problem, and they are associated with high rates of morbidity and mortality, prolonged hospital stay, and increased medical treatment costs. The purpose of theproject was to evaluate the effectiveness of educating registered dialysis nurses regarding CVC maintenance care to reduce catheter-related bloodstream infection (CRBSI) in a hemodialysis unit. The project question focused on the educational program derived from the evidence-based guidelines recommended by the Centers for Disease Control and Prevention (CDC) to improve registered dialysis nurses' knowledge regarding CVC maintenance care. The theoretical foundation of the study was based on Donabedian's structure-process-outcomes model. In this project, nurses considered a structural element and used a self-study module to improve the process of providing CVC maintenance care. A paired-samples *t*test was conducted to compare knowledge scores of the participants in the posttest (n = 56) and knowledge scores of participants in the pretest (n = 57). The *t*test was significantly higher for the posttest than scores for the pretest. The results suggested a statistically significant improvement in the registered dialysis nurses' knowledge following the educational intervention. This study contributes to social change by identifying an educational intervention that helped improving nurses' knowledge in hemodialysis unit, thus helping hemodialysis patients stay safer and possibly reducing infectious complications.

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Dedication

I dedicate this paper to my wonderful wife, Um AlKadium, and my charming kids, AlZahra, Zainab, Kawther, Rahma, AlKadium, and Mesk, for their love and willingness to support my passion for writing this paper. I am so grateful to have you by my side as we continue through life's journey together.

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Section 1: Overview of the Evidence-Based Project

Introduction

Central venous catheters (CVCs) have become necessary components of hemodialysis patient care and might result in catheter-related bloodstream infections (CRBSIs). Complications associated with CVC use were known to increase patient morbidity, mortality, medical treatment costs, and length of stay (Jeong et al., 2013). Relatively little has been known about the costs and duration of stay associated with CRBSIs in the Sultanate of Oman.

Some studies provided estimates (O'Grady et al., 2002; Pronovost et al., 2010; Burden et al., 2012; Halton, Cook, Paterson, Safdar, & Graves, 2010). Many of these studies came from other countries and, therefore, might not be generalizable to the Oman population.

In general, the cost of CRBSIs in the hemodialysis unit was between $21,000 and $24,000 (National Healthcare Safety Network [NHSN], 2013). The annual cost to the health care system of CRBSIs in U.S. intensive care units (ICUs) was $296 million to $2.3 billion (O'Grady et al., 2002). National data from the U. S. Renal Data System showed that hospitalizations for CRBSI among hemodialysis patients had increased 47% since 1993 (NHSN, 2013).

CRBSIs occurred in 21% to 31% of hemodialysis patients, and it increased the duration of a hospitalization stay by 9 to 13 days (NHSN, 2013). Approximately 19% of hemodialysis patients died within 12 weeks of the infection. Eighty thousand CRBSIs

occurred in U.S. hospital ICUs nationwide, causing an estimated 28,000 deaths annually (Pronovost et al., 2010).

The risk factors that helped in the occurrence of CRBSI included the type of device, the insertion site, the adherence to preventive measures, and patient hygiene. Risk factors also include the previous CRBSI, recent hospitalization, and the duration of catheter use. Further risk factors include hypoalbuminemia, iron overload, *Staphylococcus aureus* nasal carriage, and the immune-compromised host (Han, Liang, & Marschall, 2010; Bisiwe, Van Rensburg, Barrett, Van Rooyen, &Van Vuuren, 2015).

One recent study found that an educational intervention program significantly increased nurses' knowledge regarding the care of the patient with CVC, thereby improving patient outcomes (Shrestha, 2013). However, although growing evidence suggested that these infections were preventable with evidence-based educational interventions, no studies had been conducted in hemodialysis units concerning CRBSI. The Centers for Disease Control and Prevention (CDC) are published guidelines for preventing CRBSI (CDC, 2011), which was the benchmark for all CVC care recommendations.

The guidelines referred to recommendations for hand hygiene, maximal sterile personnel protection equipment (PPE), chlorhexidine for skin preparation, catheter site dressing regimens, and the site chosen for catheter placement. Several studies had validated these factors in reducing CRBSI (Kim, Holtom, & Vigen, 2011). This study focused on the educational intervention.

The self-study module was developed to educate registered dialysis nurses regarding CVC maintenance care based on evidence-based guidelines recommended by the CDC to reduce CRBSI in the hemodialysis unit.

Problem Statement

CVCs are commonly used for vascular access in patients who required hemodialysis. Using CVC was usually associated with bloodstream infections because of skin breaks during insertion (O'Grady et al., 2011). CRBSI contributed to hospitalization and death in the hemodialysis population (Jeong et al., 2013).

Like many hospitals, the hemodialysis units had struggled with CRBSIs for many years. The efforts to treat this problem focused on treating infection with antibiotics or removing the catheter and replacing it with another one. A total of 148 bacteremic episodes were recognized in 102 patients. The CRBSI rate was 0.52 per 1,000 patient days. Of the 148 episodes, 28 were in patients with permanent tunneled central catheters (1.03/1,000 patient days) and 67 were in those with a temporary catheter (3.18/1,000 patient days).

The CRBSI ratio was 4.85 with a permanent CVC ($p < .001$), and 14.88 with a temporary catheter ($p < .001$). Catheter-related eposides totaled 41 (28%). Gram-positive organisms were responsible for 96 episodes (65%); the infection was polymicrobial in 14 episodes (9.5%). During hospitalization, 18 patients (18%) died. Septic shock ($p < .001$) and polymicrobial infection ($p = .041$) were associated with in-hospital mortality (Tozawa, Iseki, & Fukiyama, 2000; Fysaraki et al., 2013).

The need for more innovative strategies to tackle this ongoing, complex problem is a very critical issue. Significant attention was paid to CRBSI prevention; the priority of the Ministry of Health in Oman (MoH) was to maintain patient safety and reduce morbidity and mortality among patients. In the last few years, many attempts to stop CRBSI were done in different regions of the world, but in Oman, a limited published data regarding the incidence of CRBSIs in hemodialysis units.

The registered dialysis nurses were responsible for applying their knowledge to reduce infection episodes. Nonadherence to recommended evidence-based guidelines for preventing CRBSI could be due to nurses' lack of knowledge of the guidelines.Pravikoff, Tanner, and Pierce (2005) found that not every nurse was skillful in database searching to find the best evidence on the clinical issue.

Further, professional literature was not available to the nurses in the workplace. Also, the lack of time was regarded as a barrier to applying research to practice. Labeau et al. (2007) reported that nurses' knowledge deficiency showed as an obstacle to adherence to evidence-based practice.

An education intervention provided to healthcare providers on the prevention of CRBSI might lead decreased incidence of primary bloodstream infections.These education programs might also result in a significant reduction in the cost of medical treatment and patient morbidity if they are implemented on a mandatory basis (Warren et al., 2004).The focus of this study was to educate registered dialysis nurses regarding CVC maintenance care.

Purpose Statement and Project Outcomes

The purpose of this educational project was to evaluate the effectiveness of educating registered dialysis nurses regarding CVC maintenance care to reduce CRBSI in a hemodialysis unit. As a result of the educational intervention regarding CVC maintenance care, the following outcomes would be achieved:

- Registered dialysis nurses demonstrated an improvement in their knowledge regarding CVC maintenance care as evidenced by verbalize understanding the content of self-study module, and/or perform desired CVC maintenance care.
- CRBI rates decreased due to improvement in registered dialysis nurses' knowledge as evidenced by reducing CRBSI incidence rate in the hemodialysis unit by 50%.

Significance and Relevance to Practice

The study was the first nurse-led intervention project to seek to improve clinical practice in the hemodialysis units in Oman. It was important to assess the ability of nurses to create positive change in the practice. The continuous advances in technology increased the complexity of hemodialysis treatment and put patients at a higher risk for infection due to several etiologies related to chronic disease.

CRBSI increased the likelihood of mortality, cost, and length of stay (Cooper et al., 2014; Burden et al., 2012). Patients and families demanded evidence-based care to reduce risks and complications. The findings of this study were significant to MoH, hemodialysis units, clinicians, researchers, policymakers, patients, families, and nursing education institutions.

The registered dialysis nurses are dependent knowledge workers, and education plays a critical role in the quality of health care today. Improving nurses' knowledge results in nurses' high self-efficacy when providing CVC maintenance care, and it is important that nurses feel capable of providing evidence-based care.

The registered dialysis nurses with high self-efficacy structured the situation of hemodialysis treatment and affected patient outcomes. Hemodialysis patients were a unique population, and their survival depending on the quality of hemodialysis treatment and the responsibility of health care providers, particularly registered dialysis nurses. Patients put high trust in registered dialysis nurses who provided high-quality of care, and nurses might maintain that trust.

The financial costs impacted the quality of services. CRBSIs added a significant burden and increased risk of positive patient outcomes (Al-Lawati, Mabry, & Mohammed, 2008; Al Riyami et al., 2012). Prolonged hospitalization increased the costs to the MoH, and the resulting financial burden could affect resource allocation within the MoH, which operates on a finite budget. Cost containment and a reformed health care system have affected patient care.

Implementing and adhering to the CDC guidelines has helped reduce CRBSIs and has potentially freed up resources. MoH in Oman is concerned with the health of the population and provides universal coverage health services to the entire population. MoH continuously assesses the system to look for the effectiveness and safety of the services.

Nursing sensitive indicators, such as the incidence rates of CRBSI, were measures of efficacy in any dialysis unit. Educational intervention programs regarding CVC

maintenance care to reduce CRBSI incidence rate helped to improve the outcomes of hemodialysis patients.

In summary, CRBSI was a critical problem in the hemodialysis setting. Patient risks included increased length of stay, the risk of long-term complications, and even death. Systemic issues included increased expenses and the inability to meet quality and safety standards. For these reasons, preventing CRBSI is considered essential.

Project Question

The project question was: Will the education program for 1 month, based on the evidence- based guidelines recommended by CDC, improve registered dialysis nurses' knowledge regarding CVC maintenance care?

Evidence-Based Significance of the Project

Active CRBSI prevention required multiple interventions and adherence to evidence-based practices. Evidence-based guidelines published by the Society for Healthcare Epidemiology of America/Infectious Disease Society of America (SHEA/DSA) (2008), CDC (2011), and Agency for Healthcare Research and Quality (AHRQ) (2013) provided guidelines for best practices regarding prevention and monitoring CRBSI in hemodialysis units before, during, and after CVC care.Guidelines were used to reduce the discrepancies in the delivery of care and to ensure it was high quality and evidence-based care. Further, they provided a means by which registered dialysis nurses could be held accountable for clinical activities (Vanholder et al., 2010).

Implications for Social Change in Practice

The project could improve registered dialysis nurses' knowledge regarding CVC maintenance care. Registered dialysis nurses played a significant role in the hemodialysis treatment; they contributed to the preventive, promotive and curative aspects of the dialysis unit. The CVC maintenance care promoted when nurses used what they learned from the program.

The study considered as an opportunity to create a quality improvement project for the hemodialysis units. The study provided evidence for conducting studies to determine the rates of CRBSIs in hemodialysis units in Oman. The content of the educational program in this study could be appropriate for nursing education in nursing schools.

Participants in the study could be a role model and preceptors for other dialysis nurses. The study had relevance for the educational programs in healthcare institutions. The study could improve registered dialysis nurses' knowledge regarding CVC maintenance care that leaded to save lives, improve quality of care, result in better patient outcomes, reduces CRBSI rates,improve satisfaction for the nurses, physicians, clients, and their families, and was cost efficient to implement.

Definitions of Terms

For the purpose of this project, the following terms were defined below.

Catheter-related bloodstream infection (*CRBSI*): bacteremia/fungemia in a patient with an intravascular catheter with at least one positive blood culture obtained from a peripheral vein, clinical manifestations of infection (i.e., fever, chills, and/or

hypotension), and no apparent source for the BSI except the catheter.One of the following should be present: a positive semiquantitative (>15 CFU/catheter segment) or quantitative (>10^3 CFU/catheter segment catheter) culture, whereby the same organism (species and antibiogram) is isolated from the catheter segment and peripheral blood; simultaneous quantitative blood cultures with a > 5:1 ratio CVC versus peripheral; or a differential period of CVC culture versus peripheral blood culture positivity of >2 hours (Shah, Bosch, Thompson, & Hellinger, 2013, p. 144).

Catheter care bundle: a structured way of improving the processes of care and patient outcomes: a small, straightforward set of evidence-based practices — generally a set of five steps to help prevent "catheter-related bloodstream infections," deadly bacterial infections that can be introduced through an IV in a patient's vein supplying food, medications, blood or fluid. The steps are simple, common sense tasks: using proper hygiene and sterile contact barriers; properly cleaning the patient's skin; finding the best vein possible for the IV; checking every day for infection; and removing or changing the line only when needed (Institute for Healthcare Improvement, 2014, n. p.).

Central venous catheter (CVC): catheter inserted into a centrally located vein with the tip residing in the vena cava; permits intermittent or continuous infusion and/or access to the venous system. (Association for professionals in infection control and epidemiology, 2009, p. 30).

Dialysis nurses: registered nurses who are working in the nephrology nursing specialty, addressing the protection, promotion, and optimization of the health and well-being of individuals with kidney disease. These goals are achieved through the

prevention and treatment of illness and injury and the alleviation of suffering through the patient, family, and community advocacy (American Nephrology Nurses' Association, 2011, p.1).

Evidence-based practice guidelines: a set of systematically developed statements, usually based on scientific evidence, to assist practitioners and patient decision making about appropriate health care measures for specific clinical circumstances (Marquez, 2001, p. 5).

Knowledge: essential content or body of information for a discipline that is acquired through traditions, authority, borrowing, trial, personal experience, role-modeling and mentorship, intuition, reasoning, and research (Grove, Burns, & Gray, 2013, p.698).

Registered nurse (RN): a nurse who has graduated from an accredited school of nursing and has been registered and licensed to practice by state authority (Medical Dictionary, 2007, n. p.).

Self- directed learning:a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning,choosing and implementing appropriate learning strategies and evaluating learning outcomes (Knowles, 1975, p. 18).

Self- study module: Educational self-study format designed to provide information about CVC maintenance care (CDC, 2014, n.p).

Assumptions and Limitations

The project faced some limitations because the duration of the study was relatively short and small sample size. Participants' learning styles did not assess. In pre and post-intervention of this nonrandomized study, there was a possibility that changes in the registered dialysis nurses' knowledge might be due to the awareness that the outcome was being measured. The study carried out in a single hemodialysis unit. The results did not correlate with those from other groups with different populations and medical policies. Therefore, the results were not generalizable to any other population other than the population included in the sample.

The study sample selected from the registered dialysis nurses who were working in the largest hemodialysis unit in Oman. There were characteristics of this group that differed both individually and significantly from dialysis nurses working in hemodialysis units in other regions.

