

Comparison of alcohol, povidone-iodine and octenidine dihydrochloride as skin disinfectants to reduce bacterial count prior to peripheral venous catheter insertions in newborn infants

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Abstract

Background Vascular access may increase the risk of bloodstream infections, especially in newborn infants with weak immune systems and requiring invasive supportive care. Skin disinfection prior to peripheral venous catheter insertion lowers the risk of infection. However, antiseptics chosen for this task should be effective and safe for newborn infants.

Objective To compare the effectiveness of 70% alcohol (BD alcohol swabs ®), 10% povidone-iodine (Pharma-RSUPNCM), and octenidine (Octenisept ®) as antiseptics for reducing skin bacteria for pre-invasive procedures in neonates.

Methods Infants aged less than 28 days, regardless of gestational age, at the Neonatal Unit of Cipto Mangunkusumo Hospital (RSUPNCM) were included in our study. Infants were divided into three groups, each tested with different skin antiseptics (alcohol, povidone-iodine or octenidine). Skin swabs were performed before and after application of skin antiseptic, followed by inoculation onto blood agar plates. Colony-forming units were counted after 18 hours of incubation at 37°C.

Results Ninety subjects were divided into 3 groups of 30, each group using either 70% alcohol swabs, 10% povidone-iodine, or octenidine as skin antiseptic. Skin swabs were taken before and after antiseptic application and drying, as well as 5 minutes after application. The mean reductions in CFU/cm² (%) after antiseptic application (and fully dried) were 97.54% for povidone-iodine, 97.52% for octenidine, and 89.07% for alcohol. There were no significant differences in mean CFU reductions among the three antiseptics groups (P=0.299). Furthermore, 5 minutes after application, there were still no significant differences in the three antiseptic groups (P=0.289).

Conclusions Although octenidine showed a significant bacterial count reduction after application, it was not significantly different from those of alcohol or povidone-iodine. [Paediatr Indones. 2011;51:277-81].

Keywords: octenidine, 70% alcohol, 10% povidone-iodine, reduction bacterial count, newborns

Hospitalized newborns are at risk of infection due to weak immune defenses and invasive supportive care, including intravascular catheters and respiratory therapy.¹ Vascular access devices (VADs) are among the most common interventions contributing to hospital-acquired infections. Increased demand for

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vascular access and increased incidence of catheter-related bloodstream infections (CRBSIs) resulting in prolonged hospitalization and additional therapies has been documented.² Skin preparation is one important strategy for prevention of CRBSI, along with health care worker education and training, hand hygiene, use of aseptic techniques during catheter insertion and care, and catheter-site dressing regimens. Chlorhexidine is a standard antiseptic to the prepare skin for insertion of either central or peripheral venous catheters, as its use has been shown to lower rates of CRBSI compared to povidone-iodine or alcohol antiseptics.³

The skin may absorb the applied chemicals, as cleansing agents containing iodine have been shown to cause transient hypothyroidism, while prolonged contact with alcohol-based products may cause second- or third-degree skin burns on pre-term infants.⁴ Side effects of chlorhexidine have also been reported, including contact dermatitis, photosensitivity, toxicity in certain cases, and in rare cases, hypersensitivity reactions.⁵

Few formal protocols exist for aseptic skin preparation in infants. Swabs moistened in antiseptic solution are generally used for skin disinfection before venipuncture or intravascular catheter placement. In a busy neonatal intensive care situation, where multiple sites of puncture may be required, in most cases skin disinfection is performed by way of a brief wipe with these swabs. However, Malathi *et al.* reported high bacterial colony counts on the skin around intravenous sites, despite prior cleansing.⁶ The Centers for Disease Control and Prevention (CDC) 2011 guidelines recommend allowing antiseptics to dry according to each manufacturers' recommendations prior to placing the catheter (Category IB).³ There have been no recommendations for duration of skin exposure to the antiseptic or optimal method of cleansing.⁶

Commercially available products containing chlorhexidine are not available in Indonesia. At present, octenidine is offered as an alternative skin antiseptic in Indonesia. An investigation by Bühner *et al.* reported 0.1% octenidine and 2-phenoxyethanol to be safe for use on the skin of preterm infants < 27 weeks' gestation.⁷

We aimed to compare the reduction in the number of bacteria after the use of octenidine

(Octenisept®), 70% alcohol swab (BD alcohol swabs®), or 10% povidone-iodine (Pharma-RSUPNCM) in disinfecting the skin prior to peripheral venous catheter insertion in neonates.

Methods

This clinical study was performed to compare the reduction in the number of bacteria after application of 70% alcohol swab (BD alcohol swabs®), 10% povidone-iodine (Pharmacy of Cipto Mangunkusumo Hospital), or octenidine (Octenisept®) as an antiseptic prior to peripheral venous catheter insertion in newborn infants in the Neonatal Unit of Cipto Mangunkusumo Hospital, Jakarta, Indonesia.

