Alcohol-Based Chlorhexidine vs. Povidone Iodine in Reducing Skin Colonization Prior to Regional Anesthesia Procedures

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Background: *Povidone-iodine is a commonly used antiseptic for preparing the skin for regional anesthesia. However, chlorhexidine solution has been demonstrated superior for skin preparation before insertion of intravascular devices, taking of blood cultures and before epidural insertion in children. The information regarding the initial efficacy of these disinfectants has not yet been defined. The purpose of the present study was to investigate the initial efficacy of an alcohol-based chlorhexidine and povidone iodine solution as the antiseptic of choice for all regional techniques.*
Material and Method: *One hundred patients requesting regional anesthesia were randomly assigned to receive skin preparation with either single-use povidone iodine or alcohol-based chlorhexidine solution. Two quantitative skin cultures were obtained from the insertion site: one obtained just prior to skin disinfection and the other immediately following antisepsis after allowing it to air-dry.*
Results: *Complete data were available for 98 patients. Bacteriological examination revealed mainly coagulase negative Staphylococci (78.6%; 77/98). The proportion of subjects with a positive skin culture immediately after skin disinfection differed significantly between the povidone iodine and alcohol-based chlorhexidine groups (35% vs. 10%, respectively; p = 0.003). The incidence of positive skin culture was lower in the chlorhexidine group, with an absolute risk reduction (ARR) of 0.25, a relative risk reduction (RRR) of 71% and a number need to treat (NNT) of 4.*
Conclusion: *For skin disinfection prior to the neuraxial blockade procedure, the use of alcohol-based chlorhexidine compared with the use of povidone iodine lowered the incidence of insertion-site-colonization.*

Keywords: *Antiseptic, Anesthesia, Povidone iodine, Chlorhexidine*

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The complication of infection, *i.e.,* meningitis, transverse myelitis and epidural abscess, may occur following regional anesthesia technique. The consequences of these complications may be potentially devastating sequelae, including paralysis and even death. A recent systemic review found 179 reported cases of postdural puncture meningitis[1]. Evidence suggests that 23% of the infections were caused by organisms considered common skin flora, thus the transmigration of skin bacteria through a needle track is the main point of entry of microorganism[2,3]. Some national societies of regional anesthesia have issued guidelines addressing the prevention of infection following neuraxial technique but there is great variation in aseptic practices among anesthesiologists[4-6]. Controversy also exists regarding the most appropriate and safe antiseptic to use for skin preparation before neuraxial procedures. Some of the more commonly used solutions include povidone iodine, chlorhexidine gluconate with or without alcohol, iodophor preparation in alcohol and alcohol alone. In many countries (including Thailand), povidone iodine remains a frequently used and widely available skin antiseptic solution. Povidone iodine is a germicidal compound that has good activity against most gram-negative and gram-positive microorganisms. Its bactericidal effect relies on the continuous release of iodine, which penetrates cell walls and alters or discontinuous protein synthesis[7]. This mechanism of action requires several minutes to achieve maximal

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effect. In addition, colonization with bacteria occurs in previously opened, multi-use bottles of povidone iodine and results in poorer performance[8]. Chlorhexidine gluconate is an antiseptic solution gaining in popularity. It is a potent broad-spectrum germicide effective against nearly all nosocomial yeasts and bacteria (grampositive and gram-negative)[9-11]. The compound efficiently alters cell wall permeability, immediately precipitating components of the cell membrane and cytoplasma[7]. The addition of alcohol further increases the anti-microbial activity.

Chlorhexidine solution has been demonstrated superior to povidone iodine for skin preparation before insertion of intravascular device[9,10,12], taking of blood cultures[11] and before epidural insertion in children[13]. Unfortunately, these studies have not been provided information regarding skin colonization prior to procedures and the initial efficacy of disinfectants. To gather sufficient information for comparing the use of chlorhexidine and povidone iodine for skin preparation, the authors conducted a clinical trial to investigate the initial efficacy of alcohol-based chlorhexidine and povidone iodine solution as the antiseptic of choice before doing regional techniques.

Material and Method

The present study was approved by the ethics committee of Chaiyaphum Hospital, and informed consent was obtained from all patients. Adult patients (100) with ASA I or II scheduled for elective surgery using a regional anesthesia were enrolled and assigned by computerized randomization to undergo skin decontamination prior to regional technique with either alcohol-based chlorhexidine or povidone iodine. Exclusion criteria were patients with a history of allergy to chlorhexidine or povidone iodine, skin infection at the planned puncture site, fever or pre-existing skin infection and currently using antibiotics. Regional anesthesia was performed in the operative room by the same staff anesthesiologist, using aseptic technique (*i.e.,* wearing a surgical hat, mask, and sterile gloves and using sterile drapes). Swabs moistened with sterile saline were taken of each patient's back at the planned puncture site before skin preparation and sent for culture to determine baseline skin flora. Neither the patient nor the anesthetist was apprised of which disinfectant was to be used. Before regional anesthesia, three consecutive applications of 0.5% chlorhexidine in 70% alcohol (Department of Pharmacy, Chaiyaphum Hospital: prepared with chlorhexidine (Hibitane; OLIC Thailand; Thailand) and 70% alcohol) or 10% povidone iodine (Septyl; Burapha Dispensary; Thailand) was applied to an area approximately 20 cm in diameter covering the lower thoracic, lumbar and upper sacral spinal areas. A new povidone iodine bottle was used for subjects in the povidone iodine group. The antiseptic solution was allowed to air-dry between each of the three applications. Dryness was assessed on appearance alone. A swab culture was taken from the same area immediately following antisepsis of the skin to determine initial efficacy of the disinfectant. The swabs were cultured on blood agar plates incubated at 37°C for 48 h and the number of colonies estimated. Microorganisms were identified using standard techniques. A single microbiologist processed and analyzed the swabs in order to reduce variability in the semi-quantitative count of colony-forming units. The microbiologist was also not apprised of the disinfectant solution used. None of the patients was administered antimicrobials before regional anesthesia procedures.

