IMPROVING CENTRAL VENOUS CATHETER INFECTION RATES THROUGH THE USE OF A BUNDLE: AN INTEGRATIVE REVIEW

A Scholarly Project
Submitted to the
Faculty of Liberty University
In partial fulfillment of
The requirements for the degree
Of Doctor of Nursing Practice

By
Janice Harris-Hall
Liberty University
Lynchburg, VA
June 2020
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ABSTRACT
The role of Central Venous Catheters (CVC) is significant for the End-Stage Renal Disease (ESRD) population. The placement of the CVC for a HD (HD) patient is not only necessary, but life-sustaining. CVCs are usually placed for an emergent HD treatment, while awaiting a permanently placed arteriovenous fistula or graft (AVF/AVG), or when the permanent access becomes non-functioning. There are multiple risk factors related to having a CVC placed, the most predominant complication being catheter line-associated bloodstream infections (CLABSI). Studies have shown that implementing a CVC prevention bundle was associated with a significant reduction in the CLABSI rates within the HD population. Implementing and examining the efficacy of best evidence-based practices to determine whether infection rates decrease in the ESRD population with a prevention bundle intervention, was the aim of this integrative review. Having the ability to control infection in ESRD patients is a challenging task for healthcare providers, especially because catheters are often manipulated during HD treatments, and ESRD patients are already immunocompromised.

Keywords: bundle, central venous catheter (CVC), central line associated bloodstream infection (CLABSI)
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Dedication

I would like to thank God almighty for keeping me grounded throughout this process. Through faith and perseverance, I have learned to never give up on this journey to attain my DNP degree. I am dedicating this project to my mother and father, Betty Jeanne & William Roy Harris and my wonderful son, Julian Michael Hall, who have been supportive throughout this process. Thank you for believing in me especially to my friend Wade; thank you for the words of encouragement when the load appeared unbearable and unachievable. I truly thank my father who is my guardian angel watching from heaven and proud of my achievement. I thank you mom and dad for the values you have instilled in me which have made me the woman that I am today.
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Table of Contents

Acknowledgements .................................................................................................................. 6
List of Abbreviations ............................................................................................................... 9
SECTION ONE: INTRODUCTION ............................................................................................ 10
    Background ......................................................................................................................... 13
    Problem Statement .............................................................................................................. 15
    Purpose of the Project .......................................................................................................... 15
    Clinical Question ............................................................................................................... 16
    Project Goals ..................................................................................................................... 16
SECTION TWO: METHODOLOGY ............................................................................................. 16
    Framework ......................................................................................................................... 17
        The PRISMA Statement .................................................................................................. 17
        Cooper, Whittemore and Knafl .................................................................................... 18
        Building the Scholarly Project ...................................................................................... 18
        Conceptual Framework ................................................................................................. 18
        Methods .......................................................................................................................... 19
    Data Collection Process ...................................................................................................... 20
    Eligible Criteria .................................................................................................................. 21
    Search Strategy .................................................................................................................. 22
    Search Outcome .................................................................................................................. 22
    Critical Appraisal ............................................................................................................... 23
    Data Analysis Stage ............................................................................................................ 23
    Data Analysis ..................................................................................................................... 24
    Study Selection ................................................................................................................... 25
    Validated Tools ................................................................................................................... 25
        Evidence Pyramid .......................................................................................................... 25
        Data Items ....................................................................................................................... 26
        Synthesis Results ............................................................................................................ 26
    Data Reduction .................................................................................................................. 27
    Data Display ....................................................................................................................... 27
    Data Comparison ................................................................................................................. 27
SECTION THREE: RESULTS .......................................................................................................................... 28
  Study Characteristics .......................................................................................................................... 28
  Synthesis of Results .......................................................................................................................... 28
Results of Individual Studies .................................................................................................................. 28
Bundle Intervention & Strategies............................................................................................................. 30
  Prevention Bundle .......................................................................................................................... 30
  Bundle Devices ............................................................................................................................. 31
Bundle Intervention ............................................................................................................................. 34
  Hand Hygiene .................................................................................................................................. 35
  Aseptic Technique .......................................................................................................................... 35
  Maximal Barrier Precautions .......................................................................................................... 35
  Skin Preparation ............................................................................................................................. 36
  Catheter Site Dressings Regimens ................................................................................................... 36
  CVC Maintenance ........................................................................................................................... 37
  Prophylactic Antibiotic Lock, Antimicrobial Flush & Catheter Lock Solutions .................. 37
  Disinfection of Catheter Hubs, Connectors & Injection Ports ....................................................... 38
  Education and Training of Health Care Personnel ...................................................................... 38
Conclusion Drawing & Verification ..................................................................................................... 39
  Additional analysis ........................................................................................................................ 39
  Evaluation Methods ....................................................................................................................... 39
SECTION FOUR: DISCUSSION .................................................................................................................. 40
  Summary of Evidence ...................................................................................................................... 41
  Limitations ..................................................................................................................................... 43
  Conclusions .................................................................................................................................... 44
References .............................................................................................................................................. 48
Appendix A ........................................................................................................................................... 56
Appendix B ........................................................................................................................................... 76
Appendix C ........................................................................................................................................... 77
Appendix D ........................................................................................................................................... 78
Appendix E ........................................................................................................................................... 79
List of Abbreviations

Arteriovenous Fistula (AVF)
Arteriovenous Graft (AVG)
Central Venous Catheter (CVC)
Catheter Related Bloodstream Infection (CRBSI)
Central Line Associated Bloodstream Infection (CLABSI)
Doctor of Nursing Practice (DNP)
HD (HD)
Institutional Review Board (IRB)
Section One: Introduction

Introduction

Each year in the United States, more than 300,000 patients receive ongoing maintenance HD (HD) for the treatment of end-stage renal disease (ESRD) (Rebmann & Barnes, 2011). The risk of bloodstream infections (BSIs) in HD patients is 100 times higher than in the general population (45.2 versus 0.4 episodes per/1,000 patient-years), with HD patients accounting for up to 15% of all invasive infections (Fitzgibbons, Puls, MacKay, & Forrest, 2011). Infections have been identified as the second-leading cause of death in the HD population (Hess & Bren, 2013). Vascular access-related bloodstream infections and their complications that require hospitalization account for nearly one-third of the cost of ESRD management with reported mortality rates of 12-25.9% (Rebmann & Barnes, 2011).

HD aids in sustaining life among three conditions which include poisoning, End-Stage Renal Disease (ESRD), and Acute Kidney Injury. In order to have a successful HD treatment for any of these conditions, a large blood vessel efficient of facilitating rapid extracorporeal blood flow is required. The objective of vascular access is to deliver frequent access to the circulation with the least complications. Dialysis catheters (DC) are frequently used as temporary vascular access in HD for patients; at times, this can become permanent access. These catheters are unavoidable due to their significance in providing uncomplicated, immediate access for HD to take place safely. Complications from a dialysis catheter can include mechanical, thrombotic and infections resulting from insertion or removal, morbidity, and mortality. Catheter Related Blood Stream Infection (CRBSI) have been reported to an have adverse impacts on the quality of life, survival, and healthcare costs. The data in the United States show that BSIs occur at a rate of 0.5
to 27.1 per 100 dialysis patients in a month (Fram et al., 2014). The average cost of hospitalization of an HD patient with a BSI was estimated to be $24,034, placing an enormous burden on healthcare organizations (Lindenberg et al., 2013).

The staff and healthcare providers play a significant role in HD treatments, and this increases their contributions to the prevention of BSI. Many of the recommended practices in dialysis centers have been extrapolated from studies conducted in hospital intensive care units, which are not specific to HD environments (Hess & Bren, 2013).

The Institute for Health Care and Improvement (IHI), developed the concept of “Bundle” to help clinicians deliver bedside care more reliably and effectively (Furuya, Dick, Perencevich, Pogorzelska, & Stone, 2011). A bundle is a small set of evidence-based practices that are combined as a group of recommended interventions and are applicable to the patient population with the goal to use them as usual practice and improve care delivery (Resar et al., 2012). The introduction of bundles was originally an initiative by the IHI designed to reexamine the structure and assumptions of care delivered in the intensive care unit. The outcome was to design processes that provided reliable care and would prevent serious adverse events (Resar et al., 2012). The IHI Central Line Bundle consists of five interventions: hand hygiene; maximal barrier precautions; chlorhexidine skin antisepsis; optimal catheter site selection, with avoidance of the femoral vein for central venous access in adult patients; and daily review of the line necessity with prompt removal of unnecessary lines (Furuya et al., 2011). The use of bundles is recommended in the current literature as a method of increasing staff compliance with nursing processes and policies (Resar et al., 2012).

Current interventions are focused on decreasing the effect of BSIs after they occur (Rebmann & Barnes, 2011). The creation and use of a bundle are a significant step in the
improvement of overall healthcare and quality through prevention. The cost of treating a patient with a BSI is approximately $24,034, and there is a nominal cost to monitor staff practices when accessing a catheter for HD treatment.

The significance of searching the literature regarding prevention bundles merely combines all components of HD care to be monitored for compliance with the aim of improving staff compliance, reducing infections, and improving patient outcomes. Central venous catheters (CVC) are essential devices for health care currently. According to the Center for Disease Control and Prevention (CDC), half of the patients in Intensive Care Units (ICU) in the United States of America (USA) use CVC resulting in an amount of 15 million catheters are used per year (Reyes, Morphet, & Bloomer, 2017).

CVCs play a vital role in U.S. healthcare. Annually 3 million CVCs deliver fluids, blood products, medications, and parenteral nutrition, and provide HD access and hemodynamic monitoring. Despite the advantages of its use, there are associated risks, and among them are bloodstream infections. The majority of CRBSIs are caused by microorganisms through the contamination of the catheter insertion site, or through the infusion of contaminated IV solutions, the device’s connections, and staff’s hands (Sakshi, M. V., & Saluja, V., 2019).

National quality improvement programs, including the breakthrough fistula first initiative, have been ineffective and, in many cases, have contributed to many patients on HD initiating HD with a catheter (CDC, 2011). Over 300,000 patients undergo maintenance HD in the United States with up to 80% initiating treatment with a central venous catheter (US Renal Data System, 2013). A host of resources has been dedicated to combating CRBSIs in patients on HD. CRBSIs remain a considerable problem that plague the ESRD community and health care
providers due to the consequences of the disease and mortality effects. Early efforts must be directed toward preventative care.

Should no other option exist outside of HD catheter placement and use, proper catheter care and infection control procedures are the first step in preventing these infections. Auditing staff and educating both patients and dialysis nurses are of the utmost importance. The Centers for Disease Control (CDC) offer several recommendations and guidelines for catheter maintenance care in the dialysis population. Offering appropriate education to staff through training and auditing techniques ensures a vested interest on the part of dialysis staff. Facilities are encouraged to conduct monthly surveillance for bloodstream infections (BSI) using the National Healthcare Safety Network (NHSN) of the CDC audit and surveillance tools (US Renal Data System, 2013).

**Background**

In 2014, there were approximately 408,711 patients receiving maintenance HD. For patients receiving HD for end-stage kidney disease, the current options for vascular access include an arteriovenous fistula (AVF), arteriovenous graft (AVG), or central venous catheter (CVC) (Silverstein et al., 2018). The percentage of patients using a CVC varies depending on several parameters, including time of pre-ESRD care. As of 2017, the US Renal Data System’s annual data reported that 80% of patients with ESRD had a CVC as vascular access, whereas 61.9% had neither and AVF or AVG in place at the initiation of HD. Among all patients on maintenance HD, 62.9% had an AVF, 17.7% had an AVG, and 19.4% had a CVC as a vascular access (Silverstein et al., 2018).

