7-11-2024

# Wiping Out Central Line Associated-Bloodstream Infections: Cleaning High Touch Surfaces in the PICU

Emily Heth
*University of Missouri-St. Louis*, eedmfh@umsystem.edu

# Wiping Out Central Line Associated-Bloodstream Infections: Cleaning High Touch Surfaces in the PICU

Emily E. Heth

B. S. Nursing., Goldfarb School of Nursing at Barnes-Jewish College, St. Louis, MO
2018
B. S. Criminology, Missouri State University, Springfield, MO 65897
2015

A Dissertation Submitted to the Graduate School at the University of Missouri-St. Louis
In partial fulfillment of the requirements for the degree Doctor of Nursing Practice with an emphasis in Acute Care Pediatric Nurse Practitioner

August 2024

<u>Advisory Committee</u>

Sarah Jackson, DNP, APRN, FNP-C

Candace-Rae Davis, DNP, APRN, ACCNS-P, CNP-PC/AC

Rachel Allen, DNP, PNP-AC

**Abstract**

**Problem:** Central line-associated bloodstream infections (CLABSIs) are a significant, preventable healthcare-related complication of hospital admission and medical management of critically ill and medically complex patients. CLABSIs result in significant adverse outcomes such as increased morbidity and mortality, prolonged length of stay (LOS) in the intensive care unit (ICU) and in the hospital, increased cost of treatment, and increased rates of readmission. Direct and indirect contact within the patient's hospital environment are potential means of transmission for microorganisms, increasing the inherent risk of acquiring a CLABSI.

**Method:** For this quality improvement (QI) project, a pre-post design was utilized to evaluate the effect of a standardized high touch surface cleaning protocol on CLABSIs. This was completed with the utilization of retrospective and prospective chart review three months prior to and following the implementation of this protocol. Nurses were provided with education via a virtual staff meeting four weeks prior to implementation as well as the utilization of infographic bathroom flyers. The QI project evaluated number of CLABSIs, nursing compliance, and LOS in the ICU.

**Results:** Seventy-six patients with 87 central lines met criteria and were included in this QI project. There was one CLABSI in three months prior to implementation and one CLABSI during the study period. The average PICU LOS was 18.29 days. RN compliance with cleaning high touch surfaces together was 11.54%.

**Implications for Practice:** After evaluating the implementation of the new high touch surface cleaning protocol in the pediatric ICU (PICU), the number of CLABSIs were the same. Clinical significance was exemplified as the PICU remained CLABSI-free for over

100 days after the study period ended. More research is necessary, including future studies containing more pediatric patients, greater sample sizes, multiple ICUs or institutions, and longer study periods.

WIPING OUT CLABSIS IN THE PICU

## Hospital-Associated Infections

Hospital-associated infections (HAIs) are a significant preventable healthcare-related complication responsible for approximately 1.7 million infections, 99,000 deaths, and cost $28 to $34 billion in the United States of America annually (Christenson et al., 2021). According to the U. S. Department of Health and Human Services (HHS) (2021), approximately 1 in 31 patients experience an infection related to hospital care every day (Centers for Disease Control and Prevention [CDC], 2023). HAIs are a significant threat to patient safety and the community at large as it is the most common complication of hospitalization and has been among the top 10 major causes of death in the United States of America (Haque et al., 2018). Patients requiring admission to intensive care units (ICUs) are experiencing critical illness, placing them at a higher risk of acquiring HAIs; additionally, HAIs are characteristically correlated with the utilization of invasive devices, a common component of intensive care treatment and monitoring (Hsu et al., 2020).

Occurring most frequently, and thus accruing the most cost, specifically in pediatric patients, are central line-associated bloodstream infections (CLABSIs), occurring at a rate of 0.3 to 1.3 per 1,000 central line days (CLDs) (Ward et al., 2023). The CDC's National Healthcare Safety Network (NHSN) (2024) define CLABSI as a laboratory-confirmed infection in the bloodstream of a patient with a central line that is not related to an infection at another site. CLABSIs result in multiple, significant sequela, including increased morbidity and mortality, prolonged length of ICU stay and hospitalization, increased cost of treatment, and increased rates of readmission (Buetti et al., 2022; Hsu et al., 2020). Estimation assertions specific to CLABSIs include increased length of hospital days, from 11 to 21 days, and incurred hospital costs reaching $32,000 to $55,000 on average, exceeding $100,000 per patient (Chovanec et al., 2021; Wolf & Milstone, 2020).

Central lines are utilized in the management of critically ill or medically complex patients to deliver simultaneous infusions, obtain frequent lab specimens, provide invasive hemodynamic monitoring, and facilitate treatment modalities such as dialysis or apheresis (Chovanec et al., 2021). Advantages of central lines compared to standard intravenous (IV) access include delivery of caustic IV medications, monitoring of hemodynamics, rapid delivery of crystalloid or colloid infusions, obtaining lab specimens without multiple venipunctures, and administration of parenteral nutrition (Fahy & Sockrider, 2007). Unfortunately, because central lines are recognized by the immune system as a foreign body, and thus activate the inflammatory cascade, central lines can serve as a portal of entry for infectious microorganisms, posing a significant risk to the patient's medical condition (Chovanec et al., 2021). Risk factors for CLABSIs include populations with a central line in place; vulnerable populations such as immunocompromised, hemodialysis, and neonatal and pediatric patients; lengthy hospitalization; prolonged central line placement; microbe colonization at the catheter insertion site or catheter hub; central lines with multiple lumens; concurrent catheters; neutropenic conditions; body mass index (BMI) greater than 40; prematurity; parenteral nutrition; and transfusion of blood products (Buetti et al, 2022; The Joint Commission, 2013).

