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Evaluation of Chlorhexidine Bathing Practices in Trauma/ Surgical Intensive Care Units

Kara Willett
University of Kentucky, kawill5@uky.edu

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Kara Willett, Student

Dr. Melanie Hardin-Pierce, Advisor

DNP Practice Inquiry Project Report

Evaluation of Chlorhexidine Bathing Practices in Trauma/ Surgical Intensive Care Units

Kara A. Willett BSN, RN, CCRN

University of Kentucky

College of Nursing

Spring 2015

Melanie G. Hardin-Pierce DNP, APRN, ACNP-BC Committee Chair/Academic Advisor

Karen Butler DNP, RN Committee Member

Robyn Cheung PhD, RN Committee Member/Clinical Mentor

Dedication

This capstone project is dedicated to my family, whose love and support made my achievement of a Doctorate of Nursing Practice possible. To my parents, Mike and Debbie Willett, whose guidance and unwavering support throughout my life have enabled me to reach my goals. I would like to thank Dr. Hardin-Pierce for her steady guidance throughout the course of this program. Through her direction and encouragement I have been able to succeed. I would like to thank fellow students Katie Layton and Jessica Johnston for their friendship and support through this journey. They have allowed me to find a balance between school, work and life.

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Table of Contents

List of Tables

List of Figures

Introduction to DNP Practice Inquiry Project Report

Kara A. Willett BSN, RN, CCRN

University of Kentucky

College of Nursing

Central venous catheters (CVC) are vital in present-day medical practice, particularly in the intensive care unit (ICU). However, their use puts patients at risk for developing central line-associated bloodstream infections (CLABSIs). Forty-eight percent of ICU patients have central lines, accounting for about 15 million central-line-catheter-days per year (Institute for Healthcare Improvement [IHI], 2012). Central line-associated blood stream infections are one of the deadliest types of hospital acquired infections (HAIs) with a mortality rate near 18%, and are the sources of considerable morbidity and health care costs (CDC, 2011; Burke, 2003; Glance, Stone, Mukamel, & Dick, 2011). CLABSIs require additional treatments that impose substantial economic consequences. The downstream effects of these infections include extended illness, loss of wages, and the intangible costs related to a reduced quality of life. These bloodstream infections prolong hospitalization by a mean of seven days, and the estimated attributable cost per infection is between $3,700 and $39,000 (Institute for Healthcare Improvement, 2012).The overall direct medical costs of HAIs, (including CLABSI) in hospitals in the United States range from 28.4 to 33.8 billion dollars annually (Klevens et al., 2007).

The Association for Professionals in Infection Control and Epidemiology (APIC) promotes a culture of zero tolerance for HAIs (APIC, 2012). The Institute for Healthcare Improvement (IHI) has described care bundles, or groups of best practices with respect to a disease process, that when used together result in superior patient outcomes. Research demonstrates that ICUs which have implemented multiple preventive interventions, including central line bundles, have nearly eliminated CLABIs (Behrenholtz et al., 2004). However, sustained reduction of CLABSIs remains intangible in many institutions despite increased awareness of evidence-based preventive strategies, publication of successful hospital CLABSI elimination programs, and elimination of reimbursement for the cost of treating CLABSIs

(Agency for Healthcare Research and Quality, 2010; IHI, 2012; The Society of Healthcare Epidemiology of America; 2014).

The key to achieving sustainable CLABSI reduction is to combine adaptive cultural changes with evidence-based practices. The Joint Commission requires hospitals to conduct periodic risk assessments, measure CLABSI rates, monitor compliance with best practices, evaluate effectiveness of prevention efforts, provide rate data and outcome measures to key stakeholders, evaluate all CVCs routinely, and remove nonessential catheters (The Joint Commission, 2014). This practice inquiry project is an evaluation of provider adherence to an evidence-based CLABSI prevention guideline utilizing daily chlorhexidine gluconate patient bathing. The evaluation of provider guideline adherence will provide insight and guide future quality improvement initiatives in the prevention of CLABSIs. This practice inquiry project includes three manuscripts, each of which discusses relevant aspects of CLABSIs prevention utilizing daily whole body chlorhexidine gluconate bathing.

• Manuscript one is an evidence review of the literature to (i) determine the potential impact of iatrogenic blood loss on the development of anemia, and (ii) to evaluate the effectiveness of available blood conservation devices and strategies in decreasing iatrogenic anemia and blood transfusions in adult ICU patients.

• Manuscript two is a cost-analysis of the potential financial benefits of implementing daily whole body patient bathing with 2% Chlorhexidine Gluconate impregnated cloths in a large university level-1 trauma center .

• Manuscript three describes the development, implementation, and evaluation of a blood conservation education intervention, and its impact on nursing knowledge and attitudes towards future implementation of blood conservation practices.

Manuscript 1

Chlorhexidine Gluconate Bathing an Adjunct Therapy in Reducing Central Line Associated

Blood Stream Infections: A Literature Review

Kara A. Willett BSN, RN, CCRN

University of Kentucky

College of Nursing

Abstract

The complexity of the healthcare system is increasing, and the moral duty to provide

quality patient care is threatened by the sky rocketing cost of healthcare. A major concern for

both patients and the hospital's economic bottom line are hospital-acquired infections (HAIs),

including central line associated blood stream infections (CLABSIs). These often serious

infections result in significantly increased patient morbidity, mortality, length of stay, and use of

health care resources. Historically, most infection prevention and control measures have focused

on aseptic technique of health care providers and in managing the environment. Emerging

evidence for the role of host decontamination in preventing HAIs is shifting the paradigm and

paving a new path for novel infection prevention interventions. Chlorhexidine gluconate has a

long-standing track record of being a safe and effective product with broad antiseptic activity,

and little evidence of emerging resistance. As the attention is directed toward control and

prevention of HAIs, chlorhexidine-containing products may prove to be a vital tool in infection

control. Increasing rates of multidrug-resistant organisms (MDROs), including methicillin-

resistant *Staphylococcus aureus* (MRSA), *Acinetobacter baumannii*c and vancomycin-resistant

Enterococcus (VRE) demand that evidence-based research drive all interventions to prevent

transmission of these organisms and the development of HAIs. This review of literature

examines current evidence related to daily chlorhexidine gluconate bathing and its impact on

CLABSI rates in the adult critically ill patient population.

Keywords: daily chlorhexidine gluconate bathing, central line associated bloodstream

infections (CLABSI), methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-

resistant *Enterococcus* (VRE) or Acinetobacter *baumannii*c skin colonization acquisition

Chlorhexidine Gluconate Bathing an Adjunct Therapy in Reducing Central Line Associated

Blood Stream Infections: A Literature Review

An estimated 1.7 million hospital-associated infections (HAIs) occur in United States

hospitals annually, resulting in approximately 100,000 deaths and a cost of up to $45 billion

(Klevens, 2007; Scott, 2009; Umscheid et al., 2011). According to the Center for Disease

Control and Prevention (CDC; 2011a), HAI's are the most common adverse events encountered

by hospitalized patients, with estimates of one out of twenty patients affected. Forty-eight

percent of intensive care unit (ICU) patients have central venous lines, accounting for about 15

million central venous catheter days per year (Institute for Healthcare Improvement, 2012).

Central line associated blood stream infections (CLABSIs) are one of the deadliest types of HAI

with a mortality rate near 18%, and are the source of considerable morbidity and increased health

care costs (CDC, 2011; Burke, 2003; Glance et al., 2011). The CDC (2011a) defines a CLABSI

as a hospital-acquired infection where a primary bloodstream infection develops in a patient who

had documented presence of a central venous line at the time of infection or within the preceding

48 hours. The infection cannot be related to any other infectious process and cannot be present or

incubating upon patient hospital admission.

Historically, most infection prevention and control measures have focused on aseptic

technique of healthcare providers and in the management of environment (Agency for

Healthcare Research and Quality, 2010). Central line associated bloodstream infection

prevention attempts have included using evidence-based practices at the time of central venous

line insertion, along with novel strategies including antibiotic or antiseptic-coated catheters and

antiseptic dressings. The recent shift towards evidence-based practice has many healthcare

organizations adopting new practices that are aimed at improving patient outcomes and

decreasing healthcare costs. The CDC (2011b) reported major reductions in CLABSI rates in the

U.S. ICUs from 2001 to 2009; this was based upon data submitted to the CDC's National

Healthcare Safety Network (NHSN) from healthcare institutions nationwide. An estimated

43,000 CLABSIs occurred among U.S. ICU patients in 2001, compared with 18,000 in 2009, a

58% reduction (Srinivasan, 2011). Due to the significant reduction in CLABSI rates, the

implementation of various prevention initiatives has fostered the idea that CLABSIs are largely

preventable, and that a CLABSI rate of zero is an achievable goal.

The recent increase in multi-drug resistant organisms (MDRO) intensifies the scrutiny for

CLABSI prevention practices. Infections caused by multi-drug resistant organisms, such as

methicillin-resistant *Staphylococcus aureus* (MRSA), multi-drug resistant *Acinetobacter*

baumannii, and vancomycin-resistant *Enterococcus* (VRE), limit the number of effective

antibiotics available for treatment, prolong hospital lengths of stay and increase cost, patient

morbidity and mortality. The idea that these infections may be preventable has spurred interest in

the development of novel strategies and adjunct therapies to reduce infection rates. A major

mechanism underlying the development of a CLABSI particularly with short-term devices in

place for ten days or fewer, is the extra-luminal route, where skin microorganisms invade the

percutaneous tract (Sadfar & Malki, 2004). One intervnetion strategy is daily whole body patient

bathing with chlorhexidine gluconate (CHG). Chlorhexidine gluconate a topical antiseptic has

been used as decolonization therapy to control cross infections (Wendt, et al., 2007). It also has

broad-spectrum antimicrobial effects and has been used to disinfect the skin for surgical

procedures and intravascular catheter insertion (Milstone et al., 2008). Chlorhexidine gluconate

has an excellent safety profile and proven efficacy over a wide spectrum of gram-positive and

gram-negative bacteria, as well as fungi and some viruses (Lin & Hayden, 2010). Unlike many

other antiseptics, CHG has residual antibacterial activity, which may reduce the microbial colonization of the patient's skin and prevent secondary environmental contamination (Milstone, Passaretti, & Perl, 2008).

Research indicates that daily bathing with two percent CHG-impregnated cloths decreases patient bacterial skin colonization, healthcare workers' hand contamination, and environmental surface contamination (Vernon et al., 2006). Daily cleansing of ICU patients' skin with CHG has been associated with reduced incidence of colonization's with VRE, MRSA(Climo et al., 2009; Vernon et al., 2006), and multi-drug resistant *Acinetobacter baumannii* (Borer et al. 2007; Evans et al. 2010) and has been linked with decreased incidence of CLABSIs due to VRE and MDR *Acinetobacter* baumannii (Bleasdale et al., 2007; Borer et al., 2007; Popovich et al., 2009).

Research Question (PICO)

The development of a well-framed and defined research question is the foundation to conducting quality research (Stern, C., Zoe, J. & McArthur A., 2014). Using a defined PICO question will lead to an appropriate study design and methodology, and is an essential part of the evidence review process. The formation of a PICO question is the first step in the evidence based practice process and includes the following components: (a) patient population; (b) intervention or area of interest; (c) comparison intervention or comparison group; and (d) outcomes. The following PICO question will serve as a guide for extracting the best evidence from current literature and facilitate evidence-based practice (Fineout-Overholt, Melnyk, & Schultz, 2005).

Does daily whole body patient bathing using chlorhexidne gluconate in the critically ill adult population impact central line associated blood stream infection (CLABSI) rates compared

to traditional daily soap and water bathing?

Methods

Using a predefined strategy to identify the most current and relevant research

articles from the literature, a comprehensive search of the Cumulative Index of

Nursing and Allied Health Literature (CINAHL), Medical Literature Analysis and Retrieval

System Online (MEDline), and PubMed databases was conducted using various

combinations of the following key words: central line associated blood stream infections

(CLABSIs); chlorhexidine gluconate, daily bathing, methicillin-resistant *Staphylococcus aureus*

(MRSA), Vancomycin-resistant *Enterococcus (VRE)* or *Acinetobacter baumanniic* colonization/

acquisition used. Along with these searches, a manual review of reference lists was completed on

the relevant published articles.

The goal of this review was to identify published clinical research to determine

the potential impact of daily CHG whole body patient bathing on the prevention of CLABSIs.

Inclusion criteria were as follows: full-text, peer reviewed nursing or medical journal articles

published in English after the year 2000. Articles involving the study of critically ill human

subjects 18 years of age or older were included in this review. Articles that dealt with

decolonization strategies other than CHG bathing were excluded. Article titles and abstracts were

sorted and literature relevant to the topic of daily whole body chlorhexidine bathing in the adult

critically ill patient population was evaluated. The database search ultimately resulted in the

selection of eight research articles (see Table 1).

Summary of Findings

The eight articles reviewed included one randomized control trial, one non-randomized

clinical trial, one observational cohort with historical controls and five quasi-experimental

designs. The study settings were in a variety of critical care specialty areas, both medical and surgical. Hospital sizes ranged from community medical centers to large tertiary level one trauma centers. All studies evaluated the impact of using 2% CHG impregnated non-rinse cloths with the traditional soap-and-water bath basin technique. All but one out of the eight studies found a statistically significant reduction in CLABSIs with the introduction of CHG daily patient bathing.

A clinical trial of 836 patients using concurrent controls and a crossover design investigated whether CHG cleansing would decrease the incidence of primary blood stream infections (BSIs) compared with traditional soap and water baths in two medical ICUs (Bleasdale et al., 2007). Patients in the CHG arm were 61% less likely to acquire a primary BSI. Patients receiving the CHG bathing intervention compared to the traditional soap and water bathing were at a significantly lower risk of developing a CLABSI (6.4 vs. 16.8 BSIs per 100 central line-days; P=.01). Montecalvo et al. (2012) conducted a prospective, 3-phase study in both medical and surgical ICUs in four community hospitals totally 21,022 central venous catheter days. Pre-intervention (phase 1) patients were bathed with soap and water; intervention (phase 2) patients were bathed with two percent CHG impregnated cloths; post-intervention (phase 3) CHG bathing was continued but without oversight by research personnel. Study analysis included CLABSI rates compared over study periods using Poisson regression. Compared with pre-intervention, during active intervention there were significantly fewer CLABSIs (6.4 vs. 2.6 per 1000 central venous catheter days, relative risk; P<.001), and this reduction was sustained during post-intervention (2.9 per 1000 central venous catheter days; relative risk; P<.001).

Popovich et al. (2009, 2010) conducted two quasi-experimental studies, one in a medical population and the other in a surgical population. Popovich et al. (2009) evaluated the use of 2% impregnated CHG cloths versus soap and water for daily bathing in 318 patients in a 21-bed MICU at Rush University. The results showed a significant decrease in CLABSI rates (from 5.31 to 0.69 cases per 1,000 central line days; P= .006), along with blood culture contaminations, but no significant change in rates of secondary blood stream infections, ventilator associated pneumonia, or urinary tract infections. Popovich et al. (2010) used a surgical ICU setting to test the use of daily CHG bathing versus traditional soap and water. In a sample of 254 patients results showed no significant difference in the CLABSI rate between soap-and-water and CHG bathing periods (3.81 to 4.6 per 1,000 central line days; p = 0.57). However, blood culture contamination significantly decreased, suggesting that the microbial burden on the skin was reduced. The authors addressed this finding by pointing out that surgical ICU patients more often have large, open abdominal wounds. These serve as a source for healthcare worker contaminations and translocation of bacteria into the bloodstream, causing possible misidentification of positive blood cultures as CLABSIs.

Evans et al. (2010) demonstrated that bathing trauma patients in the ICU with 2% CHG impregnated cloths versus soap and water decreased rate of colonization of MRSA and *Acinetobacter baumannii*, significantly lowered rates of CLABSIs, and MRSA ventilator associated pneumonia versus the soap and water group in 539 patients. The patients receiving the CHG daily bathing intervention demonstrated a significantly lower risk in developing a CLABSI from the control group (2.1 vs. 8.4 infections per 1000 catheter days; P=0.01). An observational cohort study design using historical controls at a Level I trauma center evaluated effectiveness of a quality improvement intervention protocol implementing daily cleansing with CHG cloths

versus soap and water in144 patients. The results included a CLABSI rate reduction of 73.7% (12.07 to 3.17 CLABSIs per 1000 central line-days; P=.0358; Dixon & Carver, 2010). Another quality improvement initiative utilizing daily CHG bathing versus soap and water in efforts to reduce CLABSI rates was conducted at Emory University Hospital (Holder & Zellinger, 2009). A six-month before and after design was used; CLABSI rates decreased from 1.6 to 0.73 in the cardiovascular ICU, from 4.39 to 0.83 in one medical ICU, and from 2.35 to 0.78 in the second medical ICU. Overall both the CLABSI reduction rate and MRSA/VRE colonization incidence decreased from 3.6 to 1 per 1,000 patient days upon initiation of daily CHG patient bathing.

A large multicenter, cluster-randomized, non-blinded crossover trial of 7,727 patients investigated the effect of daily bathing with CHG impregnated cloths versus soap and water on the acquisition of MDROs and the incidence of hospital-acquired bloodstream infections (Climo et al., 2013). Overall the rate of MDRO acquisition decreased 23% between intervention and control group (5.10 versus 6.60 cases per 1000 patient –days; P=.03) and rate of hospital-acquired bloodstream infection reduction of 28% (4.78 vs. 6.60 cases per 1000 patient-days; P=0.007).The analysis showed a 53% reduction (1.55 vs. 3.30 cases per 1000 catheter-days, P0.004) in CLABSI rates between the intervention and control (Climo et al., 2013). In this multicenter study consisting of various medical and surgical ICUs a secondary analysis examined whether the reductions in bloodstream infection rates were related to the type of unit. There were no significant variations between the type of unit and the development of bloodstream infections, suggesting that daily CHG bathing may be beneficial in a range of settings.