Summary

CVC infection was among the most frequent healthcare-associated infections and causes significant morbidity and mortality, as well as increased costs to the health care system.The section highlighted the dilemma of CRBSI and presented its significance for dialysis nurses. The importance of educating dialysis nurses was imperative.

Through this project, registered dialysis nurses would better understand the need for evidence-based guidelines regarding CVC maintenance care to prevent CRBSI. A literature review had performed before the project started to enhance the project methods and provide a context within which to evaluate the results. A literature review presented in Section 2.

Section 2: Review of Scholarly Evidence

The purpose of this section is to review literature relevant to educational interventions to reduce CRBSI in hemodialysis units. Also, the section highlights the search methodology and search results.

Search Methods

Literature was searched via the e-journals of the Walden University Library. Databases included the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, and MEDLINE, as well as Google Scholar (2009–2014). Relevant articles were retrieved and examined by reviewing the abstracts. The keywords used in the search included *CVC infection*, *educational intervention*, *nurses' knowledge*, *CRSBI educational intervention*, *CRSBI bundle*, *hemodialysis infection prevention*, the *impact of nurses' knowledge*, and *characteristics of nurses*.

Inclusion and exclusion criteria were developed to define the eligibility of studies to be included in the review. The search focused on selecting only studies that met the inclusion criteria. The literature was excluded if it did not meet any one of the inclusion criteria. 1The inclusion criteria included primary studies, text written in English, articles with full text available, studies with participants who were adult patients with CVC (aged 18 years and older), and articles on CVC infection and reported educational intervention. The exclusion criteria included only pediatric literature.

Review of Literature

After searching the electronic databases, 96 articles were retrieved. A selection of these studies was based on the inclusion and exclusion criteria, and 18 studies were

potentially eligible. The 18 studies fulfilled the selection criteria, and no relevant local studies (studies that were concerned with the analysis and solving of CRBSI nationally or regionally) were found.The following literature review consists of two sections: a general review of the literature and particular consideration of the literature.

General Review of the Literature

Boonma et al. (2014) conducted a target surveillance study to reduce the rate of CRBSI at Bangkok Hospital by using 2002 CDC evidence-based guidelines to prevent CRBSI. The result indicated that CRBSI incidence rate in 2010 approached zero per 1,000 catheter days. The study demonstrated the contents of educational intervention and method of education without indication of the duration and frequency of education. The study suggested that all healthcare personnel must take responsibility for preventing nosocomial infections.

Cooper et al. (2014) conducted a comprehensive epidemiological and economic review to estimate the additional costs and health benefits from introducing such interventions and the costs associated with CRBSI. A comparison was made between introducing an educational intervention with clinical practice and clinical practice without the intervention. The result showed that the educational intervention to prevent CRBSI improved patient life expectancy and reduced the overall costs.

Dumyati et al. (2014) conducted a prospective preintervention-postintervention study. The study was comprised three phases (preintervention [baseline], intervention, and postintervention) during a 4.5-year period (2008–2012). It implemented through a

collaborative of 37 adult non-ICU wards at six hospitals in the Rochester, New York, area.

The purpose of the intervention was to prevent CRBSI through engagement, education of nursing staff, and standardization of best practices for CVC care and maintenance. The educational intervention implemented during phase 2 through the computer-based educational module. Completion of the module mandated by each hospital and tracked electronically. More than 90% of nursing staff on the surveyed units completed the module.

Quarterly CRBSI rates compared during time about intervention implementation. The result indicated that the overall CRBSI rate for all participating units decreased from 2.6/1000 line-days preintervention to 2.1/1,000 line-days during the intervention and to 1.3/1,000 line-days postinervention, a 50% reduction (95% confidence interval, .40–.59) compared with the preintervention period (p = .0179).The authors noted that engagement and education of nursing staff on an evidence-based guideline for CVC maintenance resulted in a sustainable reduction in CRBSI rates outside the ICU in six diverse hospitals.The sample size was large which may increase the statistical significant of the data. The outcomes were clearly defined and the results of this study directly applicable to the patient. Confidence intervals are provided.

Abdelsatir (2013) conducted a descriptive study that included 50 Hemodialysis (HD) nurses practicing in Khartoum State. Nurses selected randomly from four HD centers. The purpose of the study was to evaluate nurses' awareness and practice of HD access care in Khartoum state, focusing on the application of proper hand hygiene and

HD access care. Data collected between July and September 2010 in two stages. Nurses' knowledge evaluated using a questionnaire filled by respondents, including items related to the benefits of hand washing, glove use, and HD access care.

Nurses' practice assessed by on-the-job monitoring of hand-washing, use of gloves and HD access care. The result showed that females composed 72% of study participants, and 85% were university graduates, and 50% of the participants had more than two years' experience in HD work. Structured training on HD access care received by 56%. The participants reported that proper HD access care helped prevent access infection, but only 54% indicated that it assisted in preserving access function. Nurses with a bachelor degree tended to be more adherent to hand hygiene (72.5 versus 42.9%, $p = .1$) and the use of gloves (100% versus 85.7%, $p = .1$) compared to nurses with a diploma degree, but the difference was not statistically significant.The outcomes were clearly defined, and the study suggested that HD units required organizing adequate training on HD access care for their nursing staff.

Chu, Adams, and Crawford (2013) conducted a project aimed to use a practice development framework derived from New South Wales 2009. The study addressed an appropriate and clearly focused question, and comparison of two consecutive 12 months was done to assess the effects of the practice development framework. The result indicated that rates of dialysis CRBSI have decreased from 4.39 per 100 patient-months to 3.42 per 100 patient-months ($p < .001$) 12 months after the implementation of the project. A statistically significant association existed between improved staff practice and infection outcome measures.

The potential confounding factors of the observed relationship between nurses' practice and CRBSI addressed adequately. The outcomes were clearly defined and the results of this study directly applicable to the patient. Confidence intervals did not provide.

Khanna et al. (2013) conducted a case-control study in the tertiary care hospital. The number of participants in this study was 50 cases and 50 controls.The purpose of the study was to identify catheter-related bloodstream infections, to isolate pathogenic microorganisms present in intravascular catheter-related local infections, exit site infections, and to determine the predisposing factors for the development of such infections and antibiotic sensitivity pattern of the isolated organisms in tertiary care hospital.The results indicated that the commonest premorbidity among the controls and patients with CRBSI were a renal failure (36% versus 36.4%) while that among the patients with local catheter infections was diabetes (28.2%).The study highlighted the increasing rate of CRBSI and helped in the better management of patients as well as in the prevention of nosocomial bloodstream infection, mainly due to multidrug-resistant organisms.

Aiken et al. (2011) conducted a cross-sectional study to measure the relationship between the levels of nurse-to-patient staffing, nurse work environment, nurse education and inpatient mortality and failure to rescue across 665 adult acute care general hospitals. The study addressed a clearly defined research question, and a comprehensive literature search carried out. Descriptive statistics provided to show characteristics of the study hospitals, and logistic regression models used to estimate the effects of nurse staffing,

nurse work environment, and nurse education on patient outcome. The result of this study was directly applicable to the patient and indicated positive effect of increasing percentages of BSN nurses was consistent across all hospitals, lowering the patient-to-nurse ratios markedly improves patient outcomes in hospitals with healthy work conditions. The study used appropriate methods to combine the individual research findings.

Apisarnthanarak et al. (2010) conducted a prospective quasi-experimental study, provided an educational intervention for nurses. The purpose of the study was to evaluate the long-term impact of bundled infection control practices on the reduction of CRBSI in a tertiary care center in Thailand. The results recorded in the first period, 88 episodes of CRBSI, and the CRBSI rate decreased by 54.1 %in the second period, and then 78% in the third period. The study focused on conducting the educational course periodically, and the components derived from CDC's Healthcare Infection Control Practices Advisory Committee's and WHO's hand hygiene guideline. The study supported the role of a bundle of care in achieving and maintaining a low incidence of CRBSI.

Guerin, Wagner, Rains, and Bessesen (2010) conducted surveillance for CRBSI by trained infection preventionists using National Health Safety Network case definitions and device-day measurement methods. The sample size was large; more than 1,000 and comparison of preintervention and postintervention performed to assess the effects of the post insertion care bundle on the incidence density for CRBSI. After the implementation of the interventions, 3 CRBSIs were recognized in a total of 2825-days, and the incidence density was 1.1 per 1000 catheter-days. The relative risk for a CRBSI occurred during the

postintervention period compared with the preintervention period was 0.19 (95% confidence interval, 0.06– 0.63; p = .004). In the study, the basic clinical characteristics of the patients in both periods were similar. The surveillance methods described clearly. The potential confounding factors of the observed relationship between catheter insertion and infections addressed adequately, for example, nurse-to-patient ratio and some critical steps of routine CVC care.

Kim et al. (2011) conducted an interventional study to evaluate the effectiveness of a CVC bundle in ICUs. An education program initiated by nursing staff and fellows in the ICU about CVC bundle as well as their importance. The result indicated that changing the CRBSI rate was better with the use of a CVC bundle that could improve patient care while reducing hospital stays, costs, and possible mortality (p = .05). The potential confounders explicitly addressed, for example, antibiotic use before the infection.

Marra et al. (2010) conducted a quasi-experimental pre and postintervention study to reduce the incidence of CRBSI in a medical-surgical ICU and two step-down units (SDUs). The result of the study indicated that the mean incidence density of CRBSIper 1000 catheter-days in the SDUs was 4.1 in period one and 1.6 in the period two at p =.005.In this study, the clinical characteristics of the patients in both settings were similar. The intervention methods described clearly. The potential confounding factors of an observed CRBSI addressed adequately, for example, nurse-to-patient ratio and some critical steps of routine CVC care. The study suggested that reducing CRBSI rates in an

ICU setting was a complex process and required multiple interventions that could apply to SDU settings.

Pronovost et al. (2010) conducted a collaborative prospective cohort study to implement and evaluate interventions to improve patients' safety in ICUs, predominantly in the U.S. state of Michigan. Intervention conceptual model used to develop clinicians' use of five evidence-based recommendations to reduce rates of CRBSI. The result showed there was a significant decrease in incidence rate ratios of CRBSI 0.68 (95% confidence interval 0.53– 0.88) at 0–3 months to 0.38 (0.26– 0.56) at 16–18 months and 0.34 (0.24– 0.48) at 34–36 months post implementation. The potential confounders did not address, for example, previous antibiotic therapy, and the sample size was large which may increase the statistical significant of the data.

Specific Review of Literature

Deshmukh and Shinde (2014) conducted a quasi-experimental study with the pretest –posttest design.The sample size for the study was 60 purposive sampling method by the investigator. The purpose of the study was to assess the impact of structure education on knowledge and practice regarding venous access device among nurses. The study conducted in three phases. The result showed that the structured education was useful in knowledge and practice of staff nurses regarding venous access device car. The sample size was not large enough; only30 in the control group and 30 in the case group; a small sample size may reduce the statistical significant of the data.

Pushpakala and Ravinath (2014) conducted a preexperimental study to inform the recommendations concerning the nursing care of the patient with CVC among staff

nurses working in ICU. The sample size was 50 staff nurses working in intensive critical care units, coronary ICU, and cardiovascular ICU. The result showed that a significant increase in the staff nurses' knowledge scores after the self-instructional module. The pretest mean score was 9.80%, and the average posttest score was 16.58% and the difference between pretest and posttest knowledge scores was 6.78%. The study indicated that the staff nurses in posttest were having an average of moderately 30% knowledge and adequate 70% of knowledge regarding the nursing care of patients with a CVC.The self-instructional module was useful in increasing the knowledge regarding the nursing care of patients with CVC among staff nurses. The potential confounder addressed, for example, the behavior changes and the compliance of personnel. The sample size was not large enough; a small sample size may reduce the statistical significant of the data.

Shrestha (2014) conducted a pre experiment study design (preintervention, intervention, and postitervention) to determine the effectiveness of the educational intervention in improving nurses' knowledge regarding the care of patients with CVC among nurses. Forty nurses selected by randomization sampling method to participate in the study. The results indicated that there was a significant difference between the preintervention and postintervention knowledge score (p = .039). The study showed that educational intervention program significantly improved the nurses' level of knowledge about the care of the patient with CVC. Overall, mean knowledge score between preintervention and postintervention was found to be significant. The outcomes were clearly defined and the results of this study directly applicable to the patient. Confidence intervals did not provide.

Bianco et al. (2013) conducted a cross-sectional self-administered survey, taking place from September to December 2008; the target population comprised health care workers (HCW) who insert CVCs and responsible for CVC management. The purpose of the study was to acquire information about the level of knowledge, attitudes, and frequency of evidence-based practices associated with insertion and maintenance of CVCs for the prevention of CRBSI. The anonymous self-administered instrument for data collection included questions designed to capture information in the following areas: (1) sociodemographic and practice characteristics, including queries about gender, age, ward of activity, position, and total number of years of practice; (2) knowledge, attitudes, and practice regarding evidence-based procedures associated with insertion and care of CVC for the prevention of CRBSI; (3) formal education received by HCWs and principal sources of information concerning CVC insertion, use, and care; (4) availability of written hospital policies regarding CVC management.

The result showed that correct answers about the knowledge of physicians and nurses ranged from 43% to 72.9% and were significantly higher in respondents who worked in ICU wards in hospitals that had a written policy about CVC maintenance and had active formal training. The study illustrated that written policies, formal training, and years of experience contributed to an increase in knowledge, practice and positive attitudes toward CRBSI prevention.The authors noted a lack of consistent adherence to the CDC guidelines.

El Nemr, Fahmy, El Razek, and El Salam (2013) conducted an educational intervention study in surgical and emergency ICUs. The patients with CVC, health care

providers, working in ICU enrolled in the study and the study performed at three periods. The results showed there was statistically significant improvement in physician practice post-intervention, and detected that implementation of simple education program promoted level of knowledge, and developed practice of healthcare providers as well as reduced CRBSI by 50% in ICUs during the period of the study. The patient characteristics were comparable across the study phases.

Parra et al. (2010) conducted an observational, preintervention and postintervention study during the period from February 2006 through August 2007 in 3 adult ICUs.The aims of the study were to analyze the effect of a single, evidence-based educational intervention on the incidence of CRBSI in ICUs with acceptable baseline frequencies and to assess the knowledge of standards for CRBSI prevention among healthcare workers in a large teaching hospital. Researchers gave 30 lectures, covering all shifts in all three ICUs. Six months after the educational intervention, 74 healthcare workers completed the postintervention tests. The mean duration of work experience among ICU staff was 8.9 years (95% CI, 7.8–10.1 years) for nurses and 8.1 years (95% CI, 5.3–10.8 years) for physicians. The results showed that the overall incidence of CRBSI in all 3 ICUs was significantly lower during the post-intervention period: 34 CRBSI episodes diagnosed during 11,582 CVC-days (2.94 episodes per 1,000 CVC-days) after the intervention.The outcomes were clearly defined and the results of this study directly applicable to the patient.