Data analysis

Since a positive culture after skin preparation with povidone iodine rate is 30%[14], 92 patients was required to confirm a clinically important difference between the two groups with a power of 0.9, at an $\pm$ of 0.05. Categorical variables were compared using the Chi-square or Fisher's exact test, as appropriate. Continuous variables were expressed as mean and standard deviation (SD). A p value < 0.05 was considered to be significant. All analyses were performed using SPSS version 10.0 for Windows (Chicago, IL).

Results

The two study groups were similar with regard to age, height, weight, and ASA physical status (Table 1). Complete data were available for 98 patients. Two in the povidone iodine group had to be excluded due to accidental contamination before culturing. The groups did not statistically differ in the positive skin cultures at the planned puncture site prior to disinfection (Table 2). Bacteriological examination revealed mainly coagulase negative *Staphylococci* (79%; 78). Other species isolated included *Corynebacterium species, Bacillus species*, and *Pseudomonas species.* The proportion of subjects with positive skin cultures immediately after skin disinfection differed significantly between the povidone iodine and alcohol-based chlorhexidine groups (35% vs. 10%, respectively; $p = 0.003$).). The incidence of positive skin culture was lower in the

Table 1. Demographic data

	Povidone iodine (n = 48)	Alcohol-based chlorhexidine (n = 50)
Age (yr)	48 ± 15	46 ± 13
Sex		
Male	30 (63)	30 (60)
Female	18 (37)	20 (40)
Height (cm)	168 + 9	169 + 7
Weight (kg)	64 + 8	66 + 8
ASA physical status		
I	37 (77)	40 (80)
II	11 (23)	10 (20)

Data are expressed as number (%) and mean ± SD

Table 2. Skin culture before and after skin disinfection for povidone iodine and alcohol-based chlorhexidine groups

	Povidone iodine (n = 48)	Alcohol-based chlorhexidine (n = 50)	p-value
Skin culture			
Before disinfection			
Positive culture	38 (79)	39 (78)	0.888
Negative culture	10 (21)	11 (22)	
After disinfection			
Positive culture	17 (35)	5 (10)	0.003*
Negative culture	31 (65)	45 (90)	

Data are expressed as number (%)
* $p < 0.05$

chlorhexidine group, with an absolute risk reduction (ARR) of 0.25, a relative risk reduction (RRR) of 71% and a number of need to treat (NNT) of 4.The majority of cultures after skin disinfection in the two groups yielded growth of the same bacterial species that were present before disinfection. The most common organism isolated remained coagulate negative *Staphylococci*. Neither local nor systemic hypersensitivity reactions were observed with the use of either antiseptic solution. None of the patients showed any evidence of local or central nervous system infection at the 48 h follow-up.

Discussion

Lack of a good skin preparation is a common cause of infection in procedures that disrupt the skin barrier. Despite widespread knowledge of the importance of asepsis before doing a neuraxial block, there is no consensus on the most appropriate and safe antiseptic solution to use for skin preparation. Although the presence of bacteria at the insertion site would be expected to correlate with an increased risk of needle and catheter contamination, the initial efficacy of povidone iodine and alcohol-based chlorhexidine solution for skin disinfection before neuraxial block have not been reported. The present study demonstrates that in the adult population studied, an alcohol-based chlorhexidine used for skin disinfection before regional anesthesia was more effective than povidone iodine solution in reducing skin colonization at the time of insertion. Although there are several studies assessing the efficacy of antiseptics, inter-study comparisons are difficult because of differences in (1) the definition of colonization, (2) the choice of antiseptic solution, (3) the methods of disinfection (*i.e.,* swabs vs. sprays), (4) the best time to take the skin swab culture (*i.e.,* immediately after skin preparation *vs.* before catheter removal), and (5) the site of colonization (*viz.,* the skin, needle or tip of the catheter). There have been few studies comparing the efficacy of alcohol-based chlorhexidine and povidone iodine for use as a skin disinfectant for skin preparation of the back. For example, Kinirons at al[13] demonstrated that use of chlorhexidine solution for skin disinfection before short-term epidural catheter insertion was more effective than povidone iodine in preventing catheter colonization; however, they did not do a skin surface culture before and after skin disinfection to compare the efficacy of the antiseptics. Kasuda et al[15] were unable to demonstrate any benefit of chlorhexidine over povidone iodine in reducing catheter colonization associated with short-term epidural catheter placement. Sato et al[16] showed that bacterial activity of chlorhexidine was significantly more potent than that of povidone iodine solution for skin disinfection. They assessed 69 paired skin specimens that had been excised from the incisional site (laminectomies) after disinfection with povidone iodine and chlorhexidine. The exposure time of skin specimens to disinfectant was 10 min or longer, which explains in part the difference between the authors' methodologies and results. The authors assessed the initial efficacy of an alcohol-based chlorhexidine and povidone iodine solution as the antiseptic used for skin disinfection in routine regional anesthetic practice. The aseptic techniques included skin preparation and the use of