## CLABSI Prevention

Direct and indirect contact with healthcare workers, hospital staff, visitors, contaminated surfaces, and the hospital environment are all means of transmission for microorganisms between patients, increasing the inherent risk of acquiring a HAI (Cohen et al., 2012). Following the advent and implementation of CLABSI prevention bundles, CLABSI occurrences decreased by 25,000 in ICUs across in the United States, saving nearly 6,000 lives and $414 million in hospital costs (Haque et al., 2018). Despite these improvements, CLABSIs remain among the highest number of preventable deaths related to HAIs, contributing to approximately ICU 28,000 deaths annually (Karagiannidou et al., 2020; Ward et al., 2023). Strategies for CLABSI prevention were first introduced in 2008, then revised in 2014, and most recently, in 2022 (Prestel et al., 2023). However, while pediatric-specific studies were included in these recommendations, they were not equally represented compared to adult studies, leading to limited evidence and applicability to pediatric populations (Prestel et al., 2023). Children are not small adults; they have different diseases, anatomy and physiology, physical and psychological development, and responses to therapy. As a result, adult prevention efforts are not synonymous and, therefore, not transferrable to pediatric patients, requiring modification and tailored infection prevention efforts for the pediatric setting (Prestel et al., 2023).

## Infectious Transmission

Approximately 12 to 17 microorganisms are responsible for 80% to 87% of HAIs, and among those, 16% to 20% are considered MDRO (multi-drug resistant organisms) phenotypes (Haque et al., 2018). The environmental transmission of microorganisms responsible for HAIs include fomites and vectors such as high-touch surfaces, medical equipment, air ventilation units, healthcare workers hands, wheelchairs, and shared hospital equipment (Christenson et al., 2021; Kuczewski et al., 2022). Additionally, the inpatient room environment can serve as a transmission pathway between current, previous, and future patients (Christenson et al., 2021; Redmond et al., 2021). Should the previous patient incur a HAI, subsequent patients who reside in the room are six times more likely to acquire the HAI due to the microorganism's vigor to environmental conditions, inefficient terminal cleaning of environmental reservoirs, cleaning agent susceptibility, and virulence (Christenson et al., 2021; Cohen et al., 2017; Cohen et al., 2018; Redmond et al., 2021).

## Disinfecting High-Touch Surfaces

At this time, there is not a protocol in place for disinfecting high-touch surfaces in the pediatric intensive care unit (PICU) of an urban, midsized pediatric hospital, located in the Midwest of the United States of America. The purpose of this quality improvement (QI) project will be to evaluate the effect of implementing a specific cleaning protocol of high-touch surfaces on CLABSIs reduction rates in the PICU setting. The protocol will identify PICU-specific high-touch surfaces and the necessity for disinfection of these surfaces once per 12-hour nursing shift. The evidence-based practice (EBP) framework used to guide this study is the Plan-Do-Study-Act (PDSA) model. The aim of this project is to evaluate if CLABSI rates have improved following protocol implementation in 12 weeks' time. The primary outcome measure of interest is the number of PICU CLABSIs. Secondary outcomes of interest to be evaluated include high touch surface cleaning compliance and PICU patient average length of stay in days. CLABSI occurrences will be measured by notification by the Patient Safety and Quality Improvement Specialist. Protocol compliance will be measured by nursing documentation in the electronic health record (EHR). Patient length of stay will be measured by standard documentation within the EHR from date of admission to date of discharge or death. The question for study is: in pediatric patients within the PICU setting, does the implementation of a specific cleaning protocol for high-touch surfaces, versus standard cleaning practices, reduce CLABSI rates?

## Literature Review

An extensive literature search was performed to evaluate CLABSI reduction rates and correlated clinical practice interventions as well as environmental contamination and transfer in ICUs. To conduct this literature search, the Cumulative Index of Nursing and Allied Health Literature (CINAHL), Medline, PubMed, and Ovid databases were utilized. Search terms and phrases included *pediatric, intensive care unit* OR *ICU, hospital environment, high touch surfaces, central line associated bloodstream infections* OR *CLABSIs*, *bundle, clinical practice guidelines,* with Boolean operators AND or OR to create phrases. Initially, 9,794 publications were generated. The search was refined with inclusion criteria of studies conducted within the last five years (2018-2023), full-text, English, human subjects, peer-reviewed, journal articles, high income countries, and ages 0-18 years old. Exclusion criteria included studies greater than five years old, non-English, non-human, duplicates, and greater than 18 years old. The number of publications resulted after refining the search were 3,088 articles. Additional modifiers were included such as intensive care setting and exclusions such as ambulatory and outpatient studies and settings; hematology/oncology, neonatal, and other specific patient populations; specific antibiotic impregnated lines or dressings; and catheter salvage, leaving 142 studies. An ancestry search was conducted and articles from 2010 and 2012 were included outside the defined parameters, due to significance of findings. After further exclusion based on abstract review and relevance, 14 publications were selected for this literature review with varying levels of evidence including systematic reviews, randomized clinical trials, cohort studies, and clinical practice guidelines. Common themes included CLABSI prevention and outcomes, environmental transmission and contamination, environmental contact, and disinfection effectiveness.