Summary

There had been a great deal of studies on CRBSI prevention, but the majority of them focused on the ICU setting and very limited on hemodialysis setting. Studies demonstrated many prevention strategies for CRBSI prevention particularly at the time of catheter insertion. Although, these strategies; the incidence rates were very high specifically in hemodialysis setting.

Studies reported critical interventions to reduce CRBSI, and the central theme was an education to health caregivers with continuous assessment of the competencies and barriers. Most of the studies had their research purpose or objective clearly stated, and some of them aimed to examine the effects of the intervention for preventing CRBSI. Outcome measures were entirely consistent with the reviewed studies. Studies provided evidence of effects of improving nurses' knowledge on reducing CRBSI. Some studies provided training modules to develop the required skills for health workers.

For CRBSI reduce, it was necessary to look at the evidence to support equipment that could leverage success with other efforts in infection prevention such as Chlorhexidine Gluconate (CHG) bathing or re-evaluation of dressing techniques. The greater part of the studies proposed that the educational intervention could improve or enhance nurses' knowledge in reducing CRBSI rates. An overlapping was present between educational and non-educational interventions because planning was unclear.

In all of the studies reviewed, preintervention data about the CVC maintenance care considered acceptable for the time leading up to the educational intervention. One could no longer at once accept the practice as usual for CRBSI prevention. Based on the

evidence, there understood about any intervention to prevent CRBSI was better than no intervention at all. The individual studies and evidence-based guidelines may serve as a guide, and the responsibility of dialysis nurses was to implement these guidelines successfully to reduce CRBSI to improve safety and quality for CVC dependent patients.

In conclusion, this section had reviewed the evidence regarding CRBSI reducing and had identified the gaps in the literature. A project designed to address the disparities in the literature and to build on the work of the previous studies. A lack was in the literature relevant to hemodialysis unit. The majority of reviewed literature provided promising evidence regarding the effect of educational and/or intervention programs directed at ICU doctors and nurses on the theoretical knowledge of prevention of CVC-related infections.

Theoretical Framework

The conceptual framework for this project based on Donabedian's model (Figure 1). The components of the model were structure, process, and outcome. Donabedian (1997) explained that the structure denoted the attributes of the settings in which care occurs. This included the characteristics of material resources (facilities, equipment, and funds), human resources (medical staff and qualifications of dialysis nurses), and organizational structure (leadership style, and policy of reimbursement).

The process was defined as the actual action in providing care. It included a nurse's activities in making a diagnosis and recommending or implementing treatment. The concept of outcome referred to the consequences of a nurse's knowledge of the health status of dialysis patients.

The evidence supported the linking between nursing care (process) and patient outcomes (Duffy & Hoskins, 2002, Deshmukh & Shinde, 2014). The inference was that the three-part approach to quality assessment was possible only because significant structure increases the likelihood of proper process, and the right process increases the likelihood of good outcomes (Donabedian, 1988). Using Donabedian's framework to improve the process also affected the outcomes.

In this project proposal, nurses were regarded a structural elements and used a particular education intervention to improve the process of providing the CVC maintenance care, improving the outcomes by reducing catheter-related bloodstream infection. It was important to identify the literature that supported the particular characteristics identified in Donabedian's structure-process-outcomes model when providing the CVC maintenance care. The structural component of Donabedian's model focused on characteristics of registered dialysis nurses, patients, and dialysis unit characteristics.

The process components included those specific interventions of care practices that dialysis nurses provided; in this project, it included the CVC maintenance care. Outcomes were the effects or results of the health care process (Duffy & Hoskins, 2003).

In this project, the data collected about nurse characteristics include age, gender, education, years of experience, infection control training, and hours worked. Then the characteristics listed above analyzed and evaluated to determine their effects on registered dialysis nurses' knowledge. Using Donabedian's framework allowed us to define and identify variables as they related to the structure-process-outcomes model.

Structure Component-Nurse Characteristics

The recent studies supported particular nurse characteristics as they related to health outcomes. The specific features included nurse education and years of experience. An increase in the percentage of nurses with higher educational degrees decreased the risk of mortality and failure to rescue (Aiken, Clarke, Sloane, & Silber, 2003). Aiken et al. (2003) found "each 10% increase in the proportion of nurses with higher degrees decreased the risk of mortality and failure to rescue by 5%" (p.1617). Tourangeau, A. (2002) described an association between nurses' experience and patients' death, suggesting nursing units with more experienced nurses provide higher-quality care (Blegen, Vaughn & Goode, 2001). The quality of nurse communication was higher on units where nurses had a higher level of education (Doran, Sidani, Keatings, & Doidge, 2002).

Structure Component-Patient Characteristics

The literature identified numerous risk factors that associated with increasing patients' risks of CRBSI. In an article published the most common risk factors that increased bloodstream infection included increasing severity of illness, integrity of the skin, and presence of distant infection recently (Shah, Bosch, Thompson, & Hellinger, 2013).

Process Component- CVC Maintenance Care

The process component of Donabedian's model involved interventions or practices that registered dialysis nurses offered (Duffy & Hoskins, 2003). The project

focused on the effect of the CVC maintenance care on patient outcomes. A catheter care bundle included educational and noneducational interventions to prevent CRBSI.

The bundle contained the five elements of evidence–based guidelines for CRBSI prevention: hand hygiene, use of maximum sterile barriers with catheter maintenance, use of chlorhexidine for skin preparation, avoiding use of the femoral and jugular sites for catheter insertion, and prompt removal of unnecessary catheters(Rinke et al., 2012).

Self-Directed Learning

Self-directed learning (SDL) was an essential skill for nurses to meet the challenges in today's healthcare environment. In SDL, learners took the initiative and responsibility in using learning resources (Ramnarayan and Hande, 2005). The aim of SDL was to develop the skills and acquire new knowledge. The concept supported the intervention of the project that in turn helped the process that defined by Donabedian's framework.

In the conclusion, this section reviewed the existing literature on research related to educational intervention to improve nurses' knowledge regarding the CVC maintenance care in a hemodialysis unit. Also, the section discussed the conceptual framework for this project. The theoretical framework of Donabedian regarding structural, process and outcomes presented and served as a basis for the development of the educational intervention.

Using Donabedian's framework, improving the process also affected the outcomes. In this project, nurses were considered as a structural component, and the educational intervention as part of the process. A self-study module utilized to improve

registered dialysis nurses' knowledge. The method used to carry out the project prescribed in Section 3.

Section 3: Methodology

Project Design and Methods

The project used a pretest-posttest educational intervention design. This design helped investigate the effectiveness of a nursing intervention in achieving the desired outcome in a natural setting (Grove, Burns, & Gray, 2013). The purpose of the educational intervention was to improve the knowledge of the registered dialysis nurses regarding CVC maintenance care. I contacted the nurse manager of the hemodialysis unit to discuss the recruitment of the registered dialysis nurses who met the inclusion criteria.

The manager introduced me to the staff working in the hemodialysis unit, and I verbally announced in the hemodialysis unit inviting all registered dialysis nurses for voluntary participation in the current study. I communicated privately with participants at convenient times in the dialysis unit.

I provided verbal information about the significance and the purpose of the study, and I explained what the subject would be asked to do,the time commitment needed, the name and address of the investigator, the setting of the project, and the name of the person to contact for further information. I did not have any influence on the employment of the participants, and they had their nursing manager for supervisory functions. No element or hint of coercion existed. It was a meeting for only providing information and clarifications.

The plan for implementing the educational intervention was shared with the hemodialysis unit and a signed approval was obtained on September 15, 2014 (Appendix E). The hemodialysis unit provided excellent support to facilitate the implementation of

the educational intervention. A committee made up of an infection control nurse, a staff development nurse, a statistic nurse, and the medical director of the hemodialysis unit was provided for administrative assistance to the investigator during the period of the study. The educational program was implemented after obtaining the approval of the Institutional Review Board (IRB) at Walden University. The study conducted in three phases.

In Phase I, a discussion session was approximately 30 minutes in duration, held in the conference room. The conversation encompassed information regarding the study purpose, method, required time commitment, potential risk/benefits, contact information for the investigator, and knowledge that participation was voluntary. Following the discussion, I provided each participant with a randomized study number to use throughout the study to maintain confidentiality.

Each participant was given an envelope with the information letter and a demographic sheet. The information letter informed the participants that the proposed study had approved by the Walden University's IRB. The IRB was responsible for ensuring that all Walden University research complied with the university's ethical standards.

IRB approval was obtained before collection of any data. Walden University did not accept responsibility for research conducted without the IRB's approval. Also, the university did not grant credit for any student work that failed to comply with the policies and procedures related to ethical standards in research.

The study participants were asked to read and sign the informed consent form. No time limitation for completing the demographic sheet; however, 5 minutes was a sufficient amount of time for completion. Each participant was instructed to put their study number on the demographic sheet and to return it, sealed in the envelope provided, whether or not the questionnaire was completed. This process allowed participants to respond without disclosing participation to others in the room.

The envelopes were placed in a collection box and kept in a locked cabinet in my office in a more secure and confidential location because the investigator was the only the person who knew the details of the office and can access it easily.

The study conducted on active hemodialysis unit, therefore, the participants shared in the scheduling of the pretest, the educational intervention, and posttest to minimize scheduling difficulties. The pretest session was held at the conference room in a hemodialysis unit, and 57 participants completed the survey. The participants allowed 30 minutes of their working hours; their patients and other duties were assigned to other staff while they were taking the test. The test time was organized by the manager of the dialysis unit in collaboration with the investigator. I distributed the questionnaires to the study participants.

I collected all the envelopes, placed them in a collection box, and kept them a locked cabinet separately from the completed demographic sheets in the investigator's office. I performed the task of the test grading to avoid placing the data at risk particularly the confidentiality. The test grading was manual. The quantitative data coded,

entered, and analyzed using IBM SPSS Statistics for Windows (Version 20.0. Armonk, New York: IBM Corp).

In Phase II, an educational lecture delivered, and the self-study module distributed. The duration of this stage was 30 days to allow participants sufficient time for completing the self-study module. The education program consisted of a one-hour lecture and the administration of the self-study module.

I presented a one-hour lecture using a PowerPoint demonstration (Appendix I). The learning objective was to improve registered dialysis nurses' knowledge regarding CVC maintenance care to prevent Catheter Related-Bloodstream Infection (CRBSI) in a hemodialysis unit. The content outline included an explanation of the following subheadings from the CDC evidence-based clinical practice guidelines to prevent CRBSI:

- The learning objectives.
- Introduction.
- The incidence of infections with central lines.
- Statistics for CRBSIs.
- The impact of vascular catheter-related BSI.
- Definition of a central line.
- Central lines cause bloodstream infections.
- Sources of CRBSIs.
- Pathogenesis.
- Clinical features of catheter sepsis.
- Prevention of CRBSI.

  - Hand hygiene.
  - Maximal patient barrier.
  - Chlorhexidine.
  - Subclavian vein.
  - Hub/clave.
  - Dressing changes.
  - Line necessity.
  - Daily review of line necessity.
- Intrinsic and extrinsic risk factors for CRBSI.
- CRBSI criteria.
- Provide optimal care for IV injection ports.
- Conclusion and references.

The hemodialysis unit oversaw the quality of the lecture content. Views and opinions expressed were those of the investigator and did not necessarily represent the views and policies of the hemodialysis unit. I did not disclose any conflicts of interest about this presentation.

Phase 3 included the assessment of nurses' knowledge regarding CVC maintenance care after the education intervention.The posttest occurred approximately one month following the pretest phase with the 56 completed surveys (N = 56). The allocated time of the test was 30 minutes. The participants allowed 30 minutes of their working hours; their patients and other duties assigned to other staff while they were taking the test.

I distributed the post-test questionnaire. For the posttest, each participant was given an envelope containing the survey. The questionnaire was identical to the pretest. Each participant asked to return the questionnaire to the investigator sealed in the provided envelope, whether they completed the survey or not. The participants instructed to use same study number on the posttest questionnaire. I collected the completed questionnaires, graded each test manually, and stored in a locked cabinet separately. The quantitative data coded, entered, and analyzed using IBM SPSS Statistics for Windows (Version 20.0. Armonk, New York: IBM Corp).

Topics that covered in the pretest, posttest, and self-study module included (a) the epidemiology of CRBSI, (b) aseptic technique; the use of maximal barrier precautions during CVC maintenance care, (c) the need to avoid femoral insertion sites, (d) proper technique for obtaining blood cultures, and (e) guidelines for changing dressing. The investigator developed the self-study module and reviewed by the medical director of the hemodialysis unit.

The self-study module discussed the necessary knowledge that was needed for a competent registered dialysis nurse when working with CVCs. The module covered the most common types of CVCs short-term and long-term. The emphasis was undertaken signs and symptoms, CRBSI definition according to CDC/ NHSN surveillance definition, potential routes of infection, modifiable risk factors for CRBSI, and CRBSI prevention measures based on CRBSI bundles.

Implementation of care bundles could reduce CRBSI. A care bundle was a grouping of best practices that individually improve care and when applied together

results in greater improvement. Every component of the bundle was essential and indispensable. The CRBSI bundle consisted of five essential elements: (a) hand hygiene;(b) maximal sterile barrier precautions including large sterile drape, sterile gown and gloves, mask, and a cap;(c) selection of optimal catheter insertion site with avoidance of the femoral vein for access in adults; (d)chlorhexidine skin antisepsis; and (e) daily review of the line necessity and prompt removal of unnecessary lines.

The participation in this study was voluntary. A convenience sample of the registered dialysis nurses in the hemodialysis unit utilized. The expected outcome of this educational intervention was improving the knowledge about CVC maintenance care.

The participants answered a 25-question pretest; the same questions answered as a posttest after completing a self- study module. There was a 25-question posttest of knowledge regarding CVC maintenance care (Appendix A). There was seven question demographic questionnaires.

I developed the demographic questionnaire to collect data about nurses' age, gender, the level of education, years of experience, infection control training, and the amount of hours the nurse works. The participant filled out the demographic sheet before starting the educational program (Appendix B).

Instruments

I developed a 25-question knowledge-based pre- and post-assessment tool. Each correct answer carried one score; the total scores were 25. The level of knowledge score converted into a percentage, and overall adequacy of knowledge graded according to the following criteria: if the score was > 75%: high level of knowledge, if the score was 50%

to 75%: moderate level of knowledge, and if the score was < 50%: inadequate level of knowledge.

The reliability of test scores estimated from a single administration of a test using Kuder-Richardson Formula 20 (KR20). The experts assessed the content and face validity. Furthermore, the quantitative method of determining test validity used by reviewing the discrimination of each item.

Internal Consistency Reliability

The reliability of test scores estimated from participants' responses to the items on the pretest. Kuder-Richardson Formula 20 (KR20) and Cronbach's coefficient alpha used to verify the internal consistency of a 25-question knowledge-based questionnaire. Table 1 showed the descriptive statistics for Cronbach's alpha. In this statistical method, the variance for each item and the variance for the total scores computed.

