A Comparison of the Rate of Central Line-Associated Bloodstream Infection (CLABSI) in a NICU Pre- and Post-Implementation of Sterile Tubing Change

Nicole Sanders

Creighton University
Abstract

Central line-associated blood stream infections (CLABSI) are health care associated infections (HAI) that are serious but preventable adverse events. Implementation of care bundles, quality improvement projects, and education have been successful in decreasing rates of CLABSI in all intensive care units (ICU).

PURPOSE: The purpose of this project was to compare the rate of central line associated blood stream infection (CLABSI) in a Midwestern Neonatal Intensive Care Unit (NICU) pre- and post-implementation of sterile tubing change.

METHODS: A descriptive retrospective non-experimental study design was used to report CLABSI rates of a Midwestern NICU before and after implementation of a care bundle. Data was collected by retrospective chart review of NICU patients with birth weights less than 1500 grams. Results were obtained quarterly, from the first quarter of 2007 to the fourth quarter of 2012. CLABSI rates were compared over this six-year period.

RESULTS: The rate of CLABSI in this NICU decreased from 9.4 bloodstream infections per 1000 central line days in 2007 to 1.4 bloodstream infections per 1000 central line days in 2012.

CONCLUSIONS: The decrease was in response to care bundle components implemented in 2010 and 2011 including sterile tubing change. The results have shown the effectiveness of a care bundle including sterile tubing change, in decreasing CLABSI in this NICU.
Background

Health care associated infections (HAI) cause significant morbidity, mortality, and cost billions of dollars every year. In the United States, approximately one in 20 hospitalized patients will develop a HAI (Centers for Disease Control and Prevention [CDC], 2011a). Thousands of lives are lost to these infections with a mortality rate of 12-25% (CDC, 2011a). One population at high risk for HAI is the neonatal population. This includes premature and term infants up to one month of age that are patients in a neonatal intensive care unit. Neonates are at higher risk for HAI due to immature immune response, increased susceptibility, the need for invasive monitoring and invasive procedures, medication administration, and altered skin integrity when compared to adults (Polin, Denson, & Brady, 2012b; Wu & Mu, 2010). Lachman and Yuen (2009) conducted a review in which one study found an 11.4% incidence of HAI in the NICU with 45.7% incidence in the extremely low birth weight infants (1000g or less).

Central line-associated blood stream infections (CLABSI) are HAIs that are serious but preventable adverse events. Hospital patients experience about 250,000 central line infections every year; 80,000 occur in intensive care units (O’Grady et al., 2011a). Due to the widespread incidence and effects of HAI, the Agency for Healthcare Research and Quality (AHRQ) has provided funding and has collaborated with other agencies to help reduce and prevent HAI (Agency for Healthcare Research and Quality [AHRQ], 2009). Data from 2009 show a 58% decrease in CLABSI when compared to 2001 with a cost savings of approximately $414 million and saving thousands of lives (CDC, 2011a). This provides strong evidence for the effectiveness of current prevention strategies.

Several issues need to be considered when evaluating the incidence of HAIs. Risk factors for developing HAIs include indwelling devices, invasive procedures, surgery, injections,
A COMPARISON OF THE RATE OF CLABSI

contamination of the environment, transmission of communicable diseases between health care workers and patients, and the overuse or improper use of antibiotics (U.S. Department of Health & Human Services [HHS], 2012). Indwelling devices include urinary catheters, intravenous and central venous catheters, and endotracheal tubes. Indwelling devices become vital in sustaining life as patients become critically and chronically ill. Prevention strategies have been developed with consideration of these issues.

Implementation of care bundles, quality improvement projects, and education has been successful in decreasing rates of CLABSI in all ICUs. Care bundles are several interventions implemented together that are evidence-based practices aimed at reducing CLABSI. They are not implemented in the same way across institutions. Individual facilities have decided what components of the bundle they use. Multidisciplinary quality improvement projects have identified several interventions that have been successful in decreasing CLABSI rates. Interventions include education of staff, evaluation of best practice with practice changes, surveillance methods, and celebrations for success. Additional evidence is needed to further understand the effectiveness of quality improvement interventions as well as individual components of the care bundle. It is also imperative to show sustainability of decreased CLABSI.

Multiple stakeholders have an interest in decreasing the rate of CLABSI. Patients, healthcare professionals, insurance companies, government, and patient advocates are all vested in reducing CLABSI in order to decrease costs, length of stay, morbidity, and mortality. Government agencies such as the Centers for Disease Control and Prevention (CDC) are highly involved in CLABSI prevention. In 2005, the CDC set priority to reducing catheter-associated events by 50 percent (Curry, Honeycutt, Goins, & Gilliam, 2009). The National Healthcare
Safety Network (NHSN) is a surveillance system within the CDC that collects data from multiple institutions. Data collection enables healthcare institutions to monitor rates of adverse events, adherence to preventive practices, recognition of trends, compliance with legal requirements for mandatory reporting, as well as several other measures (CDC, 2011b). The NHSN published rates of CLABSI in level III NICUs across the country ranging from 0.8 to 2.64 per 1000 central-line days (Dudeck et al., 2010). Rate of CLABSI in all other ICUs was 1.65 infections per 1,000 central line-days (CDC, 2011a). Neonatal intensive care unit CLABSI rates are grouped by weight categories, with the highest rate being in the smallest weight group, those less than 750 grams.

**Significance**

Central line associated blood stream infection (CLABSI) is a significant risk factor causing increased morbidity and mortality, increased length of stay, and increased costs in all hospitalized patients, including the neonatal population. The CDC definition of CLABSI is a blood stream infection in a patient who has had a central line within the 48 hours before developing the blood stream infection that is not related to an infection at another site (O’Grady et al., 2011). CLABSI is used interchangeably with catheter-related blood stream infection (CRBSI). These two terms have different definitions whereas CRBSI requires more thorough testing to identify the catheter as the source (O’Grady et al., 2011). For the purpose of this proposal, the term CLABSI will be used.

The CDC has made several recommendations for the prevention of CLABSI. An emphasis is placed on 1) education of healthcare staff that insert and maintain central lines; 2) use of maximal sterile barrier precautions when placing central lines; 3) use of chlorhexidine with alcohol skin preparation for antisepsis; 4) avoiding routine replacement of central lines; and
5) using antiseptic antibiotic impregnated central lines and chlorhexidine impregnated sponge dressings if infection rate does not decrease despite using previous strategies (O’Grady et al., 2011). Performance improvement is also emphasized by implementation of care bundles and measuring compliance with components of the bundle to assure quality and improvement (O’Grady et al., 2011). Initiatives to decrease CLABSI are based on these recommendations.