CLABSIs can result in adverse outcomes detrimental to patient safety. In four adult hospitals, Chovanec et al. (2021) noted a significant difference among in-hospital deaths in patients with CLABSI versus those without CLABSI, 15.6% and 11.6% respectively. Using bivariate analysis, those who developed a CLABSI were 36.6% more likely to die in the hospital as well as 37% more likely to be readmitted within 30 days (Chovanec et al., 2021). Similarly, Karagiannidou et al. (2020) conducted a systematic review and meta-analysis with 21 articles to analyze mortality, length of stay (LOS), and cost of pediatric and neonatal CLABSIs. PICU LOS ranged from 11.4 to 21.2 days with meta-analysis determining pooled mean attributable LOS of 16.4 days (Karagiannidou et al., 2020). The attributable cost of each PICU CLABSI ranged from $1,642 to $160,804 (Karagiannidou et al., 2020). Lastly, attributable mortality in PICU was 0.11 to 0.24 with a meta-analysis pooled mortality rate of 0.13 (Karagiannidou et al., 2020). Chovanec et al. (2020) found a longer length of stay in patients with CLABSIs, but this was not statistically significant when compared to Karagiannidou et al. (2020). Additionally, a significant limitation of Chovanec et al. (2020) is not accounting for CLABSI-specific mortality.

Fomites are implicated in CLABSI acquisition within the patient environment such as high touch surfaces and vectors such as healthcare workers, visitors, or other healthcare staff (Christenson et al., 2021; Kuczewski et al., 2022). The CDC has recognized 17 high touch surfaces, which include bed rails and controls, bedside tables and handle, IV poles, call light, room phone, chair, room and bathroom sinks, room and bathroom light switches, room and bathroom doorknobs, bathroom grab bars, toilet seat and handle, and bedpan (n. d.).

The number of contacts between a patient and their environment poses a significant risk, as each contact point is a possible means of infectious transmission. Wang et al. (2021) and Cohen et al. (2012) conducted observational studies to quantify contact with patients and surfaces. In Wang et al. (2021), staff were directly observed in emergency departments (EDs) and hemodialysis facilities (HDFs), and every contact was counted and characterized as hand-touched or non-hand contact. Non-hand contact consisted of leaning, sitting, or stepping on surfaces (Wang et al., 2021). Observers totaled 1,805 hand contacts with 58 surfaces and 320 non-hand contacts on 6 surfaces with the most common contact points being bedrails, curtains, chair arm rests and backs, carts, keyboards, and worktops (Wang et al., 2021). Cohen et al. (2012) also utilized direct observers to witness contact between the patient and healthcare workers, other staff, and visitors in ICUs. In 3,250 room entries, there were 0 to 28 visitors per hour, each visit lasted from 1 to 124 minutes, and visitors consisted of 1 to 18 different individuals (Cohen et al., 2012). On average, the nurse entered the room an average of 4.5 times per hour (Cohen et al., 2012). Upon entering the room, Cohen et al. (2012) noted 22% of people touched nothing, 33% touched only the environment, 27% touched patient's intact skin, and 18% touched the patient's blood or bodily fluids. Huslage et al. (2010) also performed an observational study to further investigate staff frequency of surface contact in patient rooms resulting in an average of 44 surfaces per interaction. When compounded over a 12 hour shift of 4.5 entries per hour, over 2,000 surface touches could occur per patient with the primary nurse alone each shift (Cohen et al., 2012; Huslage et al., 2010). However, a limitation of these studies is possible influence of Hawthorne effect, which is the consequential awareness the subject is being studied, resulting in modified behavior (McCambridge et al., 2014).

Wolfensberger et al. (2018) conducted a systematic review and meta-analysis which determined pathogen transfer occurred frequently among the environment, patient, and healthcare worker or medical devices during patient care. Greater frequency of contamination resulted when duration of care was longer, involved moist body site contacts, and patients had invasive devices (Wolfensberger et al., 2018). These specific characteristics are frequent in PICU environments and populations as patients are critically ill, requiring longer duration of care; frequent contact of intact and non-intact skin as well as various bodily fluids; and frequently have invasive devices.

HAIs are correlated with the existence of contaminated surfaces, and those surfaces serve as a reservoir for these microorganisms (Christenson et al. 2021). Kuczewski et al. (2022) sought to establish in real world conditions related to surface contamination by pathogens via obtaining microbial samples from a randomly chosen ICU rooms once per month. Samples were obtained from contact surfaces near the patient such as the bedrail, bedside table, and stethoscope as well as high-touch surfaces utilized by healthcare workers such as the computer, worktop, and hand sanitizer dispenser

(Kuczewski et al., 2022). Over 87% of the 137 samples obtained were positive for one or more bacteria (Kuczewski et al., 2022). Bedrails, bedside tables, and computer worktops indicated bacterial contamination rates of 92-100% (Kuczewski et al., 2022). Bacteria strains of 223 varieties were documented with 14 strains present in both environmental and clinical samples (Kuczewski et al., 2022). Ten samples were initially found in the patient samples, then subsequently in the environment, indicating the patient introduced the bacteria to their environment (Kuczewski et al., 2022). Four samples indicated environmental transfer to the patient from the environment (Kuczewski et al., 2022). Lastly, one sample indicated bacterial contamination from the previous occupant (Kuczewski et al., 2022).