Central venous catheters have become necessary components of HD patient care and may result in catheter-related bloodstream infections (CRBSIs). Complications associated with CVC
use are known to contribute to patient morbidity and mortality, as well as increasing medical treatment cost and length of stay (Al Salmi & Kadium, 2013). The total excess cost of any given catheter-related bloodstream infection (CRBSI) is approximately $32,254 (Kim, Holtom, & Vigen, 2011). The estimated costs reported in the literature for CRBSIs vary widely from $28,690 to $56,000 per infection, with annual cost depending on what factors are used in analysis (Kim et al., 2011). According to the Centers for Disease Control and Prevention (CDC), there are 80,000 related CRBSIs among patients in ICUs each year, accounting for up to 24,000 deaths. Each CRBSI extends a patient’s stay in the hospital by a mean of 7.5 days. Assuming the average cost of $16,550 per CRBSI, the annual cost of managing these infections is approximately $414 million per year (Sacks et al., 2014).

In recent years, great strides have been made in the direction of central line-associated bloodstream infections (CLABSIs). From relatively simple interventions, such as the use of bundle strategies and their associated components, to more advanced interventions, such as antimicrobial lock solutions and antimicrobial dressings and central venous catheters (CVCs), reported rates have been markedly reduced (The Joint Commission, 2012). Any effort utilized to reduce CLABSI rates begins with competent staff members being trained to insert or maintain CVCs. Prior to the specific strategies to prevent CLABSI, the essential roles of education and training of health care personnel must be emphasized. Health care providers who insert or maintain CVCs should be knowledgeable and competent regarding care related to the prevention of CLABSIs. It is imperative that health care providers remain current regarding technological advances in the prevention of CLABSIs: proper techniques and procedures for CLABSI prevention is essential. Competence of health care providers should be assessed at the time of
initial employment, on a periodic ongoing basis, when new technology or equipment is introduced and when staff members’ scope of practice changes (The Joint Commission, 2012).

**Problem Statement**

Central venous catheters (CVC) continue to be utilized in inpatient and outpatient settings providing long-term venous access. CVC lines disrupt the integrity of the skin, causing infection. Infection could spread, causing hemodynamic changes and possibly organ dysfunction, which could lead to death. Approximately 90% of central line-associated bloodstream infections (CLABSI) occur with central lines (IHI, 2012). Seeking to contribute to safer care provided to critically ill patients, this project’s aim was to identify an evidence-based prevention bundle strategy to prevent and/or reduce infections among patients of ESRD.

Previous studies concentrated mainly on the effect of insertion bundles on the incidence of CLABSI, and very few studies addressed maintenance practices. The aim of this project was to determine whether there is an intervention strategy for a prevention bundle, which may have an impact on the reduction of HD catheter-related infections. The HD patient is chronic, and a considerable percentage of these patients rely on CVCs for dialysis blood access. Recent evidence suggests that focusing on a strategy which uses the evidence-based recommended guidelines for practice by the CDC of bundling together various approaches to infection prevention in order to improve adherence to recommended practices can have a positive impact on outcomes for the ESRD population (CDC, 2012).

**Purpose of the Project**

The purpose of this scholarly project was to conduct an integrative review of literature to explore the historical, contextual, and evolving nature of research on strategic approaches to implement a prevention bundle in HD and determine if an appropriate intervention or strategic
A initiative exists that can reduce infections in ESRD patient populations. CVC prevention bundles for HD include hand hygiene, maximal barrier precautions, chlorhexidine skin antisepsis, and optimal catheter site selection, with avoidance of using the femoral vein for central venous access in adult patients, and daily review of line necessity, with prompt removal of unnecessary lines. This supported best evidence-based practices and optimal outcomes in the dialysis and health care providers of the practice setting.

**Clinical Question**

The National Health and Safety Network (NHSN) of the Centers for Disease Control suggested conducting observations involving catheter care maintenance and assessing adherence of staff to aseptic technique when caring for central venous catheters to reinforce preventative infection control techniques (Soi et al., 2016). The purpose of a review is to give a synopsis of what is already known about a topic and communicate the synthesis of literature to a targeted community (Toronto & Remington, 2020). For the review to be considered rigorous, a comprehensive method was applied and reported. This process allowed the reader the ability to evaluate the reviewer’s attempt to mitigate bias and if desired, replicate the same review procedure and draw a similar conclusion. This integrative review addressed the following clinical question: Does the evidence support a Central Venous Catheter Bundle intervention to prevent infections?

**Project Goals**

1. Identify what patient factors are linked to catheter-related infections.
2. Determine which intervention is best to reduce infections.
3. Explore the feasibility and advantages of a prevention bundle for patients with ESRD used among health care providers.
Section Two: Methodology

Framework

The reviewer conducted an integrative review following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009).

The PRISMA Statement

The PRISMA statement simplifies the technique authors use to ensure transparent and complete reporting of systematic reviews and meta-analyses. PRISMA was developed to assist authors in reporting a wide array of systematic reviews of non-randomized studies which assess the benefits or harm of interventions (Liberati et al., 2009). The flow diagram defines the literature search, search results combined, articles screened that were either included or excluded, and the causes for each selection (Appendix B).

Polit and Beck

A good review needs a thorough familiarity with available evidence (Polit & Beck, 2012). A thorough review lends support to the researcher in determining how to respond to existing evidence. The process of identifying gaps and inconsistencies, as well as considerations for next steps were facilitated by the integrative review. Primary sources were relied upon in the review of literature. Secondary sources and non-research references were also reviewed to better comprehend the problem, demonstrate a need for research, and describe aspects of clinical practice (Polit & Beck, 2012). A review should be comprehensive, systematic, without bias, current, and strive to provide insight that is more than the total of its parts (Polit & Beck, 2012).
Cooper, Whittemore and Knafl

Cooper (2001) implied that when seeking to understand a phenomenon it is important to utilize the integrative review methodology which includes use of non-experimental and experimental research. Integrative reviews function to incorporate a wide array of purposes: to define concepts, to review theories, to review evidence, and to analyze methodological issues of topics (Whittemore & Knafl, 2005).

Building the Scholarly Project

The phenomenon of interest, broadly stated, was a bundle for bloodstream infection of HD patients. Deciding on that topic was challenging, as there are a significant number of reasons why bloodstream infections occur with the dependency upon use of a central venous catheter. Exploring a bundle for BSI infection required a comprehensive search of the current literature followed by critique and analysis to determine the current and relevant evidence-based practice that could be implemented with a healthcare organization.

Conceptual Framework

The literature search should be systematic in its approach and comprehensive using two or more methods. Examples of the methods include multiple electronic databases and ancestry along with hand search methods. The purpose of comprehensive searches is to minimize biased conclusions in reviews (Whittemore & Knafl, 2005). Systematic methods for data analysis that are specific to the integrative review method are necessary to protect against bias while enhancing its rigor and improving the accuracy of conclusions. The integrative review is a methodology that provides synthesis of knowledge and applicability of results of significant studies to practice. The framework chosen for this integrative review was conducted by the reviewer following the Preferred Items for Systematic Reviews and Meta-analysis (PRISMA)
guidelines (Moher, Liberati, Tetzlaff, Altman, & Prisma Group, 2009) and Cooper’s five-stage method (Cooper, 1982, 1998), as modified by Whittemore & Knafl (Whittemore & Knafl, 2005), which includes the following steps: problem identification, data collection, evaluation of data quality, analysis and interpretation of data (data abstraction), and presentation of results (Cooper, 1982, 1998; Russell, 2005; Whittemore & Knafl, 2005). At the beginning of the review process the reviewer identified the research problem by conducting a preliminary literature search using the search term, “Prevention Bundle for central venous catheter, and catheter related infection.” The reviewer chose to conduct an integrative review to consider using a variety of methodologies and to present a comprehensive understanding of the phenomenon of prevention bundle.

**Methods**

Methodological rigor is associated with the quality of the research, leading to the reason an integrative review should be conducted with as much rigor as in the studies they summarize (Toronto & Remington, 2020). The integrative review method allows inclusion of diverse methodologies and plays a role in evidence-based practice for nursing (Whittemore & Knafl, 2005). According to research, the importance of this methodology sustains rigor while decreasing inaccuracy and bias. Systematic reviews have become increasingly important in healthcare and are used to develop clinical practice guidelines. An integrative review of literature was conducted to consider the use of bundles by health care providers in catheter maintenance care of patients with end-stage renal disease. This integrative review sought to utilize a review method which summarized past empirical or theoretical literature in order to provide a more inclusive recognition of a phenomenon or healthcare issue (Whittemore & Knafl, 2005).

This integrative review was submitted to the Liberty University Institutional Review Board for approval. A copy of the Collaborative Institutional Training Initiative (CITI) was
provided (Appendix C) as evidence that the institutional requirements have been met. Research was focused on the following question: Does the evidence support a Central Venous Catheter Bundle intervention to prevent infections?

Data Collection Process

Incomplete and biased searches can evolve into an inadequate database and potential for inaccurate results, requiring transparent literature search strategies (Whittemore & Knafl, 2005). The goal of the detailed search of literature was to accomplish locating the maximum number of eligible sources, using two or more strategies (Toronto & Remington, 2020). For this review, information sources and eligibility criteria were clearly defined to support data collection. The project leader was the only person collecting information from the literature and has appropriately completed the necessary Collaborative Institutional Training Initiative (CITI) modules in order to meet the institutional requirement for project leader education. Prior to the initiation of the search, the Liberty University librarian was consulted for assistance with the selection of appropriate databases and choice of keywords based on the topic.

The reviewer collected data from the electronic databases CINAHL, MEDLINE, PubMed, and Cochrane in order to locate articles that were specific to prevention bundles to reduce bloodstream infection in ESRD population. The reviewer formulated the search terms based on the preliminary literature search. The search terms consisted of combinations of free words and indexed terms concerning prevention bundle, and catheter-related bloodstream infection among HD patients see (Appendix D). The reviewer limited the search studies that focused on the prevention of CVC infection and had adult patients who required the use of a catheter for HD as the study population. The reviewer included only peer-reviewed, original empirical and theoretical studies. The reviewer excluded studies of pediatric patient populations.
Eligible Criteria

The collection of data included identifying a target audience, setting, and inclusion and exclusion criteria. The target audience for this project was healthcare providers, to include physicians, nurses, nurse practitioners, and advanced practice nurses. The secondary population for this review was adults 18 years of age and older, living with ESRD, and requiring preventative catheter maintenance care during HD. HD outpatient and acute care HD in the ICU/SDU settings were included. Data collection was supported by determining inclusion and exclusion criteria (Appendix F). The types of interventions included: infection prevention, bundle intervention, prevention bundle implementation, and bundle elements. Types of outcomes from the primary sources incorporated reduction of infection intervention. The search included publications from the last ten years. Research specifically involving subjects 18 years old and older were included. Publications that involved health care providers, defined as nurses, advanced practice nurses, nurse practitioners, vascular surgeons, and nephrologists were consulted. Additional inclusion criteria considered publications of the inpatient and outpatient practice setting and finally written reports in the English language. Knowledge of eligibility criteria is essential in appraising the validity, applicability, and comprehensiveness of a review (Liberati et al., 2009).
Search Strategy

The full electronic search strategy for EBSCO Host, Ovid, PubMed, Medline, Cochrane, EBSCO Host, Clinical Trials.gov, Joanna Briggs Institute, ProQuest including the last ten years MEDLINE, and Cumulative Index to Nursing and Allied Health Literature (CINAHL) included prevention bundles; central venous catheter; bloodstream infection; implementation of a central line prevention bundle; and enhanced central venous catheter bundle (O’Neil et al., 2016; Brunelli et al., 2018; Lavallee et al., 2017; Marang-van et al., 2016; Abaddy et al., 2019; Safdar et al., 2014).