With the use of any medication or solution, the occurrences of adverse reactions or side effects are major concerns. Four out of the eight studies addressed adverse reactions linked with

the use of CHG to patient rash, breakdown, or allergic reactions. In Climo et al. (2013), the overall incidence of skin reactions among patients assigned to CHG bathing group was 2.0% (78 of 3970 patients). All skin reactions were ruled to be unrelated to the bathing interventions, and overall, 85% of the reactions were classified as mild to moderate. During the study conducted by Bleasdale et al. (2007) only three out of the three hundred ninety one patients in the CHG arm developed a skin reaction but all were ultimately attributed to other factors. Evans et al. (2010) reported only two rashes during the interventions period, both of which were attributed to antibiotic therapy and resolved without treatment. Chlorhexidine gluconate bathing was discontinued in three patients because of skin rash and restarted in two of the three patients without adverse event; the third patient also had thrombocytopenia that resolved with stopping multiple medications and chlorhexidine (Montecalvo et. al, 2012). In total all reactions were eventually attributed to other factors and no major adverse reactions were reported.

The routine and frequent use of CHG bathing may raise concerns about promoting the emergence of CHG resistance organisms. Only two of the eight studies explored the possibility of CHG resistance. In Bleasdale et al. (2007) no isolates obtained demonstrated significant CHG resistance. In Climo et al. (2013) no emergence of MRSA or VRE isolates with high-level resistance were identified. In the remaining reviewed studies, resistance was not addressed. The potential for the development of resistance to CHG remains a significant concern and should be examined over time.

<div align="center">

Cost Analysis

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Although no formal cost analysis was undertaken in any studies reviewed or currently available in the literature. Some studies address cost, which in the state of today's economy is essential for both organizational and patient financial well-being. Climo (2009) identified the use

of CHG as a low cost solution for infection control. However, this study used CHG solution mixed in basins, versus the other studies that utilized the CHG impregnated cloths, which would be basin free. It has also been suggested that bath basins may be a reservoirs of pathogenic microbes, and the link in transmission of such pathogens (Milstone, Passaretti, & Perl, 2008). Although, the cost of chlorhexidine cloths is greater than non-chlorhexidine cloths ($5.50 vs $1.46 per bath), due to the 75% reduction in CLABSIs over a six month period of time, a projected calculated cost savings of $1.56 million per year was estimated, if CHG baths were used in all of the study hospital's ICUs (Holder & Zellinger, 2009). There was no statistical difference found in cost between bathing using 2% CHG-impregnated cloths ($7.85 per patient per day) versus the four percent CHG solution basin bath ($5.22 per patient per day), although a statistically significant decrease in nursing time to administer the bath was observed with CHG-impregnated cloth (p =0.008; Ritz et al., 2011). Evans et al. (2010) estimated the cost of CHG impregnated cloths to be $5.52 per bath at the time of the trial as opposed to $1.23 per bath for a disposable bathing product that does not contain CHG. Dixon and Carver (2010) identified a $728,820 cost savings using two percent CHG-impregnated cloths versus traditional soap and water within seventeen months of use. After calculating the difference between the increased expenditure of switching to CHG impregnated cloth bathing there was an equivalent to a savings of $945,000, which was more than ten times the cost of chlorhexidine, bathing (Montecalvo et al., 2012).

Implications for Practice

Poor compliance with hand hygiene, reluctance to adopt barrier precautions owing to unintended consequences of isolation, and controversy over the cost-effectiveness and feasibility of legislated universal surveillance have been barriers to effective infection control (Agency for

Healthcare Research and Quality, 2010). Furthermore, while these methods (when practiced consistently) may prevent transmission to other patients, they confer little or no protection to the patient who becomes colonized with the resistant organism. While chlorhexidine bathing should not be considered a replacement for contact precautions, use of a routine decontamination-bathing regimen can decrease the potential for organism transmission even before results of surveillance testing are available. Furthermore, in a recent epidemiologic investigation of the impact of universal active surveillance for MRSA conducted in an academic medical center with a long history of comprehensive infection-control practices, more than half of MRSA colonization's were demonstrated to occur after a negative surveillance culture was confirmed on admission, suggesting that there is room for potential benefit from daily inpatient decontamination procedures in addition to the current infection-control efforts (Harbarth, 2008).

Limited but promising studies have demonstrated that daily CHG bathing is an option to reduce HAIs and bacterial colonization on patients' skin, especially in patients in the ICU (Bleasdale et al., 2007; Popovich et al. 2010 ; Holder & Zellinger, 2009; Evans et al. 2010; Dixon & Carver, 2010; Climo et al., 2013; Montecalvo et. al, 2012). The Healthcare Infection Control Practices Advisory Committee (HICPAC) of the Centers for Disease Control and Prevention published revised CLABSI-prevention guidelines in 2011. The 2011 guideline for prevention of intravascular catheter related infections by the Centers for Disease Control and Prevention includes a category II recommendation for daily bathing with two percent CHG (O'Grady et al., 2011).

Implications for Future Research

As CLABSIs and other healthcare-associated blood stream infections are becoming increasingly more prominent outside the ICU, the use of CHG daily bathing should also be

examined in the non-ICU setting (Climo et al., 2013). Additional considerations in this noncritical population should include a careful assessment of adverse effects, such as patient reports of skin dryness and irritation. A recommendation for further nursing research would include future studies to evaluate the effectiveness and feasibility of CHG bathing in non-ICU settings.

Follow up studies are also needed within various ICU settings, including surgical versus non-surgical, patients receiving immunosuppressant therapy, and invasive equipment, along with the potential benefits of this intervention on blood-culture contamination rate, use of antibiotic agents, and mortality. There are several different types of central venous line access devices including non-tunneled, tunneled, implantable ports, and peripherally inserted central catheters. An area for future research is to evaluate effectiveness of CHG bathing in the prevention of CLABSIs based on type of central venous line access device.

A delicate balance must be achieved between the rigorous regulatory oversight inherent in the traditional research model, and the necessity for innovative quality-improvement initiatives, such that novel products can be tested in high-risk populations, including children. Avoiding overuse of CHG in settings where it has not been proven to have benefit may be especially prudent with the possibility of CHG organism resistance.

Conclusion

Identifying simple, cost-effective, and safe strategies for the prevention of health care–associated infection is essential. Daily bathing with CHG impregnated cloths is a strategy that is relatively straightforward to implement and sustain because it does not require a substantial change from patient-bathing practices that are currently routine. Daily bathing with 2% CHG impregnated cloths as an adjunct therapy in the prevention of CLABSIs is promising. The

evidence is strongest for MICU patients; a trial conducted solely in a surgical ICU did not find a benefit with CHG bathing. The majority of the studies were quasi-experimental, with little to no assessment of or adjustment for confounding variables. While no formal cost analysis was done, the low cost of CHG compared with the high cost of even a single CLABSI suggests that CHG bathing likely saves costs. In conclusion, existing data largely obtained from a single randomized clinical trial, a non-randomized controlled trial and quasi-experimental designs support the practice of daily bathing with 2% CHG impregnated cloths for the reductions of CLABSIs.

Table 1 Summary of reviewed articles

Author	Study Design	Sample/Setting	Purpose	Findings
Bleasdale, S.C., Trick, W.E., Gonzalez, I.M., Lyles, R.D., Hayden, M.K., & Weinstein, R.A. (2007). Effectiveness of chlorhexidine bathing to reduce catheter-associated bloodstream infections in medical intensive care unit patients. *Archives Internal Medicine, 167*(19), 2073-2079.	Cross-over (concurrent control group) Clinical Trial	836 patients/MICU	Determine if patients bathed daily with 2% CHG cloths have a lower incidence of primary bloodstream infections (BSI) compared to those bathed in soap & water	Patients in the CHG arm were 61% less likely to acquire a primary BSI compared to soap & water group. Patients in the CHG arm were at a lower risk of CLABSI (6.4 vs 16.8 BSIs per 1000 central line-days; P=.01)
Dixon, J.M., & Carver, R.L. (2010). Daily chlorhexidine gluconate bathing with impregnated cloths results in statistically significant reduction in central line-associated bloodstream infections. *American Journal of Infection Control, 38* (8), 17-21. doi: 10.1016/j.ajic.2010.06.005	Observational Cohort with Historical Controls	144 patients/SICU	Evaluate a quality improvement protocol instituted to reduce CLABSI rates with a 3-month effectiveness study using 2% CHG cloths for daily bathing	A decrease in CLABSI rates from 12.07 per 1000 central line days to 3.17 CLABSIs per 1000 central line-days (73.3% rate reduction; P = .0358)
Climo, M., Yokoe, D., Warren, D., Perl, T., Bolon, M., Herwaldt, L., & Weinsten, R.A., Sepkowitz, K.A., Jernigan, J.A., Sanogo, K., & Wong, E. (2013). Effect of daily chlorhexidine bathing on hospital-acquired infection. *New England Journal Of Medicine, 368*(6), 533-542. doi:10.1056/NEJMoa1113849	Cluster-randomized, nonblinded crossover trial	7727 patients/ MICU, CCU, SICU, CTICU	Evaluate the effectiveness of bathing patient with 2% CHG cloths in reducing the risk of MDRO acquisition & hospital acquired bloodstream infections	CLABSIs rates decreased by 53% during intervention period compared to control (3.61 vs. 5.24 cases per 1000 patient days, P=0.004). Overall HAI rates decreased 28% & MDRO acquisition decreased 23% after CHG bathing.
Evans, H.L., Dellit, T.H., Chan, J., Nathens, A.B., Maier, R.V., & Cuschieri, J. (2010). Effect of chlorhexidine whole-body bathing on hospital-acquired infections among trauma patients, *Archives of Surgery, 145*(3), 240-246.	Before and after study	TICU/ 539 total patients	Determine if daily bathing with 2% CHG cloths would decrease colonization & HAIs of resistant bacteria in trauma patients	Pts. receiving CHG baths were significantly less likely to acquire a CLABSI (2.1 vs 8.4 infections per 1000 catheter-days; P=.01), incidence of VAP was not affected by CHG baths however, pts. were less likely to develop MRSA VAP, Colonization of MRSA & *Acinetobacter* were significantly lower in the CHG group than in the comparison group

Author	Study Design	Sample/Setting	Purpose	Findings
Holder C. & Zellinger M. (2009) Daily bathing with chlorhexidine in the ICU to prevent central line-associated bloodstream infections. *Journal of Clinical Outcomes Management*, 16, 509-513.	Before and after study	NR/MICU/ CTICU	Evaluate quality improvement initiative to reduce CLABSI rates using CHG wipes for daily bathing	CLABSI rates decreased from 3.6 to 1 per 1000 patient days; Rate of MRSA/VRE colonization decreased from 3.6 to 1 per 1000 patient days
Montecalvo, M., McKenna, D., Yarrish, R., Mack, L., Maguire, G., Haas, J., DeLorenzo, L., Dellarocco, N., Savatteri, B., Rosenthal, A., Watson, A., Spicehandler, D., Shi, Q., Visintainer, P. & Wormser, G. (2012). Chlorhexidine bathing to reduce central venous catheter-associated bloodstream infection: impact and sustainability. *The American Journal Of Medicine*, *125*(5), 505-511. doi:10.1016/j.amjmed.2011.10.032	Before and after study	21,022 Central Venous Catheter Days/MICU, SICU	Determine the impact & sustainability of daily patient bathing with 2% CHG cloths on CLABSI rates	CLABSI rates 6.4 versus 2.6 per 1000 central venous catheter days
Popovich, K.J., Hota, B., Hayes, R., Weinstein, R.A., & Hayden, M.K. (2009). Effectiveness of routine patient cleansing with chlorhexidine gluconate for infection prevention in the medical intensive care unit. *Infection Control and Hospital Epidemiology, 30*(10), 959-963. doi: 10.1086/605925	Before and after study	318 patients/ MICU	To examine effectiveness of cleansing patients with 2% CHG cloths in reducing rates of CLABSI	CLABSIs decreased from (5.31 to 0.69 cases per 1000 central line days; P=.006) from soap/water bathing to CHG bathing. Additional outcomes included a decline in blood culture contamination rate in CHG group. Secondary BSI, CDI, VAP, & UTI rates did not change between CHG & soap/water groups
Popovich, K.J., Hota, B., Hayes, R., Weinstein, R.A., & Hayden, M.K. (2010). Daily skin cleansing with chlorhexidine did not reduce the rate of central-line associated bloodstream infection in a surgical intensive care unit. *Intensive Care Medicine*, 36(5), 854-858. doi: 10.1007/s00134-010-1783-y	Before and after study	254 patients /SICU	To evaluate the effect of daily 2% CHG cloth bathing on CLABSI rates	No significant difference in the rates of CLABSI in the soap-and-water versus CHG periods were noted (4.6 vs. 3.81 per 1,000 central line days), blood culture contamination rates declined significantly

Note. CHG=Chlorhexidine Gluconate; HAI=hospital acquired infections; MRSA= methicillin-resistant Staphylococcus aureus; VRE= vancomycin-resistant Enterococcus; CVC= Central venous catheter; BSI= blood stream infection; VAP=ventilator associated pneumonia; UTI= urinary tract infection; MICU=medical intensive care unit; TICU=trauma intensive care unit; SICU=surgical intensive care unit; CCU=coronary care unit; CVSICU=cardio vascular surgical intensive care unit, CLABSI= Central line associated blood stream infection CDI=*Clostridium difficile* infection, NR=Not Reported

References

Agency for Healthcare Research and Quality (2010). Agency for Healthcare Research and

   Quality (AHRQ) efforts to prevent and reduce health care-associated infections.

   Rockville, MD: AHRQ. Retrieved from: http://www.ahrq.gov/qual/haiflyer.htm

Baily, R. Stucky, D. Norman, B, Duggan, A., Bacon, K., Connor, D., & Lee, B. (2011).

   Economic value of dispensing home-based preoperative chlorhexidine bathing cloths to

   prevent surgical site infection. *Infection Control and Hospital Epidemiology*, 32, 465-

   471.

Bleasdale, S.C., Trick, W.E., Gonzalez, I.M., Lyles, R.D., Hayden, M.K., & Weinstein, R.A.

   (2007). Effectiveness of chlorhexidine bathing to reduce catheter-associated bloodstream

   infections in medical intensive care unit patients. *Archives Internal Medicine, 167*(19),

   2073-2079.

Burke, J.P. (2003). Infection control a problem for patient safety. *New England Journal

   of Medicine,* 348, 651-656.

Center for Disease Control & Prevention. (2011a). 2011 Guidelines for the prevention of

   intravascular catheter-related infections. Retrieved from

   http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html

Center for Disease Control & Prevention. (2011b). Vital signs: Central line-associated blood

   stream infections, United States, 2001,2008, & 2009. *Morbidity & Mortality Weekly

   Report*, 60, 1-6.

Climo, M., Diekema, D., Warren, D.K., Herwaldt, L.A., Perl, T.M., Peterson, L., Plskett, T.,

   Sepkowitz, K., Solomon, S., Tokars, J., Fraser, V.J., & Wong, E. (2003). Prevalence of

   the use of central venous access devices within and outside of the intensive care unit:

results of a survey among hospitals in the prevention epicenter program of the Centers for

Disease Control and Prevention. *Infection Control & Hospital Epidemiology, 24*(12),

942–945.

Climo, M.W., Sepkowitz, K.A., Zuccotti, G., Fraser, V.J., Warren, D.K., Perl, T.M., Speck, K.,

Jernigan, J.A., Robles, J.R., & Wong, E.S. (2009). The effect of daily bathing with

chlorhexidine on the acquisition of methicillin-resistant staphylococcus aureus,

vancomycin-resistant enterococcus, and healthcare-associated bloodstream infections:

Results of a quasi-experimental multicenter trial. *Critical Care Medicine, 37*(6), 1858-

1865. doi:10.1097/CCM.0b013e31819ffe6

Climo, M., Yokoe, D., Warren, D., Perl, T., Bolon, M., Herwaldt, L., & Weinsten, R.A.,

Sepkowitz, K.A., Jernigan, J.A., Sanogo, K., & Wong, E. (2013).

Effect of daily chlorhexidine bathing on hospital-acquired infection. New England

Journal Of Medicine, 368(6), 533-542. doi:10.1056/NEJMoa1113849

Dixon, J.M., & Carver, R.L. (2010). Daily chlorhexidine gluconate bathing with impregnated

cloths results in statistically significant reduction in central line-associated bloodstream

infections. *American Journal of Infection Control, 38* (8), 17-21. doi:

10.1016/j.ajic.2010.06.005

Evans, H.L., Dellit, T.H., Chan, J., Nathens, A.B., Maier, R.V., & Cuschieri, J.

(2010). Effect of chlorhexidine whole-body bathing on hospital-acquired infections among

trauma patients, *Archives of Surgery, 145*(3), 240-246.

Fineout-Overholt, E., Melnyk, B. M., & Schultz, A. (2005). Transforming Health Care from the

Inside Out: Advancing Evidence-Based Practice in the 21st Century. *Journal of

Professional Nursing*, 21, 335-344.

Glance, L.G., Stone, P.W., Mukamel, D.B., & Dick, A.W. (2011). Increase in mortality, length of stay, and cost associated with hospital-acquired infections in trauma patients. *Archives of Surgery, 146*(7), 794-801. doi: 10.1001/archsurg.2011.41

Harbarth, S., Fankhauser, C., Schrenzel, J., Christenson, J., Gervaz, P., Bandiera-Clerc, C., Renzi, G., Vernaz, N., Sax, H., & Pittet, D. (2008). Universal screening for methicillin-resistant staphylococcus aureus at hospital admission and nosocomial infection in surgical patients. *Journal of the American Medical Association, 299*(10), 1149-1157. doi: 10.1001/jama.299.10.1149

Hibiclens [material safety data sheet]. Wilmington, DE: ICI Americas, 1987.

Hidron, A.I., Edwards, J.R., Patel, J., Horan, T.C., Sievert, D.M., Pollock, D.A., & Fridkin S.K. (2008). Antimicrobial-resistant pathogens associated with healthcare-associated infections: Annual summary of data reported to the national healthcare safety network at the centers for disease control and prevention, 2006–2007. *Infection Control and Hospital Epidemiology*, *29* (11), 996-1011. doi: 10.1086/591861

Holder, C. and Zellinger M. (2009). Daily bathing with chlorhexidine in the ICU to prevent central line-associated bloodstream infections. *Journal of Clinical Outcomes Management, 16*(11), 509-513.

