Paediatrica Indonesiana

VOLUME 51 November • 2011 NUMBER 6

Original Article

Skin antiseptic choice to reduce catheter-related bloodstream infections

Lily Rundjan

Abstract

Background The use of vascular access devices (VADs) may put patients at risk for bloodstream infections. Despite infection control prevention methods used in our neonatal unit, mean catheter-related blood stream infection (CRBSI) rates are quite high. One contributing factor for these high infection rates may be the skin antiseptic preparation procedure undertaken prior to intravenous line insertion.

Objectives We aimed to reduce CRBSI rates by changing to octenidine hydrochloride antiseptic solutions for skin preparation in the neonatal unit at Cipto Mangunkusumo Hospital.

Methods Antiseptics for skin preparation were changed from povidone-iodine or alcohol to octenidine hydrochloride from September to November 2010. Bloodstream infection rates and hand hygiene compliance were recorded and compared before and during the study.

Results The mean CRBSI rate in the neonatal unit before changing the skin antiseptic solution (January – August 2010) was 11.68‰ (‰ means per 1000 patient-days). During the study, CRBSI rates decreased significantly to 1.1‰ in the first month, increased to 8.7‰ in the second month, and decreased to 2.4‰ in the third month. Hand hygiene compliance for 1 moment (before aseptic task) fluctuated, reaching 93.8% and 100% before and during the study, respectively. Compliance for the remaining 4 moments of hand hygiene as defined by the World Health Organization (WHO), ranged from 33.0 – 87.3% before the study and 8.0 – 100.0% during the study. The most striking decrease in these 4 moments of hand hygiene compliance in the second month was accompanied by a marked increase in CRBSI rate.

Conclusions Reduced CRBSI rates cannot be attained by solely changing antiseptic solutions for skin preparation. Maintaining other prevention strategies, such as adhering to the 5 moments of hand hygiene recommended by WHO is also very important. **[Paediatr Indones. 2011;51:345-50]**.

Keywords*: catheter-related bloodstream infection, skin antiseptic, octenidine*

Newborn infants in neonatal intensive care units (NICU) have intrinsic factors that predispose them to infections, such as immature immune systems and compromised skin or mucous membranes. In addition, multiple extrinsic factors contribute to infection, such as the presence of indwelling catheters, invasive procedures and administration of certain medications including steroids and antimicrobial agents.[1]

Catheter-related blood stream infection is associated with the presence of a peripheral or central line within the 48-hour period before a BSI develops.[2,3] Mean BSI rate in the neonatal unit at Cipto Mangunkusumo Hospital in 2009 was 47.22‰, while that from January – August 2010 was 11.68‰.

We identified one of the contributing factors to high BSI rates to be ineffective skin antiseptic procedures prior to intravenous line insertion. Improved skin preparation is one of the strategies for CRBSI prevention, along with health-care worker education and training, hand hygiene, as well as aseptic techniques during catheter insertion and care,

From the Department of Child Health, Medical School, University of Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia.

Reprint requests to: Lily Rundjan, Division of Neonatology, Medical School, Department of Child Health, University of Indonesia, Cipto Mangunkusumo Hospital, Jl. Diponegoro No. 71, Jakarta 10430, Indonesia. Tel +62-21-392 8660. E-mail: *lily_kartono69@yahoo.uk*

catheter-site dressing regimens and replacement of administration sets and catheters.[4,3]

Chlorhexidine is a standard antiseptic for skin preparation for the insertion of both central and peripheral venous catheters. The use of chlorhexidine has been shown to lower CRBSI rates compared to povidone-iodine or alcohol.[4] Unfortunately, chlorhexidine is not available in Indonesia. However, a new antiseptic, octenidine hydrochloride, is offered in Indonesia. Octenidine has proven to be highly effective against a wide range of microorganisms and displays low absorption and toxicity. The antimicrobial effect of octenidine was reported equal or superior to chlorhexidine at lower concentrations (0.1% vs 0.25%, respectively), though at higher concentration chlorhexidine may cause skin reactions. [5,6]

The aim of this study was to determine if the use of a new skin antiseptic, octenidine, would reduce BSI rates in the neonatal unit of Cipto Mangunkusumo Hospital.

Methods

We conducted a quasi-experimental study from September to November 2010. Skin antiseptics for preparation of VAD insertion were changed to 0.1% octenidine hydrochloride, 30% 1-propanol, and 45% 2-propanol (Octenisept®). Skin reactions in newborns less than 28 weeks of gestational age were recorded. Other infection control prevention policies remained unchanged.