We included infants aged less than 28 days (newborns), regardless of gestational age, who required intravenous catheter insertion. Skin swabs were taken before antiseptic application, after antiseptic application and drying, as well as 5 minutes after antiseptic application.

One of the skin antiseptics was rubbed on a predetermined area (3 cm²) using a no-touch technique with sterile tweezers, in a circular direction from the inside out for 10 seconds, followed by waiting for the skin to dry, according to each manufacturers' recommendations (30 seconds for alcohol swab, 1 minute for povidone-iodine and 2 minutes for octenidine).

Skin swabs were taken before and after the application of antiseptics. A sterile swab moistened with nutrient broth was rubbed on infants' skin, an area of approximately 3 cm² marked with a circular cut of Fixomull® (a transparent adhesive). The swab was placed in nutrient broth (in duplicate), mixed vigorously, then discarded. Broth samples were taken to the laboratory where they were used to inoculate blood agar plates (in duplicate). Skin swabs were also taken after a contact time of 5 minutes, by holding the infant's arm for 5 minutes without touching the swabbed area. These skin swabs were taken in the same area and in the same manner as above.

Colony forming units (CFUs) were counted after incubation of agar plates at 37°C for 18 hours. Data was analyzed by SPSS 15 with descriptive and analytical statistics. Significance level was considered to be P < 0.05.

Results

Ninety subjects were divided into three groups of 30 infants each. Each group received a different skin antiseptic, either alcohol, povidone-iodine, or octenidine. Distributions of gender and birth weights were similar across the three groups, as shown in **Table 1**.

Before antiseptic application, we found a significantly higher bacterial count in the octenidine and povidone-iodine groups, with medians of 2,750 CFU/cm² (range 100-500,000), than that of the 70% alcohol group, at 700 CFU/cm² (range 100-

27,000). After the skin antiseptics had dried, we found that skin bacteria decreased to median 0 CFU/cm² (0-10,000) (P=0.016) in the octenidine group, median 0 CFU/cm² (0-200) (P=0.001) in the povidone-iodine group and median 0 CFU/cm² (0-1000) (P = 0.004) in the alcohol group. Furthermore, there were no significant differences between after the antiseptics had dried and 5 minutes following antiseptic application. (**Table 2**)

Mean reductions in CFU/cm² (%) after povidone-iodine and octenidine applications had dried were 97.54% and 97.52%, respectively, while that of the alcohol group was 89.07%, a statistically insignificant

Table 1. Baseline characteristics of subjects

Characteristic	Alcohol swab group n=30	Povidone-iodine group n=30	Octenidine group n=30	P
Gender, n (%)				
Male	14 (46.7)	15 (50.0)	15 (50.0)	1*
Female	16 (53.3)	15 (50.0)	15 (50.0)	
Birth weight, n (%)				
<1000 g	1 (3.3)	1 (3.3)	1 (3.3)	0.999 [^]
1000-1499 g	12 (40.0)	9 (30.0)	10 (33.3)	
1500-1999 g	9 (30.0)	7 (23.3)	7 (23.3)	
2000-2499 g	2 (6.7)	3 (10.0)	3 (10.0)	
>2500 g	6 (20.0)	10 (33.3)	9 (30.0)	

[^]Kolmogorov-Smirnov test, *Kruskal-Wallis test

Table 2. Comparison in reduction of skin bacterial counts across antiseptic groups based on time periods of application

Groups	Time	Median (range) CFU/cm ²	P [†]
Alcohol	Before	700 (100-27,000)	0.004
	30 seconds	0 (0-1000)	
	30 seconds	0 (0-1000)	
Povidone iodine	5 minutes	0 (0-400)	0.415
	Before	2750 (100-500,000)	
	2 minutes	0 (0-10,000)	0.001
	2 minutes	0 (0-10,000)	
	5 minutes	0 (0-10,000)	
Octenidine	Before	2750 (100-50,000)	0.016
	1 minute	0 (0-200)	
	1 minute	0 (0-200)	0.888
	5 minutes	0 (0-700)	

[†]Wilcoxon test

Table 3. Mean reduction of CFU/cm² and sterilization rate of antiseptics

	Alcohol	Povidone-iodine	Octenidine	P [‡]
Mean reduction, CFU/cm ² , %				
After application was dry	89.07	97.54	97.52	0.299
After contact time of 5 min	88.72	98.71	98.68	0.289
Sterilization rate, %				
After application was dry	63.33	83.33	70.00	0.264
After contact time of 5 min	70.00	86.67	70.00	0.210

[‡]Friedman test

difference ($P=0.299$). In addition, after a contact time of 5 minutes, there were no significant differences in mean reduction of CFU/cm² across the three antiseptic groups ($P=0.289$). Sterilization rates were alcohol 63.33%, octenidine 70% and povidone-iodine 83.33%, with no significant differences among the groups after the antiseptics had dried ($P=0.264$) and 5 minutes after application ($P=0.210$). (Table 3)