Search Outcome

The literature search identified 832 identified references. Ten additional articles were identified through other sources. Thirty-two of the 842 were duplicates and removed from the review. Once duplicates were excluded, titles and abstracts of the remaining 810 were reviewed. An additional 667 were excluded contingent on not meeting the established selection criteria, leaving 143 full-text articles to evaluate for eligibility. After further assessment, 118 additional studies were excluded based on nature of the work, which was not included in the critical analysis, by not providing useful contextual information. This left 25 studies for critical review. The critical review of 25 studies is available in Appendix A.

While conducting a literature search it is crucial to identify potential search terms that need to be included, along with a list of sources to search for scientific evidence. The selected online engine Ebscohost was used, where the databases available were PubMed and Cumulative Index of Nursing and Allied (CINAHL). Peer-reviewed journal articles regarding bundles that were ten years old were also reviewed. The tool for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was applied to reveal pertinent information surrounding
the use of bundles in ESRD patient population. The search goal was to ascertain as many relevant studies as possible, without being overwhelmed by results that were not useful (Toronto & Remington, 2020).

**Critical Appraisal**

Critical appraisal is the course of action for watchfully and systematically examining research to assess its reliability, value, and relevance in order to direct professionals in their vital decision making (Toronto & Remington, 2020). Critical appraisal forms for systematic reviews, quantitative, and qualitative research are available to guide a systematic approach to critical appraisal of the evidence. Evidence should be analyzed individually and. This section includes discussion of the strength and weakness, limitations, methods, and results that pertain to the clinical question. Assessing the research methods used in the study is a prime step in its critical appraisal, but there is no gold standard tool identified for determining quality (Whittemore, 2005). A table of evidence is required. The Literature Review is a matrix for organizing the critical appraisal of the evidence that is included in the literature review (Appendix A).

**Data Analysis Stage**

The data analysis phase involves a thorough, unbiased interpretation of the selected primary sources, along with synthesis (Whittemore & Knafl, 2005). The data analysis stage of the integrative review was a vital process to assist in achieving synthesis; by utilizing rigorous methods of data analysis, the reviewer was be able to recast, combine, reorganize, and integrate concepts across a body of literature in order to create knowledge surrounding the phenomena of interest (Toronto & Remington, 2020). Initially the reviewer read the full texts of the included articles to obtain an overview of the content. The data were then extracted and tabulated
according to the authors, year, country, aim, method, the characteristics evaluated and then the main findings.

Methodological rigor is associated with the quality of the research. Quality is the measure that will minimize bias in the design, conduct, and analysis of the research. Anything that systematically distorts the results of a study in a manner that veers away from the truth is bias (Toronto & Remington, 2020). Sources of bias can occur at any phase of the research.

During the data evaluation phase, a critical approach is necessary when deciding about the data reported from the selected literature (Toronto & Remington, 2020). Theoretical, empirical, primary, and secondary sources were included during the evaluation. Reviewers should make critical judgements about the methodological strengths and weaknesses of all included studies prior to making inferences about the phenomena of interest (Toronto & Remington, 2020). During the integrative review, the reviewer ordered and utilized the constant comparison methods which consisted of four phases. The four phases include data reduction, data display, data comparison, conclusion drawing, and verification (Whittemore & Knafl, 2005). There is no documented gold standard for this phase of the process for evaluating quality in research reviews (Whittemore & Knafl, 2005).

Data Analysis

In this final phase, all results relating to elements of the maintenance bundle care for CVC infection prevention were analyzed (Cooper, 1982, 1998; Whittemore & Knafl, 2005; Russell, 2005). The reviewer conducted a thematic analysis to synthesize and summarize the factors and findings obtained from the literature on the prevention bundle and infection prevention of central venous catheters. The data were categorized into themes according to the research questions and analyzed collaboratively by the reviewer.
**Study Selection**

While performing an integrative review of the most current literature on prevention bundles in HD care settings, the content must be reviewed, critiqued, and analyzed utilizing a matrix and systematic review protocol. When reviewing inclusion criteria this process required locating journal articles that were peer-reviewed and written within the past ten years. The articles included only the adult population; no pediatric populations were included. An integrative review was conducted to utilize a systems approach for preventing and reducing causes for bloodstream infection by implementing prevention bundles in a chronic HD population. The Institutional Review Board approval was sought through Liberty University and granted per university guidelines. A completed analysis and critique of research of gathered literature was included through a thorough review of 25 peer-reviewed journal articles that were determined promising sources based on inclusion and exclusion criteria. The 25 articles were selected out of 832 articles for appropriate criteria, rigor, and relevance to the clinical question.

**Validated Tools**

**Evidence Pyramid**

The tool that was used to ascertain the levels of evidence was Melnyk’s hierarchy of evidence (Melnyk & Overholt, 2015), which noted that there are 13 steps and main components of literature review that can be referred to in order to keep the articles consistent. Once consulting with Melnyk’s hierarchy of evidence for the 25 articles was completed, all the articles were noted as primary sources. A range of levels of evidence existed among the 25 articles used for the integrative review with a range of five articles being at Level II, where the evidence is obtained from at least one well-designed Randomized Control Trial (RCT). Level III evidence includes well-designed control trials without randomization; quasi-experimental was found in six
peer-reviewed journal articles. Level IV where evidence from well-designed case control and cohort studies was included in nine of the articles for this review. Level V evidence stems from evidence from systematic reviews of descriptive and qualitative studies. Level VI evidence is derived from a single descriptive or qualitative study. Finally, Level VII evidence comes from the opinion of authorities and/or reports of expert committees, was noted in two journal articles in this review. Evidence-based practice is a problem-solving approach that incorporates the best available scientific evidence and clinicians’ and patients’ preferences and values (Melnyk & Overholt-Fineout, 2015). This tool can be located in Appendix E.

**Data Items**

Defining variables that would assist in seeking data was a primary part of the process. Data reduction is the process where initial categorization of articles was completed based on chronology, subject matter, inclusion criteria, or setting, which started the process of paring down the plethora of information about prevention bundles. This involved the determination of an overall classification system for managing the data from diverse methodologies by utilizing subgroups. The proposed initial subgroup classification was based on source evidence and levels. Each level of evidence was analyzed successively (Whittemore & Knafl, 2005).

**Synthesis Results**

There are four processes which outline the evidence found in an integrative review which consist of data reduction, data display, data comparison, and confirming and drawing a conclusion (Toronto & Remington, 2020).
Data Reduction.

Data reduction involves two phases. The initial phase determines the overall classification system for managing the data from diverse methodologies, by utilizing subgroups. The proposed initial subgroup classification was based on source evidence and levels. Each level of evidence was analyzed successively. Phase two involved a process of coding and extracting data from primary sources to clarify, abstract, focus, and organize data into a feasible framework. These data reduction processes are necessary in order to provide methodological rigor in order to compare primary sources on specific issues and variables (Whittemore & Knafl, 2005).

Data Display.

Data display can incorporate forms, matrices, graphs, or charts which allow comparisons of all primary sources. The purpose of the data display matrix is to enhance visualization of patterns and relationships within and across all data sources (Whittemore & Knafl, 2005). Visual display assists the reviewer with what relationships or patterns emerge within the sample of literature during the data reduction process (Toronto & Remington, 2020). A table was constructed with all applicable data; afterwards extracted data that supported trends was identified and analyzed.

Data Comparison.

This next step defined by Whittemore & Knafl (2005), is considered an iterative process which examines the data displays of primary source data to identify themes, patterns, or relationships. To capture the comparison and visualization process, similar themes were grouped in order to portray relationships and meaning to the review findings.
Section Three: Results

Study Characteristics

In all studies, the primary outcome assesses whether reduction in infections or strategies directed at infection prevention of dialysis catheters was feasible. All studies evaluated adverse effects, including those of any kind and serious events. The identified problem that was addressed by this integrative review was whether an opportunity existed through the identified bundle intervention to reduce catheter infections in the HD population. During this phase it was apparent that there was a need to inspect the inclusion and exclusion criteria to ensure that important studies were included. No bias was identified within or across studies that would interfere with the integrity or rigor of the final articles selected for review.

Synthesis of Results

Toronto & Remington (2020) suggested that the reviewer synthesize information obtained from the literature into a coherent understanding of the question and purpose of the review. After completion, these categories were aggregated into synthesized themes which formed the basis of the findings. The emergent themes were prevention bundle intervention, bundle implementation in HD for maintenance catheter care, infection prevention, bundle, devices, education, adherence, and surveillance.

Results of Individual Studies

In each study, patients were involved because the purpose of the bundle included the assessment of patient catheter related infections, pre and post bundle intervention, overall patient outcomes, safety, satisfaction, and the prevention of increased infection rates (Perin et al., 2016; Blot et al., 2014; Reyes et al., 2017; Zhang et al., 2019). Infection prevention of central line associated bloodstream infection was associated with substantial morbidity, mortality, and cost
and was potentially lethal. Studies have evaluated the outcomes of implementing bundles of care related to CLABSI, CRBSI, and BSI in ICU’s improved nurses’ performance, compliance, and improved catheter care in clinical practice (O’Neil et al., 2016; Sakshi & Vandana, 2019; Abbady et al., 2019; Mheen & Bodegom-Vos, 2014).

One intervention included in the study focused on quality in two distinct bundles; each involved hand hygiene as a primary element. Both bundle interventions included maximal sterile barrier, skin asepsis with chlorhexidine, avoidance of the femoral vein, CVC maintenance, and daily assessment for line necessity. The intervention was coupled with an educational program implemented through videos, surveillance of staff processes, and results (Perin et al., 2016). Another study intervention reported the introduction of a bundle for prevention of CLABSI through quality improvements interventions that included checklists or did not report what contents comprised the bundle. Following the line of care bundles, one study audited the implementation of a CVC insertion bundle and a maintenance bundle for the Institute for Healthcare Improvement (IHI) associated with checklists and results feedback to the team. The study revealed that the medical and nursing approach combined through care bundles reduced the average rate of infection from 6.43% to 1.83% (Perin et al., 2016). In order to show the importance of staff compliance when using a bundle for effectiveness, one study associated a care bundle proposed by the IHI with a verification list and monitored compliance with the bundle elements. The study emphasized that only when compliance with a care bundle is high, is it associated with reduced rates of infection (Perin et al., 2016). These studies presented a multidimensional program that revealed reduced rates of infections. Two of the studies implemented the multidimensional approach International Nosocomial Infection Control Consortium, which consisted of six simultaneous interventions: bundle of interventions;
education; outcome surveillance; process surveillance; feedback on infection rates; and performance feedback on infection control practices (Borgert et al., 2015).

**Bundle Intervention & Strategies**

CVC central line infection prevention bundle intervention should focus on maximizing aseptic technique for accessing catheters for HD treatments. The bundle intervention consists of educational programs for nurses emphasizing catheter/dressing care, enhancement of organizational catheter-care policies, visual aids illustrating proper catheter care techniques, including accessing hubs, competency assessment, process monitoring, and consolidation and standardization of the supplies necessary for optimal central line maintenance into a convenient package located in a standard location in the dialysis unit (Wright, 2017; Blot et al., 2018; Dumyati et al., 2014). The essential roles of continual education and/or competency validation for nursing and training of health care personnel must be emphasized.