Table 1

Descriptive Statistics for Cronbach's Alpha

M	Variance	*SD*	Cronbach's alpha	No. of items
13.84	16.85	4.10	.67	25

All the items in the questionnaire scored1 if the answer was right and 0 if the answer was wrong or missed. The reliability coefficient should be greater than .70 (Grove, Burns, & Gray, 2013; Polit and Beck, 2010). The result showed a positive correlation of the items α = 0.667, indicated accepted internal consistency reliability because the investigator designed the tool; it had not tested previously. Grove, Burns, & Gray (2013) reported "the new instruments might have internal reliability from 0.60 to 0.69" (p. 392). Table 2 presented the Cronbach's alpha for the 25-items of the knowledge-based questionnaire.

The item-total correlation investigated, and the associations of items 5, 6, 8, 9, and 24 with the overall test is −.141, −.071, −.013,−.087, and −.064, while all other items correlate at .63 or better. By considering the alpha if deleted, the reliability of the scale (alpha) would increase to .759 if these items removed (Polit, 2010). Thus, the overall knowledge-based questionnaire Cronbach's alpha considered satisfactory.

Table 2

Cronbach's Alpha for the Knowledge-Based Questionnaire

Questions	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
Q1	14.25	14.939	.342	.647
Q2	14.25	16.189	.013	.677
Q3	14.21	14.633	.438	.638
Q4	14.23	15.251	.261	.654
Q5	14.37	16.808	−.141	.691
Q6	14.21	16.526	−.071	.684
Q7	14.28	14.598	.429	.638
Q8	14.47	16.289	−.013	.679
Q9	14.33	16.583	−.087	.687
Q10	14.23	14.858	.369	.644
Q11	14.37	14.808	.365	.644
Q12	14.23	15.393	.222	.658
Q13	14.25	14.403	.492	.632
Q14	14.44	14.715	.397	.641
Q15	14.21	14.348	.521	.629
Q16	14.19	15.587	.178	.662
Q17	14.21	14.955	.347	.646

(table continues)

Questions	scale mean if item deleted	scale variance if item deleted	corrected item-total correlation	Cronbach's alpha if item deleted
Q18	14.18	14.790	.408	.641
Q19	14.28	16.206	.007	.678
Q20	14.35	15.946	.069	.672
Q21	14.16	14.992	.357	.646
Q22	14.16	15.314	.264	.654
Q23	14.18	15.504	.205	.660
Q24	14.18	16.504	−.064	.683
Q25	14.44	14.822	.368	.644

Expert Validation

Test for face and content validity was important to appreciate whether the relevance and clarity of items covered the material that it supposed to measure. Before conducting the intervention, the self-study module and questionnaire handed to a team of three experts for face and content validation. Each expert had at least ten years of experience in nursing education and a master's degree in nursing sciences.

The experts together decided to employ Content Validity Index (CVI) to calculate the validity score for the questionnaire and self-study module. The CVI developed to obtain a numerical value that reflects the level of content-related validity evidence for a measurement method (Grove, Burns, & Gray, 2013). Consistent with the experts' desire, the investigator designed an evaluation form about relevance and clarity and emailed it to the experts for calculating the CVI. Each expert rated each item independently.

To achieve face validity, experts asked if all questions clearly worded and would not be misinterpreted.For the nursing relevance of all items, the experts marked an "X" to the most appropriate score, 1 = not relevant; 2 = appropriate but not necessary, and 3 = necessary.

The experts decided to sum only the items scored "3" the percentage of agreement with all items. The CVI for the instrument was the percentage of the total items rated as a three (Zamanzadeh et al., 2014; Yaghmale, F., 2009). However, an acceptable level of experts' agreement value greater than or equal to 0.80 (Zamanzadeh et al., 2014), the computed CVI achieved 0.88. It was higher than the minimum CVI of 0.80.This result

ascertained the content of the questionnaire was appropriate and relevant to the study purpose. See Appendix G.

Item Analysis

The results of the participants' accomplishment in the pretest utilized to assess the quality of the items through measuring the difficulty index and discrimination index of each multiple choice questions and True/False questions. The item difficulty index calculated as the percentage of participants that correctly answered the item (Sabri, 3013; Oluseyi et al., 2012; Instructional Assessment Resources, 2011; Labeau et al., 2010; Mitra et al., 2009). It calculated using the formula P = R/T, where P was the item difficulty index; R was the number of participants who got an item correctly, and T was the total number of who answered it (Instructional Assessment Resources, 2011; Labeau et al., 2010).

The item considered difficult when the difficulty index value was below 0.20, and the item found to be easy when the index value was above 0.90 (Instructional Assessment Resources, 2011).The item discrimination index measures the power of test item to distinguish between participants who were knowledgeable and those who were not. The Point-Biserial (PBS) used to measure discrimination coefficients (Instructional Assessment Resources, 2011; Sabri, 3013; and Grove, Burns, & Gray, 2013).

The correlation, commonly known as Pearson's product-moment correlation (Grove, Burns, & Gray, 2013) computed to determine the relationship between participant's performance on each item and their overall test scores. The Statistical Package for the Social Sciences (SPSS) version 20 utilized to compute the discrimination

coefficient, the Pearson, *r* for each item. The Pearson, *r* coefficient ranges from –1.00 to 1.00 (Instructional Assessment Resources, 2011*;* Mitra et al., 2009). An extremely discriminating item revealed that participants with high score got the item right, and participants with low score answered the item incorrectly.

In general, values for the item, the difficulty was moderate with values ranging between 0.39 and 0.72. Values indicating the quality of the response alternatives ranged from 0 to 16, thus demonstrating an overall good quality. Sixty-four percent of the items showed to discriminate adequately between low scores and high scores in a good to very good way. Table 3 provided the results obtained from the analysis of the item difficulty index and item discrimination coefficient.

The experts conducted the analysis process and unanimously declared the outcomes of the content and clarity. The investigator's responsibility was to ensure that data analysis was suitably treated e.g. anonymized and in a format suitable for sharing.

I developed the demographic tool. It was a questionnaire that addressed the demographic data of the participants, which included age, gender, level of education, years of experience, infection control training, and the amount of hours the nurse works.The responses kept confidentially.

Table 3

Item Difficulty, Discrimination Coefficient, and Response Frequency Distribution of Items

Item No.	Item difficulty	Discrimination coefficients	Response frequency distribution					
			A	B	C	D	E	F
Q1	.61	.18	22	35*				
Q2	.61	.09	22	35*				
Q3	.65	.50	20	37*				
Q4	.63	.50	2	5	7	7	36*	
Q5	.49	−.26	4	6	7	28*		9
Q6	.65	.13	5	6	9	37*		
Q7	.58	.25	33*	34				
Q8	.39	.17	11	22*	9	12		
Q9	.53	.00	30*	0	0	25		
Q10	.63	*.29*	21	36*				
Q11	.49	*.28*	4	7	28*	16		

(table continues)

Item No.	Item difficulty	Discrimination coefficients	Response Frequency Distribution					
			A	B	C	D	E	F
Q12	.63	.24	36*	21				
Q13	.61	.56	35*	22				
Q14	.42	.21	8	24*	0	7	6	12
Q15	.65	.46	9	6	37*	4		
Q16	.67	−.18	38*	19				
Q17	.65	.29	37	20				
Q18	.68	.47	39*	6	6	6		
Q19	.58	−.26	24	33*				
Q20	.51	−.12	28	29*				

(table continues)

Item No.	Item difficulty	Discrimination coefficients	Response frequency distribution					
			A	B	C	D	E	F
Q21	.72	.14	17	40*				
Q22	.70	.19	40*	17				
Q23	.68	.23	39*	18				
Q24	.68	−.07	39*	18				
Q25	.42	.48	33	24*				

Note. Items mark with * indicates the correct answers.

Data Collection

The plan for collecting data included the procedures to collect data, the required time, and the cost. Then data collection forms developed to facilitate data entry. Also, the codebook prepared to help in coding the variables to be entered into a database.Moreover, the Institutional Review Board (IRB) approval secured prior to any data collection. Prior data collection, the demographic data sheet designed to record the demographic data. The data collected in raw form at the time of collection and then coded.

Coding was the process of transforming data into numerical symbols that entered quickly into the computer. The codebook developed before initiating data collection. The codebook identified and defined each variable in the study. Variable gender categorized and gave numerical labels; the male identified by a "1" and the female category by a "2". Variable education level identified by a "1" for Basic Diploma in general nursing, a "2" for Nephrology NursingDiploma and a "3" for BSN. Variable infection control training course categorized and gave numerical labels, Yes category identified by a "1" and No category identified by a "2".

A master list of participants and their code numbers developed and stored in a separate location and encrypted in an electronic file as well as they locked in a file drawer to ensure the participant's privacy.The investigator handled coding the data. The data collection forms and questionnaire put together in a booklet to minimize the likelihood that a questionnaire or forms missed.

All the data from a single participant kept together until analysis initiation. The Participant's study number wrote on each form, and the forms checked to ensure that they present. Furthermore, the database backed up and stored on an encrypted flash drive to avoid loss of all data due to the computer crashing. The study completed on the participants' time during work hour.

The timeline for the educational intervention described in Table 4. The schedule involved the conducting of the pre, posttest data, and collecting participants'demographic data. The practical and operational responsibility for study data throughout the life cycle of the project was in the hands of the investigator. The investigator held the responsibility of distributing the pre/ post instruments to ensure the data management plan had accomplished successfully in the dialysis unit.

Table 4

Timeline for Educational Intervention

April 9 –April 14	I contacted the nurse manager of hemodialysis unit to discuss the recruitment of the registered dialysis nurses who met the inclusion criteria. The manager introduced me to the staff working in the hemodialysis unit, and I verbally announced in the hemodialysis unit invited all the registered dialysis nurses for voluntary participation in the current study. I communicated privately with participants at convenient times in the dialysis unit. I provided verbal information about the significance and the purpose of the study, explained what the subject would be asked to do, the time commitment, name and address of the investigator, setting of the project, and the name of the person to contact for further information
April 15–April 21	Informed consent distribution Collected the demographic data Performed the pretest to assess participants' knowledge regarding CVC maintenance care preintervention.
April 16–May 15	Delivered the educational lecture for one- hour, and distributing the self-study module, the duration of this phase was 30-days to allow participants sufficient time for completing the self-study module.
May 16	Performed the posttest to assess the impact of the educational intervention on participants' knowledge postintervention.

Data Analysis

Descriptive statistics, including percents, means, and standard deviations used to identify the predicted relationships between the nurses' knowledge of the evidence-based guidelines and demographic variables (age, gender, years of experience, level of education, infection control training). The *t*tests conducted to analyze the pretest and posttest results of the 25- questionnaire of knowledge regarding CVC maintenance care at p <.05% by using IBM SPSS Statistics for Windows (Version 20.0. Armonk, New York: IBM Corp).

Protection of Human Subjects

The study conducted in accordance with the Walden University Institutional Review Board as well as the Research and Ethical Review & Approve Committee (RERAC) Directorate of Research and Studies in the MoH in the Sultanate of Oman.The preparation via Walden University completed regarding protecting human subjects in the study.

The participants' privacy and confidentiality are maintained. Informed consent obtained. The informed consent form contains all relevant material, including purpose, background, procedures, benefits, risks, and the right to refuse or withdraw, confidentiality, and any contact information. Collected data coded with numbers one to 60 for nurses and entered without any verifying information into a computerized database available only to the investigator.

The consent forms kept in a locked file cabinet. Prior to implementing the intervention, permission from RERAC was obtained, and approval from the IRB at

Walden University # 04-10-15-0420516 was also obtained. See Appendix E and Appendix F.

Project Evaluation Plan

The evaluation was a systematic investigation of the value and significance of the project. It facilitated recognizing the progress and effectiveness of the project. The purpose of the evaluation plan was to provide information for actions such as educational program adjustment, decision-making, reporting and problem-solving. It presented the entire picture of the project, including insight into the relationships between educational intervention and outcomes.

Project evaluation assessed all the activities that were designed to achieve the purpose of the project. The impact of the educational intervention measured by comparing the pre-test and posttest dialysis nurses' knowledge scores about CVC maintenance care. Feedback was a critical part of the evaluation process to ensure that the results of evaluations were used for the program expansion and sustaining.

For this reason, feedback mechanisms established, for instance, seminars and workshops, and follow-up procedures of CVC maintenance care. Informal means such as networking and internal communications used for the dissemination of evidence-based guidelines and information on CVC maintenance care to promote registered dialysis nurses' knowledge and keep them updated.

Summary

A convenience sample of the registered dialysis nurses in the hemodialysis unit was utilized. A pretest–posttest educational intervention design. Sixty registered dialysis nurses were surveyed prospectively for knowledge regarding CVC maintenance care. Intervention: A self-study educational module was developed based on CDC guidelines to highlight correct practices for the prevention of catheter-related bloodstream infection. The program consisted of a 25-page self-study module on risk factors and practice modifications involved in catheter-related bloodstream infections, and one-hour lecture. Each participant was required to complete a pretest before reviewing the study module and an identical test after completion of the study module. The posttest occurred approximately 1 month following the pretest phase.

Section 4: Findings, Discussion, and Implications

Summary of Findings

The section demonstrated and examined the results of the demographic characteristics, and knowledge-based questionnaires. Also, the section summarized the central concepts and findings arising from the present study. The target population of the study was registered dialysis nurses who employed full-time in the hemodialysis unit and provided CVC care daily between April and May 2015. For the purpose of the study, the population included only registered dialysis nurses who completed both the pretest and the posttest.

The population was (pretest N = 57; posttest N = 56). As displayed in Table 5, from the population surveyed, almost all participants, 93% were women, and 7% were men. The study participants asked to provide their age. As displayed in Table 5, the reported years of age ranged from 23–50 years. Using the study year (2015) and the mean (*SD*) age of participants estimated at (M = 30.75 years, SD = 7.27) for the entire sample, (M = 33 years, SD = 6.58) for the men, and (M = 30.58 years, SD = 7.35) for the women.

The information on the participants' level of education showed in Table 5. It demonstrated that the most predominant level of education was Basic Diploma in general nursing. The distribution of education level was Basic Diploma in general nursing (n = 36, 63.2%), specialized nephrology nursing diploma (n = 19, 33.3%), and BSN (n = 3.5%).

Table 5

Distribution of the Study Participants (N = 57)

Variables	Frequency (n)	(%)
Sex		
Men	4	7
Women	53	93
Age		
22 -27years	18	31.6
28 - 32 years	15	26.3
33 years and above	24	42.1
Level of Academic Qualification		
Basic Diploma in General Nursing	36	63.2
Specialized Diploma in Nephrology Nursing	19	33.3
BScN	2	3.5
Years of experience as a registered dialysis nurse		
1 -5 years	20	35.1
6- 10 years	22	38.6
11 years and above	15	26. 3
Completion Infection Control Course		
Yes	22	38.6
No	35	61.4

The participants asked to indicate how many years of hemodialysis nursing experience they had. The distribution of the participants' years of experience as a registered dialysis nurse showed in Table 5. It explained that a large portion of the participants 35.1% had less than five years of dialysis nursing experience.