Managing CLABSI is a national safety and quality initiative for the Centers for Medicare and Medicaid Services (CMS) and has been classified as a never event. Never events are conditions that have been shown to be preventable, high-volume, high cost, and could result in lower reimbursement to health care facilities when a patient experiences the never event (Mattie & Webster, 2008). Several private insurance companies have followed CMS’s lead in limiting reimbursement for never events (Mattie & Webster, 2008).

Pathogens and routes of contamination involved in the development of CLABSI commonly focus on duration, location, and type of catheter used as well as common pathogens and routes of contamination. The most likely pathogens to cause CLABSI include coagulase-negative staphylococci, Staphylococcus aureus, enterococci, and Candida (O’Grady et al., 2011). The four routes identified as contamination sources: 1) skin organisms at the insertion site, 2) contamination by direct contact with hands, fluids or devices, 3) seeding from another infection, and 4) infusate contamination (O’Grady et al., 2011).

It is critical that the most effective ways of preventing CLABSI be identified as all patients with central lines are at risk for developing CLABSI. Finding the best approach to preventing CLABSI will decrease costs to multiple stakeholders, decrease the loss of life, and provide for safe, high quality healthcare. The neonatal population experiences higher rates of CLABSI when compared to adults. Central lines are needed in this population for intravenous
A COMPARISON OF THE RATE OF CLABSI

fluids, nutrition, medications, and vascular access for laboratory testing as well as hemodynamic monitoring. It is therefore necessary to identify evidence-based practices that will lead to reduced rates of CLABSI in the neonatal population. Several interventions have shown to be effective in decreasing CLABSI rates. There is limited research looking at the effect of these interventions individually. The purpose of this descriptive retrospective non-experimental study was to compare the rate of central line associated blood stream infection (CLABSI) in a NICU pre- and post-implementation of sterile tubing change.

Literature Review

Central line-associated bloodstream infections have been determined to be preventable, high cost infections with increased morbidity and mortality. Several strategies have proven to be successful in the reduction of CLABSI. In order to determine best evidence for prevention of CLABSI a literature review was completed. The discovery of research articles and other supporting literature was completed by using the electronic databases PubMed and CINAHL. Key terms used included care bundles, hand hygiene, central venous catheter, central line associated blood stream infection, CLABSI in the NICU, umbilical lines, PICCs in neonates, biofilm, pathogens, routes of contamination.

CLABSI Pathogens

Four pathogens have been recognized as the most common pathogens to infect central lines. They are coagulase-negative staphylococci, Staphylococcus aureus, enterococci, and Candida (O’Grady et al., 2011a). Pathogens are found on skin, mucous membranes, equipment, and the patient’s environment; and can be transmitted by contact with the environment, healthcare workers, visitors, contaminated catheters or infusate. Garland et al. (2008) conducted a cohort study of neonates and found a majority of their bloodstream infections caused by
coagulase-negative staphyloccoci. If a central line becomes infected with these pathogens it will require antibiotic treatment and possible removal.

**Biofilm.** An important concept in the pathogenesis of CLABSI is biofilm. Microorganisms form biofilms on medical devices such as central venous lines in order to survive, multiply, and colonize. When central lines are initially placed, contamination is more likely due to mobility of the catheter, sliding in and out at the insertion site (Garland et al., 2008). There are three phases in the development of biofilm: attachment, growth, and detachment (Talsma, 2007). Central lines are exposed to blood, which contains proteins that adhere to the surface of the line making it suitable for bacterial growth (Talsma, 2007). As pathogens attach, they multiply, colonize the surface, and secrete substances forming the biofilm (Talsma, 2007). In the final phase, parts of the biofilm detach, travel through the bloodstream, and may cause infection in some patients (Garland et al., 2008; Talsma, 2007).

**Coagulase-negative staphyloccoci.** Coagulase-negative staphyloccoci are opportunistic pathogens. Staphylococcus epidermidis frequently cause foreign body infections due to the biofilm they form on the surface of objects such as central lines (Kayser, Bienz, Eckert & Zinkernagel, 2005). This pathogen is part of the normal flora on skin and mucosa and only causes infection in certain host dispositions (Kayser et al., 2005). Coagulase-negative staphyloccoci cause nearly 50% of CLABSI (Polin et al., 2012a).

**Staphylococcus aureus.** Staphylococcus aureus is Gram-positive cocci that occurs in a cluster and colonizes skin and mucosa frequently (Kayser et al., 2005). It is a common cause of a variety of infections. Because of its ability to bind to proteins such as fibrinogen, fibronectin, and collagen, it can bind to tissues and foreign bodies covered with these proteins (Kayser et al., 2005).
**Enterococci.** Enterococci are Gram-positive cocci that are found most often in the gastrointestinal tract (Kayser et al., 2005). This pathogen typically causes urinary tract infections, endocarditis, bacteremia, and wound infections (Fraser, 2012). Enterococci would cause CLABSI by seeding the central line in the presence of infections such as urinary tract infection or necrotizing enterocolitis.

**Candida.** Candida albicans is Gram-positive yeast that is a normal inhabitant of the mucosa (Kayser et al., 2005). This pathogen infects those with compromised immune systems and those who have been receiving antibiotic treatment.

**Central Line-Associated Bloodstream Infection Routes of Contamination**

Central lines may become contaminated by pathogens in four ways: skin organisms at the insertion site, contamination by direct contact, seeding from another infection, and infusate contamination (O’Grady, 2011a).

**Skin organisms at insertion site.** The skin is our most effective barrier against the invasion of microorganisms. A break in the skin, such as in the placement of a central line, can introduce pathogens into the system. The normal flora that is present on skin may enter through the insertion site when a central line is placed or during the time a central line is present. As stated previously, movement of the catheter can also encourage bacterial introduction. Broekhuizen et al. (2008) took central venous catheters and excised tissue around the catheter before autopsy on adult patients to culture. They found 9 out of 35 catheters and surrounding tissue to be culture positive, predominantly with Staphylococcus epidermidis and enterococci (Broekhuizen et al., 2008).