Key elements of the bundle should be included in slides or PowerPoints with pictures showing proper procedure for changing catheter dressings, accessing catheter lines, regular feedback of data summarizing direct observations of catheter dressings, and catheter port access for patients. The intervention should take approximately three to four months to implement and establish baseline catheter care practices and CLABSI rates (Wright, 2017; Dumyati et al, 2014).

**Prevention Bundle**

Knowledge of bundle implementation for preventing catheter-related infections with initiatives that aimed to reduce the occurrence of adverse patient outcomes and events, by creating improved patient outcomes and safety was a primary recommendation initiated by the CDC (CDC, 2011). Facilities worked along with the CDC to review the evidence, which supported various BSI prevention recommendations and concluded the interventions should be a
basis for the HD specific implementation bundle (Borgert et al., 2015). The “Core Interventions for BSI Prevention” placed the focus on evidence-based practices for HD CVC postinsertion care, use of standardized infection rate measures collected through the National Healthcare Safety Network (NHSN) for benchmarking, the education and engagement of staff and patients directed at the importance of infection prevention topics, performance of regular audits, and competency assessments of staff to reinforce adherence to the interventions (CDC, 2012; Mheen & Bodegom, 2014; Abbady et al., 2019; Sakshi et al., 2019; Reyes et al., 2017). Key strategies that impacted the collaborative were to increase awareness and continue implementation efforts of CDC recommendations for BSI prevention and involving staff in all phases of infection prevention (Borgert et al., 2015).

**Bundle Devices**

Studies revealed that in 2017, the update to the 2011 CDC guidelines for the prevention of intravascular catheter related infections, chlorhexidine impregnated sponge dressings have been newly added as an alternative to ointments at the exit site for prophylactic catheter care. The data derived from studies performed in hospitalized adult patients with short term catheters in an ICU setting in which there was a marked reduction in CRBSI rate from the use of using chlorhexidine impregnated dressings (Safdar et al., 2014; Brunelli et al., 2018). Two published studies in which chlorhexidine-based exit site applications were performed in patients using catheters for HD; however, their outcomes were conflicting. The first study compared a chlorhexidine sponge dressing to a transparent dressing (dressing to be changed weekly in both groups) and found no significant difference in CRBSI in small cross-over study (Safdar et al., 2014). In contrast, a significant CRBSI was reported in a recent quality improvement project using chlorhexidine transparent dressings (changed weekly) versus dry gauze dressings and
antibiotic ointment (changed weekly) (Safdar et al., 2014). A well-designed study is needed to evaluate chlorhexidine-based exit site applications for use in HD catheters (Sadfar et al., 2014).

Catheters used for the provision of HD are associated with excess morbidity and mortality. Catheter site and bloodstream infections are major risk of their use. Antimicrobial locks are highly concentrated antiseptic/antibiotic or anticoagulant agents, which are used alone or in conjunction, and are instilled in the catheter hub while the catheter is not in use. The goal is to prevent colonization and biofilm formation, for which an antimicrobial agent is needed. Various antimicrobial catheter locking agents which target the intraluminal route of entry have been studied for the prevention of CRBSI. The prophylactic use of combination and antibiotic-anticoagulant antimicrobial locks is associated with a significant reduction in CRBSI: 50% to 100% antimicrobial lock (Brunelli et al., 2018; Hymes et al., 2017).

Ethanol antimicrobial locks have been studied for CRBSI prevention in HD setting. The potential advantage of ethanol is it is inexpensive, reduces biofilm, poses no risk of resistance, and has broad antimicrobial and antifungal properties (Zhao, Liu, & Han, 2018). Two studies used high concentration ethanol 70% lock. In a small proof of concept study in 49 patients, ethanol 70% used once weekly was associated with a reduction in CRBSI compared to heparin thrice weekly, (0.28 versus 0.85 per 1000 days, P=.12) (Zhao, Liu, & Han, 2018).

There are two available catheter hub devices (Tego ICU Medical, Inc.) used at the catheter hub, which is changed weekly and locked with either saline or heparin. This was reported to be associated with a small (10%-12%) reduction in CRBSI in a large (17,000 patients) retrospective study among patients with catheters receiving in-center HD at a large dialysis organization (Brunelli et al., 2018). Another catheter hub developed for CRBSI prevention is the ClearGuard HD antimicrobial barrier cap (Pursuit Vascular, Inc) which
contains a rod coated with chlorhexidine, which extends into the catheter hub, and is changed three times a week, using a heparin lock. Chlorhexidine is a nonantibiotic antimicrobial agent; therefore, the risk of selection for resistance organisms is minimal. In a prospective cluster-randomized trial 40 HD units, pairing control and treatment facilities with similar CRBSI rate, the use of ClearGuard cap was associated with a significant (56%) reduction in the rate of positive blood cultures compared to standard hub caps (Hymes et al., 2017; Brunelli et al., 2018).

Patient care in hospitals often involve insertion of central venous catheters for HD patients who require the device long-term. A study was conducted that the use of catheter devices come with some risk when not used with strict compliance in order to prevent added complications. When these devices are in use there is an increased risk factor of infection along with possible occlusion (Deshmukh & Shinde, 2012). When considering CRBSIs, cost of antibiotics, prolonged length of stay, morbidity, and mortality are some of the main effects included in care (Deshmukh & Shinde, 2012). Complex nursing care is required during device management which supports the need for ongoing education for any health care provider involved in this preventative care practice. Findings from the literature suggest that education is needed in infection control practices and evidence-based practice guidelines for HD vascular access management which are consistent findings from other studies (Wright, 2017). The study also suggested that HD nurses lacked knowledge and consensus of infection control guidelines and that adherence to best guidelines in infection control education required improvement (Wright, 2017). Yousif et al. (2017) revealed that a structured educational program based on K/DOQI clinical practice guidelines for HD access care had a significant impact on the dialysis nurses’ knowledge, and the knowledge level was successfully maintained for at least three months after the educational intervention (Yousif, Abu-Aisha, & Abboud, 2017). Another study
revealed that after an educational intervention program was completed it was found to have enhanced the knowledge and improved practice of nursing personnel regarding CVC care bundle after regular intervals (Marang-van de Mheen & Bodgom-Vos, 2014). An additional study revealed that an educational intervention expanded the body of knowledge about the status of nurses’ compliance with CLABSI prevention guidelines and its effect on the rate of CLABSI in ICUs (Aloush & Alsaraireh, 2018). However, nurse compliance was sufficient, but more improvement could be obtained if there was a decrease in the nurse patient ratio, and moreover the study explained that the rate of CLABSI in the ICUs could not fully be explained by the nurses’ compliance with the guidelines (Aloush & Alsaraireh, 2018; Pushpakala & Ravinath, 2014).

**Bundle Intervention**

According to the literature, hand hygiene is one of the components that is suggested for any bundle as one way of decreasing the risk of a CRBSI (O’ Grady et al., 2011). Maximal barrier precautions are another bundle measure supported by the literature when used in preparation of catheter access (O’ Grady et al., 2011). An additional bundle component supported by the literature is chlorhexidine use for skin antisepsis during catheter site selection and in adult patients seeking to avoid the use of the femoral vein is suggested as this may cause even higher risk of infection long-term (O’ Grady et al., 2011). A final component that can promote change that will result in improvement is a daily review of the lines need and if any changes have occurred prompt removal is suggested (O’ Grady et al., 2011).
**Hand Hygiene**

Hand Hygiene is a key component of any effective patient safety and infection prevention program. Hand hygiene is generally accepted as the single most important measure in preventing the spread of infection. Soap and water along with alcohol-based hand rub products can be used to achieve proper hand hygiene. It is essential that health care providers be knowledgeable of the recommended practices for hand hygiene, and they need to consistently adhere to them. Health care organizations need to integrate hand hygiene into routine procedures and have strong systems in place to support, monitor, and promote the correct behavior.

**Aseptic Technique**

Aseptic technique is a method used to prevent contamination with microorganisms. Aseptic technique is recommended by the evidence-based guidelines for all instances of CVC care (The Joint Commission, 2012). Aseptic technique is also referred to as sterile technique and is used to keep objects and areas free from microorganisms and thereby minimize infection risk for patients. Sterile technique requires the use of multiple barriers, to include sterile gloves, sterile gowns, sterile drapes, and masks to prevent the transfer of microorganisms from health care personnel and the environment to the patient during a procedure.

**Maximal Barrier Precautions**

Maximal barrier precautions require the CVC care provider to wear a mask and cap, sterile gown, and sterile drape over the patient during placement to reduce the risk of CLABSIs (The Joint Commission, 2012). A research team from John Hopkins University School of Medicine developed a comprehensive statewide quality improvement model which included the use of evidence-based interventions, including maximal sterile barrier precaution to reduce the
rate of CLABSI (Mermel, McCormick, Springman, & Maki, 1991). This initiative resulted in a dramatic decrease in CLABSI rates across the 103 participating intensive care units.

**Skin Preparation**

Reducing colonization at the insertion site is a critical component of CLABSI prevention. A recent meta-analysis of more than 400,000 catheters found that the use of chlorhexidine reduced the risk of bloodstream infection by almost 50% when compared to the use of povidone-iodine (Chaiyakunapruk, Veenstra, Lipsky, & Saint, 2009). Chlorhexidine is believed to have an advantage over povidone-iodine due to its prolonged antimicrobial effect and its lack of inactivation when exposed to blood and serum. There is also evidence that adding alcohol to chlorhexidine (chlorhexidine tincture) results in a synergistic effect against bacteria, due to the rapid bactericidal activity of the alcohol (Chittick & Sherertz, 2010). According to the available evidence, chlorhexidine is the preferred antiseptic for skin preparation for reducing the risk for CLABSIs in patients over the age of two months.

**Catheter Site Dressings Regimens**

Dressings that are clean and dry at the site of insertion are important to protect the site and to minimize the risk of infection. Generally, there are two types of dressings that are utilized to cover and protect the insertion site: a sterile gauze and tape or sterile semipermeable transparent polyurethane dressing. The type of dressing is a matter of choice, given that studies have shown clinically substantive differences in site colonization or CLABSI rates between them. Dressings that are transparent allow for continuous visual inspection of the insertion site, which helps hold the device in place and does not require changing as frequent as tape and gauze dressing. Only if the patient is diaphoretic or the insertion site is oozing with blood, are gauze dressings suggested (O'Neil et al., 2016).
Chlorhexidine impregnated dressings are also used to reduce the risk of CLABSI. A recently published multicenter trial showed that patients in the chlorhexidine-impregnated dressing group had significantly fewer CLABSI which those in the group randomized to a standard dressing (Apisarnthanaraks, Thongphuberth, Yuekyen, Warren, & Fraser, 2010). It is important that the insertion site be visually monitored and/or palpated through an intact dressing. If a fever without an obvious source, tenderness at the insertion site, or other symptoms suggesting either local or bloodstream infection, present, the dressing should be removed, and the site thoroughly inspected.

**CVC Maintenance**

Proper maintenance of CVCs is essential for continued patient safety by utilizing prophylactic lock and flush solutions, disinfection of catheter hubs, connectors, and injection ports, chlorhexidine bathing, and use of a CVC maintenance bundle.