Institute of Medicine. (2011). *The future of nursing: Leading change, advancing health.* Retrieved from http://www.nap.edu/catalog/12956.html

Instituate for Healthcare Improvement. (2012). *How-to Guide: Prevent Central Line-Associated Bloodstream Infections*. Cambridge, MA: Institute for Healthcare Improvement. Retrieved from www.ihi.org

Klevens, M.R., Edwards, J.R., Richards, C.L., Horan, T.C., Gaynes, P.R., Pollock, D.A., &

Cardo, D.M. (2007). Estimating health care-associated infections and deaths in U.S. hospitals, 2002. *Public Health Reports*, 122, 160-166.

Lin, M.Y., Hayden, M.K., (2010). Methicillin-resistant Staphylococcus aureus and vancomycin-resistant Enterococcus: Recognition and prevention in intensive care units. *Critical Care Medicine, 38*(8), 335–344.

Merrer, J., Santoli, F., Vecchi, C.A., Tran, B., De Jonghe, B., & Outin, H. (2000). "Colonization pressure" and risk of acquisition of methicillin-resistant staphylococcus aureus in a medical intensive care unit. *Infection Control and Hospital Epidemiology, 21*(11), 718-723.

Milstone, A.M., Passaretti, C.L., & Perl, T.M. (2008). Chlorhexidine: Expanding the armamentarium for infection control and prevention. *Clinical Infectious Disease*, 46 (2), 274-281. doi: 10.1086/524736

Nelson, R.E., Samore, M.G., Smith, K.J. Harbarth, S., & Rubin, M.A. (2010). Cost-effectiveness of adding decolonization to a surveillance strategy of screening and isolation for methicillin-resistant *Staphylococcus aureus* carriers. *Clinical Microbiology and Infection, 16,* 1740-1746.

O'Grady, N. P., Alexander, M., Burns, L. A., Dellinger, E. P., Garland, J., Heard, S. O., & … Saint, S. (2011). Guidelines for the prevention of intravascular catheter-related infections. *American Journal Of Infection Control*, *39*(4), 1-34. doi:10.1016/j.ajic.2011.01.003

O'Horo, J.C., Silva, G.L.M, Munoz-Price, S., & Safdar, N. (2012). The efficacy of daily bathing with chlorhexidine for reducing healthcare-associated bloodstream infections: A meta-analysis. Infection Control and Hospital Epidemiology, 33(3), 257-267. doi: 10.1086/664496

Montecalvo, M., McKenna, D., Yarrish, R., Mack, L., Maguire, G., Haas, J., DeLorenzo, L., Dellarocco, N., Savatteri, B., Rosenthal, A., Watson, A., Spicehandler, D., Shi, Q., Visintainer, P. & Wormser, G. (2012). Chlorhexidine bathing to reduce central venous catheter-associated bloodstream infection: impact and sustainability. *The American Journal Of Medicine, 125*(5), 505-511. doi:10.1016/j.amjmed.2011.10.032

Popovich, K.J., Hota, B., Hayes, R., Weinstein, R.A., & Hayden, M.K. (2009). Effectiveness of routine patient cleansing with chlorhexidine gluconate for infection prevention in the medical intensive care unit. *Infection Control and Hospital Epidemiology, 30*(10), 959-963. doi: 10.1086/605925

Popovich, K.J., Hota, B., Hayes, R., Weinstein, R.A., & Hayden, M.K. (2010). Daily skin cleansing with chlorhexidine did not reduce the rate of central-line associated bloodstream infection in a surgical intensive care unit. *Intensive Care Medicine, 36*(5), 854-858. doi: 10.1007/s00134-010-1783-y

Ritz, J., Pashnik, B., Padula, C., & Simmons, K. (2011). Effectiveness of two method of chlorhexidine bathing. *Journal of Nursing Care Quality, 27,* 171-175.

Safdar, N., & Maki, D.G. (2004). The pathogenesis of catheter-related blood-stream infection with noncuffed short-term central venous catheters. *Intensive Care Medicine, 30*(1), 62–67.

Sare, M. & Ogilvie, L. (2010). *Strategic planning for nurses: Change management in health care.* Jones and Bartlet: Sudbury, MA.

Schein, E. H. (2010). *Organizational culture and leadership.* (4th ed.). San Francisco: Jossey-Bass.

Scott II, D.R. (2009) The direct medical costs of healthcare-associated infections in U.S.

hospitals and the benefits of prevention. Center for Disease Control and Prevention, Division of Healthcare and Quality Promotion.

Stern, C. (2014). Developing the Review Question and Inclusion Criteria. *American Journal Of Nursing*, *114*(4), 53.

Stone, P.W., Braccia, D., & Larson, E. (2005). Systematic review of economic analyses of health care-associated infections. *American Journal of Infection Control*, 33(9), 501–509.

Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. (2011).Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. *Infection Control & Hospital Epidemiology*, *32*(2), 101–114.

University of Kentucky Hospital. (2013). *Central venous catheter maintenance bundle #NI08-25.* Retrieved from Employee CareWeb: UK Healthcare Policy Web on Decemeber 02, 2013.

Vernon, M.O., Hayden, M.K., William, T.E., Hayes, R.A., Blom, D.W., & Weinstein, R.A. (2006). Chlorhexidine gluconate to cleanse patients in a medical intensive care unit: The effectiveness of source control to reduce the bioburden of vancomycin resistant enterococci. *Archives of Internal Medicine, 166*(3), 306-312.

Wendt, C., Schinke, S., Wurttemberger, M., Oberdorfer, K., Bock-Hensley, O., von Baum H. (2007). Value of whole-body washing with chlorhexidine for the eradication of methicillin-resistant Staphylococcus aureus. *Infection Control & Hospital Epidemiology, 28*(9), 1036–1043.

Wolf, Z.R. (1993). The bath: A nursing ritual. *Journal of Holistic Nursing, 11*(2), 135-148.

Yukl, G. (2010). *Leadership in Organizations*. Upper Saddle River, NJ: Pearson

    Education, Inc.

Zaccheo, M. M., & Bucher, D. H. (2010). Establishing evidence-based transfusion education for

    best practice. *Nursing 2010 Critical Care*, *5*, 41-44.

    doi.org/10.1097/01.CCN0000387740.50994.9c

Manuscript 2

Quantifying the Value of Daily Bathing with Chlorhexidine Gluconate Impregnated Cloths

Kara A. Willett BSN, RN, CCRN

University of Kentucky

College of Nursing

Abstract

Hospital-acquired infections including central-line associated blood stream infections (CLABSIs) are a major concern in today's health care system. CLABSIs are a significant source of patient mortality, increased length of stay, and healthcare spending. The heightened awareness of these infections along with their escalating cost has amplified implementation of preventative protocols. Organizations are continuously reevaluating routine operating procedures and patient care guidelines to assure the delivery of safe and effective care but also financially responsible care. The search for CLABSI prevention strategies with a range of benefits, including improved patient outcomes and an overall cost reductions is critical. The purpose of this paper is to review a daily bathing protocol utilizing chlorhexidine gluconate impregnated cloths as a CLABSI reduction technique and to explore potential financial worth of implementation.

Quantifying the Value of Daily Bathing with Chlorhexidine Gluconate

Impregnated Cloths

Hospital-associated infections (HAIs) are a significant cause of morbidity, mortality, and increase in healthcare costs (World Healthcare Organization [WHO], 2014). HAIs affect one out of every twenty hospitalized patients at any given time (Klevens, 2007). Some of the most serious HAIs are those that involve the bloodstream. Central-line associated bloodstream infections (CLABSIs) are the most common cause of health care-associated infection in the bloodstream (WHO, 2014). Forty-eight percent of intensive care unit (ICU) patients have central lines, such as broviac and peripherally inserted central lines, accounting for approximately 15 million central venous catheter days per year (Institute for Healthcare Improvement, 2012). CLABSIs are one of the deadliest types of HAI with a mortality rate near eighteen percent, and significantly increased healthcare costs (Centers for Disease Control and Prevention [CDC], 2011a; Burke, 2003; Glance et al., 2011). The increased length of hospital stay and risk of mortality lead to an additional $39,000 per episode of CLABSI (The Society of Healthcare Epidemiology of America, 2014).

The recent increase in multi-drug resistant organisms (MDROs) intensifies the scrutiny for CLABSI prevention practices. Infections caused by MDROs, such as methicillin-resistant *Staphylococcus aureus*, multi-drug resistant *Acinetobacter baumannii*, and vancomycin-resistant *Enterococcus*, limit the number of effective antibiotics available for treatment. The idea that these infections may be preventable has spurred interest in the development of novel strategies and adjunct therapies to reduce infection rates. In the last several years, major changes have impacted HAI prevention in U.S. healthcare. These developments include improved interdepartmental coordination of federal efforts aimed at HAI prevention, (US Department of

Health and Human Services, 2013) posting of hospital-specific HAI rates on public websites to promote transparency, and linking of hospital specific HAI performance to financial reimbursement as a strategy to motivate hospitals' HAI prevention efforts (Centers for Medicare and Medicaid Services, 2013).

Description of Whole Body Patient Bathing with
Chlorhexidine Gluconate Impregnated Cloths

Research indicates that daily bathing with two percent chlorhexidine gluconate (CHG)-impregnated cloths decreases patient bacterial skin colonization, healthcare workers' hand contamination, and environmental surface contamination (Vernon et al., 2006). CHG is a topical antimicrobial agent and a primary ingredient in numerous products including oral rinses, creams, lotions, foams, gels, sprays, dressings, and ointment forms. CHG has broad-spectrum antimicrobial effects and is used to disinfect the skin for surgical procedures and intravascular catheter insertion (Milstone, Passaretti, & Perl, 2008). CHG also has an excellent safety profile and proven efficacy over a wide spectrum of bacteria, as well as fungi and some viruses (Lin & Hayden, 2010). Unlike many other antiseptics, CHG has residual antibacterial activity, which may reduce the microbial colonization of the patient's skin and prevent secondary environmental contamination (Milstone, Passaretti, & Perl, 2008).

A CHG bathing protocol (Figure 1) utilizing impregnated cloths would direct nursing staff to perform whole body bathing; replacing traditional soap and water bathing during hospitalization. Prepackaged cloths containing two to six large wipes for a full body wash provide an ideal medium for hospital bathing. Cloths depending on manufacturing labels can be warmed or used at room temperature. Each cloth is utilized for areas below the jaw line daily; episodes of incontinence are to be cleaned with non-medicated washcloths and water. Bathing

with CHG cloths includes firm massage to remove bacteria. Once bathed, a patient skin may feel sticky momentarily. However, the skin should be allowed to air dry and not rinsed. All lotions, ointments or emollients must be CHG compatible because some can inactivate the CHG. After cleansing each body area, device tubing within six inches of the patient should be cleansed including Foleys, drains, G-tube/J-tubes, rectal tubes, and chest tubes (Agency for Healthcare Research and Quality, 2013).

<center>Implementation of an Evidence-Based CLABSI Prevention Protocol</center>

Translating evidence into practice requires an integrated approach to address both mechanical and adaptive workflow, including a thorough understanding of the healthcare delivery system and human behavior (Pronovost, Berenholtz, & Needham, 2008). Cultural change and the transformation in behaviors of healthcare workers significantly affect the reduction in HAIs, as seen in the 2006 Michigan Keystone Project (Pronovost et al., 2006). The project implemented evidence-based preventive strategies recommended by the CDC along with focusing on changing provider behavior by creating a culture of safety, incorporating a centralized education program for team leaders at each institution, and closely collaborating with infection control personnel. The intervention was extremely successful resulting in a large and sustained reduction (up to sixty-six percent) in rates of CLABSIs that was maintained throughout the eighteen-month study period (Pronovost et al., 2006).

A recent document providing guidance for CLABSI prevention implementation identifies four key principles for strategy implementation: engaging, educating, executing, and evaluating (Marschall et al., 2014). The engagement of hospital frontline staff and senior leadership is the first step in the process to implement a CLABSI protocol (Weaver et al., 2014). Identifying and involving prevention champions can fuel organizational motivation by engaging and stimulating

<center>37</center>

peers. Establishing a multidisciplinary team will encourage collaboration and create a culture of safety with promotion of accountability for prevention of CLABSI. Outcome data will be shared regularly with individual units. Open communication with frontline staff will be maintained involving program improvement and sustainability (Marschall et al., 2014). Educational programs including CLABSIs prevention significance and appropriate bathing technique should be provided to all healthcare personnel involved in the direct delivery of CHG baths and vary in delivery method and evolving competencies.

Program implementation will be executed by standardizing the care process to help increase staff compliance and prevention sustainability. Quality improvement methodologies will be utilized to structure the prevention effort (Marschall et al., 2014). Process measures will be evaluated by performing bathing audits and outcomes measures by trending CLABSI rates. Stakeholders and frontline staff will be provided with frequent program evaluation data. Goals of improvement and outcomes should be clearly articulated and evaluated with mandatory competencies (Marschall et al., 2014). Successful implementation requires the ongoing support, involvement, and shared accountability of hospital leadership, healthcare providers, payers, legislative leaders, and other members of the healthcare community who together are privileged with the responsibility for providing patients with safe, high-quality, high-value health care.

Review of Evidence to Support Daily Chlorhexidine Gluconate Bathing

A major mechanism of CLABSIs particularly with short-term devices, in place for ten days or fewer is the extra-luminal route, where skin microorganisms invade the percutaneous tract (Sadfar & Malki, 2004). One strategy is daily whole body patient bathing with chlorhexidine gluconate (CHG). Research indicates that daily bathing with two percent CHG-impregnated cloths decreases patient bacterial skin colonization, healthcare workers hand

contamination, and environmental surface contamination (Vernon et al., 2006). Daily cleansing

of ICU patients' skin with CHG has been associated with reduced incidence of colonizations with

vancomycin-resistant *enterococcus* (VRE), methicillin-resistant *Staphylococcus aureus* (MRSA;

Climo et al., 2009; Vernon et al., 2006), and multi-drug resistant *Acinetobacter baumannii*

(Borer et al. 2007; Evans et al. 2010) and has been linked with decreased incidence of CLABSIs

including those due to VRE and MDR A. *baumannii* (Bleasdale et al., 2007; Borer et al., 2007;

Evans et al., 2010, Popovich et al., 2009).The Healthcare Infection Control Practices Advisory

Committee (HICPAC) of the Centers for Disease Control and Prevention published revised

CLABSI prevention guidelines in 2011 that included a category II recommendation for daily

bathing with two percent CHG (O'Grady et al., 2011).

The Cost-Benefit Analysis of Implementing the CHG Protocol

Although no formal cost-benefit analysis is available in the literature, several studies

evaluated CHG impregnated cloths and CLABSI preventions addressed the financial

implications of using CHG impregnated cloths. The cost of cloths is greater ($5.50 per bath)

compared to the traditional soap and water ($1.46 per bath). However, a projected cost savings

of $1.56 million per year was estimated by reducing CLABSIs by 75 percent over a six month

period when utilized in all ICUs (Holder & Zellinger, 2009). Evans et al. (2010) estimated the

cost of CHG impregnated cloths to be $5.52 per bath at the time of the trial as opposed to $1.23

per bath for a bathing product that did not contain CHG. Dixon and Carver (2010) identified a

$728,820 cost savings by using two percent CHG-impregnated cloths versus traditional soap and

water over seventeen months of use. After calculating the cost difference between switching to

CHG impregnated cloth bathing, there was an equivalent to a savings of $945,000, which was

more than ten times the cost of CHG bathing (Montecalvo et al., 2012). A cost benefit analysis

for the implementation of a CHG bathing protocol includes staff training, product and CLABSI cost. Implementation in one hospital unit with 30 nurses and six nursing care assistants, each obtaining a one-hour in-service at $24/hr for nurses and $12/hr for assistants would total $822. Using the current market price of CHG impregnated cloths of $8.47 per bath and calculating for 1000 central line days totals $8,470. Total protocol implementation cost would be $9,292. Using an estimated CLABSI cost of $39,000 if only one incidence of CLABSI is prevented the total savings is significant at $29,708 (Table 1; The Society of Healthcare Epidemiology of America, 2014).

Another important factor to address when assessing cost is nursing time to deliver CHG baths which hinges on the delivery method. One study comparing bathing delivery methods found that the mean time to administer the traditional basin bath was 4.065 minutes, while the mean time of a CHG impregnated cloths bath was 3.314 minutes (Ritz et al., 2012). This difference was statistically significant (t = 2.855; P = .008). More time was likely saved when considering the time needed to gather bath supplies and linen for the traditional basin bath. This time saved can be better utilized to optimize workflow thus having the potential for cost savings elsewhere.

Conclusion

Significant financial costs are associated with CLABSIs, in addition to the increased morbidity and mortality that results from these infections. CLABSI costs include those related to diagnosis and treatment; prolonged hospital stays, and, more recently, lack of reimbursement by third-party payers for expenses incurred. The economic consequences of CLABSIs and implemented prevention strategies can be complex to quantify, as many factors come into play. Identifying simple, cost-effective, and safe strategies for the prevention of HAIs is essential. The

cost of providing any intervention merits consideration in a climate of cost containment. Each

institution negotiates prices with their vendors, so costs of the methods may vary. Daily bathing

with two percent CHG impregnated cloths, as an adjunct therapy in the prevention of CLABSIs

is promising for both improved patient outcomes and decreased healthcare costs.

Figure 1. Example Chlorhexidine Bathing Protocol

- Chlorhexidine gluconate (CHG) replaces routine bathing for entire ICU stay.
- Do NOT use soap below the jawline. Certain soaps and lotions can inactivate CHG.
- Only use CHG-compatible lotions and/or barrier products.
- Dispose of all cloths in the trash. Do NOT flush.