Discussion

Proper skin disinfection prior to venous catheter insertion is an important prevention strategy for CRBSIs.⁸ Ideally, skin disinfection should achieve total elimination of microflora from the cleansed site. Otherwise, there is a risk for direct inoculation of bacteria during cannula insertion, and for contamination of venipuncture or cannula insertion sites if large numbers of bacteria persist after skin cleansing. Skin antiseptics used in most neonatal intensive care units include chlorhexidine, isopropyl alcohol, povidone-iodine, or a combination of these agents. Octenidine hydrochloride is commercially available in Europe, but has not yet been studied widely.⁶

We found the mean CFU reductions after application of the antiseptics and subsequent drying were as follows: alcohol 89.07%, povidone-iodine 97.54% and octenidine 97.52%. The duration of antiseptic exposure used in this study was 10 seconds. In some conditions, it was difficult to obtain peripheral intravenous access. As such, we also evaluated skin swabs taken 5 minutes following antiseptic application (without reapplication) to further assess antiseptic efficacy. Malathi *et al.* showed that the use of a single chlorhexidine/alcohol swab reduced bacterial counts, but effectiveness depended on the duration of exposure. A long duration of cleansing (30 seconds) produced 96.0 - 99.7% reductions in CFUs and was more effective than 5 or 10 second cleansings, which resulted in 93 - 96% CFU reduction. The use of two consecutive 10 second chlorhexidine/alcohol swabs was reported to result in a 99.6% reduction in mean CFUs, a significant improvement compared to the use of a single 10 second swab ($P=0.01$). In addition, they observed that 10 seconds of povidone-iodine application reduced CFUs by 98.3%, not significantly

different from chlorhexidine/alcohol.⁶ Our study showed similar results, as the application of alcohol, povidone-iodine or octenidine for 10 seconds did not totally eliminate bacteria from skin. Further study is needed to determine the appropriate duration of antiseptic exposure and number of swabbings required for maximum bacterial reduction.

Malathi *et al.* reported the sterilization rate of chlorhexidine/alcohol to be 33% following a 10-second application and 92% following a 30-second application, while povidone-iodine resulted in an 82% decrease following a 10-second application. We observed a higher sterilization rate for octenidine (70.00%) and povidone-iodine (86.67%). Nonetheless, there was no significant difference in our povidone-iodine and octenidine sterilization rates.

Koburger *et al.* reported on the most efficacious antiseptics in an in-vitro study. When an immediate effect is required (after 1 minute), prioritization of the agent of choice should be octenidine = povidone-iodine >> polyhexanide > chlorhexidine > triclosan. If a prolonged contact time is required (as for wound antiseptics and treatment for mucosal infections), agent prioritization should be polyhexanide = octenidine > chlorhexidine > triclosan > povidone-iodine.⁹

Another study showed that octenidine/propanol was more effective than alcohol (ethanol/propanol) alone in reducing skin microflora at peripherally inserted central catheter (PICC)/central venous catheter (CVC) insertion sites over a 24-hour period.⁸

There have been few studies comparing the efficacies of octenidine to other skin antiseptics. Chlorhexidine is highly active against gram-positive organisms and has a relatively long duration of antibacterial activity. Isopropyl alcohol has the advantage of rapid onset of action, although it may be absorbed through neonatal skin. Iodine preparations are as effective as chlorhexidine and demonstrate good sporicidal effect.⁶ Compared to other antiseptics, octenidine is highly effective against a wide range of microorganisms and displays low absorption and toxicity. The antimicrobial effect of octenidine was reported to be equal or superior to chlorhexidine at lower concentration (0.1% vs 0.25%, respectively),

while at higher concentration, chlorhexidine may cause skin reactions.^{8,10}

We found that the mean reduction in CFU between octenidine and povidone-iodine was similar, though povidone-iodine showed a higher sterilization rate than that of octenidine. However, these rates were not significantly different. Compared to the other two antiseptics, alcohol consistently showed lower mean reduction in CFU and sterilization rate, after the application was dry, as well as after 5 minutes following application.

A limitation of our study was not comparing the efficacy of octenidine to that of chlorhexidine.

Based on our results and other trials, octenidine may be used as an antiseptic of choice before peripheral intravenous line insertion in newborn infants. However, the required application time for a 100% sterilization effect needs further study. In conclusion, we demonstrated that a brief exposure (10 seconds) to skin antiseptics may be insufficient for total elimination of skin bacteria. The use of octenidine resulted in a significant bacterial count reduction. However, compared to alcohol and povidone-iodine, there were no significant differences in bacterial count reduction after allowing all antiseptics to dry. There were also no significant reductions in bacterial counts 5 minutes after antiseptic application. Povidone-iodine appeared to be superior in sterilization rate compared to alcohol and octenidine, although it was statistically insignificant. Nonetheless, in clinical practice, the choice of antiseptic for skin preparation in newborn infants should be based on availability, side effects, effectiveness and price.

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