They completed their Basic Diploma in general nursing recently without having the sufficient experience of caring for patients depend on CVC. They were only Nursing Diploma holders, and they did not prepare to deliver hemodialysis care. Additionally, it revealed that only 26.3% of participants had greater than 10 years' experience in hemodialysis nursing. This was a significant feature of the study participants, but that group of participants considered as experienced undergraduates.

The *t*test is a parametric analysis technique, used to determine significant differences between measures of two samples. The *t*test analysis techniques exist for dependent and independent groups (Grove, Burns, & Gray, 2013; Polit, 2010). A one-sample *t*test run to determine whether the male nurses' years of experience was different to the female nurses.

Men (M = 9.25 years, SD = 6.45) was longer than women (M = 7.41 years, SD = 5.43), a statistically significant difference of 1.84 (95% CI, 5.85 to 9.23), $t(56) = 8.95$, $p = < .001$. However, the number of work experience as a registered dialysis nurse for the entire sample was (M = 7.54, SD = 6.36) did not significantly differ from men and women. Table 6 summarized participants' work experience as a registered dialysis nurse.

Table 6

Years of Experience as Registered Dialysis Nurse

	N	*Minimum*	*Maximum*	*M*	*SD*
Men experience years	4	5.00	17.00	9.25	5.44
Women experience years	53	1.00	31.00	7.41	6.45

Hemodialysis unit used to conduct infection control course for a short period 1-3 days from time to time to prepare the registered dialysis nurses to prevent and monitor the spread of infection. The content of the course covered using the current knowledge of the chain of infection, standard precautions, and transmission-based precautions and work practice controls.The registered dialysis nurses who completed the course earned a certificate of completion for this continuous education (CE) activity. The information provided in that course used for educational purposes only. It did not intend as a substitute for the professional health care.

The participants asked to indicate if they had ever received formal or informal training in infection control. Table 7 presented the analysis of this data. The participants reported only 22(38.6%) took infection control training course. A small proportion of participants with a Basic Diploma (n = 9, 25%) indicated they took infection control training course compared to the participants with specialized nephrology diploma.

Table 7

Participants' Completion Infection Control Training Course

		Obtaining infection prevention course		Total
		yes	No	
Level of Education	Basic Nursing Diploma	9	27	36
	Specialized Nephrology Diploma	11	8	19
	BSN	2	0	2
Total		22	35	57

The analysis performed to determine the results of the registered dialysis nurses' knowledge regarding CVC maintenance care. The knowledge-based questionnaire conducted into two phases, pretest, and posttest. The pretest scores ranged from 36 – 68 (M = 52.17, SD = 9.36). (See Table 8). It determined that 46% of participants in this study rated their knowledge as being inadequate, with 54% rating their knowledge as a moderate level of knowledge. Table 9 showed none of the participants rated their level of knowledge as high.

Table 8

Descriptive Statistics Scores for Knowledge of Evidence-Based Practice for the CVC Maintenance Care Among Participants

Characteristics	*N*	*Minimum*	*Maximum*	*Range*	*M*	*SD*
Pretest	57	36	68	32	52.17	9. 63
Posttest	56	44	80	36	60.85	9.04

Table 9

Participants Knowledge Level on the Pretest

Level of Knowledge	*n%*
> 75%: high level of knowledge	0%
50% to 75%: moderate level of knowledge	54%
< 50%: inadequate level of knowledge	46%
Total	100%

The survey consisted of nine multiple-choice questions with three to five possible answers to each question. The participants instructed to choose the answer that they believed to be the correct response to each question. The questions related to various aspects of CVC maintenance care knowledge.

Table 10 showed the distribution of percentage scores for each item. These questions revealed a substantial knowledge deficit regarding CVC maintenance care in this study population. These items achieved the lowest overall percentage scores from the whole survey. The poor results obtained in multiple-choice questions acknowledged knowledge deficit.

Table 10

Percentage of Correctly Answered Items for Multiple Choice Questions

Item number	Correct percentage rate%
Q 4	36.8%
Q 5	50.9%
Q 6	35.1%
Q 8	61.1%
Q 9	47.4%
Q 11	50.9%
Q 14	57.9%
Q 15	35.1%
Q 18	31.6%

There were 16 true or false statements; each participant put a circle on the answer that they believed was the correct response for each item. Table 11 presented a breakdown of the percentage of correct scores for each of the individual 16 items in the survey. The analysis discovered that only one of the 16 items received an unsatisfactory answer rate of 42.1%. As shown in Table 11, it observed that 15 items were a correct percentage score of 51% and above. These questions revealed a moderate level of knowledge concerning the CVC maintenance care in the study population.

Table 11

Percentage of Correctly Answered Items on True/False Questions

Item number	Correct percentage rate%
Q I	61.4%
Q 2	61.4%
Q 3	65%
Q 7	58%
Q 10	63.2%
Q 12	63.2%
Q 13	61.4%
Q 16	66.7%
Q 17	65%
Q 19	58%
Q 20	51%
Q 21	70.2%
Q 22	70.2%
Q 23	68.4%
Q24	68.4%
Q 25	42.1%

Analysis of variance (ANOVA) is a statistical procedure used to examine differences among two or more groups by comparing the variability between the groups with the variability within the group (Grove, Burns, & Gray, 2013; Polit, 2010). A one-way between-subject ANOVA conducted to explore the effect of level of education, completion of infection control course, and years of experience on the pretest scores.

There was a significant impact of the completion of infection control course on the pretest scores at the $p < .05$ level $F(1, 55) = 9.10$, $p = .04$. Also, there was a significant effect of years of experience as a registered nurse on the pretest score at the $p < .05$ level $F(2, 54) = 3.47$, $p = .038$. There was no significant effect of level of education on the pretest scores at the $p < .05$ level $F(2\ 54) = 1.82$, $p = .173$. Overall, these results suggest that high levels of education do not have an effect on the pretest.

The posttest scores ranged from 44– 80 ($M = 60.85$, $SD = 9.04$). (See Table 8). It determined that the majority of the participants in the study (78.6%) rated their knowledge as good, with 7.1% rating their knowledge as excellent, and 14.3% rating their knowledge as inadequate.(See Table 12).

Table 12

Participants Knowledge Level on the Posttest

Level of knowledge	*n%*
> 75%: high level of knowledge	7.1%
50% to 75%: moderate level of knowledge	78.6%
< 50%: inadequate level of knowledge	14.3%
Total	100%

A paired-samples *t*test is a statistical test used for comparing group means when people in the groups being compared are same or are paired (Grove, Burns, & Gray, 2013; Polit, 2010). A paired-samples *t*test conducted to compare knowledge scores in the pretest and posttest $t(55) = -4.46$, $p < .001$. A paired-samples *t*test indicated that scores were significantly higher for the posttest ($M = 60.85$, $SD = 9.04$) than for the pretest ($M = 52.17$, $SD = 9.63$). These results suggested a statistically significant improvement in the registered dialysis nurses' knowledge followed the educational intervention. (See Table 13).

Table 13

A Paired-Samples t Test for Pretest Scores and Posttest Scores

	Paired differences							
				95% Confidence interval of the difference				
	M	*SD*	*SEM*	Lower	Upper	*t*	*df*	Sig. (2-tailed)
Pretest - posttest	−8.61	14.44	1.92	−12.47	−4.74	−4.46	55	.000

A Pearson's product-moment correlation coefficient performed to assess the relationship between the demographic variables and knowledge scores on the pretest. There was insignificant correlation $r(57) = -.14$, ($p = .31$) between age and the total knowledge scores on the pretest. No statistically significant associations found between years of experience and the pretest scores $r(57) = -.15$, $p = .28$. The level of education and test scores were insignificant correlated, $r(57) = -.20$, $p = .13$.

A significant, positive correlation between obtaining infection control course variable and the pretest scores was existed, Pearson Correlation $r(57) = .38$, $p < .001$. Table 14 summarized Pearson correlations between demographic variables and knowledge scores.

Table 14

Pearson Correlations Between Demographic Variables and Knowledge Scores

Variable	Pearson correlation *r*	*P*.
Age	−.14	.31
Years of Experience	−.15	.28
Level of Education	−.20	.13
Completion Infection Control Course	.38	.01

In summary, the section introduced the findings in the analysis of data collected from the current study undertaken in a hemodialysis unit. The results and conclusions from the present study formed a basis for future research initiatives. The study revealed several areas of weaknesses concerning registered dialysis nurses' knowledge on the subject of CVC maintenance care. The reasons for the knowledge deficit discussed the next part. Also, the next part highlighted the limitations of the study, recommendations for practice and future research.

Discussion of Findings in the Context of Literature and Frameworks

Discussion of findings conducted in the context of the literature on educational intervention regarding CVC maintenance care and Donabedian's Quality Improvement Model (1997). The purpose of a theoretical framework was to guide the research process through an explanation of the relationships between study variables (Wood & Ross-Kerr, 2010). Using Donabedian's Structure-Process-Outcome Model, improving the process would also affect the outcome.

In this study, registered dialysis nurses considered as a structural component, used a particular education intervention to improve the process of obtaining knowledge regarding CVC maintenance care, and hence improved outcome by reducing CRSBI.

The literature review identified research that supported particular nurse characteristics as they related to better health outcomes. The characteristics included nurse education and years of experience. Nurses' experience was associated with fewer patient deaths (Tourangeau et al., 2002). Nursing units with more experienced nurses had lower medication error rates and lower fall rates (Blegen, Vaughn & Goode, 2001).

The characteristics listed above collected to evaluate if there was a relationship between them and the registered dialysis nurses' knowledge score on CVC maintenance care. The study clarified some process and structural deficiencies within hemodialysis unit, particularly about the knowledge of registered dialysis nurses.

The demographic information in this study provided an essential description of the study participants. Of the 60 possible participants, 57 registered dialysis nurses completed the pretest, and 56 registered dialysis nurses completed the posttest. The

survey reflected a high response rate because the participants believed if they shared in the survey, they gained a better understanding of the practices, and updating of their knowledge regarding CVC care could occur. Also, the discussion regarding CRBSIs produced in the hemodialysis unit and manager encouraged registered dialysis nurses to participate in improving the quality of care that provided to patients with CVCs in their unit.

The proportion of male participants in the study was (7%), which was comparable to the (16.67%) reported by Deshmukh and Shinde (2014), and 33.8 reported by Bianco et al. (2013). According to the Annual Health Report 2013 of the MoH in Oman, the majority of registered nurses (RNs) were women. They comprised (11.54%) of manpower in the MoH and men were (1.51%).

This study sought to evaluate the effectiveness of educating registered dialysis nurses regarding CVC maintenance care to reduce CRBSI in a hemodialysis unit. As predicted, the educational intervention considerably improved the knowledge level of the participants regarding evidence-based guidelines for CVC maintenance care to prevent CRBSI in a hemodialysis unit. The scores in the posttest were overall better than the scores of the pretest. The results of the pretest revealed that the majority of the participants had a significantly an inadequate level of knowledge regarding CVC maintenance care.

The reasons might be due to the background of the participants. A greater part of the participants gained a basic diploma in general nursing (63.2%).Also, 35 nurses (61.4%) did not train in the infection control training course because the authority

provided a limited number of places. The curriculum in both basic diploma and a specialized diploma in nephrology nursing included general principles of infection control.

The focus on evidence-based practice and knowledge regarding CVC care and CRBSI prevention did not implement. Therefore, no specific contents of CRBSI prevention included in nursing programs would be one factor for lower knowledge in this area.The findings demonstrated a significant impact of the completion of infection control course on the pretest scores.

The findings were congruent with the conclusions of the previous studies that showed nurses' knowledge influenced by professional education and training (Uba et al., 2015; Deshmukh and Shinde, 2014; Pushpakala and Ravinath, 2014; Bianco et al., 2013; Shrestha, 2013; and Meherali, Parpio, Ali, & Javed, 2011). Another study found that knowledge could acquire through basic and continuing education, training, personal experience, or in-service training (Bianco et al., 2013; Parra et al., 2010; Evens & Donnelly, 2006). In contrast, a previous study showed that the training program did not make any significant difference in the knowledge level of study groups (Benneth & Weale, 1997).

The study sample comprised of basic nursing diploma prepared, specialized nephrology diploma prepared, and only 3.5% of the study participants obtained a baccalaureate degree. The first baccalaureate nursing program began on 2008 with very limited numbers (Sultan Qaboos University, 2012). The opportunities for higher education in nursing as the concepts of BScN and MScN are unfamiliar to the most of the

hemodialysis units. The baccalaureate degree in nursing was not the requirement for entry into practice.

The previous studies found that the increase in the proportion of nurses with higher educational degrees decreased the risk of mortality and failure to rescue (Aiken, Clarke, Sloane, & Silber, 2003; Tourangeau, Cranley & Jeffs, 2006). Aiken et al. (2003) found each 10% increase in the proportion of nurse with higher degrees decreased the risk of mortality and failure to rescue by 5% after controlling for patient and hospital characteristics.

The results indicated that participants scored poorly in some critical areas, like risk factors associated with the development of CRBSI, lack of knowledge regarding the best method for CVC maintenance care. Only 28 participants (49.1%) correctly answered that mask should be worn for all CVC dressing changes before the dressing is removed. About 24 participants (42.1%) understood actions that decrease the risk of CRBSIs.

Only 35 of the participants (61.4%) identified chlorhexidine as a skin preparation (as opposed to Povidone-iodine) associated with reduced CRBSIs rates. Only 24 of the participants (45.6%) identified the correct time to change the transparent dressing. Only 22 of the participants (38.6%) identified the action for oozing in the CVC insertion site. These answers indicated that participants lacked knowledge in these areas. The current study found that participants trained to perform task-oriented nursing care rather than knowledge-based practice. It suggested that registered dialysis nurses performed nursing procedures without knowing the rationales why they need to do.

The practice of the participants based solely on the tradition, experience or feelings rather than science.The results of the current study implied that CVC maintenance care was clinical knowledge that cannot obtain without an entire understanding of its fundamental science background. Participants were hard to be critical thinkers if they did not have the current knowledge related to their specialty area. The driver of their clinical decision-making was either policy and procedure or habits and routines.

Approximately (26.3%) of the participants reported had more than ten years of work experience. The previous undergraduate nursing education curriculum did not include a research course or evidence-based practice. An assumption was that experienced nurses might be less aware of the evidenced-based practice and had the low-test scores due to the unavailability of formal, specialized training and updating courses in a hemodialysis unit.