BATHE WITH CHG USING FIRM MASSAGE TO REMOVE BACTERIA

INCONTINENCE:
- Clean with chux and water, NOT soap.
- Then bathe with CHG cloths, air dry.
- Use as many CHG cloths as needed.
- Apply CHG compatible barrier.
- Repeat throughout the day, as needed.

LINES AND TUBES:
- CHG is safe on lines, tubes, and devices.
- Bathe with CHG right up to dressing.
- Okay to bathe over occlusive dressings.
- After bathing skin, clean 6 inches of tubes/Foley nearest patient.

ONLY USE CHG CLOTHS *BELOW* THE JAWLINE

1. Neck, shoulders, and chest.
2. Both arms and hands.
3. Abdomen then groin and perineum.
4. Right leg and foot.
5. Left leg and foot.
6. Back of neck, back, and then buttocks.

Skin may feel sticky for a few minutes.
Do NOT wipe off. Allow to air dry.

Front   Back

Universal ICU Decolonization: An Enhanced Protocol (Agency for Healthcare Research and Quality, 2013)

Table 1. Cost Benefit Analysis

Cost Benefit Analysis in One Hospital Unit	
CLABSI cost per episode	$39,000**
Chlorhexidine Gluconate 2% Impregnated cloths per bath $8.47* X 1000 central line days	$8,470
Educational In-service Nurses (30) - $25/hr classroom time	$750
Educational In-service Nursing Care Technicians (6) - $12.00/hr classroom time	$72
Potential Savings	$39,000 $8,470 $750 - $72 **$29,708** per hospital unit

*price based on current market price per www.sage.com

**The Society of Healthcare Epidemiology of America, 2014

References

Agency for Healthcare Research and Quality (2013). Universal ICU Decolonization: An

Enhanced Protocol: Appendix E. Training and Educational Materials. Retrieved from

http://www.ahrq.gov/professionals/systems/hospital/universal_icu_decolonization/univer

sal-icu-ape4.htm

Borer, A., Gilad, J., Porat, N., Megrelesvilli, R., Saidel-Odes, L., Peled, N., & ... Almog, Y.

(2007). Impact of 4% chlorhexidine whole-body washing on multidrug-resistant

Acinetobacter baumannii skin colonisation among patients in a medical intensive care

unit. *Journal Of Hospital Infection*, *67*(2), 149-155.

Burke, J.P. (2003). Infection control a problem for patient safety. *New England Journal*

of Medicine, 348, 651-656.

Centers for Disease Control & Prevention. (2011a). 2011 Guidelines for the prevention of

intravascular catheter-related infections. Retrieved from

http://www.cdc.gov/hicpac/BSI/BSI-guidelines-2011.html

Centers for Disease Control & Prevention. (2011b). Vital signs: Central line-associated blood

stream infections, United States, 2001, 2008, & 2009. Morbidity & Mortality Weekly

Report, 60,1-6.

Centers for Medicare and Medicaid Services. (2013). Acute inpatient prospective payment

systems. Retrieved from https://www.cms.gov/Medicare/Medicare-Fee-for-Service-

Payment/AcuteInpatientPPS/index.html?redirect=/AcuteInpatientPPS/FR2012/list.asp.

Centers for Medicare and Medicaid Services. (2013). Medicare.gov: Hospital Compare.

Retrieved from http://www.medicare.gov/hospitalcompare/search.html.

Dixon, J.M., & Carver, R.L. (2010). Daily chlorhexidine gluconate bathing with impregnated

cloths results in statistically significant reduction in central line-associated bloodstream

infections. *American Journal of Infection Control, 38* (8), 17-21. doi:

10.1016/j.ajic.2010.06.005

Evans, H.L., Dellit, T.H., Chan, J., Nathens, A.B., Maier, R.V., & Cuschieri, J.

(2010). Effect of chlorhexidine whole-body bathing on hospital-acquired infections

among trauma patients, *Archives of Surgery, 145*(3), 240-246.

Fineout-Overholt, E., Melnyk, B. M., & Schultz, A. (2005). Transforming Health Care from the

Inside Out: Advancing Evidence-Based Practice in the 21st Century. *Journal of*

Professional Nursing, 21, 335-344.

Glance, L.G., Stone, P.W., Mukamel, D.B., & Dick, A.W. (2011). Increase in mortality, length

of stay, and cost associated with hospital-acquired infections in trauma patients. *Archives*

of Surgery, 146(7), 794-801. doi: 10.1001/archsurg.2011.41

Holder, C. and Zellinger M. (2009). Daily bathing with chlorhexidine in the ICU to prevent

central line-associated bloodstream infections. *Journal of Clinical Outcomes Management,*

16(11), 509-513.

Institute for Healthcare Improvement. (2012). *How-to Guide: Prevent Central Line-Associated*

Bloodstream Infections. Cambridge, MA: Institute for Healthcare Improvement. Retrieved

from www.ihi.org

Klevens, M.R., Edwards, J.R., Richards, C.L., Horan, T.C., Gaynes, P.R., Pollock, D.A., &

Cardo, D.M. (2007). Estimating health care-associated infections and deaths in U.S.

hospitals, 2002. *Public Health Reports*, *122*, 160-166.

Lin, M.Y., Hayden, M.K., (2010). Methicillin-resistant Staphylococcus aureus and vancomycin-

resistant Enterococcus: Recognition and prevention in intensive care units. *Critical Care*

Medicine, 38(8), 335–344.

Marschall, J., Mermel, L., Fakih, M., Hadaway, L., Kallen, A., O'Grady, N., Pettis, A.M., Rupp,

45

M., Thomas, S., Maragakis, L., Yokoe D. (2014). Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014 Update. *Infection Control and Hospital Epidemiology, 35*(7), 753-771.

Milstone, A.M., Passaretti, C.L., & Perl, T.M. (2008). Chlorhexidine: Expanding the armamentarium for infection control and prevention. *Clinical Infectious Disease, 46* (2), 274-281. doi: 10.1086/524736

Montecalvo, M., McKenna, D., Yarrish, R., Mack, L., Maguire, G., Haas, J., DeLorenzo, L., Dellarocco, N., Savatteri, B., Rosenthal, A., Watson, A., Spicehandler, D., Shi, Q., Visintainer, P. & Wormser, G. (2012). Chlorhexidine bathing to reduce central venous catheter-associated bloodstream infection: impact and sustainability. *The American Journal Of Medicine, 125*(5), 505-511. doi:10.1016/j.amjmed.2011.10.032

O'Grady, N. P., Alexander, M., Burns, L. A., Dellinger, E. P., Garland, J., Heard, S. O., & ... Saint, S. (2011). Guidelines for the prevention of intravascular catheter-related infections. *American Journal Of Infection Control*, *39*(4), S1-34. doi:10.1016/j.ajic.2011.01.003

Pronovost P, Berenholtz S, & Needham D. (2008). Translating evidence into practice: a model for large scale knowledge translation. *British Medical Journal, 337*, 963–965.

Pronovost, P., Needham, D., Berenholtz, S., Sinopoli, D., Chu, H., Cosgrove, S., & ... Goeschel, C. (2006). An intervention to decrease catheter-related bloodstream infections in the ICU. *New England Journal Of Medicine*, *355*(26), 2725. doi: 10.1056/NEJMoa061115

Ritz, J., Pashnik, B., Padula, C., & Simmons, K. (2011). Effectiveness of two method of chlorhexidine bathing. *Journal of Nursing Care Quality, 27*, 171-175.

The Joint Commission (2012). Preventing central line associated bloodstream infections: A global challenge, a global perspective. Retrieved from http://www.PreventingCLABSIs.pdf.

The Society of Healthcare Epidemiology of America (2014). Expert CLABSI Guidance Adds

    Real World Implementation Strategies. Retrieved from http://www.shea-

    online.org/View/smid/428/ArticleID/286.aspx

U.S. Department of Health and Human Services. National action plan to prevent health care–

    associated infections: road map to elimination. Retrieved from

    http://www.hhs.gov/ash/initiatives/hai/actionplan/.

Vernon, M.O., Hayden, M.K., William, T.E., Hayes, R.A., Blom, D.W., & Weinstein, R.A.

    (2006). Chlorhexidine gluconate to cleanse patients in a medical intensive care unit: The

    effectiveness of source control to reduce the bioburden of vancomycin resistant

    enterococci. *Archives of Internal Medicine, 166*(3), 306-312.

Weaver, S.J., Lubomksi, L.H., Wilson, R.F., Pfoh, E.R., Martinez, K.A., & … Dy, S.M. (2013).

    Promoting a culture of safety as a patient safety strategy: a systematic review. *Annual*

    Internal Medicine, 158(2), 369-374.

Weaver, S. J., Weeks, K., Pham, J. C., & Pronovost, P. J. (2014). On the CUSP: Stop BSI:

    Evaluating the relationship between central line–associated bloodstream infection rate

    and patient safety climate profile. *American Journal Of Infection Control*, *42*S203-8.

    doi:10.1016/j.ajic.2014.05.020

World Health Organization. (2011). Report on the Burden of Endemic Health Care-Associated

    Infection Worldwide. 2011. Retrieved from

    http://whqlibdoc.who.int/publications/2011/9789241501507_eng.pdf.

Manuscript 3

An Evaluation of Chlorhexidine Gluconate Bathing in Trauma/Surgical Intensive Care Units:

A Retrospective Chart Review

Kara A. Willett BSN, RN, CCRN

University of Kentucky

College of Nursing

Abstract

Purpose: This practice inquiry project was designed to (i) evaluate adherence to a daily chlorhexidine gluconate (CHG) bathing guideline and (ii) to identify associations between guideline adherence and patient characteristics such as age, Injury Severity Score (ISS), Charlson Comorbidity Index score, location of central line, central line dwell time, and body mass index (BMI).

Setting: This project took place in two 12-bed trauma/surgical intensive care units at the University of Kentucky Chandler Medical Center, an 875-bed American College of Surgeons accredited level 1 trauma center located in central Kentucky.

Population: The sample consisted of 100 adult patients admitted with trauma-related diagnoses, Of the participants, 61 were male and 39 were female. The average age of the study participants was 48.65 years (SD = 18.7).

Inclusion Criteria: Inclusion criteria were that participants were all adults (18 years or older) with the documented presence of a central line within 24 hours of admission to the intensive care unit, a diagnosis related to trauma, and no documented CHG allergy.

Design and Methods: This retrospective descriptive study of electronic medical records data used simple random sampling to retrieve 100 electronic medical records from the University of Kentucky Trauma Registrar Database from June 2013 to June 2014.

Results: Patients received a CHG bath 60.5% of the days a central line was present. Further analysis showed 17% of patients received CHG baths each day a central line was present. Adherence did not vary significantly based on central line location. Internal jugular lines were washed with CHG 61.3% of days, subclavian lines were washed with CHG 60.7% of days, and femoral lines were washed with CHG 50.7% of days. A statistically significant negative correlation was found between central line dwell days and guideline adherence with a Spearman's rho = -0.48 and $p < 0.0001$. However, no evidence of correlation

between guideline adherence and the following existed: ISS (Spearman's rho = -0.17; p < 0.091), BMI (Spearman's rho = 0.15; p < 0.145), Charlson Comorbidity Score (Spearman's rho = -0.05; p <0.603), or age (Spearman's rho =0.13; p < 0.117). A Kruskal-Wallis Test revealed no statistically significant difference in guideline adherence across three different central venous catheter locations (χ^2 [2, n = 93] = 0.293, p = 0.864).

An Evaluation of Chlorhexidine Gluconate Bathing in Trauma/Surgical Intensive Care Units: A

Retrospective Chart Review

Hospital-acquired infections (HAIs) are infections developed by patients while in the hospital

receiving treatment for another condition (World Health Organization [WHO], 2011). HAIs may be

caused by any infectious agent, including bacteria, fungi, and viruses, as well as other less common types

of pathogens. The Healthcare Infection Control Practices Advisory Committee (HICPAC) of the Centers

for Disease Control and Prevention (CDC) advises a variety of strategies to reduce HAIs. These strategies

include hand hygiene, isolation practices, and meticulous sterile techniques for the placement of catheters

(O'Grady et al., 2011). Central lines are intravascular catheters placed into a large vein in the neck

(internal jugular vein), chest (subclavian vein or axillary vein), or groin (femoral vein). These catheters

are common in the care of hospitalized, critically ill patients, as they provide reliable venous access for

clinical activities such as blood sampling, infusion of medications, and hemodynamic measurement to

inform fluid management decisions. Although clinically useful, central lines are the leading cause of

central line-associated bloodstream infections (CLABSIs) frequently implicated in life-threatening

illnesses (U.S. Department of Health and Human Services, 2011; Klevens et al., 2007).

CLABSIs are the sources of considerable morbidity and healthcare costs (CDC, 2011b; Burke,

2003; Glance, Stone, Mukamel, & Dick, 2011). CLABSIs are one of the deadliest types of HAIs, with a

mortality rate close to 18%. Forty-eight percent of intensive care unit (ICU) patients have central lines.

This accounts for approximately 15 million central line catheter days per year (Institute for Healthcare

Improvement, 2012). In addition, these bloodstream infections prolong hospitalization by a mean of seven

days, thereby increasing the cost of care. The estimated attributable cost per infection is between U.S.

$3,700 and $39,000 (Institute for Healthcare Improvement, 2012). The overall direct medical costs of

HAIs (including CLABSIs) in hospitals in the United States range from $28.4 to $33.8 billion annually

(Klevens et al., 2007).

A major mechanism of CLABSIs, particularly with short-term devices in place for 10 days or less, is the extra-luminal route, where skin microorganisms invade the percutaneous tract (CDC, 2011; Safdar & Malki, 2004). One CLABSI prevention recommendation is bathing the patient's skin with chlorhexidine gluconate (CHG), an antiseptic agent that has broad-spectrum activity against many organisms (Bleasdale et al., 2007; Popovich et al., 2009; Munoz-Price, et al. 2009; Marschall et al., 2014; Institute for Healthcare Improvement, 2012). Unlike many other antiseptics, CHG has residual antibacterial activity that may reduce the microbial colonization of patients' skin and prevent secondary environmental contamination (Bleasdale et al., 2007; Climo et al., 2009).

Research indicates that daily bathing with CHG decreases patient bacterial skin colonization, healthcare workers' hand contamination, and environmental surface contamination (Vernon et al., 2006). Daily cleansing of ICU patients' skin with CHG has been associated with the reduced incidence of colonization with vancomycin-resistant *Enterococcus* (VRE), methicillin-resistant *Staphylococcus aureus* (MRSA);(Climo et al., 2009; Vernon et al., 2006), and multidrug-resistant *Acinetobacter baumannii* (Borer et al. 2007; Evans et al. 2010). In possible correspondence, it has also been linked with a decreased incidence of CLABSIs, including those due to VRE and multidrug-resistant *Acinetobacter baumannii* (Bleasdale et al., 2007; Borer et al., 2007; Climo et al., 2009; Evans et al., 2010, Popovich et al., 2009).

As the acuity of patients and the complexity of the healthcare system continue to intensify, patient and organizational outcomes are becoming more complex (U.S. Department of Health and Human Services, 2011). As a result, it is important that hospitals, administrators, and providers address issues, like CLABSIs, and find solutions promptly. One vital step in quality assurance is to evaluate adherence to practice guidelines and policies developed to counteract a healthcare problem. According to the CDC, the recommended guidelines for the prevention of intravascular catheter-related infections identifies daily patient bathing with 2% CHG as an adjunct therapy in the prevention of CLABSIs (O'Grady et al., 2011; Marschall et al., 2014; Institute for Healthcare Improvement, 2012). The current policy at the University

of Kentucky Chandler Medical Center is that all patients over the age of one month, with a central line present, are to be bathed daily using a CHG solution (University of Kentucky Hospital, 2013).

No current literature identifies associations between daily CHG bathing guideline adherence and patient characteristics. However, literature does identify patient characteristics and factors that increase patients CLABSI risk, mortality, and impact nursing process, which when compounded may influence nursing adherence to daily CHG bathing for CLABSI prevention. One such characteristic that should be investigated is obesity. This is based on the grounds that the management of obese patients, particularly in the intensive care unit (ICU), is often physically strenuous and requires additional resources (Humphreys, 2007; Twaij, et al., 2013). Challenges in caring for the obese population, includes turning, mobilizing, and adequately bathing. Safety during these tasks, for patient and staff, often requires more resources than many other populations. These resources may not be consistently available, which may impact guideline adherence (Humphreys, 2007; Twaij, et al., 2013). The hypothesis for this project was that the higher the patient's BMI the less adherent nursing staff will be to daily CHG bathing. Patients that are larger in size may not receive daily CHG bathing because nursing staff may not have additional staff to complete the bathing and turning processes required.

In clinical practice, age and co morbid conditions are taken into account when planning clinical management including pharmacotherapy, laboratory interpretation, and therapeutic regimens (Kircher, et al. 2007; Lea, et al., 2013). The Charlson Co-Morbidity Index was one of the first tools developed to measure the effects on mortality of co morbid conditions in hospitalized patients (Charlson et al., 1987). The Charlson Co-Morbidity has been widely used to measure co morbidities and has been extensively studied in a variety of populations including trauma (de Groot et al., 2003). As increased age and high co morbid burden are shown to have increased length of stay, ventilator days, and mortality risk following trauma these characteristics should be evaluated in trauma research, whether clinical, epidemiological, or quality improvement (Hollis, et al., 2006; Wutzler, et al., 2009;Valderas et al., 2009). The hypothesis for this project is that as age and Charlson Co-Morbidity Index increases so will guideline adherence. The

53

nursing staff will view older patients and patients with a higher co morbid burden as more likely to have

negative outcomes. Therefore they will be more diligent about adhering to guidelines that aim to prevent

CLABSI and poor patient outcomes.