**Contamination by direct contact.** Contamination of central lines can occur by direct contact with hands or contaminated fluids or devices. A study conducted by Loftus et al. (2011)
looked at contamination of the operating room (OR) and stopcock IV sets by providers in the operating room. Bacterial transmission to the OR environment occurred by providers in 12% of cases; bacterial transmission to the stopcock set was found in 11.5% of cases, of which 47% of cases were linked to anesthesia providers (Loftus et al., 2011). Sixty-six percent of provider hands were contaminated with pathogens including methicillin resistant staphylococcus aureus (MRSA), and vancomycin resistant enterococcus (VRE) (Loftus et al., 2011). This study shows the importance of hand hygiene before and after patient contact. A limitation identified by the authors in this study is that hand contamination was obtained immediately before patient contact (Loftus et al., 2011). They also cited provider knowledge of the study as a limitation in that hand hygiene was likely exaggerated (Loftus et al., 2011).

**Seeding from another infection.** This contamination happens less frequently. When another infection such as pneumonia, urinary tract infection, or necrotizing enterocolitis is present, it is believed that this infection can travel through the bloodstream and colonize the central line. The literature is limited in this area. The CDC has guidelines that help to determine whether this secondary infection can be classified as a CLABSI.

**Infusate contamination.** Due to human intervention in the preparation of intravenous fluids, medications, and administration sets it is possible for infusate to become contaminated. Dextrose containing fluids and intralipids are media that can contribute to bacterial growth (Macias et al., 2010). In their study, Macias et al. (2010) cultured 384 infusates from 384 patients with gram-negative rods reported in blood culture. Of this sample, seven specimens were considered contaminated by the same pathogen as reported in the blood specimen for a rate of 2% (Macias et al., 2010). Limitations of this study include delay in infusate culture while
waiting for results of blood culture as well as this being a single-center study in a developing
country lacking a central pharmacy (Macias et al., 2010).

Infusate may also become contaminated as it infuses through the administration set or as
healthcare workers access the line. Garland et al. (2008) found catheter hubs to grow coagulase-
negative staphylococcus aureus in seven of 64 cultures which led to two of the seven developing
CLABSI. From these findings, it can be concluded that intraluminal contamination may occur as
a result of contaminated intravenous fluids or hub contamination (Garland et al., 2008).

**Strategies to Decrease Incidences of CLABSI**

Several strategies have been shown to be effective in reducing the incidence of CLABSI.
When deciding on strategies, individual centers need to determine what interventions would be
most effective in their pursuit of reducing CLABSI rates. The CDC guideline recommends
education, care bundles, and careful selection of catheter and site to aid in meeting the goal of
reducing CLABSI rates as low as possible (O’Grady et al., 2011b).

**Education.** Education and training take place as part of the implementation of practice
change and quality improvement projects. Providing education to staff increases understanding
of evidence behind practice change and increases compliance. Part of the educational process is
assessing knowledge and compliance with guidelines (O’Grady, 2011a). Education should be
provided to all team members including physicians, nurses, pharmacists, technicians,
housekeepers and other support staff as well as family members.

**Care bundles.** Care bundles are defined as a group of interventions that when
implemented together result in better outcomes. The Institute for Healthcare Improvement (IHI)
collaborated with teams from several hospital ICUs to initiate the IHI Central Line Bundle. This
group developed bundle elements based on key elements of care associated with central lines and
evidence-based interventions already accepted by those participating (Resar, Griffin, Haraden & Nolan, 2011). The participants agreed that each individual element had sufficient medical evidence to recommend its use in most, if not all patients, and the list needed to be no more than five (Resar et al., 2011). The bundle includes hand hygiene, maximum sterile barrier for line insertion, daily assessment of need for the line, optimal catheter site selection, and the use of chlorhexidine gluconate for skin antisepsis (Resar, et al., 2012). The elements of bundles have been shown to have synergistic effects (Lachman & Yuen, 2009). Bundles elements can also be implemented individually, they are not dependent on each other.

Furuya et al. (2011) identified four objectives in their study of care bundles: the extent of adoption of central line bundles; the effectiveness of individual bundle elements on reducing infection; the effectiveness of combinations of bundle elements on reducing infection; to determine if the effect of bundle elements was specific, or if compliance with bundles reduced rate of infection in other HAI. They found a wide range of compliance with bundles, reporting 38% full compliance in those hospitals that monitored bundle implementation (Furuya et al., 2011). They also found that CLABSI rates decreased only when a bundle policy was present, compliance was monitored, and compliance was 95% or greater (Furuya et al., 2011).

Niedner et al. (2011) found a 43% decrease in the incidence of CLABSI in their pediatric intensive care units that was most strongly associated with implementation of a care bundle. In addition to implementation of a care bundle, the authors suggest success is due to the promotion and inhibition of adherence to best practice (Niedner et al., 2011). This study included 29 pediatric ICUs across the country with CLABSI incidence of 2.5 per 1,000 catheter days (Niedner et al., 2011). This is a strong study based on the sample size and the fact that multiple units were included.
Hand hygiene. Hand hygiene is an integral part of the standard precautions that should be practiced with every patient contact. Poor compliance with hand hygiene can lead to healthcare associated infection. A study conducted at the National Taiwan University Hospital found 16.6% rate of compliance with hand hygiene before their project (Chen et al., 2011). After introducing alcohol-based rubs and a hospital-wide promotion program, Chen et al., (2011) found an increase to 95.6% compliance in 2007. They credit the increased compliance with the increased use of alcohol-based hand rub (Chen et al., 2012). This group monitored HAI incidence as well and found a significant decrease in most HAIs as a result of hand hygiene compliance. Hand hygiene is to be used before placement, manipulating, and accessing central lines.

Maximum sterile barrier. Maximum sterile barrier precautions include sterile gown, sterile gloves, mask, cap, and sterile draping of the site while placing central lines. This practice has been shown to lead to decreased catheter colonization and CLABSI (O’Grady et al., 2011a). Providing maximum sterile barrier reduces the chance for environmental and staff contaminates to invade insertion sites and equipment used to place catheters.

Daily assessment of need for central line. Daily assessment of the continued need for a central line is imperative. The length of time a catheter remains increases the risk for infection. The Zingg et al., study found mean time to infection in neonates to be seven days. Butler-O’Hara (2012) found the incidence of infection highest within the first seven days. When the patient no longer needs central access for parenteral nutrition or medications, the line must be discontinued.