Chen et al. (2019) and Redmond et al. (2021) also conducted studies to investigate transmission and contamination of the hospital environment. Both studies cultured high touch surfaces including bed rails and overbed tables. Chen et al. (2019) included nearest bedside surface, chair armrests, toilet seat, and floor of the shower while Redmond et al. (2021) included the floor, call button, and patient chart. In Chen et al. (2019), of 65 patients, 12 bacterial transfer events occurred, either from the patient to the environment, from environment to patient, or indeterminant (Chen et al., 2019). However, a significant study weakness included MDRO contamination in 44 of 80 rooms after terminal disinfection (Chen et al., 2019). Redmond et al. (2021) noted similar pathogen contamination in 10 of 17 rooms after terminal cleaning; however, researched ensured negative samples prior to collecting data by conducting a second disinfection of rooms. Similar to Wang et al. (2017) and Cohen et al. (2012), the Hawthorne effect was a potential limitation in Redmond et al. (2021).

Hsu et al. (2020) calculated a mean CLABSI occurrence of 1.39 per 1,000 CLDs in pediatric patients based on the CDC 2013-2018 surveillance data of 176 hospitals. Stanford University's Pediatric Hospital noted similar CLABSI rates of 1.57 per 1,000 central line days in a 6,543-sample study (Ward et al., 2023). Robust sample sizes are present in both Hsu et al. (2020) and Ward et al. (2023) studies, but noted a plateau in CLABSI rates occurring, indicating enhancement of prevention bundles as a reasonable improvement to further decrease rates.

In 2022, Buetti et al. updated practice recommendations for CLABSI prevention in collaboration by multiple agencies with a vested interest, including the Society for Healthcare Epidemiology of America (SHEA), Infectious Disease Society of America (IDSA), the Association for Professionals in Infection Control and Epidemiology (APIC), the American Hospital Association (AHA), and The Joint Commission. The guideline defines adverse outcomes and risk factors for CLABSI and essential practices for central line insertion and management. Items addressed include checklists, hand hygiene, daily chlorhexidine baths, use of ultrasound, preferred sites, sterile barriers, disinfection of hubs, replacement of administration sets, and indications for removal (Buetti et al., 2022). One significant limitation of this guideline is lack of pediatric evidence; however, this is important to include as there are currently no pediatric-specific clinical practice guidelines.

The question that remains is whether the cleaning of high touch surfaces influences CLABSI rates. In a systemic review of 14 randomized or cluster randomized controlled trials, Thomas et al. (2022) assessed effectiveness of surface cleaning in hospitals. In three studies, either HAIs or MDROs, or both, were decreased after surface cleaning, however; six studies did not identify statistically significant reduction rates. Stated surfaces in studies included bed rails, overbed tables, call lights, visitor chairs, keyboards, bathrooms, toilet, and bathroom floors (Thomas et al., 2022). In opposition, Louth et al. (2017) performed a systematic review and noted bundled interventions with cleaning and disinfection of the environment was more effective at reducing HAIs than bundles alone (Christenson et al., 2021). Additionally, the CDC Guidelines for Infection Control in Health-Care Facilities recommends cleaning and disinfecting high touch surfaces more frequently than once per day (Wang et al., 2021). In further opposition to Thomas et al. (2022) findings, a triple-blind randomized clinical trial conducted by Warren et al. (2022) noted daily disinfection was more effective in reducing bioburden than standard cleaning in 50 hospital rooms.

CLABSIs are a significant preventable acquisition in ICUs and are associated with increased morbidity, mortality, length of stay, financial cost, and readmission. The literature supports the patient's environment is known to harbor pathogens, yet environmental hygiene is not included in current CLABSI bundles. Limitations of these studies include small sample sizes, cohort studies, lack of pediatric studies, and variance in cleaning methods, definitions, and guidelines. Significant gaps remain in the literature related to robust systematic reviews regarding disinfectant's reduction of pathogens and subsequent HAIs (Christenson et al., 2021). Additionally, efficacy of utilized disinfectants is often based on lab data rather than in situ disinfection (Christenson et al., 2021). In numerous studies, limited bacteria are cultured and very few assess fungi or viruses (Christenson et al, 2021; Kuczewski et al., 2022). Additionally, there are not current standardized methods for cleaning surfaces, measuring of cleanliness, or level of microbial contamination (Guh et al., 2010). More studies are necessary related to CLABSI prevention and environmental hygiene, as HAIs remain a risk to hospitalized patients, especially for the pediatric population.

The Plan-Do-Study-Act (PDSA) cycle was selected to guide this QI project. This is an appropriate framework for a QI project focused on small-scale testing and is best for multiple cycles to determine lessons learned (Chen et al., 2020). Investigation and experimentation are encouraged, as well as the ability to learn from failure, make small changes, and foster collaboration and communication (Chen et al., 2020).

## Methods

### Design

Quality improvement was the approach utilized for the proposed study. Furthermore, the design of the study was a pre and post design. Methods utilized include a retrospective and prospective medical record review. A retrospective medical record review of all PICU patients with central lines 90 days prior to protocol implementation was conducted to gain baseline data on the number of patients with central lines who incurred a CLABSI while in the PICU setting. Following intervention implementation in February, prospective data was collected in the same fashion. CLABSI data was collected from the Patient Safety and Quality Improvement Specialist. LOS data was collected from the EHR. Compliance with the specific cleaning protocol was collected from the EHR and completed high-touch surface bedside checklists.

### Setting

The proposed QI project was implemented in 40-bed PICU within a Level 1 455-bed urban Magnet-designated community pediatric hospital located in the Midwest. This hospital serves a city community of nearly 300,000 people with approximately 25% of the population is under the age of 18 years old and sees roughly 275,000 patient visits annually. This hospital is one of three children's hospitals in the metropolitan area and employees nearly 3,500 people with 900 physicians while the PICU employs approximately 150 nurses and 50 other team members including attending, fellow, and resident physicians; advanced practice registered nurses (APRNs); respiratory therapists; speech, occupational, and physical therapists; art and music therapists; pet therapist; and patient care technicians. This PICU experienced over 3,000 admissions in 2022, with patient populations ranging from 2 days to 25 years old and provides varying levels of care including, but not limited to, mechanical ventilation, acute kidney replacement therapy, organ transplant, and extracorporeal membrane oxygenation (ECMO).