Another important characteristic is quantifying the acuity of a patient such as using the Injury

Severity Score in the trauma population. Among anatomical severity scores, the Injury Severity Score

(ISS), created by Baker et al. in 1974 has been considered for over 20 years to be the gold standard to

classify trauma victims, both blunt and penetrating. Just as injury severity guides clinical management, is

an essential factor investigating guideline adherence it may also aid in practice improvement. An ISS

score of 15 or higher is the nationally accepted criterion for triage of the trauma patient to a Level I

center, as these patients have at least a 10% chance of dying from a single severe injury or multiple severe

injuries (Baker et al., 1974). Due to these mortality implications in conjunction with CLABSI mortality,

the hypothesis is made that as the ISS increases CHG bathing guideline adherence will also increase. In

other words, the sicker the patient the more likely the nursing staff will be to adhere to CLABSI

preventative guidelines and optimize patient outcome.

There are two other important factors that should be considered in CLABSI prevention. First is

the length of time a central line is in place. Research has demonstrated that the longer a central line is in

place the greater the likelihood of developing CLABSIs (Behrenholtz, et al., 2004; Pronovost, et al.

2006). The hypothesis is the longer a patient has a central line the more adherent nursing staff will be to

the CHG bathing guideline because of the known increased infection risk with longer dwelling central

lines. The current Healthcare Infection Control Practices Advisory Committee recommends removing

central venous lines as soon as safely possible to reduce infection and complication risk (Parenti et al.,

1994, Lederle et al., 1992; Pronovost, et al. 2006). The second is the anatomical location of the central

line. The Infectious Disease Society of America (IDSA) and the Centers for Disease Control and

Prevention (CDC) discourage the choice of femoral site for the insertion of central venous catheters due

to increased risk for infection (Marschall et al, 2008; Merrer, et al., 2001; Goetz, et al., 1998; Robinson, et

54

al., 1995). Therefore, the hypothesis is that nursing staff will be more compliant with the CHG daily bathing guideline in patients with a femoral line in order to reduce infection risk.

Increased morbidity, mortality and negative patient outcomes combined with elevated healthcare cost, CLABSIs warrant considerable preventative efforts. Evaluating preventative efforts through guideline compliance is key practice improvement and decreasing CLABSI risk. By identifying, which patient characteristics or factors are associated with low guideline adherence then practice improvement can be focused, not only the overall importance of compliance but also draw attention to identified associations of low adherence.

Description of Practice Inquiry Project

This practice inquiry project evaluated adherence to the daily CHG bathing guideline in two 12-bed trauma/surgical ICUs at the University of Kentucky Chandler Medical Center, an 875-bed level 1 trauma center located in central Kentucky by conducting a retrospective medical chart review.

Goals and Objectives

The objectives of this project were to (i) evaluate provider adherence to a daily whole body CHG bathing guideline and (ii) to identify associations between guideline adherence and patient characteristics such as age, Injury Severity Score, Charlson Comorbidity Index score, BMI along with location of central line, central line dwell days. Based on these objectives, the primary goal of this project is to utilize results to inform decisions about need for quality improvement initiative aimed toward the prevention of CLABSIs.

Methods

Human Subject and Research Approval Procedures:

Following the development of a project proposal and approval from the practice inquiry committee, approval was obtained from the University of Kentucky Nursing Research Council (Appendix

55

A). An expedited proposal was then submitted and subsequently approved by the hospital's Institutional

Review Board (IRB; Appendix B). Patient consent was waived in compliance with IRB regulations.

Service line directors and ICU nurse managers were informed of the project via hospital email

communication. Approval was obtained from the director of Trauma/Surgical Services (Appendix C).

Study Setting:

The study was conducted in two 12-bed trauma/surgical ICUs at the University of Kentucky

Chandler Medical Center, an 875-bed, American College of Surgeons accredited level 1 trauma center

located in central Kentucky.

Study Design and Selection of Participants:

A retrospective electronic medical chart review was performed. The study population inclusion

criteria was all adult trauma patients, age 18 years and over with the documented presence of a central

line within 24 hours of admission to one of the ICUs, no documented CHG allergy, and admission

between June 2013 and June 2014. The Trauma/Surgical Service Department was utilized to access the

UK HealthCare Trauma Database to obtain a generated report of patient medical record numbers with

correlating Injury Severity Scores that met the sample population inclusion criteria. A total of 154 patients

met the inclusion criteria. This generated report was in the form of an Excel spreadsheet. Using the

random sample software within the Excel program, a simple random sample of 100 medical record

numbers was selected. The master list consisted of the 100 medical records selected, and a study number

was assigned to each individual medical record number. The study numbers were used on all data

collection tool spreadsheets (Appendices D and E) and were kept separate from the master list.

Utilizing this list, a total of 100 patient charts were reviewed and data were collected via

electronic medical records. The data collected included the following: demographics (age, gender, and

ethnicity), mechanism of injury, BMI, anatomical location of central line, and documentation of daily

patient bathing during the presence of a central line. The anatomical location of central line and daily

56

bathing documentation includes documentation for each day the patient had a central line, if CHG solution was used for bathing, the Injury Severity Score, and co-morbid conditions in order to calculate the Charlson Comorbidity Index score.

Measures:

Guideline adherence for the purpose of this project is defined as documentation of a patient receiving a CHG bath once within every 24-hour period during the presence of a central line in the medical chart. In the case of blank documentation a CHG bath was considered not done and adherence was considered noncompliant. The measures of association are between provider guideline adherence to patient characteristics including: age, Injury Severity Score, Charlson Comorbidity Index score, location of central line, central line dwell days, and BMI.

Instruments:

The ISS reflects an anatomic scoring of injury severity and is generally recognized as a tool for retrospective application only. It is the injury severity score tool used by the University of Kentucky Trauma Database registrar and reported to regional and national trauma databases. It is calculated by assigning a severity score defined by the Abbreviated Injury Score (AIS) dictionary to any or all of the six body regions: head/neck, thorax, abdomen, extremities, external structure, and face. The scores range from 1 (minor) to 5 (critical—survival uncertain). A score of 6 may be assigned to a region that has an injury considered not survivable, as defined by the AIS dictionary. After all injuries are identified, scores are assigned by body region. The scores of the three most severely injured regions are squared and added together to calculate the ISS, which ranges from 1 to 75. An ISS score of 75 can be obtained any time a single body region is assigned an AIS of 6. An ISS score of 15 or higher is the nationally accepted criterion for triage of the trauma patient to a Level I center, as these patients have at least a 10% chance of dying from a single severe injury or multiple severe injuries (Baker et al., 1974).

The Charlson Comorbidity Index (Appendix D) predicts the 1-year mortality of a patient who may have a range of comorbid conditions. The index encompasses 19 medical conditions weighted 1–6, with total scores ranging from 0–37. Each condition is assigned a score of 1, 2, 3, 4, 5, or 6, depending on the risk of dying associated with each one. Scores are summed to provide a total score to predict mortality; the higher the score the higher the 10-year mortality rate (Charlson, Pompei, Ales, & MacKenzie, 1987). The Charlson Comorbidty Index was derived using a population of medical patients, and has been shown to be reliable and a valid predictor of mortality in a number of populations, including hospital inpatients and the critically ill (Charlson et al. 1987, Katz et al., 1996, Poses et al, 1996).

Data Analysis:

Data analysis was performed using SPSS ® version 22.0 (SPSS Inc., Chicago, IL). Data were analyzed using descriptive and inferential statistics. Spearman rho correlation analysis was conducted to evaluate the association between guideline adherence and patient characteristics including age, Injury Severity Score, Charlson Comorbidity Index score, central line dwell days, and BMI. A Kruskal-Wallis Test was used to analyze association between guideline adherence and anatomical locations of central line. This study considered values of $p < 0.05$ to be statistically significant for the analysis.

Results

Sample Characteristics

The demographics of the participants are presented in Table 1. Of the 100 study participants, 61 were male and 39 were female. Their average age was 48.65 years (SD = 18.7), and they had a mean BMI of 28.6. A normal BMI is 18.5 to 24.9 with below 18.5 being underweight and above 24.9 overweight. In terms of ethnicity, 93 were Caucasian, 4 were African American, 2 were Hispanic, and 1 was unknown. There was a total 589 central line days, with average dwell days of 5.9 and range from 1–19 days. The most frequent central line location was in the subclavian vein (Table 2). Over half of the patients' diagnoses of trauma had a mechanism of action of motor vehicle accidents (MVA; 52%). This was

followed by falls (14%), motorcycle accidents (10%), gunshot wounds (8%), pedestrian versus car accidents (5%), all-terrain vehicle accidents (3%), farm-related accidents (3%), and unknown causes (5%) (Figure 1). The mean ISS for the sample population was 24.23 (Figure 2). A major trauma (or polytrauma) is defined as an ISS being greater than 15 (Copes et al., 1988). The mean Charlson Comorbidity Index score of the sample population was 1.07 (Figure 3).

Guideline Adherence

Analyses showed only 17% of patients received CHG baths each day a central line was present (Figure 4). Patients received a traditional soap and water bath 96.9% of days and a CHG bath only 60.5% of days (Figure 5). Guideline adherence per central line location was not significantly different. Internal jugular locations were washed with CHG 61.3% of days, subclavian locations were washed with CHG 60.7% of days, and femoral locations were washed with CHG 50.7% of days (Figure 6).

Analysis

Spearman rho correlation analysis was conducted to assess if an association between guideline adherence and patient characteristics existed (Table 3). There was a statistically significant negative correlation between length of central line days and guideline adherence, with a Spearman rho = -0.48 and $p < 0.0001$. However, there was no evidence of correlation between guideline adherence and the following: ISS (Spearman rho = -0.17; $p < 0.091$), BMI (Spearman rho = 0.15; $p < 0.145$), Charlson Comorbidity Score (Spearman rho = -0.05; $p < 0.603$), or age (Spearman rho = 0.13; $p < 0.117$). A Kruskal-Wallis Test revealed no statistically significant difference in guideline adherence across three different central venous catheter locations (χ^2 [2, n = 93] = 0.293, p = 0.864);(Table 4).

Discussion

Central line-associated bloodstream infections result in thousands of deaths each year and billions of dollars in added healthcare costs. Fortunately, these infections are preventable and evidence based practice guidelines and institutional policies are the foundation of prevention.

Important risk factors associated with CLABSIs include poor staff adherence to infection prevention practices during insertion and care for these devices when in place. These infections are considered an avoidable risk to patient safety, and recommendations have been issued from professional and national agencies to focus on their prevention (Burke, et al., 2003; Pittet, et al., 2006; Yokoe, et al., 2008). However, there is concern that healthcare professionals may be inconsistent with adherence to guidelines or quality improvement interventions. Inherently, this may place the vulnerable patient at risk for device related infections.

The implementation and use of clinical practice guidelines among nurses is a complex process in which social and organizational barriers concerning workload, communication, and education play an important role (Abrahamson, Fox, & Doebbeling, 2012).This project was designed to evaluate adherence to a CLABSI preventative guideline and to identify practice gaps in daily CHG bathing care delivery by examining guideline adherence with patient characteristics. The results demonstrated extremely poor guideline adherences at only 17%. Meaning that out of 100 patients only 17 received a daily CHG bath during the entire length of central line dwell time. These findings are damaging to CLABSI prevention efforts because they demonstrate a lack in prevention thus increasing the risk for CLABSIs development. Of the 589 central line days analyzed, patients' received a CHG bath 60.5% of the days. However, patients' received a traditional soap and water bath 96.9% of the days). As discussed data extraction was from nursing documentation and must be factored in to any analysis of guideline adherence. Due to the significant difference in CHG baths document versus soap and water baths it leads to question the logistics of nursing documentation. Including where within the electronic chartings is CHG bathing documented. The low rate of compliance may be secondary to the additional steps required for complete documentation.

A statistically significant, negative correlation between guideline adherence and central line dwell days was identified. As central line dwell days increased, CHG bathing adherence decreased. Currently no other research is available to compare if these findings are a pattern. However, research has

shown that the longer a central line is in place the greater the likelihood of developing CLABSIs (Behrenholtz, et al., 2004; Pronovost, et al. 2006). Analysis found no other statistically significant associations between guideline adherence and age, BMI, central line location, ISS, or Charlson Comorbidity index. These findings are interesting due to the fact that line placement location and length of dwell time has long been associated with increased risk of infection (Behrenholtz, et al., 2004; Pronovost, et al. 2006). A lack of association between guideline adherence and central line location is interesting due to the continued emphasis on femoral line placement being at higher risk for infection (O'Grady et al., 2011). These findings warrant further investigation into nursing staff knowledge around CLABSI risk factors.

The lack of association between guideline adherence and Charlson Comorbidity Index may be attributed to the sample population's particularly low mean score of 1.07. This indicates that the patients making up the sample population had very few preexisting conditions and/or comorbidities. The Charlson Comorbidity Index itself was not developed specifically for trauma patients, which may explain the lack of significant findings in the current study. However, the median age of the sample population patients being quite young at 48.65 years, which correlates with trauma being the leading cause of death for people ages 1-44 in the United States may be another factor of the low Charlson Comorbidity Index (Centers for Disease Control and Prevention National Center for Injury Prevention and Control, 2011). However, 80% of older adults have one chronic condition, and 50% have at least two. Infectious diseases and injuries also take a disproportionate toll on older adults (Bell, 2014; Fuchs, et al., 2012). Efforts to identify strategies to prevent or reduce the risk of disease and injury and to widely apply effective interventions must be promptly implemented.

An absence of association between guideline adherence and ISS was surprising due to a relatively high mean ISS. The mean ISS for the sample population was 24.23 and an ISS of 15 or greater qualifies for triage at a Level I center, as these patients have at minimum a 10% chance of dying from injuries (Baker et al., 1974). Considering that patients with higher ISS scores have a higher chance of mortality, it

may be hypothesized that the higher chance of mortality may motivate adherence. The findings of this project identified a clear need for further quality improvement work in CHG bathing guideline adherence; such as poor guideline adherence and the finding of a negative correlation between central line dwell days and guideline adherence. Nurses are central in hospital efforts to improve quality care and their involvement in future improvement will be vital to its success.

Limitations

The limitations of this project include the small sample size and the retrospective chart review design, both of which may affect the validity of the study results. The small sample size minimized the statistical power and thus under powers the strength of the conclusions. Clinical significance could be looking into documentation practices to make it more likely documentation of CHG baths will be accurate therefore making the statistics more accurate and reliable. The retrospective design of the study using a chart review method represents self-reported documentation of tasks completed and thus must be considered when reviewing results. No real-time observation was conducted; therefore, the data extracted must be factored into the validity of the study results. The study population included only patients' in the Trauma/Surgical Service Line; thus, conclusions cannot be generalized to other areas within the institution or to other patient populations. Another limitations is that nursing staff patterns were not examined during this project which have been shown to impact nursing practice and patient outcomes (Mefford & Alligood, 2011; Kane et al., 2007).

Implications for Practice

The prevention of HAIs, including CLABSIs, requires a multi-disciplinary approach. However, bedside nurses are in a key position to lead preventative practices and improve patient outcomes. The current policy at the University of Kentucky Chandler Medical Center is that all patients over the age of one month with a central line present are to be bathed daily using a CHG solution (University of Kentucky Hospital, 2013). The results of this study suggest that a substantial quality

62

improvement initiative is warranted to improve CHG bathing policy adherence. Armed with this evidence nurse managers and service line directors should address nursing staff with the low policy adherence. Should first implement intense educational program aimed at risk factors for CLABSI and nursing interventions that can impact those outcomes.

Communication between bedside nursing staff and administration should include both facilitators and barriers of policy adherence. While gaining input, education is also important. Individuals that understand the purpose and evidence behind change are more likely to adapt and implement a change. Instituting an educational module on the guideline itself and emphasizing the importance of documentation is critical. Additionally, routine competencies will be necessary to improve and sustain guideline adherence. The Trauma/Surgical Service Department has an opportunity to reach out for support from hospital administration and senior leadership to develop and implement a program targeted at increasing nursing knowledge and awareness of the guideline policy throughout the enterprise.

Implications for Future Research

Future research should include a more rigorous study design to evaluate guideline adherence and perceived facilitators and barriers to adherence and include staffing patterns. This project looked at overall guideline adherence rather than the delivery method of the CHG bath. The current delivery method of CHG bathing at the University of Kentucky Medical Center involves traditional water basins, non-medicated cloths and a 4% liquid CHG solution. Investigation of care providers' CHG bathing delivery is also warranted to assure proper delivery technique is applied. As CLABSIs and other healthcare-associated bloodstream infections are becoming increasingly common outside the ICU, CHG daily bathing guideline adherence should also be examined in non-ICU settings with different patient populations.

Conclusion

The development of a CLABSI carries significant health risk and financial burden and requires the attention of every clinician involved in the management of affected patients. The commitment to preventing central line associated bloodstream infections gained national momentum with the 100,000 Lives Campaign in 2005 (Berwick, Calkins, McCannon, & Hackbarth, 2006). As pay-for-performance takes full effect, hospital-acquired infection prevention protocols have been gaining popularity and are critical to both patient outcomes and the sustainability of organizations. The Centers for Medicare and Medicaid Services (CMS) has not reimbursed hospitals for the costs of care associated with certain HAIs, including surgical site infections, CLABSIs, and catheter-associated urinary tract infections, since 2008. Many organizations have developed and implemented various evidence-based practice (EBP) guidelines that have not only improved patient outcomes but have saved millions of healthcare dollars. The results of this study provide evidence that further research is necessary to build on this educational intervention in order to design, implement, and evaluate programs that are effective and sustainable over time.