On the other hand, this group of participants overwhelmed by the personal affairs, and they appeared to lose their insight into nursing knowledge slowly. Furthermore, they acquired their knowledge of taking care of hemodialysis patients from their basic educational programs, or from hemodialysis unit policies and procedures. They did not prepare or knowledgeable enough to provide evidence-based care.

The low level of nurses' knowledge was due to the lack integration of learned concepts in the clinical setting. This problem of theory-practice gap or lack of clinical integration was not a new issue nor did it only exist in this hemodialysis unit. Moreover, the participants were coming from different types of nursing school curricula, the various

methods of teaching and study materials, as well as participants' awareness of the importance of evidence-based practice.

In such case, the clinical education with effective mentoring was imperative besides classroom instruction to improve nurses' knowledge.The analysis showed 35.1%of the participants completed their diploma recently and did not have any experience of caring for hemodialysis patient with CVC. It was critical that new nurses be provided supervision and role models within the clinical settings to help them integrate the learned concepts into real patients' care. They also need to be prepared individually according to the practice setting.

The analysis showed a significant difference in the nurses' knowledge before and after the educational intervention. The positive change in the nurses' knowledge after educational intervention reflected that education could create change in knowledge level. Other studies (Pushpakala and Ravinath, 2014; Deshmukh and Shinde, 2014; Shrestha, 2013) supported the effectiveness of the educational intervention in promoting knowledge of participants.

Also, the findings of the current study were consistent with other studies. Chu, Adams, and Crawford (2013)demonstrated that dialysis CRBSI was a common, yet preventable complication in the dialysis unit and dialysis nurses play a significant role in preventing dialysis CRBSIs. Basic infection control standards were paramount and should strictly follow for effective CVC care. The results also suggested that training for registered dialysis nurses was essential for reducing CRBSI rates using education-based intervention.

Formal training contributed to an increase in knowledge, practice, and positive attitudes toward CRBSI prevention (Bianco et al., 2013). Several other studies also demonstrated that with the implementation of educational initiatives, results in cost savings and reduction in the rate of CRBSI (Cooper et al., 2014; Kim et al., 2011).

Bruno, Ongaro, and Fraser (2007) described the principles of knowledge retention and found that knowledge retention fell to 75–89% of its original level after a relatively short period. In this study, the knowledge interval was one-month, as the post-test was conducted 1 month after the pre-test. Sisson et al., (1992) assessed 33 medical students for retention and recall of clinical information three months after taking the test on the same topic. They found that the students' mean score declined 10 percentile points from the original test. Their findings matched the findings of the current study in which the participants were not able to retain the learned knowledge.

On the whole, the results of this study consistent with the results of other previous studies performed in the similar domains (El-Bab et al., 2011; Marcel, 2006). The investigator found that the knowledge level of participants could be increased by providing them with the continuous educational programs to enhance retention of knowledge. The educational interventions and programs should focus on the meaning and understanding rather than memorization, along with sufficient time to learn the complex subjects and planned practical engagement with tasks.

At the end of the analysis, the findings were only specific to the sample population and were not generalizable to anyone else other than those individuals in the sample.

Implications

Implications for Practice/Action

This evidence-based educational intervention project had definite implications for further efforts on CVC maintenance care that based on the evidenced-based practice guidelines to reduce CRBSI. The revised CDC guidelines for the prevention of CRBSI had been in use since 2002, and the practice in the hemodialysis unit was far from the evidence. The educators and professional must provide the information in a timely fashion and assist in translating it into practice.

The leaders in the hemodialysis unit should encourage a learning environment, and support the informal learning style. Learning needed to facilitate using a wide variety of methods. As noted by Benner (1984), educators must take into account the experience of a nurse and adapt learning to the individual. More than half the registered dialysis nurses were new, and often overwhelmed in the hemodialysis unit. They usually started with little to no experience. Primarily, education focused on providing information to the novice nurse, not promoting their critical thinking skills.

The novice registered dialysis nurses benefited from formal education as the guidelines, and the multimodal teaching approaches needed to be ongoing. A reliable method using multiple methods should apply to reinforce the best practice for experienced registered dialysis nurses, and facilitate learning for novice registered dialysis nurses. More efforts should put to improve registered dialysis nurses' knowledge, and the effectiveness of translating evidenced-based knowledge to practice must evaluate objectively.

It was the responsibility of all personnel in hemodialysis unit to ensure this knowledge was practical to help patients. The risk for CRBSI and prevention strategies should be an important part of educational programs and plans among nursing leadership in a hemodialysis unit. Finally, within basic nursing programs, a focus on evidenced-based care would allow students to understand what was done was purposeful.

Implications for Future Research

The results of the study identified further research topics that might provide further insight and knowledge on the role of the registered dialysis nurses. The future research efforts should aim to explore the elements necessary for successful CVC maintenance care. The research topic, which needed further investigation included, does the educational intervention influence actual infection rates. Would the same results occur if the self-study module delivered via IT with no classroom participation? If a larger sample existed, would the results vary? Would researchers conduct such a study across different locations?

A lack of patient and family education may contribute to CRBSIs. It was an interesting research study. Did the registered dialysis nurses feel empowered to provide education to patients and families regarding CVC care? Moreover, what were the barriers that prevent registered dialysis nurses from conducting this important work?

The last informative topic that could affect the quality of care that provided to dialysis patients related to the actions that registered dialysis nurses could take when improper techniques observed. To what extent, the registered dialysis nurses were aware of substandard care. All these suggested studies could contribute to improving registered

dialysis nurses' body of knowledge related to CVC maintenance care in a hemodialysis unit.

Implications for Social Change

This study contributes to social change by identifying an educational intervention that helped improving nurses' knowledge in hemodialysis unit, thus helping hemodialysis patients stay safer, and possibly reducing infectious complications. The cost of CRBSI estimated at $ 3.2 billion annually (Pronovost et al., 2006). Introducing evidence-based education was likely to reduce the incidence of CRBSI and reducing hospital stays, costs, and possible mortality (Cooper et al., 2014; Burden et al., 2011; Kim et al., 2011; Apisarnthanarak et al., 2010). This study considered as an opportunity to create a quality improvement project for the hemodialysis units.

The study provided evidence for conducting studies to determine the rates of CRBSIs in hemodialysis units through the country. The content of the educational program in this study was appropriate for nursing education in nursing schools. The risk for CRBSI and prevention strategies should be an important part of an ongoing curriculum associated with CVCs as well as an orientation for the nurse new to the hemodialysis care practice. Participants in this study could be a role model and preceptors for other dialysis nurses.

The study had relevance for the educational programs in healthcare institutions. The application of the educational intervention to other high-risk procedures would contribute to the body of nursing knowledge. Implementing an evidence-based educational intervention to improve nurses' knowledge had untold helpful consequences

to patients, nurses, and physicians. When registered dialysis nurses empowered to share experiences and insights with the community, they could advocate for patients professionally and become an influential force in the policy-making process.

The study could help registered dialysis nurses become great partners to effect needed changes to strengthen hemodialysis services for kidney failure patients. Hemodialysis units could use the instrument of this study to assess their educational needs, and to measure their clinical registered dialysis nurses' information regarding CVC maintenance care. Finally, the study could help in changing the role of the registered dialysis nurse that include the use of evidenced based practice and caring for the complex clinical issues that occur in a hemodialysis unit.

Project Strengths and Limitations

Strengths

The main strength of the study was the thoughtfulness in hemodialysis unit because the majority of the previous information in published literature were on ICU. The project provided knowledge to the registered dialysis nurses regarding CVC maintenance care to reduce CRBSI in hemodialysis unit about which was very little written.

An excellent response to the educational intervention from the registered dialysis nurses was a notable strength. The success of the intervention was noted a significant difference in pretest and posttest scores. The self-study module, purpose, and the questionnaire were not difficult to explain to potential participants. Participants answered honestly and without the use of resources/references related to the educational intervention.

Another major strength was the low attrition rate < 7% though the initial sample size was adequate. A further strength of this evidence-based practice project was that the information obtained through the survey provided invaluable information and guidance to the efforts regarding CVC maintenance care to reduce CRBSI in a hemodialysis unit.

Limitations

The limitations of the study related to the sampling strategy, instrumentation, and demographics. The current study performed within a single hemodialysis unit from which the participants recruited. The use of a convenience sampling method which although commonly used had a significant disadvantage. That considered a weak approach to sampling because it provided little opportunity to control for bias (Grove, Burns, & Gray, 2013). Therefore, findings could not generalize to all registered dialysis nurses in hemodialysis units.

Despite a team of experts validated the tool, there was a chance that participants five questions could interpret in different ways that led to difficulty when assessing the results. The investigator designed the tool; it had not tested previously and because of this, the reliability and validity of some of the questions might be problematic. Also, the tool contained only nominal and interval level variables without any ratio level.

The pretest/posttest methodology used in the study provided helpful information, yet there was possible for historical effects. Participants were fatigued because they asked to complete the pre/posttest during work time and guess on tests could result in unreliable data (Creswell, 2012). The demographic data in the study provided a superficial description of the participants because the limited information obtained from the

participants. When comparing the number of years that the participants had practiced and the responses to the questionnaire, there was no correlation demonstrated. Being able to correlate the years of experience as registered dialysis nurse, and the question responses might provide very interesting insight into the study question.

Despite these limitations, the study resulted in significant findings with respect to knowledge regarding the maintenance care of CVC to reduce CRBSI in a hemodialysis unit.

Recommendations for Remediation of Limitations

A possible improvement to the study, the methodology could include assessment the incidence rate of CRBSI in hemodialysis unit pre and post the educational intervention. This method could add an important data to the effectiveness of the study intervention. Conducting randomized control study could elicit excellent information regarding participants' knowledge and attitude; this approach could add significant quantitative and qualitative data. For further research, the use of the representative sample comprised the participants from different dialysis units throughout the country could improve the power of the study.

Analysis of Self

Scholar

The term scholar was defined as a "learned person, who is specialized in an area of knowledge; one who has gained mastery in a particular discipline" (Chism, 2013, p.7). The investigator took this definition and applied to the DNP project. DNP project provided the means through which the investigator demonstrated advanced knowledge in

educating registered dialysis nurses regarding CVC maintenance care to reduce CRBSI in a hemodialysis unit.

A sound literature review performed prior to initiation of an educational intervention to examine the evidence for educational intervention that improves nurses' knowledge. As a scholar, the DNP must not only consult the literature related to practice, practice gaps, and potential interventions but also search for information in a variety sources as necessary. I designed nurses' knowledge survey that highlighted the additional piece of information required to inform infection prevention intervention. Translation of research into practice, as well as knowledge dissemination and integration, are the critical tasks of the nursing scholar who entered knowledge business.

Practitioner

The American Association of Colleges of Nursing (AACN, 2004) defined nursing practice as follows:"any form of nursing intervention that influences health care outcomes for individuals or populations,including the direct care of individual patients, management of care for individuals and populations, administration of nursing and healthcare organizations, and the development and implementation of health policy" (p. 1). The DNP roles were essential to the success of this project. The DNP as a clinician had a noticeable role in recognizing evidence-based practice guidelines, as well as care in a hemodialysis unit. It was through leadership that relationships with significant hemodialysis unit leaders formed to make a clear case for the project. The DNP as an advocate had the responsibility to improve the quality and safety of care for catheter-dependent patients. The role of the DNP as educator related to the designing an

educational program for the registered dialysis nurses in hemodialysis unit to improve their knowledge regarding CVC maintenance care to prevent CRBSI. Education had not only to be interesting. It needed to base on the results of knowledge based questionnaire and made the case for reducing CRBSI incidence rate and improving the quality of care that provided for the patients. The DNP as a role model established an example for others and mentoring nurses in the practice setting and encouraging further education.

Project Developer

The DNP prepared me for the advanced nursing practice through understanding the scientific foundation of the discipline. I began the project with the searching and reviewing of the related literature. I built the educational program using nursing science as its foundation, through the integration of Donabedian's health model (1997) and Self-Learning Theory. I utilized the evidence-based guidelines from the CDC to highlight the correct nursing practice regarding CVC maintenance care. Their concepts used to guide program development, implementation, and evaluation.

The experience of developing and implementing this evidence-based project had enhanced my ability to design self-study module to improve registered dialysis knowledge. Also, I created a knowledge-based questionnaire to assess nurses' knowledge regarding CVC maintenance care and evaluated the outcomes of the educational intervention in a hemodialysis unit. The DNP as an innovator handled approaching clinical practice improvement in a manner that was fitting to the practice environment.

Summary and Conclusions

The study presented an insight into the knowledge of registered dialysis nurses. Overall, the findings of the current study showed inadequate knowledge of nurses working in a hemodialysis unit. The results revealed that participates knowledge of CVC maintenance care was far from optimal. The mean scores on pretest in the study were only 52.17% that was significant below the limit of 75% that indicated the desired level at which the dialysis nurses delivered the appropriate care to prevent CRBSI.

It highlighted the size of the problem of inadequate knowledge regarding CVC maintenance care. It was worrying because CRBSI prevention was dependent on the knowledge of registered dialysis nurse. The most important areas which showed noteworthy knowledge deficits centred on: the risk factors associated with the development of CRBSI, lack of knowledge regarding the best method for CVC maintenance care; the mask should wear for all CVC dressing changes before the dressing is removed; the actions that decrease the risk of CRBSIs; chlorhexidine as a skin preparation (as opposed to Povidone-iodine) associated with reduced CRBSIs rates; and the correct time to change transparent dressing.Inadequate knowledge could improve through evidence-based educational intervention.

The self-study module was one of the efficient methods of promoting and updating the knowledge regarding CVC maintenance care. The findings of the study demonstrated that there were significant improvements in the posttest knowledge scores after implementation of the evidence-based educational intervention. The registered dialysis nurses should know the methods for the prevention of CRBSI. The importance of

conducting education programs was a need for improving the quality of care in hemodialysis units. The compliance to evidence-based guidelines and retention of knowledge were matters that required further investigation. It would be valuable to explore the appropriate educational methods affecting of registered dialysis nurses' knowledge.

Section 5: Scholarly Product

I conducted PowerPoint presentation for the stakeholders in Oman Specialized Nursing Institute. See Appendix H for certification. I submitted an abstract for the 23rd National Evidence-Based Conference – University of Iowa Hospital and Clinics.