**Sample**

A convenience sampling approach was be used. Inclusion criteria included patients zero days to 21 years old, with at least one central line in place for greater than one day. Central lines include central venous catheters (CVCs), peripheral inserted central catheters (PICCs), dialysis catheters, and ports. Exclusion criteria included patients without central line or a central line in place for less than one day, patients over the age of 21, patients transferred to the PICU with an existing CLABSI, and patients transferred to the PICU with an existing central line and subsequent CLABSI identified within 48 hours of admission.

**Intervention or Procedure:**

Preliminary work included promoting the new protocol with the creation of an infographic bathroom flyer posted in all bathrooms within the PICU explaining what high touch surfaces are, why it is important they are thoroughly cleaned, and a checklist identifying areas considered high touch surfaces. As well, this protocol was presented in the January PICU staff meeting. The high touch surfaces appropriate for this unit was reviewed with leadership and include door handles, light switches, nurse server handles, countertop, electronics such as keyboard, scanner, and mouse, IV pumps and pole, bed rails, the patient's monitor, and other pumps in the room such as dialysis or ECMO pumps. Lastly, for the PICU, a checklist was placed outside each room within a room-specific folder for nurses to indicate what surfaces were cleaned and what were not, as well as a comment box to explain why the area was not cleaned.

The intervention implemented was a cleaning protocol specific to high-touch surfaces. This protocol employed the use of hospital-supplied germicidal disposable wipes at 0700 AM and 1900 PM shift change. After shift change report, the ongoing and off-going RN staff entered the patient's room to perform safety checks, which is the current standard. During this time, both nurses cleaned the high touch surfaces on the checklist together. After completion, the oncoming nurse documented in the patient EHR on the Pediatric Daily Cares and Safety flowsheet tab "yes" and comment in the free-text comment box "together" to the question "high touch surfaces cleaned" to acknowledge if the protocol was completed and high touch surfaces were cleaned together. If the high touch surfaces were not cleaned together, but the nurse did complete the task, they were asked to comment in the free-text comment box in the EHR "self" to signify this was not performed together. As well, the nurse was asked to fill out the high-touch surface checklist posted at the desk outside the patient's room to acknowledge what surfaces were cleaned, if any surfaces were not cleaned, and the opportunity to comment on any barriers to cleaning high touch surfaces.

**Data Collection and Analysis**

The Demographic data to be collected includes: the patient's age and sex, which was de-identified and protected. The qualitative data collected included: LOS for patients admitted to the PICU who also have a central line, number of CLABSIs, type of central line, and RN compliance rates with implemented cleaning protocol. Data was obtained via retrospective and prospective chart review. Baseline data CLABSI data was obtained from the Patient Safety and Quality Improvement Specialist in the 90 days prior to implementation. Data was entered in an Excel sheet and stored on a password protected computer. No standardized tools were appropriate for this data or setting and the creation and bathroom flyers and patient checklists was used for implementation and data collection. The data analysis methods include descriptive statistics to provide an organized summary of data.

**Approval Processes**

The student investigator has gained approval and support for the proposed quality improvement project from the organization and all stakeholders. Formal, written Internal Review Board (IRB) approval was obtained from the University of Missouri-St. Louis IRB prior to implementation and retrospective data collection. The proposed project is classified as a QI project, and therefore IRB exempt. The site honored UMSL IRB waiver, as a result, site approval was not necessary. Potential benefits of this project include decreasing CLABSI rates and decreasing incidence of subsequent adverse outcomes with implementation of cleaning high touch surfaces.

## Results

The total number of pediatric patients with central lines included within this study was 76 (n = 76) with 87 central lines (n = 87). The patient population consisted of 55.2% (n = 42) male and 44.7% (n = 34) female. The average age was 7.77 years old (SD = 6.5) with a range of 0.15 to 21 years of age. The average PICU LOS was 18.29 days (SD = 39.97) with a range of one to 318 days. The average hospital LOS was 27.14 days (SD = 43.06). The average central line days was 12.51 days (SD = 21.65) with a range of one to 124 days. All patients included in this study had at least one central line, the most common of which was a triple lumen central venous catheter (n = 23, 26.43). Of the 76 patients with central lines, nine patients (11.84%) had concurrent central lines, as in two central lines simultaneously. Two of the nine patients with concurrent central lines had three. A demographic table is specified in Appendix A.

The compliance rate for cleaning high touch surfaces together was 14.1% for day shift and 9.14% for night shift with overall compliance of 11.54%. Compliance with completion of bedside folder of all high touch surfaces was 30.01%. There were 10 instances where not all items on the protocol were not marked complete with and the item most frequently omitted being the patient's central monitor. Due to a single CLABSI in the pre-intervention period and one CLABSI in the post-intervention period, no statistical test can be performed indicating no statistical significance.