Optimal catheter site selection. In adults, the subclavian site is recommended for non-tunneled central lines, rather than jugular and femoral sites (O’Grady et al., 2011a). PICCs may
be placed in the upper and lower extremities, scalp, and subclavian sites. Umbilical lines may be used as well within the first few days of life.

**Chlorhexidine gluconate.** Chlorhexidine skin preparation has been shown to be more effective than povidine iodine and alcohol in decreasing colonization and CLABSI (O’Grady et al., 2011a). Mimoz and colleagues (2007) conducted a study to test chlorhexidine effectiveness when compared to povidine-iodine. Patients were assigned to either the chlorhexidine group or the povidine-iodine group. The provider placing the line did know which solution was being used but the microbiologists processing the cultures did not (Mimoz et al., 2007). Catheter tips were cultured for a total of 538 randomized to the two groups with 481 able to be evaluated (Mimoz et al., 2007). This group found catheters in the chlorhexidine group were colonized less frequently than the povidine-iodine group for incidence of 11.6% vs. 22.2% (Mimoz et al., 2007).

Several studies reviewed show effectiveness of care bundles on reduction of CLABSI. Butler-O’Hara et al. (2012) hypothesized that a trained PICC team and care bundles would reduce the incidence of CLABSI in their NICU. They successfully reduced their rate from 8.6 per 1000 central line days to 2.4 per 1000 for PICCs (Butler-O’Hara et al., 2012). Kime et al. (2011) added “scrub the hub” to their bundle and effectively decreased CLABSI. “Scrub the hub” involves using friction with alcohol or chlorhexidine swabs to clean the needleless port, as this is a site for bacteria to harbor.

### Consideration of Type of Central Line and Duration in Neonates

The type of line chosen and its duration has an impact on CLABSI. Catheters can be long or short term, tunneled or non-tunneled, and may be placed in upper extremity, lower
extremity, jugular, subclavian, or femoral sites. In all age groups, central lines must be discontinued when no longer needed.

A neonate has the option of umbilical lines at birth or until the umbilical stump falls off, this is unique to this population. The CDC recommends the use of umbilical lines to be short term with discontinuation of umbilical artery catheters by 5 days, and umbilical venous catheters by 14 days (O’Grady et al., 2011). Umbilical vessels offer easy access for blood sampling and monitoring of hemodynamic status but the stump becomes heavily colonized after birth (O’Grady et al., 2011).

A study conducted by Balkhy et al. (2010) in Saudi Arabia compared CLABSI rate in umbilical lines and central lines; type of central line was not declared. In 1,124 neonates, this NICU found 8.2 CLABSI per 1000 device-days in central lines and 10.5 per 1000 in umbilical lines. This study took place from 2001 to 2008 with a large sample size and a variety of central lines.

A NICU in China reported 13.6 CLABSI per 1000 line days for umbilical catheters. Zingg et al. (2011) examined rate of CLABSI, time to infection and dwell time. They found the highest rate of CLABSI in babies weighing less than 750 grams and in PICCs. The median time to infection was 7 days, with rates in umbilical lines and PICCS similar in these first 7 days (Zingg et al., 2011). After 7 days, CLABSI rates for umbilical lines steadily increased while rates for PICCs declined; suggesting providers should prefer PICCs for long term access needs (Zingg et al., 2011). Results from Butler-O’Hara et al., (2012) were similar to Zingg et al.

**Quality Improvement Projects.**

Quality improvement projects have been implemented by several ICUs, including NICUs that have resulted in reduced CLABSI rate. Quality improvement projects have included
interventions such as leadership commitment, education, implementation of practice changes, and multidisciplinary and multicenter collaborations. Curry et al. (2009) lowered their rate from 4.9 per 1000 central line days to 2.1 per 1000 for all central lines with an increase in the number of line days from 7312 to 10,241. Their project focused on the IHI bundle, but they also incorporated the use of alcohol-based chlorhexidine and the chlorhexidine-impregnated patch to be placed around the catheter at the insertion site. Chlorhexidine has not been used in the neonatal population due to the skin integrity of premature infants (Curry et al., 2009). They also used a dedicated team of neonatal nurse practitioners and nurses to place and manage care of central lines.

A study conducted by Kime et al. (2011) began with formation of a multidisciplinary committee to evaluate current practice in relation to central lines. Their project was implemented in phases. It began with a contest to name the project to increase excitement for it. There were incentives throughout the project to maintain enthusiasm such as posting audit results and celebrations of milestones. They have also continued to provide staff with literature and examples of other success stories (Kime et al., 2011). As a result, CLABSI rate dropped from 15.6 per 1000 days to zero. A limitation in this study is that they looked at a time period six months before and only 3 months after implementation of their project (Kime et al., 2011).

A study done in California developed a statewide collaboration of multiple centers with the goal of decreasing CLABSI by 25 percent; this goal was achieved (Wirtschafter et al., 2010). They recognized the importance of site variation as an advantage to a quality improvement project as it allows for the ability to learn from each other. In this collaborative, individual units set their own agendas based on their needs (Wirtschafter et al., 2010). Because this was a statewide collaborative, there was substantial support of the project, as it became a priority. The
heavy involvement of hospital leadership led to improved collaboration within departments (Wirtschafter et al., 2010). The authors identified several limitations in their project. This was not a randomized control study; they could not identify which interventions were responsible for the reduction in CLABSI; and their baseline and follow-up periods were shorter than desired (Wirtschafter et al., 2010).

Bizzarro et al., (2010) successfully reduced rates from 8.44 per 1000 line days to 1.71 per 1000 in babies greater than 750 grams. Their study focused on the educational aspect of implementing quality improvement projects. Education took place on placement of central lines, dressing changes, entry into the line, limiting placement with prompt removal, and surveillance (Bizzarro et al., 2010). All of this research supports that quality improvement projects are successful in reducing the rate of CLABSI in multiple NICUs.

Summary

Central venous lines are a vital component in the care of critically and chronically ill patients of all ages. The literature is strong in showing the effectiveness of care bundles and quality improvement projects in reducing CLABSI. Several studies presented have large samples with statistically significant results, are multidisciplinary, and take place in multiple centers across the globe. Recommendations by the authors include further research needing to be done to assess care bundle effectiveness, effectiveness of individual elements, adherence with care bundle use, and sustainability of CLABSI reduction.