This randomized, single-blind clinical trial was conducted in the Neonatal Unit, Cipto Mangunkusumo Hospital (CMH), Jakarta, Indonesia. Newborn infants aged less than 28 days regardless of gestational age and requiring peripheral intravenous catheter insertion were recruited in the study. Sample size calculation was estimated to be 30 subjects for each group.

Subjects were randomly assigned to groups. Skin swabs were taken before the application of antiseptic, after the antiseptic had dried, and 5 minutes after contact by the same person, with the help of nurses in charge. Samples of swabbed skin were numbered and sent to the Laboratory. Lab technicians were blinded to the identity of the swabs. Patients' data was held by the research assistant.

Cipto Mangunkusumo Hospital (CMH) is a centre of education, neonatal care and research for the country of Indonesia, training 120 nurses, 144 residents, and 25 fellows annually. Trainees typically receive 2 weeks of lectures, demonstrations, and hands-on opportunities under direct and indirect supervision (topics include neonatal procedures and infection control prevention).

The Infection Control Committee performs monthly surveillance with the help of the Infection Control Link Nurse (ICLN) to collect data. However, there are financial constraints to what can be done to investigate infections in CMH. We can obtain cultures for solutions, environmental surfaces, hands of healthcare workers and water used. However, DNA fingerprinting is not an option for identifying the exact source of infections.

Hand hygiene practice has been performed by all medical staff since 2007. New nurses, medical students, residents and fellows who enter the unit are trained in proper hand hygiene, using a handwashing solution with 2% chlorhexidine (Primasept®) and an alcohol-based hand sanitizer solution, recommended by WHO and produced by our hospital (95% ethanol, 3% H_2O_2 mixed with glycerin and Aquadest). The WHO prescribes the 5 moments for hand hygiene to be practiced at the following times: (1) before patient contact, (2) before an aseptic task, (3) after body fluid exposure risk and after removal of gloves, (4) after patient contact, and (5) after contact with patient surroundings.[6] Proper hand hygiene technique is a 7-step handwashing technique for 40-60 seconds, followed by using hand sanitizer solution for 20-30 seconds.

Hand hygiene audits have been done sporadically in the unit by the Infection Control Nurse (ICN), as the number of ICNs in our hospital is only 2 for 1000 beds. The audit has only been performed every 3-6 months. The results were reported to all medical staff and displayed in the units, in order to improve compliance. Based on the last policy of Infection Control Committee, ICLNs in each unit were designated to perform audits and have been doing so monthly since August 2010. The ICLN is aided by the personal assistants (general practitioner) of neonatalogists. When infection rates increase and/or hand hygiene compliance decreases, all medical staff are reeducated on the importance of hand hygiene practice.

Before September 2010, povidone-iodine was used to disinfect newborns' skin prior to central line insertion (e.g., umbilical line, long line), chest drain, or lumbar puncture. Alcohol swab was utilized only for peripheral line insertion. Large-volume bottles of povidone-iodine (250 mL) were utilized for multiple patients. From September to November 2010, octenidine was used to disinfect newborns' skin for all procedures. Octenidine was provided in small-volume bottles (50mL). For skin preparation prior to peripheral intravenous line insertion, octenidine was sprayed directly on the area to be punctured, while for umbilical or central line insertion, octenidine was poured into a sterile container prior to skin application. Blood culture procedures were also done according to standard operating procedures (SOPs) in order to avoid contamination.

Peripheral lines were inserted by trained nurses using sterile gloves, sterile dressing pack, sterile tape and transparent dressings (Tegaderm®). Procedures were done with non-touch technique under aseptic conditions. Signs of phlebitis/extravasation were checked daily. Peripheral lines may be maintained up to 3-5 days if the line looks good and flushes well.

Indications for umbilical lines are stated clearly in our SOP. Removal of umbilical lines are done as soon as possible, with these decisions made by neonatologists. Umbilical lines and peripherally-inserted central catheters (PICC) are inserted by fellows or residents with sterile equipment, maximum sterile barrier precautions, large drapes, and antiseptic technique. Venous cutdown lines and chest drains are performed by fellows of the Surgical Department. Physicians from the Surgical Department are not trained in the neonatal unit, but are required to follow neonatal unit regulations in order to avoid infections, including maximum sterile barrier precautions, large drapes, and antiseptic technique. Although formal audits in central line insertion have not been done, if it is incidentally found that fellows do not comply with maximum sterile barrier precautions, the fellows are informed on the matter and reports sent to the Head of the respective Surgical Department.