**Prophylactic Antibiotic Lock, Antimicrobial Flush & Catheter Lock Solutions**

There are a variety of antibiotic and antiseptic solutions which have been used to lock or flush CVC lumens. Catheter lock is a technique by which an antimicrobial solution is injected into the catheter lumen dead space until it is filled and then allowed to dwell for a period, until the catheter is accessed again. Catheter flush is a technique used to push solution through the catheter into the bloodstream (no dwell time). The use of such locks and flushes is based on the concept that preventing colonization of the intraluminal surface of the CVC will prevent CLABSI (O'Grady et al., 2011). The US CDC currently recommends the use of antimicrobial or antiseptic flush or lock solutions only in patients with long-term catheters who have a history of multiple CLABSI despite optimal maximal adherence to aseptic technique (O'Grady et al., 2011).
**Disinfection of Catheter Hubs, Connectors & Injection Ports**

The external surface of a catheter hub, connector, or injection port is the immediate portal of entry of microorganisms to the intraluminal surface of the catheter. Microorganisms entering the systems attach at any point of contact along the intraluminal surface. The colonization of organisms from within the needless connector, catheter hub, and lumen and can be dispersed into the bloodstream, resulting in CLABSI (O'Grady et al., 2011). This is a particularly important source of contamination for long-term CVCs, where the needless connectors and catheter hubs are accessed more frequently. Novel devices, including aseptic barrier caps and coated needless connectors, may be promising in reducing microbial contamination, but all need to be further evaluated in prospective, randomized clinical trials to determine their impact on the prevention of CLABSI (O'Grady et al., 2011).

**Education and Training of Health Care Personnel**

Any efforts to reduce CLABSI rates begins with competent staff members being trained to maintain CVCs. In resource-poor areas of the world, researchers have found that basic education, and particularly education with feedback of CLABSI rates to staff, can result in lower CLABSI rates (Wright, 2017). There is much evidence in the literature published throughout the period from the 1970s to today that standardization of aseptic care decreases the risk of CLABSI (O'Grady et al., 2011). The key elements a CLABSI education program should contain are appropriate care and maintenance measures needed to prevent infection. The education methods chosen should take into consideration the preferred methods of learning, principles of adult education, resources available, cultural norms, and languages spoken by health care personnel. Trained health care personnel who have demonstrated competence in maintenance of CVCs should be allowed to care for CVCs (O'Grady et al., 2011)
Conclusion Drawing & Verification

Conclusions are the results of the integrative review. These conclusions are interpreted at an elevated level of abstraction by moving inductively from particulars to the general (Whittemore & Knafl, 2005). This is the phase where verification is needed to include returning to the sample sources to identify the truthfulness of the conclusions or may involve the confirmation of the identified patterns, subject matter, and relationships (Toronto & Remington, 2020). At this point bias was reviewed to determine if the information was exhausted and thoroughly reviewed to ensure all important data were included in the final analysis and conclusion. The reviewer determined that there were threads of common themes that surfaced through the synthesis process and formulated the concept of implementing a practice change for bundled catheter care for ESRD.

Additional Analysis

Specific strategies to decrease infection in the ESRD patient population in the outpatient care setting have emerged from the literature. The first was to identify what changes are necessary to decrease the amount of infection in the ESRD patient population by implementing the bundle, which includes several components of care. When infections rates increase it is the leadership team that must establish whether it is due to a system or process failure and concentrate on eliminating the failed process instead of blaming the staff, which has a major impact on how staff members feel about catheter maintenance care (Wright, 2017).

Evaluation Methods

The scholarly project was evaluated by this project leader, committee and chair to assure that the evolving document maintained rigor and met the requirements of the Doctor of Nursing Program at Liberty University.
Section Four: Discussion

This integrative review showed that the bundle intervention represents an alternative to the traditional approach to selecting and managing a CVC prevention bundle for catheter care in a HD setting, considering patients receive multiple HD treatments weekly. The findings indicated that the proactive approach improves patient outcomes in addition to benefitting from reduced risk for infection, especially the healthcare providers who use the devices. The proactive approach was shown to reduce the cost related to the number of catheter infections prior to the prevention bundle intervention for catheter care. The guidelines were approved by the Centers for Disease Control and Prevention (2012) to establish a homogenous and standard approach that is valid for prevention catheter care.

The review revealed several relevant findings. The characteristics of the prevention bundle were described: patients, hand hygiene, maximal barrier precautions, skin antisepsis, antimicrobial devices, education and their roles, and the outcomes improved by using the proactive approach with prevention bundle for infection.

The first category included medical aspects, such as central venous catheter infection diagnosis. Many studies evaluated these aspects and identified the relationship between the diagnosis and the choice of catheter care (Borgert et al., 2015; Lavallee et al., 2017; Marang-van de Mheen & Bodegom-Vos, 2016). The second question that has been addressed arose from the findings of this review concerned with the feasibility and advantages of bundle care in patients with ESRD used among healthcare providers. The findings confirmed that the proactive approach obtained the best outcomes when healthcare providers received ongoing education regarding infection control practices and guidelines (Yousif et al., 2017; Sakshi et al., 2019). The studies also confirmed that a multidisciplinary approach is more beneficial because of team
adherence to the team members knowledge, attitudes, and skill with other healthcare providers within the team (Deshmukh & Shinde, 2014).

Regarding healthcare providers, nurses should be considered essential in the implementation of the prevention bundle. The role of nurses in the care process is significant because they spend a more considerable amount of time with the patients than other healthcare providers, establishing a relationship and performing the actual catheter care. Despite the many advantages of the prevention bundle for patients, the ESRD healthcare system has not been widely implemented. This review revealed that the main difficulty was identifying healthcare habits and attitudes. Future research should evaluate possible strategies for implementing the proactive approach in ESRD clinical practice, testing it from the healthcare provider and patient perspectives. Several findings showed that the prevention bundle was the best choice for patients because it guaranteed the right process at the right time and reduced catheter infection rates (Marang-van de Mheen & Bodgom-Vos, 2014; Lavallee et al., 2017). Nevertheless, no study included in this integrative review discussed that research had been done in HD specific facilities; most were based in ICU settings. Therefore, future research should be conducted to evaluate prevention bundle strategies that only take place in HD facilities to evaluate whether infection prevention is feasible when being utilized in HD facilities in terms of optimizing the care process and patient outcomes.

**Summary of Evidence**

The research revealed that bundles were an influential factor in the care delivery of patients with ESRD who are prone to high risk infection rates with central venous catheter use (Yazici et al., 2018; Abbady et al., 2019; O’Neil et al., 2016; Lavallee et al., 2017; Borgert et al., 2015; Marang-van de Mheen & Bodgom-Vos, 2014). Several studies discussed implementing
bundle care elements to reduce infection, strategies to prevent CLABSI, CRBSI, BSI, educating staff, using audit tools for compliance, and adherence. The aim of this integrative review was to explore the historical, contextual, and evolving nature of research in relation to strategic approaches to implementation of HD and determine if an appropriate intervention or strategic intervention exists that can impact the reduction of infection in the ESRD patient population. However, no one study was able to clearly address the problem or purpose of the project. Several studies discussed implementing bundle care elements to reduce infection, strategies to prevent CLABSI, CRBSI, BSI, educating staff, using audit tools for compliance, and adherence. Lavellee et al. (2017), recommended that care bundles were designed to improve quality of care. During the integrative review process an examination of the literature reflected variation in care bundle outcomes. All care bundles regardless of the number of elements used, indicated that there was a reduction in the risk along with any negative patient outcomes, yet the use of the bundle was still dependent upon the level of compliance of the health care provider (Lavellee et al, 2017; Marang-van de Mheen & Bodgom-Vos, 2014).

The examination found that ESRD and catheter infection was a pressing concern in the health care delivery; however, the diverse concepts created a challenging effect to address in the setting of acute/chronic disease. With varied definitions of what type of infection, epidemiology and pathogenesis infection is indeed a complex and multifaceted health issue (Borgert et al., 2015). This health care issue has been studied for the last 30 plus years and has recently received greater attention. When analyzing research, the studies can give an indication of the need for action to aid the care continuum. Even though there is a necessity to highlight the idea in care delivery, there is no current defined approach to address bundle care elements and the effect on CRBSIs. There is not substantial evidence that bundles are effective in infection prevention for
CVC HD patients (Lamb & Norton, 2018; Aloush & Alsaraireh, 2018; Pushpakala & Ravinath, 2014; Deshmukh & Shinde, 2012; Wright, 2017; Yousif et al., 2017). Research also provided insight regarding multiple devices available to support care providers during bundle catheter care (Parienti et al., 2014; Zhao & Han, 2018; Safdar et al., 2014; Chen et al., 2019; Brunelli et al., 2018; Eggimann et al., 2019; Hymes et al., 2016). The research confirms that health care providers require more insight and education about maintenance catheter care bundles (Deshmukh & Shinde, 2012; Wright, 2017; Yousif et al., 2017; Reyes et al., 2017; Zhang et al., 2019; Blot et al., 2014).

Limitations

The limitations of this integrative review examined the search strategies used and the heterogeneity of the selected studies (Whittemore & Knafl, 2005). A clear limitation of this review was the small number of included articles, most of which were theoretical, precluding definitive conclusions of actual study interventions and outcomes in a HD setting. To minimize limitations, the reviewer followed guidelines for performing an integrative review (Whittemore & Knafl, 2005). During the process of this review, there were a few limitations noted. The results of an integrative review may find limitations by the flaws of the identified studies, by the weaknesses of the review itself, or by both. As with any research study, all reviews have methodological deficiencies that cannot be overcome (Toronto & Remington, 2020). For this novice reviewer, it was difficult to identify a subset of articles that related to the effects of prevention bundle care related specifically to ESRD settings. The initial keyword search did not reveal literature that specifically addressed the problem statement in its entirety. This led the reviewer to use ancestry and descendancy approaches to collect information that was more specific to the devised clinical question; this contributed to the complexity of data tracking and
clarity. PRISMA guidelines were used by the reviewer to examine, screen, and consider the eligible criteria of the literature. The PRISMA guideline did not combine well with the use of the Nursing: Melnyk Pyramid, hierarchy of evidence rating system and therefore caused a mismatched eligibility. This was the cause of articles being included regardless of the rating. This limitation was also noted by the reviewer who was the primary researcher.

Risk of bias was another finding across the studies. Bias can compromise the validity of an individual study’s results and lead to a biased integrative review, potentially resulting in the over or underestimation of the effect (Toronto & Remington, 2020). External validity appeared to be the most concerning bias. Most of the studies had relatively low sample sizes, without control. Settings of the studies were predominantly ICU and inpatient environments. History continues to contribute to bias, as the concept of maintenance catheter bundle care continues to change, never reaching a platform to cause overall standardization of care within the ESRD population health care continuum. Again, this was evident as the number of ESRD prevention bundle care studies increased after the Affordable Care Act recommendations of 2010.

**Conclusions**

The prevention bundle is a proactive approach to an evidenced-based intervention for implementing the prevention bundle for CVC infection prevention for the adult HD patient population. Based on the findings of this review, the proactive approach should replace the traditional approach in which bundle care is administered with variation. One way to reduce practice variation is by transferring evidenced-based knowledge into daily practice. The new approach should involve core clinical interventions that are applied across all appropriate patients.
Readmissions to acute care hospitals create a burden for patients and their health, accounting for increased costs, resources, and time for healthcare providers, payers, and ultimately the healthcare system. Despite making progress, healthcare-associated infections (HAI) continue to impact patients in the United States. One in 25 hospital patients develop at least one HAI during hospitalization. Estimates suggest HAIs result in $28 to $34 billion in excess healthcare cost each year (The Joint Commission, 2012). Although the number of CLABSI has decreased over the last decade, it is estimated over 30,000 occur nationally in hospital ward and critical care units. CLABSI may lead to longer hospital stays, increased mortality, and increased costs (The Joint Commission, 2012). The ongoing problem of readmissions continues to result in serious public health consequences by creating a burden on patients and generating unnecessary healthcare costs. Previous studies of CLABSI have focused on the visit in which the CLABSI occurred and did not examine the issue of readmission.