## Discussion

Three PDSA cycles were conducted during the study period. PDSA Cycle 1 lasted three weeks and ended due to inflated-appearing data. Initially, when charting high touch surface cleaning together, nurses were asked to chart "yes" in the "high touch surfaces cleaned" column of the patient flowsheet without any further connotation. If nurses cleaned high touch surfaces alone, they were asked to type "self" in the comment box while still charting "yes." In the first three weeks, compliance was 71.7%. In PDSA Cycle 2, the documentation requirements were modified, and nurses were asked to select "yes", then comment in the free-text comment box comment "self" or "together" to indicate how high touch surfaces were cleaned. Cycle 2 lasted 22 days and charting compliance decreased to 8.8%, indicating only 8.8% of nurses commented "together" in the comment box.

With the introduction of PDSA Cycle 3, due to low compliance, bedside education was completed with approximately 60% of staff. Also, small, colorful, bright cardstock reminders were placed outside each room next to the staff computers where they sit to chart. Additionally, reminders were placed in two separate areas inside each patient room: next to the medication scanner and above the Sani-wipes dispenser. A reminder to clean high touch surfaces together was placed on the huddle board where all nursing staff gathers before each shift. As well, the PICU educator included the high touch cleaning protocol in the weekly "Safety Updates" email. After completing these modifications, the last 41 days of the study, or PDSA Cycle 3, documentation compliance improved to 23.98%, a near three-fold increase. Overall compliance with completing the bedside folder checklist was 30.01%. Of the 10 instances where not all ten surfaces were wiped, the patient's central monitor was the most common item not cleaned with bedside staff commenting they did not know if it was safe to wipe with Sani-wipes.

Interestingly, both CLABSIs were acquired by the same patient in separate central lines with a 318-day LOS. The patient had a disproportionate amount of risk factors increasing the likelihood of CLABSI such as prolonged length of ICU stay and duration of central line, which were both 318 days; three lumens; total parenteral nutrition (TPN) recipient; *candida* colonization of the mouth, skin, and intestines; frequent loose, watery stool; frequent drooling; frequent movement due to dystonia; linen shortages due to supply chain issues, which did not allow for daily linen changes; and difficulty with completing dressing changes and chlorohexidine baths due to noxious stimuli triggering dystonic episodes (Buetti et al, 2022). The CLABSI during the pre-implementation period was positive for *Entrococcus faecalis* and was followed by two negative blood cultures. The CLABSI during the study period was positive for *Candida albicans*, which the patient was found to be colonized with, and was followed by two negative blood culture. Of note, these two CLABSIs in this patient are the only CLABSIs the PICU has identified as of 2024.

Despite lack of statistical significance, there is potential clinical significance. After the study end, the PICU reported attaining a CLABSI-free unit for over 100 days; a milestone not reached for over a year. Nursing staff reported increased knowledge and awareness as to why it is important to clean high touch surfaces as well as changing gloves more frequently after bedside re-education was completed. Nurses reported barriers to compliance include supply issues, such as Sani-wipes were empty in the room, low stimulation and comfort care patients, an instance of a neighboring code event, and, most commonly, nurses forgot to wipe surfaces together. As well, nurses reported additional surfaces cleaned including the ventilator, temporal thermometer, isolation stethoscope, feeding pump, artic sun, and portable electroencephalogram (EEG) keyboard and mouse.

This study had multiple strengths including implementation of a standardized protocol and managerial support. Verbal feedback from nursing staff was positive and included feedback of increased understanding of the importance of cleaning high touch surfaces, noting the inclusion of example studies and potential environmental microbial bioburden in nurse education as particularly impactful. Additional feedback include wiping surfaces was quicker with two people and the task was completed before they had to complete the multitude of tasks at the beginning of their shift. Nursing staff appreciated the inclusion of the list of high touch surfaces specific to the unit, and the encouragement to wipe down other surfaces they felt were “high-touch.”

Difficulties with process change, misremembrance, and prioritization are contributors to decreased high touch surface compliance. Feedback from nursing staff included difficulty remembering to do the task together as it was a change in process. While staff reported awareness of the importance of cleaning high touch surfaces, the unit culture was completion could occur at any time during the shift. Often, the beginning of nursing  shifts are fraught with tasks; on the list of priorities, cleaning high touch surfaces did not take precedence over medication administration, diagnostic scans, or patient assessments. Additional compliance issues are related to the time of year, as wintertime typically has the highest census, reaching 50 patients, and required the use of travel nurses, float pool nurses, overflow units, and nurses floating from other ICUs who were not educated on this process change. A significant barrier of this study was compliance with charting modification requests, as over 75% of charting did not provide the addition of “self” or “together” in the comment box or high touch surfaces cleaning was not charted at all. To combat this, changes could be made to the documentation options in the EHR from “yes” to “alone” or “together.”

Recommendations for the future include the application of implementation science related to cleaning high touch surfaces compliance. Implementation science is the scientific study of procedures to encourage the systemic implementation of evidence-based practice into routine practice to provide the highest quality of care, as it can take up to 17 years to incorporate new research into routine practice and its integration has made projects more successful (Bauer et al., 2015; Roberts et al., 2023). Examples include a shared governance council, which could be the current PICU Bloodstream Infection (BSI) Team or the Clinical Practice Council (CPC), and include meetings, mentors, and interview feedback (Russell-Babin et al., 2023). Increased compliance and repeated studies with larger sample sizes, longer study cycles, and implementation in multiple ICUs could produce statistically significant results.

Sources of error include under- or over-documentation. Additionally, transcriptional error is possible as the high touch surface compliance data was monitored and entered manually. Possible positive or negative impacts on study results, include a patient’s medical complexity and critical illness could impact compliance, such as urgent and emergent tests, medications, assessments, and interventions which take precedence over high touch surface cleaning. Positive study impacts bedside re-education and various reminder cards as exemplified by PDSA Cycle 3.