Since 2007 a closed-system setup has been practiced for medication and nutrition, but three-way stopcocks are used more frequently than luer-lock systems due to budget constraints. Proper procedure is used to connect administration setups, including utilizing sterile gloves, aseptic technique and alcohol swabs.

Since 2007 all total parenteral nutrition (TPN) and medications has been prepared by accredited pharmacy staff under laminar air flow hoods. However, quality control of solutions has not been done according to regulations due to financial constraints. Cultures of TPN solutions and medications are performed only during outbreaks. Beginning in January 2011, a new policy includes random culturing of TPN solutions and medications every 3 months. Guidelines require replacement of TPN bags along with their administration set every 48 hours, intravenous lipid along with disposable syringes and administration sets daily, heparin saline for arterial lines daily, and blood transfusion sets daily.

Antibiotics of choice in the neonatal unit are amoxycillin clavulonate and gentamicin as first line, piperacillin/tazobactam and amikacin as second line, and meropenem as third line. Other antibiotics used are based on blood culture sensitivity results and discussion with the Clinical Pathology physician (also a member of the Infection Control Committee). Instructions on starting and ceasing antibiotics are given by neonatologists. Prophylactic antibiotics are not given to newborn infants requiring intravenous lines or intubations if they did not have sepsis.

Results

There were no differences in microorganism patterns of BSIs before and during the study. The microorganism patterns from 2010 are shown in Table 1. The most common organisms causing BSI in our unit were *Staphylococcus epidermidis* (22.76%), followed by *Pseudomonas sp* (15.45%), *Klebsiella sp* (15.45%) and *Acinetobacter sp* (14.63%).

BSI rates are expressed as BSI per 1000 patient-days, per mil (‰). The mean BSI rate in our unit before changing the skin antiseptic (January – August 2010) was 11.7‰. During the study, the BSI rates decreased significantly in the first month (September) to 1.1‰, but increased in the second month (October) to 8.7‰. At the end of study in the third month (November), the BSI rate decreased to 2.4‰, as shown in **Figure 1**. During the study only octenidine

Table 1. Microorganism patterns of BSIs in the neonatal unit at Cipto Mangunkusumo Hospital, January – December 2010

Microorganism	Onset of Sepsis	
	Late Onset	%
Staphylococcus epidermidis	28	22.76
Pseudomonas sp	19	15.45
Klebsiella sp	19	15.45
Acinetobacter sp	18	14.63
Candida sp.	11	8.94
Staphylococcus aureus non MRSA	7	5.70
Enterobacter sp.	6	4.87
Serratia sp.	4	3.20
E. coli	3	2.40
Streptococcus sp.	3	2.40
Staphylococcus aureus MRSA	2	1.60
Bacillus sp	2	1.60
Moraxella sp.	1	0.80
TOTAL	123	100

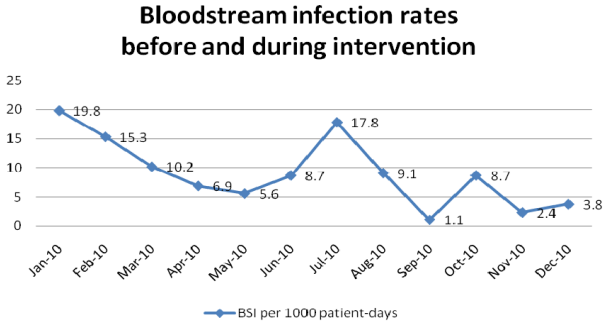

Figure 1. BSI rates before and during intervention

was used as the skin preparation antiseptic, prior to peripheral and central line insertion.

Compliance of doctors and nurses to the 5 moments of hand hygiene was audited before and during the study. As shown in **Table 2,** compliance fluctuated, with only 1 of the moments (before aseptic task) reaching consistently satisfactory levels, 93.8% before the study and 100% during the study. Compliance to the other 4 moments of hand hygiene was low before and during the study.

No skin reaction was observed after octenidine application for all babies, including those less than 28 weeks of gestational age. Total parenteral nutrition and medications were not sent for culture during the study, as previous cultures were performed in March and August 2010 and all solutions were found to be sterile.