The neonatal population has special considerations when considering type of central line to use and its duration. Compiling these results makes a strong argument in support of short-term use of umbilical lines. When the need for long-term vascular access presents, replacement of umbilical lines with PICCs is a feasible option. All central lines should be discontinued as
soon as possible to eliminate the risk for developing CLABSI. Key factors in risk for CLABSI among neonates have been identified as gestational age, weight, type of catheter used and dwell time of the catheter. The studies used for development of this review provide strong evidence for these conclusions based on sample size, length of study, and results provided.

While the ultimate goal of these projects would be elimination of CLABSI, it seems this may not be possible in this population. CLABSI rates are highest among the smallest babies due to extreme prematurity, immature immune function, and the need for long-term vascular access. Bizzarro et al. (2010) highlighted the difficulty in greatly reducing CLABSI among this high-risk group, citing the need to identify other risk factors that may be involved.

Success has been shown in reduction of CLABSI with the implementation of care bundles, education, and staff vigilance. What remains unclear is: can the reduction of CLABSI in each of these units be sustained? In searching the literature, there was difficulty in finding research to support the sustainability of these quality improvement projects. This is an area that needs to be further studied. When considering sustainability of a project, the safety culture of a unit needs to be evaluated. Safety culture in NICUs is also an area with limited data. Up until recent history, CLABSI was thought of as an unavoidable complication in the NICU (Suresh & Edwards, 2012). Education is an important factor in changing this belief. Suresh and Edwards (2012) recommend communication and role modeling by leadership, physicians, and nurses, and transparency as ways to improve unit culture.

Care bundles as described previously are a large part of initiatives to reduce and prevent CLABSI in NICUs. It has been shown in multiple studies that they are effective. The limitation of this strategy is that care bundles have several components, making it difficult to decipher which intervention provided the best results. A study done to test individual components would
be worthwhile. The risk of doing this would be possible increase in CLABSI. A particular intervention of interest is sterile tubing change. A study completed by Larwood, Anstey, and Dunn (2000) compared sterile tubing change with aseptic, non-touch tubing change. Their study showed infection rates were not statistically different between groups; the limitation being participants were not blinded (Larwood, Anstey, & Dunn, 2000). The study was done with adult patients but could be translated to the neonatal population. This study also had the effect of decreasing costs through the use of less equipment and less time spent changing tubing (Larwood, Anstey, & Dunn, 2000).

To conclude, research has shown success in reduction of CLABSI with the implementation of care bundles, education, vigilance, and multidisciplinary teamwork. The gaps in literature pertain to the sustainability of reduced CLABSI and the effect of individual interventions. Education provided at the start of these projects can evolve into education on ways to support further reduction and how to make it lasting. Further study needs to be done to assess whether NICUs can achieve elimination of CLABSI and sustain it. This study aimed to provide evidence for or against the effectiveness of sterile line change. The proposed project has added to the evidence support for reevaluating individual components.

**Theoretical Framework**

Rosswurm and Larrabee (1999) provide a model to enable healthcare practitioners to change to evidence-based practice. They developed this model citing the need for practitioners to research literature, critically appraise findings, and synthesize evidence to maximize quality and cost-effectiveness of care (Rosswurm & Larrabee, 1999). There are six steps in the model: assess the need for change; link the problem with interventions and outcomes; design a change in practice; implement and evaluate the practice change; integrate and maintain the practice change
A COMPARISON OF THE RATE OF CLABSI

(Rosswurm & Larrabee, 1999). The theoretical framework for this proposal is based on the Rosswurm and Larrabee Model for Change to Evidence-Based Practice.

Assess

The first step in this model is to assess the need for practice change. In this case, the need to reduce the rate of CLABSI required specific practice changes to be implemented. Benchmarking of internal CLABSI rate compared to external CLABSI rates through Vermont Oxford Network showed the need to address practices related to central lines. High risk of infection in this population further warrants the need to implement changes. In this Midwestern NICU, an evidence-based care bundle was implemented to decrease incidence of CLABSI.

One practice change included in the bundle is sterile tubing change. This practice includes clean set-up of tubing on a sterile field with two person sterile tubing change at the line site. The added time to complete this task has led to dissatisfaction among staff that may lead to decreased compliance. It is unknown if this would lead to a change in CLABSI rate. Other components of the bundle include hand hygiene, skin surface surveillance cultures, chlorhexidine skin antiseptic, line maintenance team, medication infusions along with use of bolus feature, and memory aid for addressing central line need. Internal data to be collected included CLABSI rate before and after this intervention as well as compliance prevalence. Further assessment of knowledge of CLABSI and practices to prevent CLABSI is also needed.

Stakeholders in this project include neonatologists, neonatal nurse practitioners, nurse manager, staff nurses, patients, and families. The outcome indicators are CLABSI rate and adherence to procedural guidelines. With increased rate of adherence to established guidelines there is increased opportunity for sustaining decreased CLABSI rate.
Link

Sterile tubing change involves multiple steps and can become time consuming in patients with multiple fluid and medication infusions. Multiple steps in this process leave opportunity for errors in the procedure. Extra time to follow long procedural guidelines is time taken away from critically ill patients. This may also lead to nursing dissatisfaction and resistance to adhere to practice guidelines, thereby affecting the sustained reduction of CLABSI. Interventions to increase satisfaction and compliance include education, report of CLABSI rate, and celebrations of success. Outcomes measured include CLABSI rate over a period of time to detect reduction as well as sustainability of reduction in CLABSI rate.

Synthesize

A review of the literature has shown the interventions used in this NICU to be successful in reducing CLABSI. Care bundles are identified as successful interventions in achieving reduction in CLABSI. Multidisciplinary quality improvement projects have also been able to produce decreased CLABSI rates in many other institutions. An important topic is to maintain continued interest in and ownership of the project and goals (Butler-O’Hara, D’Angio, Hoey & Stevens, 2012; Curry, Honeycutt, Goins & Gilliam, 2009; Kime, Mohsini, Nwankwo & Turner, 2011). Evidence is limited in showing the effectiveness of individual elements of the care bundle. Benefits and risks also need to be weighed. Does the benefit of less time spent on tubing changes relate to increased risk of CLABSI for patients? Or, does the risk of time spent away from a critically ill patient lead to lower quality of care? These relationships need to be clarified.

Design
The rate of CLABSI was obtained both before and after implementation of the care bundle including sterile tubing change. If data showed no change in CLABSI rate, it would have been feasible to reevaluate the practice of sterile tubing change or modification of current guideline. If data showed a continued decline in CLABSI rate, efforts then should focus on maintaining staff motivation.