Table 1: Sample Demographics

	N	%
Gender Male Female	61 39	61 39
Ethnicity Caucasia African American Hispanic Unknown	93 4 2 1	93 4 2 1
	Mean	SD
Age	48.65	18.7
BMI	28.6	8.97
Central line dwell days	5.9	4.18
	N	
Central Line Days	589	

Table 2: Sample central line location frequency

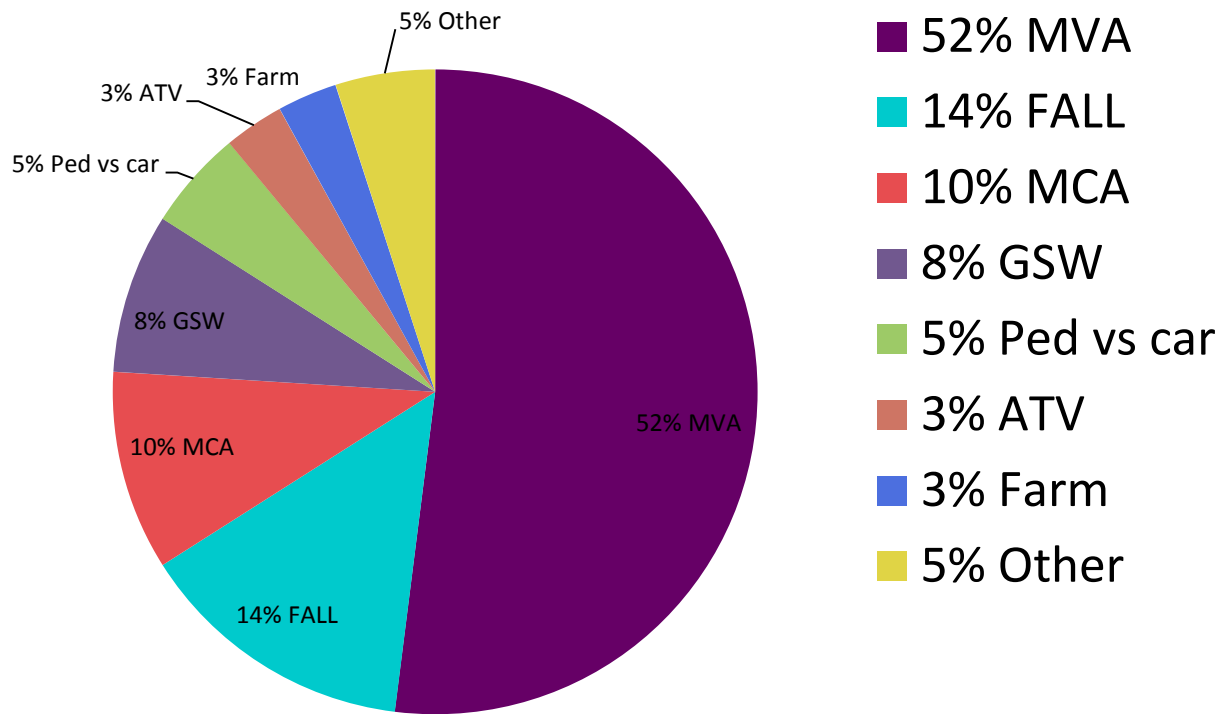| Line Location	Frequency
Subclavian (SC)	45
Internal Jugular (IJ)	39
Femoral	9
SC & IJ	4
IJ & Femoral	2

Figure 1: Sample mechanism of action demographics

Note. MVA= Motor Vehicle Accident, MCA =Motorcycle Accident, GSW=Gun Shot Wound, Ped=Pedestrian, ATV= All-terrain Vehicle
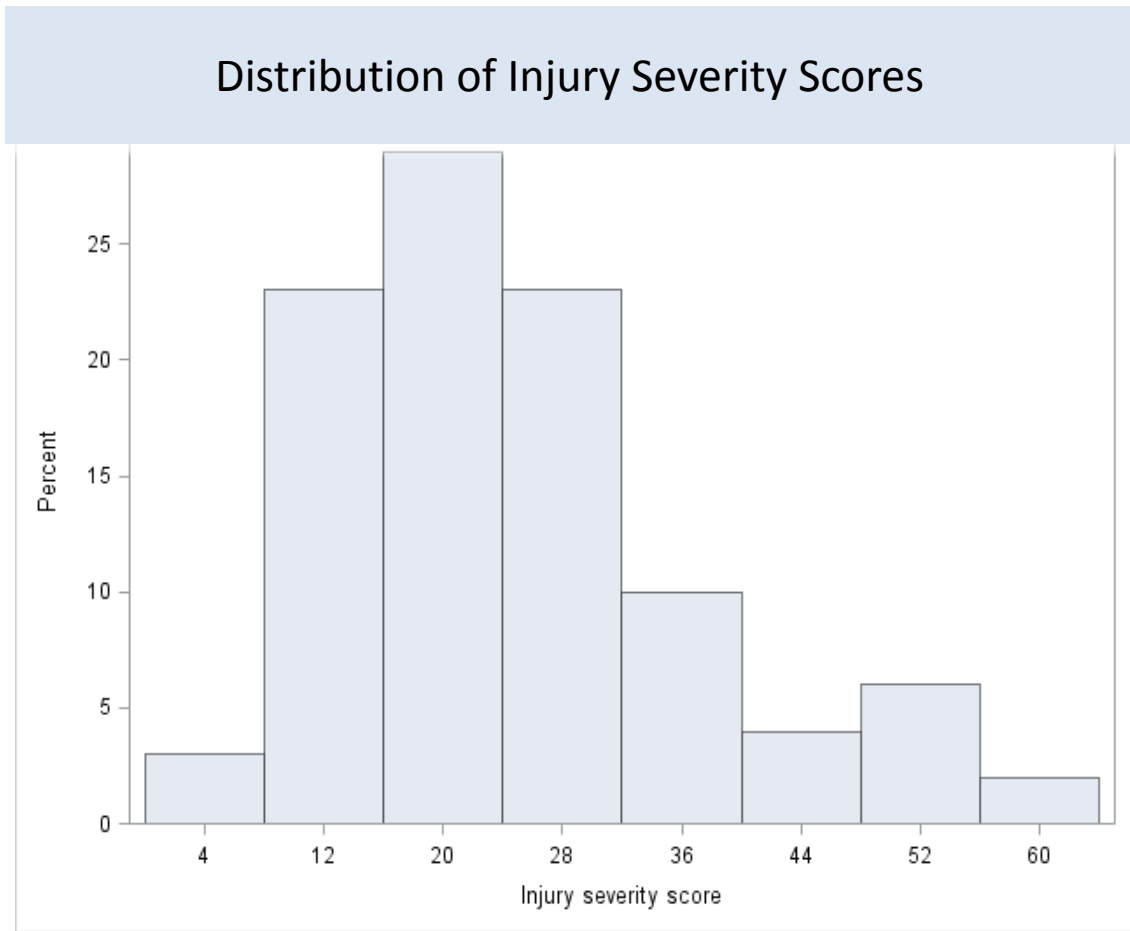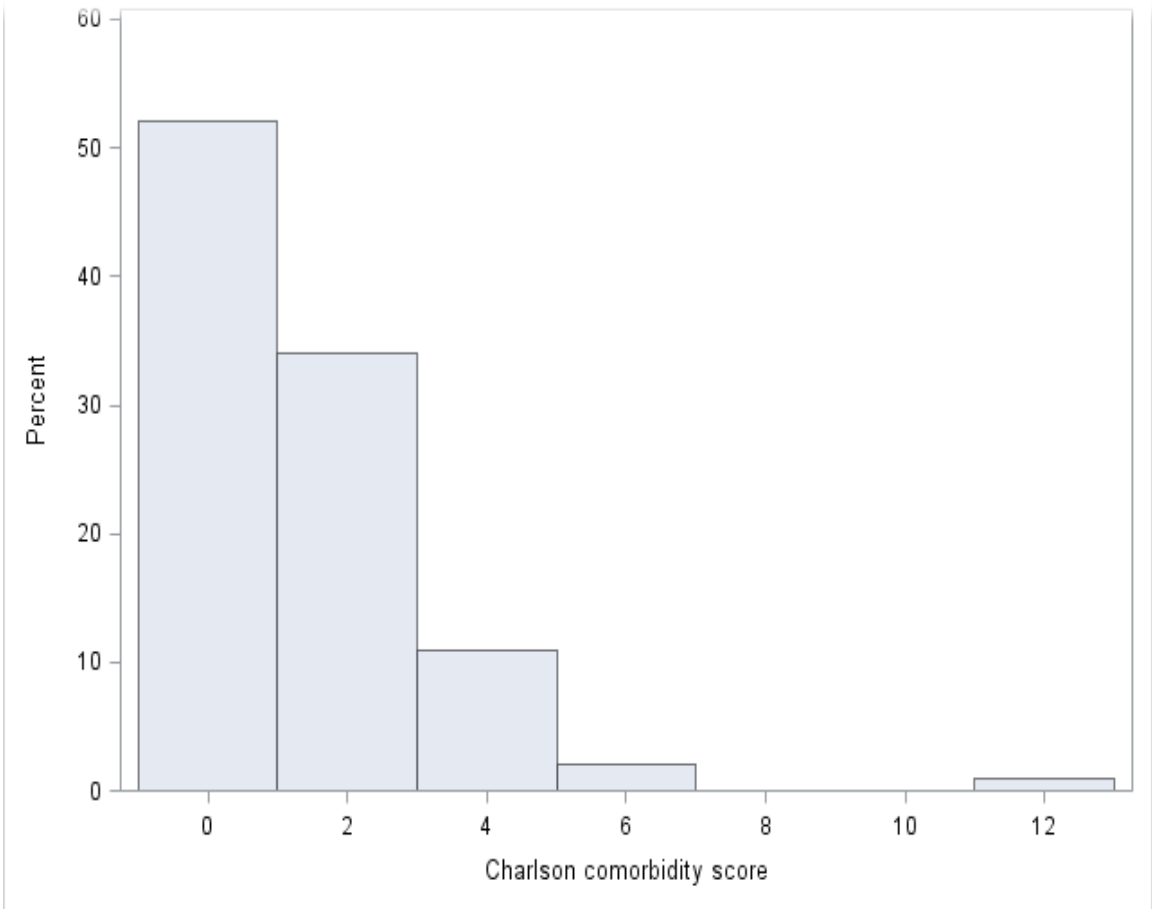
Figure 2: Distribution of Injury Severity Scores

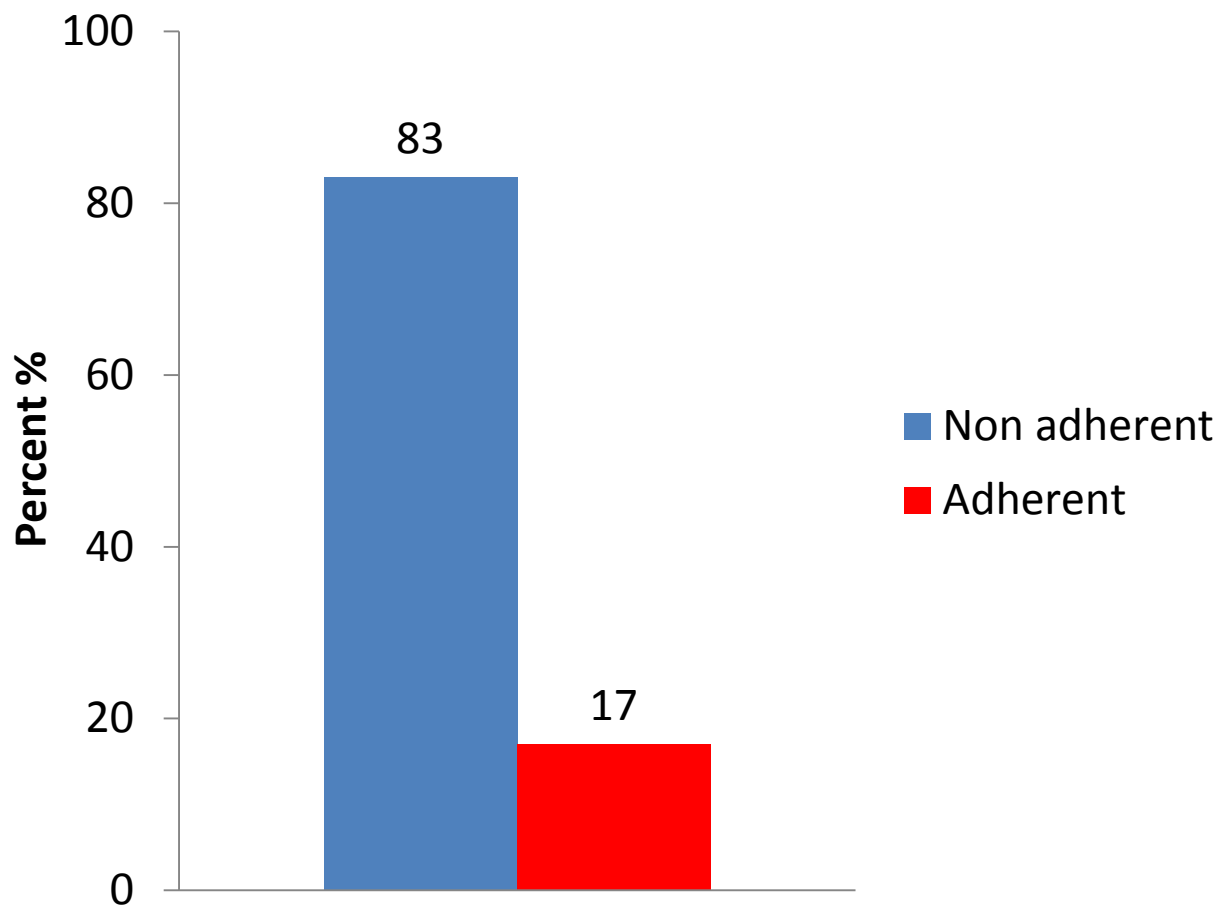Figure 3: Distribution of Charlson Comorbidity Scores
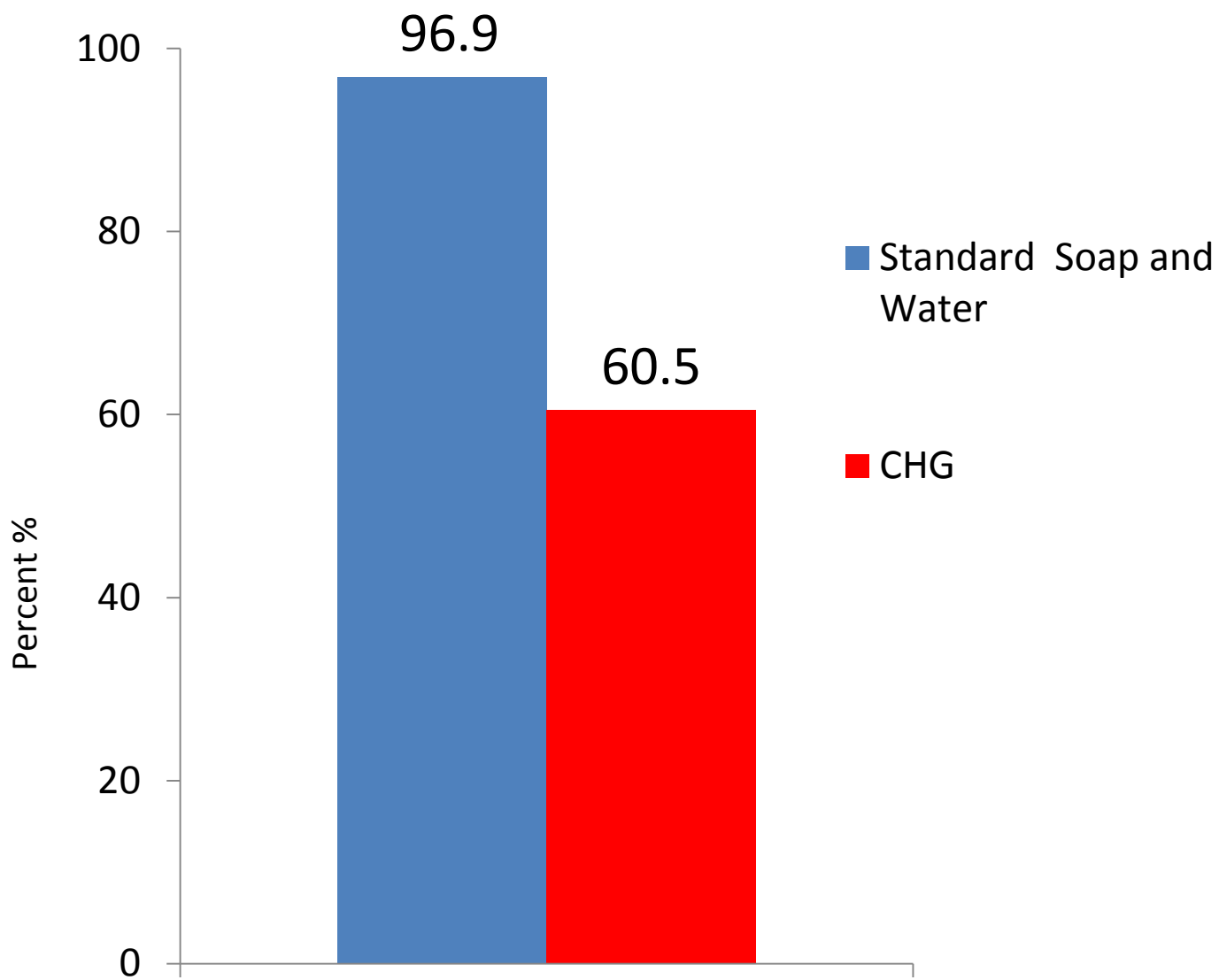
Figure 4: Guideline adherence

Figure 5: Percentage of days receiving bath (by type)