CLABSI were identified to have led to increased length of stay, increased health care costs, morbidity, and mortality (Khong et al., 2015). An estimated 250,000 bloodstream infections occur annually, most have been found to be related to the use of intravascular devices (Haddadin, Annamaraju, & Regunath, 2020). In the United States, CLABSI rates in intensive care units (ICU) is estimated to be 0.8 per 1,000 central line days (Haddadin, Annamaraju & Regnath, 2020). International Nosocomial Infection Control Consortium (INICC) surveillance data from January 2010 through December 2015 (703 intensive care units in 50 countries) reported a CLABSI rate of 4.1 per 1000 central line days. Many central lines are found outside the ICUs. In one study, 55% of ICU patients and 24% of non-ICU patients had central lines (Sadfar et al., 2014). However, as more patients are located outside of the ICU, 70% of
hospitalized patients with central venous catheters were outside the ICU (Aloush & Alsaraireh, 2018).

Between 2001 and 2009, U.S. healthcare organizations reduced CLABSI in ICUs by 58%. This decrease represents as many as 6,000 lives saved and $414 million in potential excess healthcare costs in 2009, and almost $2 billion in cumulative excess costs since 2001 (The Joint Commission, 2012; IHI, 2016). Of all the healthcare-associated infections, CLABSIs are associate with high-cost burden, accounting for approximately $46,000 per case. Most cases are preventable with proper aseptic technique, surveillance, and management strategies.

It is estimated that one in every four patients who contract a central line-associated bloodstream infection (CLABSI) dies, makes it the deadliest HAI. There is a variation in estimates for the typical cost for a single CLABSI from $ 45,000-$46,000, making it one of the costliest infections (The Joint Commission, 2012). These infections are largely preventable despite statistical reports and more attention that have been placed on reducing them in recent years.

Historically, prevention was considered too costly. However, a recent study published in JAMA Internal Medicine found that properly executing quality improvement interventions could result in 57% fewer bloodstream infections (The Joint Commission, 2012). It is also found that for every $1,000 a health system invested on quality interventions, they were able to achieve a savings of $315,000 (The Joint Commission, 2012). These results showed that investing in prevention interventions was worth the effort from both a patient care quality and financial perspective. Eliminating these complications cannot occur with a single initiative, process, or technology. Successful CLABSI reduction requires a comprehensive approach incorporating three critical components: properly trained people, implementation of industry-leading guidelines
and best practices, and use of the most critically effective products and technology. Without all three components working together, the prevention effort will not be successful.

Overall the HD patients’ quality of life is impacted by nursing practice. Nursing practice has a direct impact on readmission, length of stay, infection rate, cost, and overall patient outcomes. Multiple studies have shown that through the implementation of education and best practices bundles, CLABSI rates can be markedly reduced, and a goal of zero can be achieved. However, no study has demonstrated indefinite sustainability of a rate of zero. The researcher of this integrative review proposed that a new weighted standard be considered that incorporates patient risk factors and emphasizes sustainability.
References


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Appendix A

**Literature Review**

**Clinical Question:**
Does the use of Bundles reflect a reduction in catheter-related bloodstream infections?

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Study Purpose/Objective(s)</th>
<th>Design, Sampling Method, &amp; Subjects</th>
<th>LOE*</th>
<th>Intervention &amp; Outcomes</th>
<th>Results</th>
<th>Study Strengths &amp; Limitations</th>
</tr>
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<tbody>
<tr>
<td>1. Brunelli, S. M., Van Wyck, D. B., Njord, L., Ziebol, R. J., Lynch, L. E., &amp; Killion, D. P. (2018, February 1). Cluster-randomized trial devices to prevent catheter-related bloodstream infection. <em>JASN</em>, 29(4), 1336-1343.</td>
<td>Recent product advancements may reduce BSIs, but a sufficiently powered comparative-effectiveness study is needed to facilitate evidence-based patient care decisions.</td>
<td>This randomized comparative-effectiveness study evaluated two interventions designed to mitigate the risk of catheter-related BSI: ClearGuard HD Antimicrobial Barrier Cap.</td>
<td>LOE= Level IV (Author provided level IV)</td>
<td>Forty DaVita dialysis facilities in the United States were pair-matched by BSI rate, number of patients using CVCs, and geographic location, and then cluster randomized 1:1. We enrolled all adult patients undergoing dialysis with CVCs at these facilities, except those allergic to heparin or chlorhexidine. Overall, 1671 patients participated in the study, accruing &gt;183,000 CVC-days. During the 13-month intervention period that immediately followed, the ClearGuard group had a BSI rate significantly lower than that of the Tego + Curos group (0.28 versus 0.75 PBCs per 1000 CVC-days, respectively; ( P=0.001 )).</td>
<td>BSI rates were significantly lower with the use of Clear Guard antimicrobial caps.</td>
<td>The study demonstrated that the use of Clear Guard resulted in a significantly lower BSI rate versus use of Tego Curos.</td>
</tr>
<tr>
<td>2. Eggimann, P., Pagan, J., Dupusi-Lozeron, E., Eckholm, B., thevenin, M., Joseph, C., ... Que, Y. (2019). Sustained reduction of catheter-associated bloodstream infections with enhancement of catheter bundle by chlorhexidine dressings over 11 years. <em>Intensive Care Med, 45</em>, 823-833.</td>
<td>The purpose of the study was to evaluate the impact of chlorhexidine gluconate (CHG) dressings in addition to an already existent ongoing catheter bundles on the incidence of catheter associated bloodstream infections (CLABSI)s.</td>
<td>LOE Level of Evidence =IV</td>
<td>The intervention consisted of four stepwise modifications to an already established catheter bundle with progressive introduction of CHG dressings from 2007 to 2014.</td>
<td>The addition of chlorhexidine dressings to all CVC and arterial lines to an ongoing catheter bundle was associated with a sustained 11-year reduction of all catheter-associated bloodstream infections. This large real-world data study further supports the current recommendations for the systematic use of CHG dressings on all catheters. Strengths of the study include real world data study including greater than 18,000 patients and 160,000 catheter days over 9 years. The observation was done in a mixed tertiary ICU. The sustained decrease in infection rate was achieved despite a continuous increase in case mix severity over time. Finally, the recording of the data was performed without changes in the setting of the surveillance, in the definition of infections or in the staff in charge of catheter-bundle training and maintenance. Limitations included that the study was monocentric and without randomization and therefore does not qualify for a pragmatic trial. The study design did not allow determining the effect of the generalization of alcoholic 2% chlorhexidine for skin preparation introduced in period D and although systematic education and continuous bedside teaching to comply with the catheter bundle were provided compliance was never assessed.</td>
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The purpose of the study was to investigate whether use of ClearGuard HD caps in HD patients is associated with improvements in rates of BSIs, hospital admissions for BSIs, hospitalization-days for BSI, and intravenous (IV) antibiotic starts as compared with facilities using standard CVC caps.

The study design was a prospective cluster-randomization comparative-effectiveness trial intended to evaluate the assigned facilities’ use of the ClearGuard HD cap.

Level of evidence = IV

The intervention consisted of use of ClearGuard HD Antimicrobial Barrier Caps versus use of standard CVC caps.

The cluster-randomized comparative-effectiveness study 58respectively58 that use ClearGuard HD caps for 12 months was associated with a 56% lower BSI (p=0.01).

The study had many strengths. The study was prospective and randomized and used best-practices methods for infection prevention in the control arm. Also, it was 12 months in duration so seasonal variations and sustainability were assessed.

Study limitation was open label and intervention patients occasionally received HD dialysis at nonparticipating facilities, which likely diminished the effectiveness of the intervention.


Level of evidence = IV

Studies were eligible for inclusion if they evaluated a care bundle. Our operational definition of a care bundle was informed by the Institute for Healthcare Improvement: a

The effect of care bundles on patient outcomes is

The systematic review had some limitations. Firstly, we did not explore the strength of the evidence underpinning the care bundles. It is possible that the elements themselves have contributed to the

| care to evaluate the effects of care bundles on the risk of negative patient outcomes. Random-effect models were used to further explore the effects of subgroups. | (comprising controlled before-after studies, interrupted time series studies and cohort studies) were eligible for inclusion. Additionally, interrupted time series studies were required to have at least three data points both before and after the intervention. | small, straightforward set of evidence-based practices—generally three to five—that, when performed collectively and reliably, have been proven to improve patient outcomes'. | uncertain. Very low-quality evidence from controlled before-after studies suggests that care bundles may reduce the risk of negative outcomes when compared with usual care. By contrast, the better-quality evidence from six randomized trials is more uncertain. | heterogeneity, but it was not within the scope of the current review to assess the content of the care elements. Secondly, behavior change techniques used in each study were coded retrospectively according to the Behavior Change Technique Taxonomy Version |

5. Wright, S. M. (2017, September-October). Using evidence-based practice and an educational intervention: Pilot The purpose of this study was the examination of the effects of an educational The target population for this study was nursing staff at a chronic, adult outpatient HD facility. Level of evidence = IV The results of this project revealed a slight increase in QI measures for HD adequacy and a clinically significant decrease in the incidence of vascular access complications post-intervention. The study results from a conveniency sample of 16 out of a total 20 Limitations - The methodology was a pilot QI project used a pre-/post questionnaire design that incorporated and educational intervention.
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<tr>
<th>Project</th>
<th>Intervention aim</th>
<th>Level of evidence</th>
<th>Description</th>
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<tr>
<td>Nephrology Nursing Journal, 44(5), 427-439.</td>
<td>Intervention aimed at improving knowledge and competence of HD unit patient care staff in managing the HD access according to evidence-based guidelines.</td>
<td>IV</td>
<td>A multifaceted catheter care maintenance bundle consisting of educational programs for nurses, update of hospital policies, visual aids, a competency assessment, process monitoring, regular progress reports, and consolidation of supplies necessary for catheter maintenance.</td>
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<tr>
<td>To evaluate a central line care maintenance bundle to reduce central line-associated bloodstream infection (CLABSI) in non-ICU settings.</td>
<td>Before-after trial with 12-month follow-up period at Barnes-Jewish Hospital (BJH), a 1,250-bed urban tertiary care medical center. The study included all adult inpatients on eight general wards.</td>
<td></td>
<td>Implementation of the bundle was associated with improvement in catheter dressing compliance on intervention wards.</td>
</tr>
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</table>