## Conclusion

Prior to the implementation of a high touch surface cleaning protocol, there was no standardized protocol regarding cleanliness of the patient environment. Execution of this cleaning protocol specific to high-touch surfaces provided a standardized way of cleaning surfaces as well as two-person verification this process was completed. Limited success was achieved in this study, however, clinical significance was exemplified with subsequent PDSA cycles after bedside re-education and attainment of 100-day CLABSI free PICU. Studies related to hospital environment, CLABSIs, and cleaning protocols in pediatric patients are limited as well as CLABSI-specific pediatric bundles. Longer study cycles, such as six months to one year, a larger sample size, greater compliance, and implementation in another ICU has potential for statistical significance. Additionally, to further evaluate of what qualifies as high touch surfaces, the addition of microbial testing can direct future studies.

**References**

Bauer, M. S., Damschroder, L., et al. (2015). An introduction to implementation science for non-specialist. *BMC Psychology, 3*(1). doi: 10.1186/s40359-015-008909

Buetti, N., Marschall, J., et al. (2022). Strategies to prevent central-line associated bloodstream infections in acute-care hospitals: 2022 update. *Infection Control & Hospital Epidemiology, 43*(5). doi:10.1017/ice.2022.87

Centers for Disease Control and Prevention (CDC). (2023). *Current HAI progress reports.* Retrieved December 16, 2023 from https://www.cdc.gov/hai/data/portal/progress-report.html

Centers for Disease Control and Prevention (CDC). (2019). *Guidelines for environmental infection control in health-care facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)*. Retrieved October 28, 2023 from https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf

Centers for Disease Control and Prevention (CDC). (n. d.). *CDC environmental checklist for monitoring terminal cleaning.* Retrieved November 15, 2023 from chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.cdc.gov/hai/pdfs/toolkits/environmental-cleaning-checklist-10-6-2010.pdf

Chen, L. F., Knelson, L. P., et al. (2019).. *Infection Control & Hospital Epidemiology, 40*(1). doi: 10.1017/ice.2018.275

Chen, Y., VanderLaan, P. A., et al. (2020). Using the model for improvement and Plan-Do-Study-Act to effect SMART change and advance quality. *Cancer Cytopathology, 129*(1). doi: 10.1002.cncy.22319

Chovanec, K., Arsene, C., et al. (2021). Association of CLABSI with hospital length of stay, readmission rates and mortality: A retrospective review. *Worldview on Evidence-Based Nursing, 18*(6).

Christenson, E. C., Cronk, R., et al. (2021). Evidence map and systemic review of disinfection efficacy on environmental surfaces in healthcare facilities. *International Journal of Environmental Research and Public Health, 18*(21). doi: 10.3390/ijerph182111100

Cohen, B., Cohen, C. C., et al. (2017). Transmission of health care-associated infections from roommates and prior room occupants: A systematic review. *Clinical Epidemiology, 9*. doi: 10.2147/CLEP.S124382

Cohen, B., Hyman, S., et al. (2012). Frequency of patient contact with health care personnel and visitors: Implications for infection prevention. *The Joint Commission Journal on Quality and Patient Safety, 38*(12)

Cohen, B., Liu, J., et al. (2018). Association between healthcare-associated infection and exposure to hospital roommates and previous bed occupants with the same organism. *Infection Control & Hospital Epidemiology, 39*(5). doi: 10.1017/ice.2018.22

Fahy, B. & Sockrider, M. (2007). Central venous catheter. *American Journal of Respiratory and Critical Care Medicine, 11*(7). doi: 10.21474/IJAR01/17283

Guh, A., Carling, P., et al. (2010 December). *Options for evaluating environmental cleaning.* Centers for Disease Control and Prevention. https://www.cdc.gov/hai/toolkits/evaluating-environmental-cleaning.html

Gupta, P., Thomas, M., et al. (2021). Bundle approach used to achieve zero central-line associate bloodstream infections in an adult coronary intensive care unit. *BMJ Open Quality, 10*(1). doi: 10.1136/bjmoq-2020-001200

Haque, M., Sartelli, M., et al. (2018). Health care-associated infection – An overview. *Infectious Drug Resistance, 11*. doi: 10.2147/IDR.S177247

Huslage, K., Rutala, W. A., et al. (2010). A quantitative approach to defining high touch surfaces in hospitals. *Infection Control and Hospital Epidemiology, 31*(8). doi: 10.1086/655016

Hsu, H. E., Mathew, R., et al. (2020). Health care-associated infections among critically ill children in the US, 2013-2018. *JAMA Pediatrics, 174*(12). doi: 10.1001/jamapediatrics.2020.3223

Intellectus Statistics. (2019). Intellectus Statistics [Online computer software]. Retrieved from http://analyze.intellectusstatistics.com

The Joint Commission. (20 November 2013). *Preventing central line-associated bloodstream infections: Useful tools, an international perspectives.* https://www.jointcommission.org/-/media/tjc/documents/resources/health-services-research/clabsi-toolkit/clabsi_toolkit_tool_1-5_intrinsic_risk_factors_for_clabsis_and_susceptible_populationspdf.pdf

Karagiannidou, S., Triantafyllou, C., et al. (2020). Length of stay, cost, and mortality of healthcare-acquired bloodstream infections in children and neonates: A systematic review and meta-analysis. *Infection Control & Hospital Epidemiology, 41*(3). doi: 10.1017/ice.2019.353