Implement and Evaluate

Data were used to evaluate the effectiveness of sterile tubing change as well as other components of the care bundle that were implemented. Education was provided to staff prior to practice changes to increase motivation to comply with guidelines. If the rate of CLABSI remained the same or less, reconsider the practice of sterile tubing change.

Integrate and Maintain

Based on data collected, it will be determined whether sterile tubing change should be continued to maintain reduced CLABSI rate. Efforts to continue to reduce the rate of CLABSI should become the focus.

Methods

Design

A descriptive retrospective non-experimental study design was used to report CLABSI rates of a Midwestern NICU before and after implementation of a care bundle, specifically sterile tubing change. Data was collected by retrospective chart review of NICU patients with birth weights less than 1,500 grams. Results were obtained quarterly, from the first quarter of 2007 to the fourth quarter of 2012. Characteristics of the population gathered included total number of NICU admissions during the time period, weight, number of blood stream infections, type of central line and the identified pathogen. The number of patient days with central line, number of
A COMPARISON OF THE RATE OF CLABSI

blood stream infections, and number of blood stream infections per 1,000 days with a central line were grouped by birth weight: less than 750 grams, 751-1,000 grams, and 1,001-1,500 grams. Central line-associated bloodstream infection rates were obtained before and after the implementation of the care bundle and sterile tubing change. All NICU admissions during the specified time period with birth weight less than 1,500 grams were included in the sample during the time period specified. There was no randomization. The independent variables were care bundle components and sterile tubing change with the dependent variable of CLABSI rate.

Sample and Setting

This study took place in a Midwestern NICU with a target population consisting of premature infants with birth weight less than 1,500 grams. The sample criteria were nonexclusive to gender, ethnicity, diagnosis, or plan of care. Inclusion criteria included all neonatal patients with birth weights less than 1,500 grams before and after the implementation of a care bundle and sterile tubing change. This was a convenience sampling in one NICU.

Ethical Considerations

Permission to conduct this study was obtained from the Creighton University Institutional Review Board and the Hospital Review Board via an exempt review process as these were the results of a quality improvement project and no identifying information was collected. Approval was obtained from the unit leadership and physicians at the author’s institution. Privacy of all information was maintained by coding of patient number to a specific medical record and destruction of the list as soon as the data was collected. No identifying information was collected (see Appendix A, B, C - Data Collection Sheets).

Measurement Methods
CLABSI rates were measured using the definition outlined by the CDC according to birth weight, number of line days, and number of bloodstream infections per 1,000 line days. The CDC definition of CLABSI is a bloodstream infection in a patient who has had a central line within the 48 hours before developing the bloodstream infection that is not related to an infection at another site (O’Grady et al., 2011). Birth weight groups included: less than 750 grams, 751 - 1,000 grams, and 1,001 - 1,500 grams. Number of line days was the total number of days a central line dwelled within the patient. CLABSI rate is calculated by dividing the number of CLABSI by the number of central line days then multiplying by 1,000.

Data Collection and Analysis

Data were collected by the investigator for the time period from January 2007 to December 2012, before and after the care bundle components were implemented. Data were recorded in spreadsheet form using Microsoft Excel with all data de-identified by coding. All raw data was reviewed for errors.

Limitations

Non-randomization and the retrospective descriptive study design limits generalizability. This was a convenience sampling in one NICU which also limits generalizability to the population.

Results

CLABSI rates were obtained over a six year period from 2007 to 2012. Rates were delineated by birth weight: less than 750 grams, 751 - 1,000 grams, and 1,001-1,500 grams. In 2007, the yearly CLABSI rate for all patients less than 1,500 grams was 9.4 per 1,000 line days. By birth weight, CLABSI rates were 10.1 per 1,000 line days in patients less than 750 grams,
10.4 per 1,000 line days in patients 750 - 1,000 grams, and 8.3 per 1,000 line days in patients 1,000-1,500 grams.

In 2008, the yearly CLABSI rate was 5.1 per 1,000 lines days for patients less than 1,500 grams. By weight group, the CLABSI rates were 3.9 per 1,000 line days in patients less than 750 grams, 7.8 per 1000 line days in patients 750 - 1,000 grams, and 3.7 per 1,000 line days in patients 1,000- 1,500 grams.

In 2009, the yearly CLABSI rate was 7.1 per 1,000 lines days for patients less than 1,500 grams. By weight group, the CLABSI rates were 11.4 per 1,000 line days in patients less than 750 grams, 7.0 per 1,000 line days in patients 750 - 1,000 grams, and 5.2 per 1,000 line days in patients 1,000- 1,500 grams.

In 2010, the yearly CLABSI rate was 4.1 per 1,000 lines days for patients less than 1,500 grams. By weight group, the CLABSI rates were 7.3 per 1,000 line days in patients less than 750 grams, 3.2 per 1000 line days in patients 750 - 1,000 grams, and 0.0 per 1,000 line days in patients 1,000- 1,500 grams.

In 2011, the yearly CLABSI rate was 2.3 per 1,000 lines days for patients less than 1,500 grams. By weight group, the CLABSI rates were 2.3 per 1,000 line days in patients less than 750 grams, 2.4 per 1000 line days in patients 750 - 1,000 grams, and 2.3 per 1,000 line days in patients 1,000- 1,500 grams.

In 2012, the yearly CLABSI rate was 1.4 per 1,000 lines days for patients less than 1,500 grams. By weight group, the CLABSI rates were 0.0 per 1,000 line days in patients less than 750 grams, 1.7 per 1000 line days in patients 750 - 1,000 grams, and 2.6 per 1,000 line days in patients 1,000- 1,500 grams. CLABSI rates decreased significantly (85%) over the six year period across all groups.
There were 8,293 total central line days; 2,397 for patients less than 750 grams, 2,978 for patients 751 - 1,000 grams, and 2,918 for patients 1,001 grams. Forty-one patients less than 1,500 grams were diagnosed with CLABSI in this NICU from 2007 – 2012. The most common pathogen was Coagulase-negative staphylococcus (63%) followed by Staphylococcus aureus (18%), Enterococcus (13%), Enterobacter aerogenes (2%), Escherichia coli (2%), and Methicillin-resistant staphylococcus aureus (2%). The most common central line to be affected was an umbilical venous catheter (67%). Other catheters affected include umbilical arterial catheter (17%), central venous catheter (11%), and peripherally inserted central catheter (4%).