6. O’Neil, C., Ball, K., Wood, K., Kremer, P., Reza, S., Jafarzadeh, V., Fraser, V., and Warren, D. (2016). A central line care maintenance bundle for the prevention of catheter-associated bloodstream infection in non-ICU settings. To evaluate a central line care maintenance bundle to reduce central line-associated bloodstream infection (CLABSI) in non-ICU settings. A before-after trial with 12-month follow-up period at Barnes-Jewish Hospital (BJH), a 1,250-bed urban tertiary care medical center. The study included all adult inpatients on eight general wards. A multifaceted catheter care maintenance bundle consisting of educational programs for nurses, update of hospital policies, visual aids, a competency assessment, process monitoring, regular progress reports, and consolidation of supplies necessary for catheter maintenance. Implementation of the bundle was associated with improvement in catheter dressing compliance on intervention wards. Strengths of this study include: a focus on CLABSI prevention in non-ICU settings, direct observation of catheter insertion site care practices, and detailed microbiology data. The main limitation of this study was the small number of patients who developed CLABSI, which made it difficult to determine the impact of the central line care maintenance bundle on CLABSI incidence.
<table>
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<th>non-ICU settings.</th>
<th>medicine wards who had central lines in place for one or more days between July 1, 2012 and December 31, 2013. There were no exclusion criteria. Four wards were randomly selected to receive the intervention and four wards served as controls.</th>
<th>(78.8% compliance pre-intervention vs. 87.9% during intervention/follow-up; p&lt;0.001) but improvement was also observed on control wards (84.9% compliance pre-intervention vs. 90.9% during intervention/follow-up; P = .001).</th>
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<tr>
<td>7. Marang-van de Mheen PJ, van Bodegom-Vos L</td>
<td>Meta-analysis of the central line bundle for preventing catheter-related infections: A case</td>
<td>Across 59 studies, the central line bundle effectively reduced CLABSI by 56% (relative risk 0.44 (95% CI 0.39 to 0.50)). Studies that assessed bundle compliance at the individual patient level reported slightly higher reductions than other studies.</td>
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<td>To assess the overall evidence on the effectiveness of the central line bundle and to illustrate</td>
<td>The study purpose was to evaluate the central line bundle (hand hygiene, chlorhexidine skin antiseptis, maximum sterile Level of Evidence = IV)</td>
<td>The central line bundle could receive only a moderate evidence rating may</td>
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<td>Study in appraising the evidence in quality improvement</td>
<td>Issues related to appraising the effectiveness of QI interventions</td>
<td>Barrier precautions, optimal catheter site selection, daily review of line necessity) on CLABSI.</td>
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The aim of this study was to assess the effect of implementation of bundle of care related to central line associated blood stream infection on nurses’ knowledge and practice. A Quasi experimental research design was used in this study. Setting: The study was carried in intensive care unit, coronary care unit and cardiothoracic intensive care unit. Level of Evidence = III

A convenience sample of 70 nurses was used. Tools: The tools were used for data collection including nurses’ questionnaire sheet which include demographic characteristics, knowledge about central line, knowledge about BSI and knowledge about component of CLABSI bundle of care and observational check list regarding central line insertion, care and maintenance of central line. There were highly statistical, significant difference in total mean scores of nurses’ knowledge and practice about bundle of care related to CLABSI between pre- bundle implementation. The result of current study showed that there were statistically improvement in nurse practice after implementation of CLABSI bundle of care with highly statistical, significant difference in nurses’ practice at post and follow up of CLABSI bundle of care phases compared to pre-bundle implementation. This reflect positive effect of implementation of CLABSI bundle of care and CCNs were enthusiastic to learn more about how prevent infection related central line.
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<td>The study was to evaluate the effect of an educational program for vascular access care on nurses’ knowledge at nine dialysis centers in Khartoum State.</td>
<td>Sixty-one nurses working in these HD centers were chosen by simple random sampling method.</td>
<td>Level of Evidence = IV</td>
<td>The pre-educational intervention questionnaire consisted of 28 multiple-choice questions based on K/DOQI guidelines. Post educational intervention questionnaire was administered and then a repeat test was administered three months later.</td>
<td>The majority of the nurses scored less than good prior to the educational intervention. The scoring improved dramatically after the intervention so that 75% of the nurses scored levels of very good to excellent. There was a significant difference in the improvement of the scores attained after the educational</td>
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<td>Strengths included the significant number of HD center nurses that were included which allowed the sample to be generalizable. There was a positive correlation between the degree of education and scores attained in knowledge level, with nurses who had obtained master’s degree of nursing, did better that nurse with only bachelor’s degree.</td>
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<td>The purpose of the study is to examine the impact of quality improvement interventions on central line–associated bloodstream infections in adult intensive care units.</td>
<td>This systematic review and meta-analysis</td>
<td>Level of Evidence =I</td>
<td>All patients were subject to the following lab tests: kidney function, CBC, KT/V, serum albumin, fasting blood sugar, swab culture and sensitivity from both central and peripheral samples. In addition, radiological Doppler ultrasound was done for all patients to evaluate the vascular access.</td>
<td>The results suggest that quality improvement interventions contribute to the prevention of central line–associated bloodstream infections. Implementation of care bundles and checklists appears to yield stronger risk reductions. The results of this meta-analysis provide evidence that quality improvement interventions reduce CLABSI in adult ICUs. Forty-one before–after studies demonstrated consistent, beneficial results, which appeared to be more pronounced among studies implementing bundle and checklist interventions. Quality improvement interventions appeared equally effective in studies with low and high power or baseline CLABSI rate settings.</td>
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| The objective of this study was to assess CRBSI risk factors | The design was a retrospective cohort study of emergency-only HD patients in | Level of Evidence =V | Assessed were CRBSI risk factors including demographics, comorbidities, and duration and frequency of HD. We investigated the microbiologic Adherence to catheter-related infection guidelines | Limitations were firstly retrospective and conducted within a single hospital system. Second, our patients rely predominantly on tunneled HD catheters for HD access, whereas HD |

including demographics/comorbidities, and duration and frequency of HD.

the Harris Health System in Houston, Texas, between January 2012 and December 2015.

etiology of these infections, rates of recurrent CRBSI, and associated morbidity and mortality.

was improved by infectious diseases consultation and associated with fewer recurrent catheter use is less common in scheduled HD patients; this limits our ability to make direct comparisons between these groups. Third, we may have underestimated the true rate of CRBSI-attributable bloodstream infection in the cohort, as in our experience through-catheter blood cultures are not always obtained prior to antibiotic administration.

The main aim of the study was to assess the impact of structured education on knowledge and practice regarding venous access device care among nurses. *International Journal of Science and Research, 3*(1), 895-901. Retrieved from

The quasi-experimental study with pre-test-post-test design was used.

Level of Evidence =IV

The sample size for the study was 60. In this, 30 were in experimental group and 30 were in control group. The samples were selected from the cancer units.

From all the above findings it can be concluded that the structured education was effective on knowledge and practice of staff nurses regarding venous access device care.

The sample size was not large enough and may reduce the statistical significance of the data. Structured education will improve the knowledge and practice of staff nurses. Suitable intervention packages need to be developed and in-service education need to be given periodically for the effectiveness of qualitative nursing services.
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<td><strong>The intervention focused on engagement of nursing staff and leadership, nursing education, online care maintenance, competence evaluation, audits of line care, and regular feedback on CLABSI rates.</strong></td>
<td><strong>This project was constructed as a prospective preintervention-postintervention design.</strong></td>
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<td><strong>A multipronged approach blending both the adaptive and technical aspects of care including front line engagement, education, execution of best practices, and evaluation of both process and outcome measures may provide an effective</strong></td>
<td><strong>A multipronged approach blending both the adaptive and technical aspects of care including front line engagement, education, execution of best practices, and evaluation of both process and outcome measures may provide an effective</strong></td>
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<th>14.</th>
<th>Safdar, N., O’Horo, J. C., Ghufran, A., Bearden, A., Didier,</th>
<th><strong>The aim of the study was to assess the efficacy of a Randomized controlled trials (RCT) evaluating the efficacy of a</strong></th>
<th><strong>Level of Evidence =IV</strong></th>
<th><strong>Strategies are focused on hand hygiene, the use of full-barrier precautions during catheter insertion, skin antisepsis using</strong></th>
<th><strong>There was significant benefit for prevention</strong></th>
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<td><strong>There was significant benefit for prevention</strong></td>
<td><strong>Findings suggest that a chlorhexidine-impregnated dressing can provide considerable value in reducing the risk of CRBSI in</strong></td>
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<td>Chlorhexidine-impregnated dressing for prevention of central venous catheter-related colonization and CRBSI.</td>
<td>Chlorhexidine-impregnated dressing compared with conventional dressings for prevention of catheter colonization and CRBSI.</td>
<td>Chlorhexidine, preferential use of the subclavian/internal jugular sites for non-tunneled catheters, and daily evaluation of catheter necessity with prompt removal of unnecessary lines. Strict adherence to evidence based best practices clearly reduces CRBSI rates.</td>
<td>of catheter colonization and CRBSI, including arterial catheters used for hemodynamic monitoring. Other than in low birth weight infants, adverse effects were rare and minor.</td>
<td>patients with central vascular catheters. A chlorhexidine-impregnated dressing is expected to be of greatest benefit in a setting where the extraluminal route of infection is expected to be predominant such as short-term catheters.</td>
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<td>This study was aimed to determine effectiveness of self-instructional module on central venous catheter care.</td>
<td>Using purposive sampling technique 50 samples were selected from Chettinad Hospital and Research institute, Tamil Nadu, India. The tool used was self-administered questionnaire.</td>
<td>Level of Evidence =VI</td>
<td>The tool used was self-administered questionnaire. The collected data was analyzed using descriptive and inferential statistics.</td>
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<td>The aim of this study was to analyze the impact of routine locking solutions on the incidence of CRBSI and ESI, in preserving catheter function, and on the rate of all-cause mortality in patients undergoing HD.</td>
<td>Meta-analysis and trial sequential analysis.</td>
<td>Level of Evidence = I</td>
<td>Routine locking solutions for HD catheters are recommended with category II evidence according to the guideline by the Healthcare Infection Control Practices Advisory Committee in 2011 [15]; however, there are some limitations of the studies providing the current and update evidence. The limitations are that the sample size was not large enough. A small sample size may reduce the statistical significance of the data.</td>
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<td>The aim of the study examines the impact of quality improvement interventions on central line–associated bloodstream infections in adult ICU patients with central line catheters. Trials implemented quality improvement interventions aimed at increasing professional adherence to evidence-based infection prevention processes. The primary outcome measure was the number of CLABSI per catheter-days pre- and postintervention.</td>
<td>Systematic review and meta-analysis.</td>
<td>Level of Evidence = I</td>
<td>This meta-analysis of 43 studies, involving 584 ICUs, provides evidence that quality improvement interventions reduce CLABSI in adult ICUs. Forty-one before–after studies demonstrated consistent, beneficial results, which appeared to be more pronounced among studies implementing bundle and checklist interventions. Quality improvement interventions appeared equally effective in studies with low and high power or baseline CLABSI rate settings.</td>
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<td>18. Damiani, E., Donati, A., Serafini, G., Rinaldi, L., Adrario, E., Pelaia, P., Busani, S., &amp; Girardis, M. (2015). Effect of Studies on adult patients with sepsis, severe sepsis or septic shock that evaluated</td>
<td>Perform a systematic review of studies evaluating the impact of performance improvement</td>
<td>Level of Evidence = I</td>
<td>Performance improvement initiatives (varying from educational programs [8], introduction of clinical decision support tools [9] or dedicated medical staff [10]) were instituted worldwide in the last Pure process change programs were only able to improve</td>
<td>Limitations: all the included studies were observational investigations and cannot thus support any causality between the quality improvement programs, increase in bundle compliance and reduction in mortality. Secondly, changes in</td>
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<td>performance improvement programs on compliance with sepsis bundles and mortality: a systematic review and meta-analysis of observational studies. <em>PloS one, 10</em>(5), e0125827. org/10.1371/journal.pone.0125827</td>
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<td>changes in compliance to individual/combined bundle targets and/or mortality following the implementation of performance improvement programs. Interventions may consist of educational programs, process changes or both.</td>
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<td>programs on compliance with Surviving Sepsis Campaign (SSC) guideline-based bundles and/or mortality</td>
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<td>years in order to address the piecemeal application of sepsis bundles.</td>
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<td>compliance with the resuscitation bundle but were still associated with a significant and consistent reduction in mortality.</td>
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<td>adherence to SSC-guidelines or outcome over time may have occurred independently of the program implemented and could have influenced the result</td>
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<td>This study compared the risks of dialysis catheter infection according to the choice of locking solution in the intensive care unit (ICU).</td>
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<td>A prospective quasi-experimental study with marginal structural models</td>
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<td>Level of Evidence =III</td>
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<td>A total of 596 critically ill patients received either saline solution or heparin lock solution (the standard of care [SOC]) from 2004 to 2007 in the Cathedia cohort (n 464 for MSM; n 124 for PSM) or 46.7% citrate lock from 2011 to 2012 in the citrate (C-Lock) cohort (n 132 for MSM; n 62 for PSM) to perform RRT using intermittent HD. Catheter tip colonization and CRBSI were analyzed</td>
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<td>By reducing the risk of catheter-tip colonization, citrate lock has the potential to improve HD safety in the ICU</td>
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<td>The study had several strengths. This study represented the third cohort and largest comparison employing individual data to investigate the risk of dialysis catheter infection when using citrate locking in the ICU; thus, this cohort is unique. The findings are biologically plausible and supported by in vitro and in vivo studies.</td>
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among critically ill patients. *Antimicrobial agents and chemotherapy*, 58(10), 5666–5672.