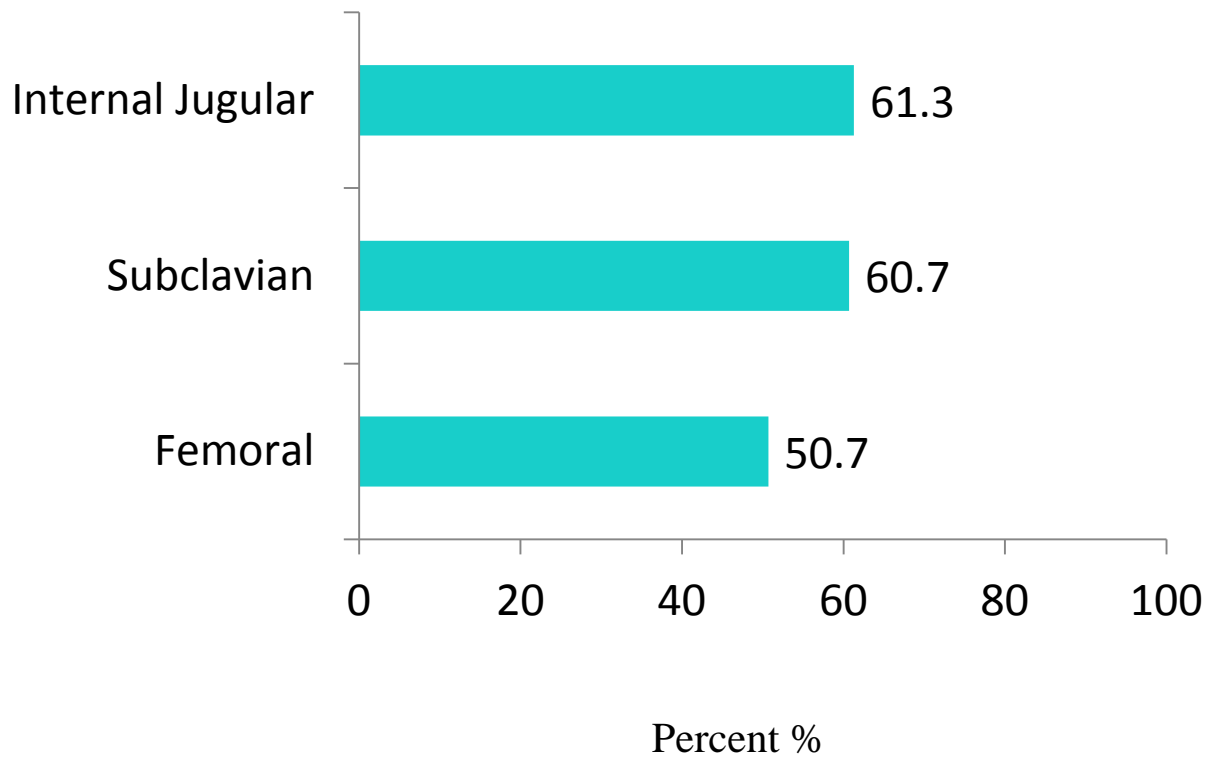Figure 6: Guideline adherence by central line location

Table. 3 Spearman Rho Analysis

Correlations

		Overall adherence with chg	# days	Injury severity score	BMI	Charlson comorbidity score	Age
Overall adherence with chg	Correlation Coefficient	1.000	-.482	-.170	.147	-.053	.130
	Sig. (2-tailed)	.	.000	.091	.145	.603	.197
	N	100	100	100	100	100	100
# days	Correlation Coefficient	-.482**	1.000	.209*	-.053	.079	-.175
	Sig. (2-tailed)	.000	.	.037	.603	.432	.081
	N	100	100	100	100	100	100
Injury severity score	Correlation Coefficient	-.170	.209*	1.000	-.068	-.364**	-.323**
	Sig. (2-tailed)	.091	.037	.	.499	.000	.001
	N	100	100	100	100	100	100
BMI	Correlation Coefficient	.147	-.053	-.068	1.000	.075	.067
	Sig. (2-tailed)	.145	.603	.499	.	.455	.508
	N	100	100	100	100	100	100
Charlson comorbidity score	Correlation Coefficient	-.053	.079	-.364**	.075	1.000	.593**
	Sig. (2-tailed)	.603	.432	.000	.455	.	.000
	N	100	100	100	100	100	100
Age	Correlation Coefficient	.130	-.175	-.323**	.067	.593**	1.000
	Sig. (2-tailed)	.197	.081	.001	.508	.000	.
	N	100	100	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table. 4 Kruskal-Wallis Test

Ranks

	Type of line	N	Mean Rank
Percent of total days had chg bath	SC ony	45	46.72
	IJ only	39	46.27
	Fem only	9	51.56
	Total	93	

Test Statistics[a,b]

	Percent of total days had chg bath
Chi-Square	.293
df	2
Asymp. Sig.	.864

a. Kruskal Wallis Test

b. Grouping Variable: Type of line

References

Abrahamson, K. A., Fox, R. L. & Doebbeling, B.N. (2012). Facilitators and barriers to clinical practice guideline use among nurses. *American Journal of Nursing, 112*(7), 26-35. doi: 10.1097/01.NAJ.0000415957.46932.bf

Agency for Healthcare Research and Quality. (2010). Agency for Healthcare Research and Quality (AHRQ) efforts to prevent and reduce health care-associated infections. Rockville, MD: AHRQ. Retrieved from: http://www.ahrq.gov/qual/haiflyer.htm

Baily, R., Stucky, D., Norman, B., Duggan, A., Bacon, K., Connor, D., & Lee, B. (2011). Economic value of dispensing home-based preoperative chlorhexidine bathing cloths to prevent surgical site infection. *Infection Control and Hospital Epidemiology*, *32*, 465–471.

Baker, S., O'Niell, B., Haddon, W., & Long, W. (1974). The Injury Severity Score: A method for describing patients with multiple injuries and evaluating emergency care. *J Trauma*, *14*, 187–196.

Bell, L. (2014). The epidemiology of acute and critical illness in older adults. *Critical Care Nursing Clinics Of North America, 26*(1), 1-5. doi:10.1016/j.ccell.2013.10.001

Behrenholtz, S., Pronovost, P., Lipsett, P., & … Perl, T. M. (2004). Eliminating catheter-related bloodstream infections in the intensive care unit. *Critical Care Medicine*, *32*(10), 2014–2020.

Bercault, N., Boulain, T., Kuteifan, K., Wolf, M., Runge, I., & Fleury, J.C. (2004). Obesity-related excess mortality rate in an adult intensive care unit: a risk-adjusted matched cohort study. *Critical Care Medicine, 32*, 998–1003

Berwick, D.M., Calkins, D.R., McCannon, C.J., & Hackbarth, A.D. (2006). The 100,000 Lives Campaign: Setting a goal and a deadline for improving health care quality. *Journal of the American Medical Association, 295*(3), 324–327.

Bleasdale, S. C., Trick, W. E., Gonzalez, I. M., Lyles, R. D., Hayden, M. K., & Weinstein, R. A. (2007). Effectiveness of chlorhexidine bathing to reduce catheter-associated bloodstream infections in medical intensive care unit patients. *Archives Internal Medicine*, *167*(19), 2073–2079.

Borer, A., Gilad, J., Porat, N., Megrelesvilli, R., Saidel-Odes, L., Peled, N., & ... Almog, Y. (2007). Impact of 4% chlorhexidine whole-body washing on multidrug-resistant Acinetobacter baumannii skin colonisation among patients in a medical intensive care unit. *Journal of Hospital Infection*, *67*(2), 149–155.

Burke, J. P. (2003). Infection control a problem for patient safety. *New England Journal of Medicine*, *348*, 651–656.

Centers for Disease Control and Prevention. (2011). Vital signs: Central line-associated bloodstream infections, United States, 2001, 2008, and 2009. *Morbidity & Mortality Weekly Report*, *60*, 1–6.

Centers for Disease Control and Prevention (2014). Healthy Weight - it's not a diet, it's a lifestyle!. Retrieved from http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html

Centers for Disease Control and Prevention National Center for Injury Prevention and Control. (2011). Web-based injury statistics query and reporting system (WISQARS). Retrieved from http://www.cdc.gov/injury/wisqars(http://www.cdc.gov /injury/wisqars/index.html).

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, R. C. (1987). A new method of

classifying prognostic comorbidity in longitudinal studies: Development and validation.

Journal of Chronic Diseases, 40(5), 373–83. doi:10.1016/0021-9681(87)90171-8

Chien, W., Lai, C., Chung, C., & Lin, C. (2013). A retrospective population-based data

analyses of unintentional fall mortality and hospitalisation in Taiwan during 2005–2007.

International Journal Of Injury Control & Safety Promotion, *20*(1), 50-58.

doi:10.1080/17457300.2012.674042

Climo, M., Diekema, D., Warren, D. K., Herwaldt, L. A., Perl, T. M., Peterson, L., Plaskett, T.,

Sepkowitz, K., Solomon, S., Tokars, J., Fraser, V. J., & Wong, E. (2003). Prevalence of

the use of central venous access devices within and outside of the intensive care unit:

Results of a survey among hospitals in the prevention epicenter program of the Centers

for Disease Control and Prevention. *Infection Control & Hospital Epidemiology*, *24*(12),

942–945.

Climo, M. W., Sepkowitz, K. A., Zuccotti, G., Fraser, V. J., Warren, D. K., Perl, T. M., Speck, K.,

Jernigan, J. A., Robles, J. R., & Wong, E. S. (2009). The effect of daily bathing with

chlorhexidine on the acquisition of methicillin-resistant Staphylococcus aureus, vancomycin-

resistant Enterococcus, and healthcare-associated bloodstream infections: Results of a quasi-

experimental multicenter trial. *Critical Care Medicine*, *37*(6), 1858–1865.

doi:10.1097/CCM.0b013e31819ffe6

Climo, M., Yokoe, D., Warren, D., Perl, T., Bolon, M., Herwaldt, L., Weinsten, R. A., …

Wong, E. (2013). Effect of daily chlorhexidine bathing on hospital-acquired infection. *New

England Journal of Medicine*, *368*(6), 533–542. doi:10.1056/NEJMoa1113849

Copes, W.S., Champion, H.R., Sacco, W.J., Lawnick, M.M, Keast, S.L., & Bain, L.W. (1988).

The injury severity score revisited". *The Journal of Trauma, 28* (1), 69–77.

doi:10.1097/00005373-198801000-00010. PMID 3123707

De Groot, V., Beckerman, H., Lankhorst, G. J., & Bouter, L. M. (2003). How to measure

comorbidity: a critical review of available methods. *Journal of Clinical*

Epidemiology, 56(3), 221–229. doi:10.1016/S0895-4356(02)00585-1

Dixon, J. M., & Carver, R. L. (2010). Daily chlorhexidine gluconate bathing with impregnated

cloths results in statistically significant reduction in central line-associated bloodstream

infections. *American Journal of Infection Control*, *38* (8), 17–21. doi:

10.1016/j.ajic.2010.06.005

Evans, H. L., Dellit, T. H., Chan, J., Nathens, A. B., Maier, R. V., & Cuschieri, J. (2010). Effect of

chlorhexidine whole-body bathing on hospital-acquired infections among trauma patients.

Archives of Surgery, *145*(3), 240–246.

Fineout-Overholt, E., Melnyk, B. M., & Schultz, A. (2005). Transforming health care from the

inside out: Advancing evidence-based practice in the 21st century. *Journal of*

Professional Nursing, *21*, 335–344.

Fuchs, L., Chronaki, C.E., Park, S., Novack, V., Baumfeld, Y., Scott, D., McLennan, S., Talmor,

D., and Celi, L. (2012). ICU admission characteristics and mortality

rates among elderly and very elderly patients. *Intensive Care Medicine, 38*(10), 1654-1661.

Glance, L. G., Stone, P. W., Mukamel, D. B., & Dick, A. W. (2011). Increase in mortality, length

of stay, and cost associated with hospital-acquired infections in trauma patients. *Archives*

of Surgery, *146*(7), 794–801. doi: 10.1001/archsurg.2011.41

Goetz, A.M., Wagener, M.M., Miller, J.M., & Muder, R.R. (1998). Risk of infection due to

central venous catheters: effect of site of placement and catheter type. *Infection Control Hospital*

Epidemiology, 19(11), 842–845.

Harbarth, S., Fankhauser, C., Schrenzel, J., Christenson, J., Gervaz, P., Bandiera-Clerc, C., …

Pittet, D. (2008). Universal screening for methicillin-resistant Staphylococcus aureus at hospital admission and nosocomial infection in surgical patients. *Journal of the American Medical Association*, *299*(10), 1149–1157. doi: 10.1001/jama.299.10.1149

Hidron, A. I., Edwards, J. R., Patel, J., Horan, T. C., Sievert, D. M., Pollock, D. A., & Fridkin S. K. (2008). Antimicrobial-resistant pathogens associated with healthcare-associated infections: Annual summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2006–2007. *Infection Control and Hospital Epidemiology*, *29* (11), 996–1011. doi: 10.1086/591861

Holder, C., & Zellinger, M. (2009). Daily bathing with chlorhexidine in the ICU to prevent central line-associated bloodstream infections. *Journal of Clinical Outcomes Management*, *16*(11), 509–513.

Hollis, S., Lecky, F., Yates, D.W., & Woodruf, M. (2006). The effect of preexisting medical conditions and age on mortality after injury. Journal of Trauma, 61(5), 1255–1260.

Humphreys, S.L. (2007). Obesity in patients and nurses increases the nurse's risk of injury lifting patients. Bariatric Nursing and Surgical Patient, 2(1), 2-6. doi: 10.1089/bar.2006.9998

Institute for Healthcare Improvement. (2011a). Science of improvement: Establishing measures. Retrieved from http://www.ihi.org/knowledge/Pages/HowtoImprove/ScienceofImprovementEstablishingMeasures.aspx

Institute of Medicine. (2011b). The future of nursing: Leading change, advancing health. Retrieved from http://www.nap.edu/catalog/12956.html

Institute for Healthcare Improvement. (2012). *How-to guide: Prevent central line-associated bloodstream infections*. Cambridge, MA: Institute for Healthcare Improvement. Retrieved from www.ihi.org

Joffe, A., & Wood, K. (2007) Obesity in critical care. Current Opinion Anesthesiology, 20, 113–118.

Kane R., Shamlian Tatyana A., Mueller C., Duval S. & Wilt T.J. (2007) The association of

    registered nurse staffing levels and patient outcomes: Systematic review and meta-analysis.

    Medical Care, 45(12), 1195–1294.

Katz J, Chang L, Sangha O, Fossel A, Bates D. (1996). Can comorbidity be measured by

    questionnaire rather than medical record

    review? *Medical Care,* 34, 73–84.

Kircher, T. J., Wormstall, H., Muller, P. H., Schwarzler, F., Buchkremer, G., Wild, K., & ...

    Meisner, C. (2007). Randomised trial of a geriatric evaluation and management consultation

    services in frail hospitalised patients. Age And Ageing, 36(1), 36-42.

Klevens, M. R., Edwards, J. R., Richards, C. L., Horan, T. C., Gaynes, P. R., Pollock, D. A., &

    Cardo, D. M. (2007). Estimating health care-associated infections and deaths in U.S.

    hospitals, 2002. *Public Health Reports*, *122*, 160–166.

Lea, M., Rognan, S., Koristovic, R., Wyller, T., & Molden, E. (2013). Severity and management

    of drug-drug interactions in acute geriatric patients. *Drugs & Aging, 30*(9), 721-727.

    doi:10.1007/s40266-013-0091-y

Lederle, F.A., Parenti, C.M., Berskow, L.C., Ellingson, K.J. (1992). The idle intravenous

    catheter. *Annuals of Internal Medicine*, *116*(9), 737-738.

Lin, M. Y., & Hayden, M. K. (2010). Methicillin-resistant Staphylococcus aureus and vancomycin-

    resistant Enterococcus: Recognition and prevention in intensive care units. *Critical Care*

    Medicine, *38*(8), 335–344.

Liu, T., Chen, J., Bai, X., Zheng, G., & Gao, W. (2013). The effect of obesity on outcomes in trauma

    patients: A meta-analysis. Injury, 44(9), 1145-1152.

Marschall, J., Mermel, L., Fakih, M., Hadaway, L., Kallen, A., O'Grady, N., … Yokoe, D. (2014).

    Strategies to prevent central line-associated bloodstream infections in acute care hospitals: 2014

    Update. *Infection Control & Hospital Epidemiology*, *35*(7), 753–771.

Mefford, L. C., & Alligood, M. R. (2011). Evaluating nurse staffing patterns and neonatal intensive care unit outcomes using Levine's conservation model of nursing. *Journal Of Nursing Management, 19*(8), 998-1011. doi:10.1111/j.1365-2834.2011.01319.x

Merrer J, De Jonghe B, Golliot F, Lefrant, J., Raffy, B., Barre, E., … Nitenberg, G., (2001). Complications of femoral and subclavian venous catheterization in critically ill patients: a randomized controlled trial. *Journal of American Medical Association, 286*(6),700–7.

Merrer, J., Santoli, F., Vecchi, C. A., Tran, B., De Jonghe, B., & Outin, H. (2000). "Colonization pressure" and risk of acquisition of methicillin-resistant Staphylococcus aureus in a medical intensive care unit. *Infection Control & Hospital Epidemiology*, *21*(11), 718–723.

Milstone, A. M., Passaretti, C. L., & Perl, T. M. (2008). Chlorhexidine: Expanding the armamentarium for infection control and prevention. *Clinical Infectious Disease*, *46*(2), 274–281. doi: 10.1086/524736

Montecalvo, M., McKenna, D., Yarrish, R., Mack, L., Maguire, G., Haas, J., … Wormser, G. (2012). Chlorhexidine bathing to reduce central venous catheter-associated bloodstream infection: Impact and sustainability. *The American Journal of Medicine*, *125*(5), 505–511. doi:10.1016/j.amjmed.2011.10.032

Nelson, R. E., Samore, M. G., Smith, K. J. Harbarth, S., & Rubin, M. A. (2010). Cost-effectiveness of adding decolonization to a surveillance strategy of screening and isolation for methicillin-resistant Staphylococcus aureus carriers. *Clinical Microbiology and Infection*, *16*, 1740–1746.

O'Grady, N. P., Alexander, M., Burns, L. A., Dellinger, E. P., Garland, J., Heard, S. O., … Saint, S. (2011). Guidelines for the prevention of intravascular catheter-related infections. *American Journal of Infection Control, 39*(4), S1–34. doi:10.1016/j.ajic.2011.01.003

O'Horo, J.C., Silva, G. L. M, Munoz-Price, S., & Safdar, N. (2012). The efficacy of daily bathing with chlorhexidine for reducing healthcare-associated bloodstream infections: A meta-analysis. *Infection Control & Hospital Epidemiology, 33*(3), 257–267. doi:

10.1086/664496

Parenti, C.M., Lederle, F.A., Impola, C.L., Peterson, L.R. (1994). Reduction of unnecessary
intravenous catheter use: Internal medicine house staff participate in a successful quality
improvement project. *Archives of Internal Medicine, 154*(16), 1829-1832.