Kuczewski, E., Henaff, L., et al. (2022). Bacterial cross-transmission between inaminate surfaces and patients in intensive care units under real-world conditions: A repeated cross-sectional study. *International Journal of Enviornmental Research and Public Health, 19*(15). doi: 10.3390/ijerph19159401

McCambridge, J., Witton, J., et al. (2014). Systematic review of Hawthorne effect: New concepts are needed to study research participation effects. *Journal of Clinical Epidemiology, 67*(3). doi: 10.1016/j.jclinepi.2013.08.015

National Healthcare Safety Network (NHSN). (January 2024). *Bloodstream infection event (Central line-associated bloodstream infection and non-central line associated bloodstream infection*. Centers for Disease Control and Prevention. https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf

Prestel, C., Fike, L., et al. (2023). A review of pediatric central-line associated bloodstream infections reports to the National Healthcare Safety Network: United States, 2016-2022. *Journal of the Pediatric Infectious Disease Society, 12*(9). doi: 10.1093/jpids/piad066

Redmond, S. N., Pearlmutter, B. S., et al. (2021). Timing and route of contamination of hospitalized patient rooms with healthcare-associated pathogens. *Infection Control & Hospital Epidemiology, 42*(9). doi: 10.1017/ice.2020.1367

Roberts, N. A., Young, A. M., & Duff, J. (2023). Using implementation science in nursing research. *Seminar in Oncology Nursing, 39*(2). doi: 10.1016/j.soncn.2023.151399

Russell-Babin, K., Friesen, M. A., et al. (2023). A nurse-led implementation science specialist program. *American Journal of Nursing, 123*(12). doi: 10.1097/01.NAJ.0000997228.84722.c7

Thomas, R. E., Thomas, B. C., et al. (2022). Cleaning and disinfecting surfaces in hospitals and long-term care facilities for reducing hospital- and facility-acquired bacterial and viral infections: A systematic review. *Journal of Hospital Infection, 122.* doi: 10.1016/j.jhin.2021.12.017

U. S. Department of Health and Human Services. (2 September 2021). *Health care-associated infections.* https://www.hhs.gov/oidp/topics/health-care-associated-infections/index.html

Wang, T. Z., Simon, M. S., et al. (2021). Quantitative characterization of high-touch surfaces in emergency departments and hemodialysis facilities. *Infection Control and Hospital Epidemiology, 42*(4). doi: 10.1017/ice.2020.466

Ward, A., Chemparathy, A., et al. (2023). The association between central-line associated bloodstream infection and central line access. *Critical Care Medicine, 51*(6). doi: 10.1097/CCM.0000000000005838

Warren, B. G., Barrett, A., et al. (2022). An enhanced strategy for daily disinfection in acute care hospital rooms a randomized control trial. *JAMA Network Open, 5*(11). doi: 10.1001/jamanetworkopen.2022.42131

Wolf, J. & Milstone, A. M. (2020). Vascular access in children to prevent and treat infectious disease. *Pediatrics, 145*(s3). doi: 10.1542/peds.2019-3474L

Wolfensberger, A., Clack, L., et al. (2018). Transfer of pathogens to and from patients, healthcare providers, and medical devices during care activity – A systematic review and meta-analysis. *Infection Control & Hospital Epidemiology, 39*(9). doi: 10.1017/ice.2018.156

# Appendix A

**Table 1.**

*Patient Demographics*

| Variable | *n* | % |
|---|---|---|
| Sex | | |
| Female | 34 | 44.74 |
| Male | 42 | 55.26 |
| Central Line Type | | |
| Single Lumen Central Venous Catheter | 1 | 1.14 |
| Single Lumen Peripherally Inserted Central Catheter | 3 | 3.44 |
| Single Lumen Broviac | 1 | 1.14 |
| Single Lumen Port | 8 | 9.20 |
| Double Lumen Central Venous Catheter | 11 | 12.64 |
| Double Lumen Hemodialysis Catheter | 9 | 10.34 |
| Double Lumen Peripherally Inserted Central Catheter | 20 | 22.99 |
| Trialysis | 1 | 1.14 |
| Triple Lumen Central Venous Catheter | 23 | 26.44 |
| Triple Lumen Peripherally Inserted Central Catheter | 7 | 8.05 |
| Extracorporeal Membrane Oxygenation | 3 | 3.45 |
| Patients with Concurrent Central Lines | 9 | 11.84 |

*Note.* Rounding errors may result in percentages not equaling 100%

**Table 2**

*Patient Age*

| Variable | *M* | *SD* | *n* | $SE_M$ | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| Age | 7.77 | 6.50 | 76 | 0.75 | 0.15 | 21.00 | 0.39 | -1.35 |

Note: "-" indicates the statistics is undefined due to constant data or an insufficient sample size.

**Table 3**

*PICU & Hospital LOS*

| Variable | *M* | *SD* | *n* | $SE_M$ | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| PICU LOS | 18.29 | 39.97 | 76 | 4.58 | 1.00 | 318.00 | 6.06 | 40.91 |
| Hospital LOS | 27.14 | 43.06 | 76 | 4.94 | 1.00 | 318.00 | 5.09 | 28.82 |

Note: "-" indicates the statistics is undefined due to constant data or an insufficient sample size.

**Table 3**

*PICU Central Line Days*

| Variable | *M* | *SD* | *n* | $SE_M$ | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| PICU CL Days | 12.56 | 21.79 | 75 | 2.52 | 1.00 | 124 | 3.95 | 28.82 |

Note: "-" indicates the statistics is undefined due to constant data or an insufficient sample size.

(Intellectus Statistics, 2019)