**Discussion**

Multiple studies and quality improvement projects have shown care bundles to be effective in decreasing the rate of CLABSI. The goal of this study was to determine the effectiveness of care bundle components in decreasing CLABSI rate, specifically sterile tubing change in this Midwestern NICU. The data demonstrated a variable but consistent decrease in the incidence of CLABSI in response to the implementation of a care bundle and sterile tubing change. After implementation of care bundle components starting in 2010, there has been a steady decrease (44% and 39%) in yearly CLABSI rates in patients less than 1500 grams: 4.1 in 2010 to 2.3 in 2011 to 1.4 per 1,000 line days in 2012.

An increasing trend in CLABSI was first identified in 2007 by a multidisciplinary team of NICU staff when comparing to other NICUs in the Vermont Oxford Network. Efforts to reduce this trend began in late 2007 with the exploration of the use of chlorhexidine in the neonatal population, implementing ‘Scrub the Hub’, and increased awareness of hand hygiene. The care bundle in this institution includes: surveillance cultures for umbilical lines after seven days, then every seven days until line is discontinued; use of chlorhexidine skin antiseptic,
except in patients less than 1,000 grams and less than two weeks of age; use of checklist to
determine continued need of the central line; use of a line maintenance team; use of continuous
medication infusions and bolus feature of infusion pump to decrease the number of accesses to
the line; use of SwabCap®; sterile tubing change; and ongoing root cause analysis of each blood
stream infection. These practice changes took place between 2010 and 2011, ending with the
initiation of sterile tubing change in July 2011. The results demonstrate the effectiveness of the
care bundle that was implemented as well as the effectiveness of sterile tubing change. This
finding is consistent with the literature and supports the continued use of both the care bundle
components as well as sterile tubing change.

A noteworthy (46%) decrease was seen from 2007 to 2008. In 2008, the National
Healthcare Safety Network (NHSN), the CDC’s healthcare-associated infection tracking system,
determined that two positive blood cultures were needed to identify a CLABSI (CDC, 2013).
Before 2008, only one positive blood culture was needed (CDC, 2013). This change showed an
effect on CLABSI rate from 2007 (9.4 per 1,000 line days) to 2008 (5.1 per 1,000 line days but
in 2009 the rate rose to 7.1 per 1,000 line days which cannot be explained by the data collected.

The most common pathogen to cause CLABSI in this NICU was Coagulase-negative
staphylococcus which is consistent with the literature. In the neonatal population, umbilical lines
are used very commonly within the first weeks of life. Studies have shown this type of central
line to be at higher risk of developing CLABSI. The finding of umbilical venous and arterial
catheters to be most commonly affected in this NICU is uniform with study findings.

By identifying the need to decrease CLABSI incidence and following evidence-based
practices, this NICU was able to decrease CLABSI by 85%. Advance practice nurses (APRN)
are perfectly positioned to influence the continued success of such quality improvement projects.
As experts in neonatal care, they research and weigh evidence to determine best practice to ensure positive outcomes in the neonatal population. They also aid in the education of neonatal staff to safeguard the continuation of low CLABSI rates. APRNs are very involved in the daily management of central lines and need to continue to advocate for prompt removal when appropriate to the needs of the patient.

Potential research to be developed from this project includes studying the best ways to continue to decrease the incidence of CLABSI, ensure staff buy-in, and sustainability of the decrease in incidence. The literature is insufficient in these areas. The success of quality improvement projects depends on several factors. A sustained low incidence of CLABSI in response to the care bundle and sterile tubing change will increase staff buy in and promote compliance with guidelines. CLABSI rates declined as a result of evidence-based interventions and multidisciplinary collaboration. This provides incentive to continue to evaluate the evidence and implement best practices in caring for central lines. It also declares the importance of multidisciplinary collaboration in the NICU.

In conclusion, central line associated blood stream infection is a significant risk factor causing increased morbidity and mortality, increased length of stay, and increased costs in all hospitalized patients, including the neonatal population. Effective strategies to decrease CLABSI have been identified in multiple studies. This NICU examined the literature, collaborated in a multidisciplinary group and was able to implement an effective care bundle including sterile tubing change with the result of an 85% decrease in the incidence of CLABSI. The focus now becomes sustaining this change and maintaining staff buy-in.
## Appendix A