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Appendix A: Pretest-Posttest for Catheter-Related Bloodstream Infections Prevention

Answer all the following questions. Each correct answer rewards one grade. Please, do not write your name. Your answer will store with a high degree of security. Circle the correct answer to the following questions:

1. **The rate of catheter-related bloodstream infections (CRBSI) in Bausher hemodialysis center is lower than the national average.**

    a. True
    b. False

2. **The mortality rate due to CRBSIs is 10% to 20%.**

    a. True
    b. False

3. **The femoral site is the best site for a central vascular catheter if the subclavian site cannot be used.**

    a. True
    b. False

4. **Infections associated with the use of central venous catheters can increase**

    a. Morbidity
    b. Mortality
    c. Hospital length of stay
    d. Costs
    e. All of the above

5. **All of the following factors increase the risk of CRBSIs except:**

    a. Low nurse to patient ratio
    b. Insertion into the femoral site.
    c. TPN and/or lipid administration
    d. Use of a tunneled venous catheter for patients requiring long-term access (>30 days)
    e. Multiple lumen catheters
    f. All of the above increases the risk of CRBSIs

6. **Risk factors for CRBSIs include placement for more than 72 hours, inexperience of personnel inserting the central venous catheter, colonization of the catheter with organisms prior to insertion and**

    a. Inappropriate skin preparation.
    b. Use of stopcocks.
    c. Lack of antibiotic prophylaxis.
    d. All of the above.
    e. a and b
    f. a and c

7. **The antimicrobial ointment should not be applied to the exit site of hemodialysis catheters because it does not help to decrease the incidence of CRBSIs.**

    a. True
    b. False

8. **The central catheter insertion site should be dressed**:

    a. After the sterile barriers are removed
    b. While the field is still sterile
    c. After an x-ray has verified correct placement of the catheter
    d. As soon as the insertion site has stopped bleeding or oozing

9. **In the insertion of a central venous catheter, the insertion site is oozing. You should**:

    a. Apply a gauze dressing
    b. Apply a transparent dressing
    c. Apply both a gauze and a transparent dressing
    d. Wait until the site has stopped oozing to apply any dressing

10. **You are not required to wash or gel hands if you wear clean gloves when checking the insertion site or changing the dressing of a central venous catheter**.

    a. True
    b. False

11. **When inserting a central venous catheter, maximal sterile barriers are required. This includes:**

    1. Face mask, cap, and sterile gloves
    2. Sterile gown that is snapped and tied

3. Assistants wearing the same barriers
4. Use of fenestrated drape in kit only
5. Use of large sterile drape that covers the entire patient

a. 1, 2, 3, 4
b. 1, 2, 4
c. 1, 2, 3, 5
d. 1, 2, 5
e. All of the above

12. After applying the ChloraPrep® to the insertion site, one should wait until the site is completely dry without fanning or blotting before proceeding.

a. True
b. False

13. The use of chlorhexidine as a skin preparation (as opposed to Povidone-iodine) is associated with decreased CRBSIs rates in studies.

a. True
b. False

14. Of the following, which actions will decrease the risk of CRBSIs.

1. Routine guidewire exchange of the central venous catheter.
2. IV antimicrobial prophylaxis.
3. Inserting a single lumen rather than multiple lumen central venous catheter.
4. Changing to a new set of sterile gloves before handling the new central venous catheter when performing a guidewire exchange.
5. Insertion of a central venous catheter through open techniques/cutdown.

a. 1, 2, 3, 4
b. 2, 3, 4, 5
c. 1, 2
d. 3, 4
e. 1, 2, 5
f. All of the above

15. Ms. M has an unexplained fever, and you suspect a Blood Stream Infection. Upon inspection of her internal jugular catheter insertion site, you see the erythema and a small amount of pus. What should you do?

a. Give vancomycin only

b. If the catheter is still necessary, remove the current catheter and replace it with a guidewire exchange and assess the need for antibiotics
c. If the catheter is still necessary, remove the current catheter and place another on a new site and assess the need for antibiotics

16. When requesting a catheter culture, submit a 5 cm segment that includes the tip.

a. True
b. False

17. If a catheter culture comes back positive, but the blood sample cultures are negative, evaluate the entire picture. Reassess the patient before giving antibiotics.

a. True
b. False

18. When attempting to diagnose CRBSIs, two sets of blood samples should be drawn for culture. The proper sites to culture are:

a. One from a catheter hub, the other from a peripheral source.
b. Two different peripheral sources.
c. Both from a catheter hub.

19. The proper procedure to culture blood from a suspected source is to draw 20cc of blood and place 10cc in each of two bottles.

a. True
b. False

20. The needleless access device should be scrubbed10-15 seconds, every time the catheter is accessed thoroughly.

a. True
b. False

21. If dressing is loose, you should reinforce it with tape until the next scheduled dressing change.

a. True
b. False

22. Central venous catheter infections are preventable by focusing on proper insertion techniques, proper maintenance and care, and removing the catheter if no longer indicated.

a. True
b. False

23. The two common sources of CVC infections are from patient's skin flora and health workers hands.

a. True
b. False

24. Mask should be worn for all CVC dressing changes before the dressing is removed

a. True
b. False

25. Transparent dressing should be changed every 48 hours.

a. True
b. False

Appendix B: Nurse Demographic Sheet

Years of experience as dialysis nurse _____

Current age _____

Education level, e.g. Basic Diploma in general nursing, Nephrology nursing Diploma, BSN, other, _____

Male or Female (Please Circle)

Amount of working hours daily _____

Patient staff ratio _____

Infection control training course (Please Circle) yes No

Appendix C: Donabedian Model and Nurses' Knowledge Regarding CVC Maintenance Care

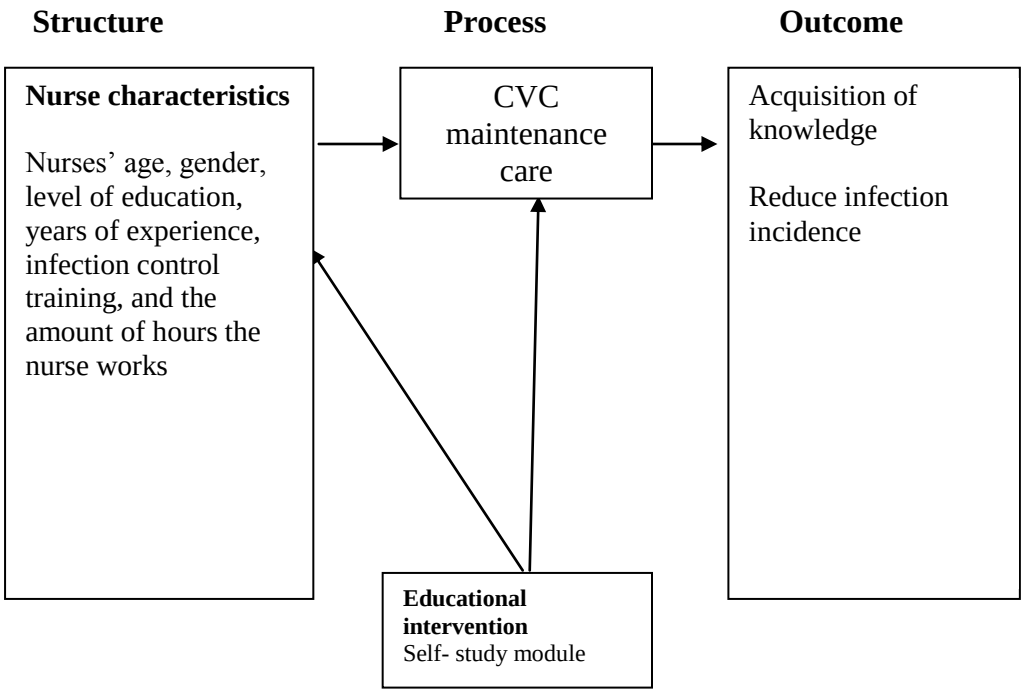
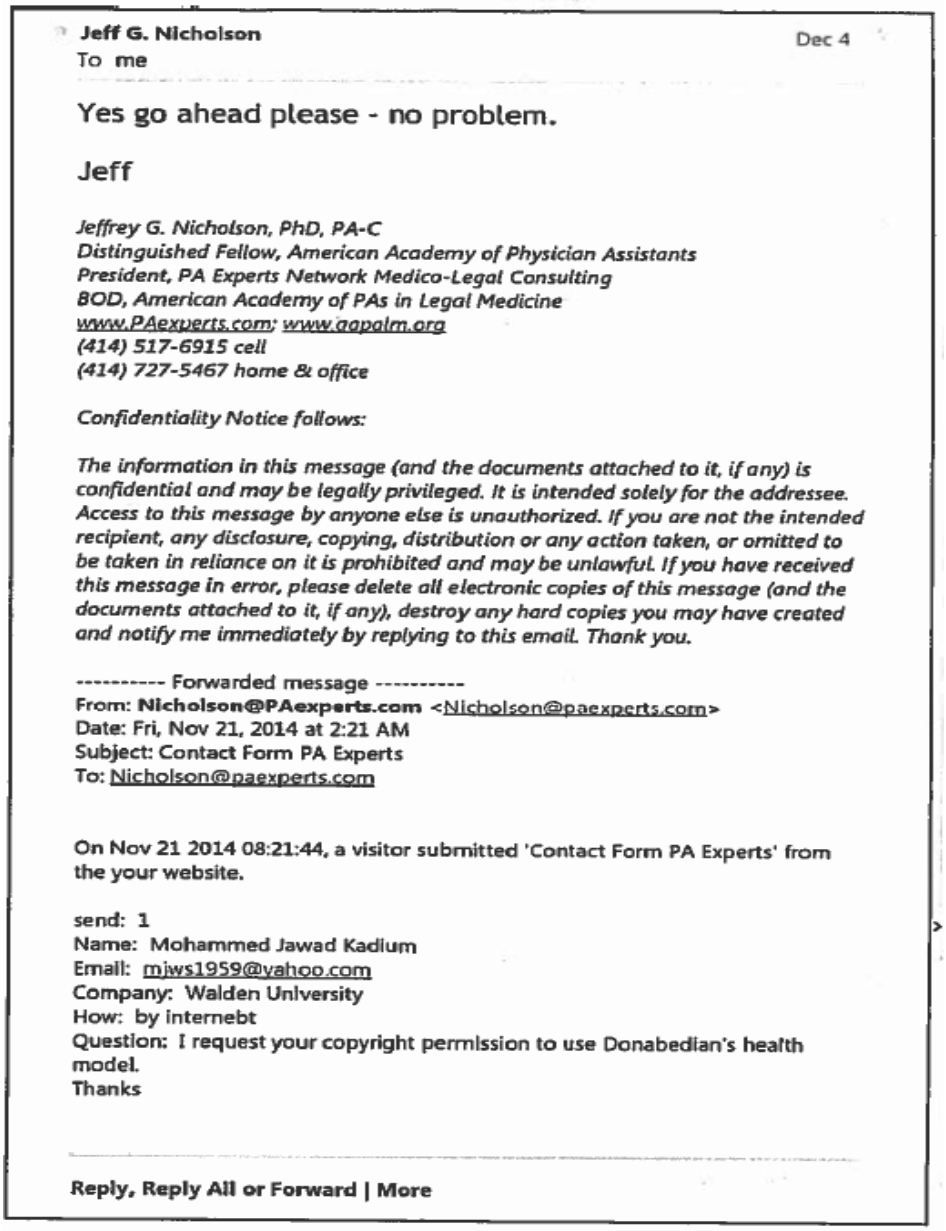


Figure 1. Donabedian's Structure-Process-Outcome Health Framework. Adapted from "Retrospective Study Of Medical Malpractice And Safety Comparing Physician Assistants To Physicians And Advanced Practice Nurses", by Jeffrey G. Nicholson, 2008, Doctoral Dissertation, P. 45. Copyright 2014 obtained from American Academy of Physician Assistants.

Appendix D: Permission to use Donabedian Health Model



Jeff G. Nicholson Dec 4
To me

Yes go ahead please - no problem.

Jeff

Jeffrey G. Nicholson, PhD, PA-C
Distinguished Fellow, American Academy of Physician Assistants
President, PA Experts Network Medico-Legal Consulting
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www.PAexperts.com; www.aapalm.org
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(414) 727-5467 home & office

---------- Forwarded message ----------
From: **Nicholson@PAexperts.com** <Nicholson@paexperts.com>
Date: Fri, Nov 21, 2014 at 2:21 AM
Subject: Contact Form PA Experts
To: Nicholson@paexperts.com

On Nov 21 2014 08:21:44, a visitor submitted 'Contact Form PA Experts' from the your website.

send: 1
Name: Mohammed Jawad Kadlum
Email: mjws1959@yahoo.com
Company: Walden University
How: by internebt
Question: I request your copyright permission to use Donabedian's health model.
Thanks

Reply, Reply All or Forward | More

Appendix E: Signed Approval From the Ministry of Health in Oman

Sultanate of Oman
Ministry of Health
Directorate General of Planning and Studies

سلطنة عمان
وزارة الصحة
المديرية العامة للتخطيط والدراسات

Ref. : MH/DGP/R&S/PROPOSAL_ APPROVED/19/2014 الرقم :

Date : 15.09.2014 التاريخ :

الموافق :

Dr. Mohammed Jawad Kadium
Principal Investigator

Study Title: **"The Influence of an Educational Program on Nurses' Knowledge and Infection Rates in Catheter-dependent Hemodialysis Patients "**

After compliments

We are pleased to inform you that your research proposal **" The Influence of an Educational Program on Nurses' Knowledge and Infection Rates in Catheter-dependent Hemodialysis Patients "** has been approved by Research and Ethical Review and Approve Committee, Ministry of Health.

Regards,

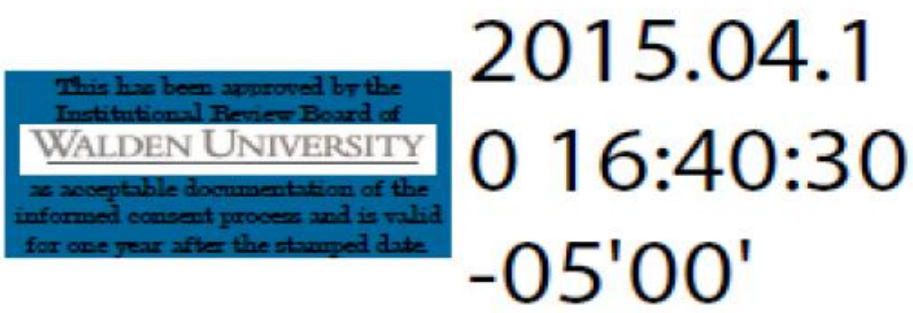
DIRECTORATE GENERAL OF PLANNING * SULTANATE OF OMAN - MINISTRY OF HEALTH *

Dr. Ahmed Mohamed Al Qasmi
Director General of Planning and Studies
Chairman, Research and Ethical Review and Approve Committee
Ministry of Health, Sultanate of Oman.

Cc
Day file

P.O. Box : 393, Postal Code: 100, Muscat, Tel.: 24601161, Fax : 24696533 ص.ب : ٣٩٣ ،الرمز البريدي : ١٠٠ ، مسقط ، هاتف: ٢٤٦٠١١٦١، فاكس : ٢٤٦٩٦٥٣٣

Appendix F: Walden Approval Number



Appendix G: Form for Face and Content Validity

The three-point scale was used to rate the "Relevance" and "Clarity" of the face and content validity of the questionnaire and self-study module.