Perla, R. J., Provost, L. P., & Murray, S. K. (2014). Sampling considerations for health care
improvement. *Quality Management in Health Care*, *23*(4), 268–279.
doi:10.1097/QMH.0000000000000042

Pittet, D., Allegranzi. B., Sax, H., Bertinato, L., Concia, E., & Cookson, B (2008).Considerations
for a WHO European strategy on health-care-associated infection, surveillance, and control
surveillance, and control. *Lancet Infectious Diseases, 5*(4), 242–50.

Popovich, K. J., Hota, B., Hayes, R., Weinstein, R. A., & Hayden, M. K. (2009). Effectiveness of
routine patient cleansing with chlorhexidine gluconate for infection prevention in the
medical intensive care unit. *Infection Control & Hospital Epidemiology, 30*(10), 959–
963. doi: 10.1086/605925

Popovich, K. J., Hota, B., Hayes, R., Weinstein, R. A., & Hayden, M. K. (2010). Daily skin
cleansing with chlorhexidine did not reduce the rate of central-line associated
bloodstream infection in a surgical intensive care unit. *Intensive Care Medicine, 36*(5),
854–858. doi: 10.1007/s00134-010-1783-y

Poses, R., McClish, D., Smith, W., Bekes, C., & Scott, W. (1996). Prediction of survival of
critically ill patients by admission co morbidity. *Journal of Clinical Epidemiology,* 49, 743–747.

Pronovost, P., Needham, D., Berenholtz, S., Sinopoli, D., Chu, H., Cosgrove, S., & ... Goeschel, C.
(2006). An intervention to decrease catheter-related bloodstream infections in the ICU. *New
England Journal Of Medicine, 355*(26), 2725.

Pronovost, P.J., Goeschel, C.A., Colantuoni, E., et al. (2010). Sustaining reductions in catheter related
bloodstream infections in Michigan intensive care units: Observational study. *BMJ*, *340*, c309.

Ritz, J., Pashnik, B., Padula, C., & Simmons, K. (2011). Effectiveness of two methods of

chlorhexidine bathing. *Journal of Nursing Care Quality, 27*, 171–175.

Robinson, .JF., Robinson, W.A., Cohn, A., Garg, K., & Armstrong, J.D. (1995). Perforation of

the great vessels during central venous line placement. *Archives of Internal Medicine*, 155, 1225–

1228.

Safdar, N., & Maki, D. G. (2004). The pathogenesis of catheter-related bloodstream infection

with noncuffed short-term central venous catheters. *Intensive Care Medicine, 30*(1), 62–

67.

Sare, M., & Ogilvie, L. (2010). *Strategic planning for nurses: Change management in

health care*. Sudbury, MA: Jones and Bartlet.

Schein, E. H. (2010). *Organizational culture and leadership*. (4th ed.). San Francisco:

Jossey-Bass.

Scott II, D. R. (2009). The direct medical costs of healthcare-associated infections in U.S.

hospitals and the benefits of prevention. Centers for Disease Control and Prevention,

Division of Healthcare and Quality Promotion.

Stern, C. (2014). Developing the review question and inclusion criteria. *American Journal of

Nursing, 114*(4), 53.

Stone, P. W., Braccia, D., & Larson, E. (2005). Systematic review of economic analyses of

health care-associated infections. *American Journal of Infection Control, 33*(9), 501–509.

Twaij, A., Sodergren, M. H., Pucher, P. H., Batrick, N., & Purkayastha, S. (2013). A growing

problem: implications of obesity on the provision of trauma care. *Obesity Surgery,

23*(12), 2113-2120. doi:10.1007/s11695-013-1093-

The Joint Commission (2012). Preventing central line associated bloodstream infections: A

global challenge, a global perspective. Retrieved from

http://www.PreventingCLABSIs.pdf.

The Society of Healthcare Epidemiology of America (2014). Expert CLABSI guidance adds

real world implementation strategies. Retrieved from http://www.shea-

online.org/View/smid/428/ArticleID/286.aspx

U.S. Department of Health and Human Services. (2011). National action plan to prevent health

care-associated infections: Road map to elimination. Retrieved from

http://www.hhs.gov/ash/initiatives/hai/actionplan/.

Umscheid, C. A., Mitchell, M. D, Doshi, J. A, Agarwal, R., Williams, K., & Brennan, P. J. (2011).

Estimating the proportion of healthcare-associated infections that are reasonably preventable and

the related mortality and costs. *Infection Control & Hospital Epidemiology, 32*(2), 101–114.

University of Kentucky Hospital. (2013). Central venous catheter maintenance bundle #NI08-

25. Retrieved from Employee CareWeb: UK Healthcare Policy Web on December 02,

2013.

Valderas, J. M., Starfield, B., Sibbald, B., Salisbury, C., & Roland, M. (2009). Defining

comorbidity: implications for understanding health and health services. *Annals of

Family Medicine, 7*(4), 357–363. doi:10.1370/afm.983

Vernon, M. O., Hayden, M. K., William, T. E., Hayes, R. A., Blom, D. W., & Weinstein, R. A.

(2006). Chlorhexidine gluconate to cleanse patients in a medical intensive care unit: The

effectiveness of source control to reduce the bioburden of vancomycin resistant

enterococci. *Archives of Internal Medicine, 166*(3), 306–312.

Ward, B.W., Schiller, J.S., & Goodman, R.A. (2014). Multiple chronic conditions among U.S.

adults: A 2012 update. Prevention of Chronic Disease, 11, 130-389. DOI:

http://dx.doi.org/10.5888/pcd11.130389.

Weber, D. J, Brown, V. M, Sickbert-Bennett, E. E, Rutala, W. A. (2010). Sustained and prolonged

reduction in central line-associated bloodstream infections as a result of multiple interventions.

Infect Control Hosp Epidemiol, 31, 875–877.

Wendt, C., Schinke, S., Wurttemberger, M., Oberdorfer, K., Bock-Hensley, O., & von Baum H.

(2007). Value of whole-body washing with chlorhexidine for the eradication of

methicillin-resistant Staphylococcus aureus. *Infection Control & Hospital Epidemiology,*

83

28(9), 1036–1043.

World Health Organization. (2011). Report on the burden of endemic health care-associated

    infection worldwide. Retrieved from

    http://whqlibdoc.who.int/publications/2011/9789241501507_eng.pdf.

Wutzler, S., Maegele, M., & Marzi I, et al. Timo, S., Arasc, W., & Lefering, R. (2009).

    Association of preexisting medical conditions with in-hospital mortality in multiple-

    trauma patients. Journal of the American College of Surgeons 209(1), 75–81.

Yokoe, D. (2008). Improving patient safety through infection control: A new healthcare

    imperative. *Infect Control Hosp Epidemiol, 29*, S3–S11.

Zaccheo, M. M., & Bucher, D. H. (2010). Establishing evidence-based transfusion education for

    best practice. *Critical Care Nurse*, *5*, 41–44.

    doi.org/10.1097/01.CCN0000387740.50994.9c

Practice Inquiry Project Report Conclusion

Kara Willett BSN, RN, CCRN

University of Kentucky

College of Nursing

Conclusion

The original "Making Health Care Safer" report examined the prevalence, strategies, and costs associated with CLABSI prevention, and found that certain practices were associated with both a decrease in CLABSI risk and reduced cost, whereas others added expense without clear benefit (Shojania et al., 2001). The efforts made for CLABSI prevention exemplify not only the complexity of these infections but also the creativity required to stop them. This practice inquiry practice identifies a simple adjunct strategy for the prevention of CLABSIs. Manuscript one reviews the literature on daily CHG whole body patient bathing and identifies it to be an effective adjunct CLABSI prevention technique. National regulatory agencies and professional organizations support the use of daily CHG bathing during the presence of a central line and is recommended adjunct therapy as part of a routine CLABSI prevention protocol (O'Grady et al., 2011; The Society of Healthcare Epidemiology of America, 2014). Daily bathing with CHG impregnated washcloths is a strategy that is relatively straightforward to implement because it does not require a substantial change from patient-bathing practices that are currently routine. Manuscript 2 highlighted a daily CHG bathing protocol using CHG impregnated cloths and demonstrated its potential cost savings through a cost benefit analysis. Manuscript 3 evaluated current CHG bathing guideline adherence in two trauma/surgical ICUs and associations between patient characteristics and factors that may impact adherence. The findings of this project showed significantly low guideline adherence. Further work is warranted to increase CHG daily bathing guideline compliance for CLABSI prevention.

Appendix A: IRB Approval Letter

UK.

KENTUCKY

Office of Research Integrity
IRB, IACUC, RDRC
315 Kinkead Hall
Lexington, KY 40506-0057

859 257-9428
fax 859 257-8995
www.research.uky.edu/ori/

Initial Review

Approval Ends
August 12, 2015

IRB Number
14-0581-P6H

TO: Kara Willett, BSN
           College of Nursing
           2189 Birkdale Dr.
           Lexington, Kentucky 40509
           PI phone #: (270)860-7424

FROM: Chairperson/Vice Chairperson
           Medical Institutional Review Board (IRB)

SUBJECT: Approval of Protocol Number 14-0581-P6H

DATE: August 15, 2014

On August 13, 2014, the Medical Institutional Review Board approved your protocol entitled:

Evaluation of Chlorhexidine Bathing Practices in Trauma/Surgical Intensive Care Units

Approval is effective from August 13, 2014 until August 12, 2015 and extends to any consent/assent form, cover letter, and/or phone script.   If applicable, attached is the IRB approved consent/assent document(s) to be used when enrolling subjects. [Note, **subjects can only be enrolled using consent/assent forms which have a valid "IRB Approval" stamp unless special waiver has been obtained from the IRB.]** Prior to the end of this period, you will be sent a Continuation Review Report Form which must be completed and returned to the Office of Research Integrity so that the protocol can be reviewed and approved for the next period.

In implementing the research activities, you are responsible for complying with IRB decisions, conditions and requirements. The research procedures should be implemented as approved in the IRB protocol. It is the principal investigators responsibility to ensure any changes planned for the research are submitted for review and approval by the IRB prior to implementation. Protocol changes made without prior IRB approval to eliminate apparent hazards to the subject(s) should be reported in writing immediately to the IRB. Furthermore, discontinuing a study or completion of a study is considered a change in the protocol's status and therefore the IRB should be promptly notified in writing.

For information describing investigator responsibilities after obtaining IRB approval, download and read the document "PI Guidance to Responsibilities, Qualifications, Records and Documentation of Human Subjects Research" from the Office of Research Integrity's IRB Survival Handbook web page [http://www.research.uky.edu/ori/IRB-Survival-Handbook.html#PIresponsibilities]. Additional information regarding IRB review, federal regulations, and institutional policies may be found through ORI's web site [http://www.research.uky.edu/ori]. If you have questions, need additional information, or would like a paper copy of the above mentioned document, contact the Office of Research Integrity at (859) 257-9428.

Patricia K. Howard, PhD, RN/jh
Chairperson/Vice Chairperson

1

An Equal Opportunity University

87

Appendix B: Approval letter from UK Nursing Research Council

UKHealthCare®

7/7/2014

Dear Kara Willett

Your proposal entitled Evaluation of Chlorhexidine Bathing Practices in Trauma Intensive Care

Units: A Retrospective Chart Review was reviewed during the June 4th, 2014 meeting of the Nursing

Research Council at the University of Kentucky Medical Center, and we are happy to report that your

proposal has been approved. If you have not yet obtained approval for your research through the

University of Kentucky Institutional Review Board (IRB), you must complete this process as well.

The Nursing Research Council reviews all proposals to conduct scientific inquiry that involve UK

nursing staff in an effort to assess for a number of indicators: to determine the feasibility of conducting

the proposed research, to establish the level of support from nursing management or administration to

conduct the research, to determine the applicability to nursing, to evaluate protection of human

subjects, and to assess the completeness of the proposal. If your proposal is amended in any way such

that the methods or procedures are modified significantly, your proposal must be re-submitted for

review by this Council.

Please contact me if you need further assistance, have questions, or wish to discuss anything.

Sincerely,

Rob Sutter, BSN, MPA

Chair, Nursing Research Council

Office of the Executive Vice President for Health Affairs

University of Kentucky • 317 Wethington Building • 900 South Limestone • Lexington, Kentucky 40536-0200
Phone: (859) 323-5126 • Fax: (859) 323-1918 • www.ukhealthcare.uky.edu

88

Appendix C: Approval letter from Director of Trauma/Surgical Services

UKHealthCare.

Appendix C: Approval Letter from Director of Trauma/Surgical Services

June 23, 2014

To whom it may concern:

As the nursing director of the Trauma ICU at the University of Kentucky HealthCare, I am happy to give my approval for Kara Willett to complete her project on the importance of Chlorhexidine baths in the management of central line bloodstream infection rates. My clinical partner Dr. Andrew Bernard is aware of and supports this project. We look forward to Kara's work and are happy to assist any way we can. We feel confident this work will yield important clinical information. Please feel free to contact me with any further information you may need.

Sincerely

Lisa Fryman RN

Lisa Fryman, RN
Nursing Director Trauma/Surgical Services

Appendix D: Charlson Comorbidity Index

Charlson Comorbidity Index			
Pt. ID # _____			
Does the Patient have?			
1.Myocardial infarction	No	Yes	Score 1
2.Congestive Heart Failure	No	Yes	Score 1
3.Peripheral Vascular disease	No	Yes	Score 1
4.Cerebrovascular Disease	No	Yes	Score 1
5.Dementia	No	Yes	Score 1
6.Chronic Pulmonary disease	No	Yes	Score 1
7.Connective tissue disease	No	Yes	Score 1
8.Stomach or Peptic ulcer disease	No	Yes	Score 1
9.Hemiplegia	No	Yes	Score 2
10.Diabetes	No	Yes	Score 1
11.If yes, has the diabetes caused any organ damage	No	Yes	Score 2
12.Moderate to severe renal disease	No	Yes	Score 2
13.Mild Liver disease	No	Yes	Score 1
14.Cirrhosis or serious liver disease	No	Yes	Score 3
15.AIDS	No	Yes	Score 6
16.Leukemia	No	Yes	Score 2
17.Lymphoma	No	Yes	Score 2
18. Cancer other than skin cancer, leukemia, or lymphoma with the last 5 years?	No	Yes	Score 2
19. If yes, has the cancer spread or metastasized to other parts of the body?	No	Yes	Score 6
			Total Score =

Data Collection Tool

Patient Study Number # _____
Sex: Male or Female
Age: _____
Race: Caucasian, African American, Hispanic, Other
Mechanism of Injury:_____
Injury Severity Score: _____
Charlson Comorbidity Index: _____
Body Mass Index (BMI): _____

Day of central line	Location of Central line IJ =1 SC=2 Femoral=3	Daily bath Received Yes=1 No=2 Blank=3	CHG Used for Bathing Yes=1 No=2 Blank=3
1			
2			
3			
4			
5			
6			
7			
8			
9			
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12			
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Key: CHG= Chlorhexidine Gluconate, IJ= Intrajugular, SC=Subclavian

References

Agency for Healthcare Research and Quality (2010). Agency for Healthcare Research and
Quality (AHRQ) efforts to prevent and reduce health care-associated infections.
Rockville, MD: AHRQ. Retrieved from: http://www.ahrq.gov/qual/haiflyer.htm

Association for Professionals in Infection Control and Epidemiology. (2012) Targeting zero
healthcare associated infections [position statement online]. Retrieved from
http://www.apic.org/AM/CM/ContentDisplay.cfm?ContentFileID=11707.

Behrenholtz, S., Pronovost, P., Lipsett, P. & … Perl, T.M. (2004). "Eliminating Catheter-Related
Bloodstream Infections in the Intensive Care Unit," *Critical Care Medicine.*
32(10):2,014-2,020.

Center for Disease Control & Prevention. (2011b). Vital signs: Central line-associated blood
stream infections, United States, 2001,2008, & 2009. Morbidity & Mortality Weekly
Report, 60, 1-6.

Glance, L.G., Stone, P.W., Mukamel, D.B., & Dick, A.W. (2011). Increase in mortality, length
of stay, and cost associated with hospital-acquired infections in trauma patients. Archives
of Surgery, 146(7), 794-801. doi: 10.1001/archsurg.2011.41

Gurses, A. P., Murphy, D. J., Martinez, E. A., Berenholtz, S. M., & Pronovost, P. J. (2009). A
practical tool to identify and eliminate barriers to compliance with evidence-based
guidelines. *Joint Commission Journal On Quality And Patient Safety / Joint Commission
Resources, 35*(10), 526-532.

Institute for Healthcare Improvement. (2012). How-to Guide: Prevent Central Line-Associated
Bloodstream Infections. Cambridge, MA: Institute for Healthcare Improvement.
Retrieved from www.ihi.org

Klevens, M.R., Edwards, J.R., Richards, C.L., Horan, T.C., Gaynes, P.R., Pollock, D.A., &

    Cardo, D.M. (2007). Estimating health care-associated infections and deaths in U.S.

    hospitals, 2002. Public Health Reports, 122, 160-166.

O'Grady, N. P., Alexander, M., Burns, L. A., Dellinger, E. P., Garland, J., Heard, S. O., & ...

    Saint, S. (2011). Guidelines for the prevention of intravascular catheter-related infections.

    American Journal Of Infection Control, 39(4), S1-34. doi:10.1016/j.ajic.2011.01.003

Shojania, K. G., Duncan, B. W., McDonald, K. M., Wachter, R. M., & Markowitz, A. J. (2001).

    Making health care safer: a critical analysis of patient safety practices. *Evidence*

    Report/Technology Assessment (Summary), (43), i.

The Joint Commission (2014). National patient safety goals. Retrieved from

    http://www.jointcommission.org/standards_information/npsgs.aspx

The Society of Healthcare Epidemiology of America (2014). Expert CLABSI Guidance Adds

    Real World Implementation Strategies. Retrieved from http://www.shea-

    online.org/View/smid/428/ArticleID/286.aspx