Discussion

The skin is the main source of organisms causing bloodstream infections. Infections may occur as a result of migration of microorganisms from the catheter insertion site along the percutaneous tract. This may occur during insertion or afterward, especially if the catheter is manipulated. Organisms may also be introduced into the catheter lumen from the external surface of the catheter or administration tubing at junction sites, especially when they are disconnected, or through cracks in the external portion of the catheter or some component of the administration set. Infection risk may be lowered by maintaining appropriate aseptic technique during catheter insertion, care of the entry site, and catheter manipulation. Intrinsic contamination of parenteral nutrition or other infusion fluids may also occur. However, use of commercially prepared sterile infusion fluids and preparation of parenteral nutrition in the central pharmacy under aseptic conditions has essentially eliminated this source of infection.[7]

Data from two NICUs demonstrated that each neonate or his immediate environment was touched

Table 2. Compliance to the 5 moments of hand hygiene in the neonatal unit, Cipto Mangunkusumo Hospital, August – December 2010

5 moments of hand hygiene	Aug 2010, %	Sep 2010, %	Oct 2010, %	Nov 2010, %	Dec 2010, %
Before patient contact	87.3	44.6	57.0	75.0	73.0
Before aseptic task	93.8	100.0	100.0	100.0	100.0
After patient contact	54.4	21.1	15.3	33.3	48.0
After contact with blood / body fluids	33.0	80.0	58.3	100.0	75.0
After contact with patient surroundings	39.0	33.7	8.0	61.8	46.6

78 times during a 12 hour shift, with more than half of these carried out by nurses. In a recent study of infections in neonates caused by gram-negative bacilli, pathogens were transmitted by hand contact in 42% of the cases.[8] Hand hygiene has been shown to minimize the incidence of hospital-acquired infections. Interrupting the transfer of organisms on the hands can prevent many infections, thus resulting in decreased length of hospital stay, mortality and morbidity rates, and better patient outcomes.[9] Despite this knowledge, compliance for hand hygine may fluctuate, so the importance of hand hygiene audits is essential. After the audit results are announced, medical staff are required to be reminded and retrained. This process should be done continuously to control infection rates. In the neonatal unit, medical staff are trained about hand hygiene, but we are unable to conduct regular hand hygiene audits. Based on our audit results during the study, compliance to the 5 moments hand hygiene were low in the neonatal unit. Medical staff only comply for hand hygiene before performing aseptic tasks, and this is insufficient for infection control and prevention. In the future, monthly hand hygiene audits should be included as part of our strategy to control infection rates in the unit.

In a previous study on the effect of skin disinfection with octenidine, Dettenkofer *et al.* reported that octenidine appeared to be effective in reducing skin microflora at the PICC/central venous catheter (CVC) insertion sites.[5] Furthermore, the antimicrobial effect of octenidine was reported to be equal or superior to chlorhexidine at lower concentration.[5,6] Our study showed that at the first month after changing the skin antiseptic to octenidine, there was a dramatic decrease in BSI, from a mean BSI rate of 11.7‰ to 1.1‰, in spite of decreased compliance in 3 of the moments of hand hygiene. However, the second month BSI rate increased to 8.7‰. Analysis of the hand hygiene audit in September compared to October (1st month of study vs. 2nd month of study) showed that compliance for 3 moments of hand hygiene decreased (after patient contact, after contact with blood/body fluids, and after contact with patient surroundings), while compliance in hand hygiene before patient contact increased and before aseptic tasks stayed the same. At the end of the study, the BSI rate decreased to 2.4‰. Compliance in hand hygiene before patient contact was still 100% and compliance for the other 4 moments of hand hygiene increased. Based on BSI rates and hand hygiene compliance before and during our study, we conclude that changing skin antiseptic alone will not successfully reduce BSI rates. In addition, other factors that may contribute to BSIs have yet to be studied, such as auditing peripheral/central line insertion, care of dressings and line maintenance.

Central VADs carry a significantly greater risk for infection than peripheral intravenous VADs. Therefore, the level of barrier precautions required to prevent infection during central VAD insertion should be more rigorous. Maximum sterile barrier precautions have been shown to reduce the risk of infection by 6 to 7 times over the use of sterile gloves and drapes alone. Maximum sterile barrier precautions during insertion of VADs include using sterile gloves, long-sleeved sterile gowns, masks, caps, as well as large, sterile sheet drapes. For infants, maximum sterile barrier precautions include covering the neonate from head to toe with sterile drapes with a small opening for the site of insertion.[9] In the neonatal unit, central line insertions are not only performed by our trained doctors, but also by doctors from the Surgical Department. Doctors from other disciplines have to be informed and trained in infection control prevention methods, too. Moreover, an audit of central line insertions is required to control CRBSIs.

Surveillance is an essential component of infection control, and is considered a measure of quality of care.[7] In order to optimize our surveillance, we need full funding support from the hospital and more ICNs, as the recommended ratio is 1 ICN : 150 beds.