<table>
<thead>
<tr>
<th>Year / Quarter of Onset</th>
<th>Less Than or Equal to 750 g</th>
<th>751 - 1000 g</th>
<th>1001 - 1500 g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BSI</td>
<td>Pt Days with a CVC</td>
<td>BSI/1000 Days with a CVC</td>
</tr>
<tr>
<td>2012Q4</td>
<td>0</td>
<td>18</td>
<td>0.0</td>
</tr>
<tr>
<td>2012Q3</td>
<td>0</td>
<td>108</td>
<td>0.0</td>
</tr>
<tr>
<td>2012Q2</td>
<td>0</td>
<td>125</td>
<td>0.0</td>
</tr>
<tr>
<td>2012Q1</td>
<td>0</td>
<td>188</td>
<td>0.0</td>
</tr>
<tr>
<td>2011Q4</td>
<td>0</td>
<td>129</td>
<td>0.0</td>
</tr>
<tr>
<td>2011Q3</td>
<td>1</td>
<td>41</td>
<td>24.4</td>
</tr>
<tr>
<td>2011Q2</td>
<td>0</td>
<td>134</td>
<td>0.0</td>
</tr>
<tr>
<td>2011Q1</td>
<td>0</td>
<td>127</td>
<td>0.0</td>
</tr>
<tr>
<td>2010Q4</td>
<td>1</td>
<td>198</td>
<td>5.1</td>
</tr>
<tr>
<td>2010Q3</td>
<td>2</td>
<td>156</td>
<td>12.8</td>
</tr>
<tr>
<td>2010Q2</td>
<td>1</td>
<td>64</td>
<td>15.6</td>
</tr>
<tr>
<td>2010Q1</td>
<td>0</td>
<td>127</td>
<td>0.0</td>
</tr>
<tr>
<td>2009Q4</td>
<td>1</td>
<td>51</td>
<td>19.6</td>
</tr>
<tr>
<td>2009Q3</td>
<td>0</td>
<td>6</td>
<td>0.0</td>
</tr>
<tr>
<td>2009Q2</td>
<td>1</td>
<td>86</td>
<td>11.6</td>
</tr>
<tr>
<td>2009Q1</td>
<td>1</td>
<td>121</td>
<td>8.3</td>
</tr>
<tr>
<td>2008Q4</td>
<td>0</td>
<td>78</td>
<td>0.0</td>
</tr>
<tr>
<td>2008Q3</td>
<td>1</td>
<td>133</td>
<td>7.5</td>
</tr>
<tr>
<td>2008Q2</td>
<td>0</td>
<td>118</td>
<td>0.0</td>
</tr>
<tr>
<td>2008Q1</td>
<td>1</td>
<td>190</td>
<td>5.3</td>
</tr>
<tr>
<td>2007Q4</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>2007Q3</td>
<td>0</td>
<td>38</td>
<td>0.0</td>
</tr>
<tr>
<td>2007Q2</td>
<td>1</td>
<td>54</td>
<td>18.5</td>
</tr>
<tr>
<td>2007Q1</td>
<td>1</td>
<td>107</td>
<td>9.3</td>
</tr>
<tr>
<td><strong>Total Number of Pt Days with Central Line</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Number of CLABSI for this Pt Group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Central Line Days</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Less Than or Equal to 750 g</th>
<th>751 - 1000 g</th>
<th>1001 - 1500 g</th>
<th>YEARLY RATES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BSI Line Days</td>
<td>BSI/1000 Line Days</td>
<td>BSI Line Days</td>
<td>BSI/1000 Line Days</td>
</tr>
<tr>
<td>YR 2012</td>
<td>0 439</td>
<td>0.0</td>
<td>1 591</td>
<td>1.7</td>
</tr>
<tr>
<td>YR 2011</td>
<td>1 431</td>
<td>2.3</td>
<td>1 414</td>
<td>2.4</td>
</tr>
<tr>
<td>YR 2010</td>
<td>4 545</td>
<td>7.3</td>
<td>1 310</td>
<td>3.2</td>
</tr>
<tr>
<td>YR 2009</td>
<td>3 264</td>
<td>11.4</td>
<td>4 574</td>
<td>7.0</td>
</tr>
<tr>
<td>YR 2008</td>
<td>2 519</td>
<td>3.9</td>
<td>4 513</td>
<td>7.8</td>
</tr>
<tr>
<td>YR 2007</td>
<td>2 199</td>
<td>10.1</td>
<td>6 576</td>
<td>10.4</td>
</tr>
</tbody>
</table>
## Appendix C

<table>
<thead>
<tr>
<th>SPECIFIC TYPE</th>
<th>ONSET</th>
<th>SERVICE</th>
<th>PATHOGEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probable UVC</td>
<td>1/29/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UAC</td>
<td>2/27/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>4/3/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>4/17/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>5/14/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UAC</td>
<td>5/25/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>5/25/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>6/23/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>6/25/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>7/17/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>UAC Line</td>
<td>7/18/2007</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>#########</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable STCVC</td>
<td>#########</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS AUREUS</td>
</tr>
<tr>
<td>UVC Line</td>
<td>#########</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS AUREUS</td>
</tr>
<tr>
<td>UVC Line</td>
<td>1/10/2008</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>2/8/2008</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>2/10/2008</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS AUREUS</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>3/5/2008</td>
<td>Neonatal ICU</td>
<td>ENTEROCOCCUS sp</td>
</tr>
<tr>
<td>Short-term CVC line</td>
<td>5/14/2008</td>
<td>Neonatal ICU</td>
<td>ENTEROCOCCUS sp</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>8/15/2008</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS AUREUS</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>8/22/2008</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS AUREUS</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>#########</td>
<td>Neonatal ICU</td>
<td>ENTEROCOCCUS sp</td>
</tr>
<tr>
<td>Probable UAC</td>
<td>2/19/2009</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>3/13/2009</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>3/14/2009</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>UVC Line</td>
<td>4/18/2009</td>
<td>Neonatal ICU</td>
<td>ENTEROCOCCUS sp</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>4/20/2009</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>4/27/2009</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS AUREUS</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>4/28/2009</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS AUREUS</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>7/2/2009</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable UVC</td>
<td>8/27/2009</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCCUS, COAGULASE NEGATIVE</td>
</tr>
<tr>
<td>Probable LTCVC</td>
<td>Neonatal ICU</td>
<td>ENTEROBACTER AEROGENES</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td>Probable STCVC</td>
<td>Neonatal ICU</td>
<td>ENTEROCOCCUS sp</td>
<td></td>
</tr>
<tr>
<td>Probable UAC</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS, COAGULASE NEGATIVE</td>
<td></td>
</tr>
<tr>
<td>Probable UVC</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS, COAGULASE NEGATIVE</td>
<td></td>
</tr>
<tr>
<td>UVC Line</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS, COAGULASE NEGATIVE</td>
<td></td>
</tr>
<tr>
<td>UAC Line</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS, COAGULASE NEGATIVE</td>
<td></td>
</tr>
<tr>
<td>Probable UAC</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS, COAGULASE NEGATIVE</td>
<td></td>
</tr>
<tr>
<td>Probable UAC</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS, COAGULASE NEGATIVE</td>
<td></td>
</tr>
<tr>
<td>Probable PICC</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS, COAGULASE NEGATIVE</td>
<td></td>
</tr>
<tr>
<td>Probable UVC</td>
<td>Neonatal ICU</td>
<td>ESCHERICHIA COLI</td>
<td></td>
</tr>
<tr>
<td>UVC Line</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS, COAGULASE NEGATIVE</td>
<td></td>
</tr>
<tr>
<td>Probable STCVC</td>
<td>Neonatal ICU</td>
<td>ENTEROCOCCUS sp</td>
<td></td>
</tr>
<tr>
<td>Probable PICC</td>
<td>Neonatal ICU</td>
<td>MRSA (5417001442)</td>
<td></td>
</tr>
<tr>
<td>Probable UVC</td>
<td>Neonatal ICU</td>
<td>STAPHYLOCOCCUS COAGULASE-NEGATIVE</td>
<td></td>
</tr>
</tbody>
</table>
References


doi:10.1097/QCO.0b013e3283297b68


doi:10.1213/ANE.0b013e3181e7ce18

doi:10.1016/j.ajic.2009.08.015


A COMPARISON OF THE RATE OF CLABSI  37

pediatric intensive care unit. *Infection Control and Hospital Epidemiology* **32**(12), 1200-1208. doi:10.1086/662621