| The studies objective: to identify evidence-based care to prevent CLABSI among adult patients hospitalized in ICUs. | Systematic review conducted in the following databases. | Level of Evidence = I | The search included studies that answered the research question, were related to the topic, and addressed interventions regarding the care and maintenance of catheters. | The studies presented care bundles including elements such as hand hygiene and maximal barrier precautions; multidimensional programs and strategies such as 71 respectively catheters and bandages and the involvement of facilities in and commitment. | Care bundles coupled with education and the commitment of both staff and institutions is a strategy that can contribute to decreased rates of central line-associated bloodstream infections among adult patients hospitalized in intensive care units. |
|---|---|---|---|---|
| To assess nurses’ compliance with central line associated bloodstream infection (CLABSI) prevention guidelines related to maintenance of the central line and the predictors of compliance. |
| This was an observational study that used a descriptive cross-sectional design. |
| An observational sheet was developed based on existing CLABSI prevention guidelines from the Center for Disease Control and Prevention. The focus of the selected guidelines was the maintenance of the central line. |
| One hundred and twenty participants (70%) showed sufficient compliance. This study found that the majority of nurses were sufficiently compliant; however, the rate of CLABSI varied across the participating ICUs. Nurses working with a low ratio had higher compliance scores. |

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<td>The aim of present study was to evaluate the Effectiveness of Education Program regarding CVC Care Bundle in terms of Knowledge and Practice.</td>
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<td>Pre-Experimental study using One Group Pretest Posttest Design was conducted.</td>
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<td>An Observation Checklist was prepared to assess the practice of the Nursing Personnel regarding CVC Care Bundle.</td>
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<td>Study concluded that the Education Program was effective in enhancing the Knowledge and improving the Practice. Study was limited to only liver coma ICU 2. No attempt was made to measure the retention of knowledge gained and improved practice due to time limitation. 3. Standardized tool could not be located by investigator, so investigator developed the tool for the study.</td>
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23. Zhan, J., Wang, B., Wang, J., & Yang, Q. (2019). Ethanol locks for the prevention of catheter-related infection in patients with central venous catheter: A systematic review and meta-analysis of randomized controlled trials (RCTs) assessing the efficacy and safety of ethanol locks for preventing catheter-related infection (CRI). This study aimed to provide a comprehensive summary of randomized controlled trials (RCTs) assessing the efficacy and safety of ethanol locks for preventing CRI. The purpose, ethanol is a potential candidate for the prevention of CRI. It is an easily available antiseptic with a broad antimicrobial spectrum, no known acquired resistance and minimal adverse effects. The study adds to these previous efforts by providing an RCT-based confirmation of the efficacy of ethanol lock solutions for decreasing CRBSI.

Limitations: study adds to these previous efforts by providing an RCT-based confirmation of the efficacy of ethanol lock solutions for decreasing CRBSI.

A systematic review was conducted to determine the strategies used to implement care bundles in adult intensive care units and to assess the effects of these strategies when implementing bundles. The results show that compliance is influenced by multiple factors, i.e. types and numbers of elements varied, and different compliance measurements were reported. The three most frequently used strategies were education, reminders and audit and feedback. The conclusions were that the heterogeneity among the included studies was high due to the variety in study designs, number and types of elements and types of compliance measurements. Due to the heterogeneity of the data and the poor quality of the studies, conclusions about which strategy results in the highest levels of bundle compliance could not be determined.


To evaluate the efficacy of a care bundle aimed at preventing three most frequent intensive care unit-acquired infections. The sample consisted of 120 patients older than 18 years and receiving invasive mechanical ventilation therapy, or had a central venous catheter or urinary catheter. The study comprised three stages. In stage one, the intensive care unit nurses were trained in infection measures, VAP, CA-

| controlled trials. *Plos One, 14*(9), e0222408. | CRI in patients with CVC. | solutions for decreasing CRBSI. | solutions for decreasing CRBSI. | A systematic review was conducted to determine the strategies used to implement care bundles in adult ICU settings and to assess the effects of these strategies when implementing care bundles. The results show that compliance is influenced by multiple factors, i.e. types and numbers of elements varied, and different compliance measurements were reported. The three most frequently used strategies were education, reminders and audit and feedback. The conclusions were that the heterogeneity among the included studies was high due to the variety in study designs, number and types of elements and types of compliance measurements. Due to the heterogeneity of the data and the poor quality of the studies, conclusions about which strategy results in the highest levels of bundle compliance could not be determined. | To evaluate the efficacy of a care bundle aimed at preventing three most frequent intensive care unit-acquired infections. The sample consisted of 120 patients older than 18 years and receiving invasive mechanical ventilation therapy, or had a central venous catheter or urinary catheter. The study comprised three stages. In stage one, the intensive care unit nurses were trained in infection measures, VAP, CA-

| A systematic review was conducted to determine the strategies used to implement care bundles in adult intensive care units and to assess the effects of these strategies when implementing bundles. | A systematic review was conducted. | Level of Evidence = I | Level of Evidence = III | A systematic review was conducted to determine the strategies used to implement care bundles in adult ICU settings and to assess the effects of these strategies when implementing care bundles. | The catheter-associated urinary tract infection rates were higher during July – September (6.7/1000) | The infection rates decreased with increased compatibility of the care bundle prepared from evidence-based guidelines.
UTIs and CLABSIs sections of the care bundle.

catheter days) compared to January – March (5.7/1000 catheter days) and April – June (10.4/1000 catheter days) but the differences were not significant ($p > 0.05$).
Appendix B

April 23, 2020

Janice Harris-Hall
Cynthia Goodrich


Dear Janice Harris-Hall, Cynthia Goodrich:

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study does not classify as human subjects research. This means you may begin your research with the data safeguarding methods mentioned in your IRB application.

Decision: No Human Subjects Research

Explanation: Your study does not classify as human subjects research because:

(2) evidence-based practice projects are considered quality improvement activities, which are not considered “research” according to 45 CFR 46.102(d).

Please note that this decision only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued non-human subjects research status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this determination or need assistance in determining whether possible modifications to your protocol would change your application’s status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP
Appendix C

CITI Training Certificate

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
COMPLETION REPORT - PART 1 OF 2
COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: Janice Harris-Hall (ID: 775446)
- Institution Affiliation: Liberty University (ID: 2448)
- Institution Email: Jharris4@liberty.edu
- Institution Unit: Renal Dialysis
- Phone: 7572728179

- Curriculum Group: Social & Behavioral Research - Basic/Refresher
- Course Learner Group: Social & Behavioral Researchers
- Stage: Stage 1 - Basic Course
- Description: Choose this group to satisfy CITI training requirements for investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- Record ID: 3002827
- Completion Date: 16-Jan-2019
- Expiration Date: 15-Jan-2022
- Minimum Passing: 80
- Reported Score: 94

REQUIRED AND ELECTIVE MODULES ONLY

<table>
<thead>
<tr>
<th>Module Description</th>
<th>Date Completed</th>
<th>Score</th>
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<tbody>
<tr>
<td>Belmont Report and Its Principles (ID: 1127)</td>
<td>13-Jan-2019</td>
<td>3/3 (100%)</td>
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<tr>
<td>Liberty University (ID: 15111)</td>
<td>13-Jan-2019</td>
<td>No Quiz</td>
</tr>
<tr>
<td>Populations in Research Requiring Additional Considerations and Protections (ID: 16680)</td>
<td>13-Jan-2019</td>
<td>5/5 (100%)</td>
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<tr>
<td>History and Ethical Principles - SBE (ID: 490)</td>
<td>13-Jan-2019</td>
<td>4/5 (80%)</td>
</tr>
<tr>
<td>Defining Research with Human Subjects - SBE (ID: 461)</td>
<td>13-Jan-2019</td>
<td>5/5 (100%)</td>
</tr>
<tr>
<td>The Federal Regulations - SBE (ID: 502)</td>
<td>13-Jan-2019</td>
<td>5/5 (100%)</td>
</tr>
<tr>
<td>Assessing Risk - SBE (ID: 503)</td>
<td>13-Jan-2019</td>
<td>4/5 (80%)</td>
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<tr>
<td>Informed Consent - SBE (ID: 504)</td>
<td>13-Jan-2019</td>
<td>5/5 (100%)</td>
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<tr>
<td>Privacy and Confidentiality - SBE (ID: 505)</td>
<td>13-Jan-2019</td>
<td>5/5 (100%)</td>
</tr>
<tr>
<td>Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)</td>
<td>13-Jan-2019</td>
<td>5/5 (100%)</td>
</tr>
<tr>
<td>Research with Prisoners - SBE (ID: 505)</td>
<td>16-Jan-2019</td>
<td>4/5 (80%)</td>
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</tbody>
</table>

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/getinfo/76cb18d8c0b60-e6fe-eb01-83a0-a05e6f6419f1300282727

Collaborative Institutional Training Initiative (CITI Program)
Email: support@citiprogram.org
Phone: 888-528-5529
Web: https://www.citiprogram.org
Appendix D

PRISMA Flow Diagram

Identification

Records identified through database searching (n = 832)

Additional records identified through other sources (n = 10)

Records after duplicates removed (n = 810)

Screening

Records screened (n = 810)

Records excluded (n = 667)

Eligibility

Full-text articles assessed for eligibility (n = 143)

Studies included in qualitative synthesis (n = 19)

Studies included in quantitative synthesis (meta-analysis) (n = 25)

Included

Full-text articles excluded, with reasons (n = 118)
Articles not in English (n = 75)
Studies not conducted in a health care setting (n = 43)

Appendix E
### Inclusion and Exclusion Criteria

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare providers to include physicians, nephrologist, nurses, advanced practice nurses, and nurse practitioners.</td>
<td>Non-healthcare workers</td>
</tr>
<tr>
<td>Anyone 18 years old and older with ESRD requiring the catheter maintenance care during HD.</td>
<td>Anyone younger than 18 years old with ESRD requiring catheter maintenance care during HD.</td>
</tr>
<tr>
<td>ESRD/HD outpatient and acute inpatient (ICU/SDU) HD settings.</td>
<td>Permanent inpatient HD based in a hospital.</td>
</tr>
<tr>
<td>Publications in the English language.</td>
<td>Publications in anything other than English language.</td>
</tr>
<tr>
<td>Literature which included: central venous catheter (CVC), bloodstream infection (BSI), Catheter-related bloodstream infection (CRBSI), and central line-associated bloodstream infection.</td>
<td>Any other infections not related to ESRD.</td>
</tr>
<tr>
<td>Peer-reviewed articles</td>
<td>Non-research articles</td>
</tr>
</tbody>
</table>