Please marks an "X" just next to the most appropriate scale, e.g. if you want to rate 3, type X as shown as:

1	2	3X

Thanks.

Knowledge-based Question No.	**Relevance** 1 = not relevant 2 = appropriate but not necessary 3 = necessary			**Clarity** 1 = not clear 2 = clear but need minor revision 3 = very clear		
1	1	2	3	1	2	3
2	1	2	3	1	2	3
3	1	2	3	1	2	3
4	1	2	3	1	2	3
5	1	2	3	1	2	3
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3	1	2	3	1	2	3
4	1	2	3	1	2	3
5	1	2	3	1	2	3
6	1	2	3	1	2	3
7	1	2	3	1	2	3
Self-study module	1	2	3	1	2	3

Appendix H: Scholarly Product Certificate

Sultanate of Oman
Ministry of Health
Directorate General
of Education & Training
Oman Specialiged Nursing Institute

سلطنة عمان
وزارة الصحة
المديرية العامة للتعليم والتدريب
معهد عمان للتمريض التخصصي

MOH/DGET/OSNI/2014/305

20th October, 2014

To Whom It May Concern

After Compliments,

Re: Mr. Mohammed Jawad Kadium - First Consultant, Nephrology Nursing Programme, OSNI.

This is to certify that Mr. Mohammed Jawad Kadium (DNP) student at Walden University conducted a power point presentation on 20th October, 2014 at 09:00 am at Conference Room in Oman Specialized Nursing Institute (OSNI). The topic was "An educational intervention to improve nurse's knowledge regarding CVC maintenance care to reduce CRBSI in Hemodialysis Units, Number of audience 32. The presentation concluded with the feedback and discussion.

This letter has been provided upon his request and bears no responsibility on our side.

Thank you.

Abdallah bin Ahmed Al Rubaiey
Dean

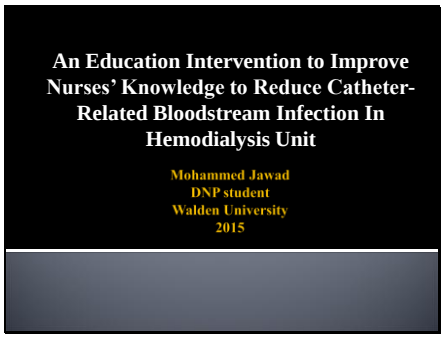
Cc: M.file/C.file

P.O.Box : 634 Hai Al-Minaa, Postal Code : 114
Tel. : 24571225 / 24560085, Fax : 24562688
E-mail : osnidget@hotmail.com

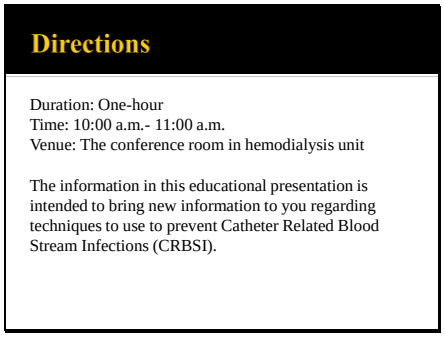
ص.ب : ٦٣٤ حي الميناء، الرمز البريدي : ١١٤
هاتف : ٢٤٥٧١٢٢٥ / ٢٤٥٦٠٠٨٥، فاكس : ٢٤٥٦٢٦٨٨
البريد الإلكتروني : osnidget@hotmail.com

Appendix I: PowerPoint Demonstration Content of the Educational Lecture

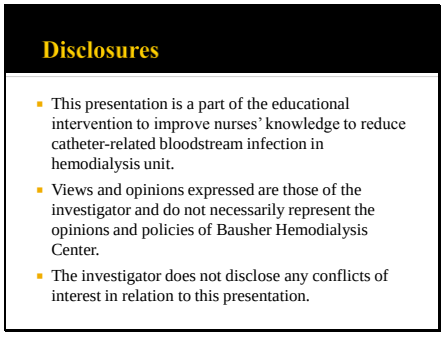
Slide 1



Slide 2



Slide 3



Slide 4

Contents

Topics that are covered in the presentation include:

a) The epidemiology of catheter-related bloodstream infection.
b) Aseptic technique; the use of maximal barrier precautions during CVC maintenance care.
c) The need to avoid femoral insertion sites.
d) Proper technique for obtaining blood cultures, and
e) Guidelines for changing dressing.

Slide 5

Objectives

- Know the definition of a central venous catheter (central venous line).
- Identify the incidence of infections with central lines.
- Discuss risk factors and sources of catheter related bloodstream infections (CRBSI).
- Understand management of central venous during maintenance care.
- Identify clinical signs and symptoms of catheter related bloodstream infections (CRBSI).
- Describe interventions designed to prevent catheter related bloodstream infections (CRBSI).

Slide 6

Incidence of Infections with Central Lines

- In 2009, about 18,000 bloodstream infections occurred in ICU patients with central lines.
- About 37,000 bloodstream infections occurred in 2008 in hemodialysis patients with central lines.

Slide 7

Statistics for CRBSI's

- CRBSI's are:

1. Associated with increased morbidity
2. Associated with mortality rates of 10% - 20%.
3. Associated with prolonged hospitalization (mean of 7 days) and increase in medical costs $28,000 - $47,000.

Slide 8

Impact of Vascular Catheter-related BSI

- What is the rate of CRBSI at your unit?
- Do you know how much CRBSI is costing your unit?
- Is that an acceptable rate?
- What is your goal?
- Have you done everything you can in your facility to achieve your target?
- How can you sustain your effort?

Slide 9

What is a Central Line?

A central venous access catheter, also called a central line, is a long, thin, flexible tube used to give medicines, fluids, nutrients, or blood products over a long period of time, usually several weeks or more. A catheter is often inserted in the arm, neck or chest through the skin into a large vein. The catheter is threaded through this vein until it reaches a large vein near the heart.

Slide 10

How do central lines cause bloodstream infections?

- Central venous catheters (CVCs) disrupt the integrity of the skin allowing bacteria and/or fungi to enter.
- Infection can spread to the bloodstream (bacteremia)
- Hemodynamic changes and organ dysfunction (sepsis) may ensue.

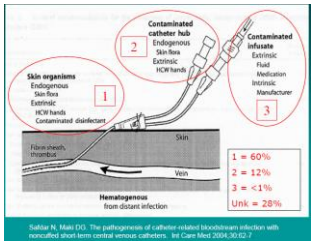
Slide 11

Sources of CRBSI's

- Migration of skin organisms at the insertion site into the cutaneous catheter tract with colonization of the catheter tip is the most common route of infection.
- Contamination of the catheter hub also contributes to intraluminal colonization of long-term catheters.
- Rarely, contamination of the infused fluid leads to infection.

Slide 12

Pathogenesis



Slide 13

Clinical Features of Catheter Sepsis

- *Nonspecific*
  - Fever
  - Chills, shaking rigor
  - Hypotension, shock
  - Hyperventilation
  - Gastrointestinal
    - abdominal pain
    - Vomiting
    - Diarrhea
  - Neurologic
    - confusion
    - seizures
- *Highly Suggestive of Line Sepsis*
  - Source of sepsis unapparent
  - Patient unlikely candidate for sepsis
  - Intravascular line in place (or recently in place)
  - Inflammation or purulence at site
  - Abrupt onset, with shock
  - Sepsis response to antimicrobial therapy or dramatic improvement after removal of device

Slide 14

What can we do to prevent a CRBSI?

- The central line bundle is a group of **evidence based interventions** for patients with intravascular central catheters that, when implemented together, result in better outcomes than when implemented individually.
- The science behind the bundle is so well established that it should be considered standard of care.
- Key Components:
  1. Hand hygiene
  2. Maximal barrier precautions (both for the patient and the inserter) when placing a central line
  3. Chlorhexidine skin antisepsis
  4. Optimal catheter site selection (subclavian preferred site)
  5. Daily assessment of line necessity with prompt removal of unnecessary line

Slide 15

Hand Hygiene

- Since 1977, at least 7 prospective studies have shown that improvement in hand hygiene *significantly* decreases a variety of infectious complications. Proper hand-hygiene procedures can be achieved through the use of either a waterless, alcohol-based product or an antibacterial soap and water with adequate rinsing. Compared with peripheral venous catheters, CVCs carry a substantially greater risk for infection; therefore, the level of barrier precautions needed to prevent infection during insertion of CVCs should be more stringent than proper hand hygiene alone.

Slide 16

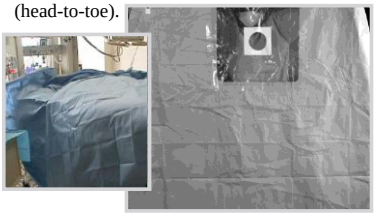
Demand Strict Hand Hygiene

Observe proper hand washing procedures either with conventional antiseptic-containing soap and water or with alcohol-based hand rub.

Slide 17

Maximal Patient Barrier

- Drape the patient with the full body drape (head-to-toe).



Slide 18

What are Maximal Barrier Precautions?

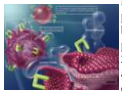
For Provider:

- Hand hygiene
- Non-sterile cap and mask
  - All hair under cap
  - Mask covers nose and mouth tightly
- Sterile gown/gloves

Image provided by author

Slide 19

Chlorhexidine



- In a study from 1991, preparation of central venous and arterial sites with a 2% aqueous chlorhexidine gluconate lowered BSI rates compared with site preparation with 10% povidone-iodine or 70% alcohol. Since that time, there has been growing evidence that chlorhexidine-containing skin preparation is superior to other options. A meta-analysis from 2002 that pooled results of these studies demonstrated use of a chlorhexidine-containing preparation decreased central catheter related infections by 49% relative to povidone-iodine preparations. Because a smaller effect of chlorhexidine was seen in studies using a 0.5% concentration of chlorhexidine, preparations with greater concentrations are recommended.

Joint Commission – CLABSI Fact Sheet

Slide 20

You should

Use chlorhexidine skin prep in a back-and-forth friction scrub.

- For the so-called dry sites (subclavian or jugular), prep for at least 30 seconds – allowing a **30 second dry time.**
- For the wet sites (**femoral or groin**)**,** prep for at least **2 minutes with a 1 minute dry time**.
- Ensure that solution dries completely before attempting to insert the central line.

Slide 21

Chlorhexidine

Chlorhexidine <u>should not</u> be used on:

- Infants less than 2 months of age

or

- Anyone with a chlorhexidine sensitivity or allergy.
  - For those meeting the above alerts, 10% povidone-iodine or 70% alcohol may be used as an alternative skin prep.
  - If inserting an umbilical central line, avoid tincture of iodine because of the potential effect on the neonatal thyroid. Other iodine-containing products (e.g., povidone-iodine) can be used.

Slide 22

Subclavian Vein

- The site at which a catheter is placed influences the subsequent risk for catheter-related infection and noninfectious complications. For adults, lower extremity insertion sites are associated with a higher risk for infection than are upper extremity sites. As a result, authorities recommend that the femoral vein be avoided. Place CVCs in an alternative site to reduce the risk for infection. The risk of noninfectious complications should be assessed on an individual basis when determining which site to place the CVC.

Slide 23

Hub/Clave

- Before accessing catheter hubs/claves or injection ports, clean them with an chlorhexidine preparation or a 70% alcohol prep pad to reduce contamination
- Chlorhexidine containing sponge dressing for CVC's in patients older than 2 months of age

Slide 24

Dressing Changes

- Replace catheter-site dressing if it becomes damp, loosened, or visibly soiled or when inspection of the site is necessary.
- Dressing changes are to be done based on your facility's policy and line type.
- Chlorhexidine is the preferred cleansing agent. When cleansing the dressing site, use chlorhexidine (CHG) swab or other approved agents per your facility's policy.

Slide 25

Dressing Changes

- Do not use topical antibiotic ointment or creams on insertion sites (except dialysis catheters).
- Do not submerge the catheters under water.
- Visually inspect site for swelling, erythema or drainage. If any of these symptoms are present notify physician.
- Do not use acetone or adhesive remover to remove old dressings.
- Transparent dressing material will release when stretched.
- Transparent occlusive dressing; leave in place up to 7 days if clean and dry

Slide 26

Line Necessity

- Daily review of central line necessity may prevent delays in removing lines that are no longer needed.
- Many times, central lines remain in place simply because of their reliable access and because personnel have not considered removing the line.
- However, it is clear that the risk of infection increases over time as the line remains in place and that the risk of infection is decreased if removed.

Slide 27

Daily Review of Line Necessity

- Every day, ask the following:
  - Does the patient still need the line?
    - **If yes,** can a less risky catheter be used? (e.g., triple lumen to a peripheral)?
    - **If no**, can we remove the line today?

Slide 28

Intrinsic and Extrinsic Risk Factors for CRBSI

Intrinsic Risk Factors (nonmodifiable characteristics of the patient)	Extrinsic Risk Factors (potentially modifiable factors associated with CVC insertion or maintenance)
Patient age	Prolonged hospitalization before CVC insertion
Underlying diseases or condition	Multiple CVCs
Patient's gender	Parenteral nutrition
	Femoral or internal jugular access site
	Heavy microbial colonization at insertion site
	Multilumen CVCs
	Lack of maximal sterile barriers for CVC insertion
	CVC insertion in an ICU or emergency department

Slide 29

CRBSI Criteria

Surveillance Definition (different from clinical)

- Must have a central line in place for two calendar days.
- Must have a recorded symptom like chills or hypotension and/or fever .
- Must have one positive blood culture from a central line or venipuncture or 2 common commensals drawn from 2 or more blood cultures on separate occasions, no more than 1 day between.
- Unable to link the pathogen to another site such as sputum, wound or urine.

Slide 30

Provide optimal care for IV Injection Ports

- Prior to accessing the port, clean it per the manufacturer's guidelines (**10 twists with 70% alcohol**) and allow to air dry before accessing the system. (No blowing or fanning).
- Cap all central line ports when not in use.
- Change caps no more frequently than every 72 hours and at least every 7 days or according to the manufacturer's recommendations.

EXCEPTION: Change the cap when: it has been removed for any reason or any time the cap appears damaged, is leaking, blood is seen in the catheter without explanation, blood residue in the cap or when cap has been laid down on a non-sterile surface.

Slide 31

Take This Note

- Do not use hemodialysis catheters for blood drawing or applications other than hemodialysis except during dialysis, under emergency circumstances.
- Use povidone-iodine antiseptic ointment at the hemodialysis catheter exit site after catheter insertion and at the end of each dialysis session only if this ointment does not interact with the material of the Hemodialysis catheter per manufacturer's recommendation.

Slide 32

References

- http://www.cdc.gov/nhsn/PDFs/pscManual/4PSC_CLABScurrent.pdf
- http://www.ihi.org/IHI/Programs/Campaign/CentralLineInfection.htm
- CDC. Guidelines for the prevention of intravascular catheter-related infections. MMWR 2002;51(No. RR-10)