Some medical conditions in newborn infants predispose them to BSIs, whether they have a catheter in place or not. For example, BSI in infants with major intestinal problems are common because intestinal bacteria can easily access the bloodstream.[2] In our unit, we have large numbers of surgical patients who may be sources of health care-associated infections to other patients. Recently, we provided a room for surgical infants (including level II and level III) to reduce the possibility of microbial transmission to other patients.

Multiple studies have shown a significant reduction of CRBSI when an educational program is initiated.[10] In the neonatal unit, there are many

medical staff from other centres who need training in CRBSI prevention strategies, as well as our own medical staff who need continous reminders and retraining in these strategies. Comprehensive prevention programs have also been shown to dramatically decrease CRBSI rates. One key component is daily evaluation of whether a central line is needed. Central lines should be removed as soon as possible, although there is no benefit to routine replacement of central lines.[10] Knowledge about hub care practice, standardization of line setups are also important to control CRBSI.[9]

A limitation of this study was that octenidine was not available in single-use preparations. Multi-use preparations have a risk of contamination. In some countries, antiseptics are provided in single-use, 2 mL vials.

Data from the National Healthcare Safety Network (NHSN) in 2006 – 2007 revealed that mean rate of central CRBSI ranged from 1 – 3.7 per 1000 catheter days for infants of all birth weights.[1] Before the study, our mean BSI rate was higher than rates in developed countries. After the application of the new antiseptic, BSI rates decreased dramatically, except in the second month in which compliance to the moments of hand hygiene decreased. We hope that by undertaking all strategies to reduce CRBSI in the future, our infection rates will be as low as those in developed countries.

All infection control prevention methods should be performed comprehensively. Solely changing the antiseptic solution for skin preparation, without maintaining other prevention strategies, cannot reduce BSI. Key components of reducing CRBSI should include surveillance, health care education, hand hygiene, maximum sterile barrier precautions, care of peripheral / central lines, skin antiseptic choice, dressing care and daily review of line necessity with prompt removal of unneccessary lines.

Acknowledgments

This study was supported by Schülke & Mayr, Indonesia branch. The author declares no conflict of interest.

Special thanks to Rinawati Rohsiswatmo and Sarah Rafika for their support in this research.

References

1. Coffin SE, Zaoutis TE. Healthcare-associated infections in the nursery. In: Remington JS, Klein JO, Wilson CB, Nizet V, Maldonado Y, editors. Infectious Diseases of the Fetus and Newborn Infant. 7th ed. Singapore: Elsevier; 2011. p. 1126-40.
2. Center for Disease Control. Central line-associated bloodstream infection (CLABSI) event. [cited 2011 May 11]. [about 8 screens]. Available from: http://*www.cdc.gov/nhsn/PDFs/pscmanual/4PSC_CLABScurrent.pdf*
3. O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, et al. Guidelines for the prevention of intravascular catheter-related infections. Pediatrics. 2002;110:e51.
4. O'Grady NP, Alexander M, Burns LA, Dellinger P, Garland J, Heard SO, et al. Guidelines for the prevention of intravascular catheter-related infections, 2011. [cited 2011 May 11]. Available from: http://www.cdc.gov/hicpac/pdf/guidelines/bsi-guidelines-2011.pdf
5. Dettenkofer M, Jonas D, Wiechmann C, Rossner R, Frank U, Zentner J, et al. Effect of skin disinfection with octenidine dihydrochloride on insertion site colonization of intravascular catheters. Infection. 2002;30:282-5.
6. Darmstadt GL, Hossain MM, Choi Y, Shirin M, Mullany LC, Islam M, et al. Safety and effect of chlorhexidine skin cleansing on skin flora of neonates in Bangladesh. Pediatr Infect Dis J. 2007;26:492-5.
7. Moore D, Johnston L, Henderson E, John M, Langley J, Suh K, et al. Central venous catheter-associated blood stream infections in intensive care units and in recipients of haematopoeietic stem cell transplants. [cited 2011 May 11]. Available from: *http://www.phac-aspc.gc.ca/nois-sinp/projects/pdf/vc_protocol_e.pdf*
8. Goede MR, Coopersmith CM. Catheter-related bloodstream infection. Surg Clin N Am. 2009;89:463-74.
9. Heeg P. Nosocomial infections in newborn nurseries and neonatal intensive care units. Int J Infect Control. 2006;2:1.
10. Cooley K, Grady S. Minimizing catheter-related bloodstream infections: one unit's approach. Adv Neonatal Care. 2009;9:209-26.