sterile gloves and sterile drapes, which all together unlikely took as much as 10 minutes.

In the present study, pre-disinfected skin culture showed normal bacterial skin flora. The most-common isolate on each patient's skin was coagulase negative *Staphyllococci*. This finding is consistent with previous reports[14,17,18]. Coagulase negative *Staphyllococci* are well recognized as the most common agents of cannula-related infections. The purpose of a skin preparation is to reduce the number of pathogens present on the skin surface. Sato et al [16] Birnbach et al[14] and Yentur et al[19] found that skin disinfection on the back did not decrease the number of bacteria below the level of detection in all cases as microorganisms can persist in lumbar skin after disinfection. The present, results therefore support these findings. By contrast, Debreceni et al[18] found only one patient in 64-after skin disinfection with a $\pm$ -2 propanol and benzalkonium-chloride-containing solution-with detectable bacterial growth and a very low number of colony forming units. Different methods for skin sampling likely affect the results, whereas Sato et al[16] excised the skin to obtain bacterial specimens from the deeper layers of the skin, the authors and Birnbach et al[14] used swabs of the skin[16]. Although many studies have shown that exposure of microorganisms to povidone iodine for $\geq$ 60 seconds reduces the bacterial colony count by $\geq$ 95%[20,21], the present study found that 35% of participants in the povidone iodine group had positive cultures immediately after skin disinfection. These results corroborate those of Sato et al[16] and Birnbach et al [14] who showed the respective contamination rate of the skin surface after disinfection was 32% and 30%. Therefore, povidone iodine may not be the most effective disinfectant for reducing colonization on the skin surface, for the short periods of time typical of regional procedures. Several investigations have compared the antiseptic effect of chlorhexidine and povidone iodine under a variety of experimental conditions[7,9,11,13,14,16,20]. The present study was a randomized trial that compared the initial efficacy of povidone iodine and alcohol-based chlorhexidine for the preparation of the site in advance of regional anesthesia. Based on cultures obtained immediately after the skin disinfection, the alcohol-based chlorhexidine was clearly the better disinfectant. In fact, cultures from the povidone iodine group were more than three times as likely to be contaminated as those from the alcohol-based chlorhexidine group. In conclusion, alcohol-based chlorhexidine, for use in skin antisepsis, is more effective than povidone iodine for reducing skin colonization. The use of alcohol-based chlorhexidine solution might reduce the risk of infection after regional anesthesia.

Potential conflicts of interest

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การลดเชื้อแบคทีเรียที่ผิวหนังด้วยน้ำยาฆ่าเชื้อ alcohol-based chlorhexidine และ povidone iodine ในการทำหัตถการให้ยาระงับความรู้สึกเฉพาะส่วน

บรรจง ครอบบัวบาน, ศิริวรรณ ดิเรกโภค, เสริม ประสาร, มาลิน ถนอมสัตย์, สุจริต คำแก้ว

วัตถุประสงค์: *เพื่อศึกษาประสิทธิภาพของน้ำยาฆ่าเชื้อ alcohol-based chlorhexidine และ povidone iodine ในการทำหัตถการให้ยาระงับความรู้สึกเฉพาะส่วน*

วัสดุและวิธีการ: *เป็นการศึกษาเชิงทดลองแบบสุ่มในผู้ป่วยที่เข้ารับการผ่าตัดและให้ยาระงับความรู้สึกเฉพาะส่วน จำนวน 100 ราย โดยผู้ป่วยทุกรายได้รับการตรวจเพาะเชื้อผิวหนังตำแหน่งที่วางแผนจะแทงเข็ม spinal ก่อนทาน้ำยาฆ่าเชื้อที่ผิวหนังบริเวณแผ่นหลัง จากนั้น สุ่มผู้ป่วยออกเป็น 2 กลุ่ม กลุ่มที่ 1 ใช้น้ำยาฆ่าเชื้อ alcohol-based chlorhexidine ในการทำหัตถการให้ยาระงับความรู้สึกเฉพาะส่วน และกลุ่มที่ 2 ใช้น้ำยาฆ่าเชื้อ povidone iodine ผู้ป่วยทุกรายได้รับการตรวจเพาะเชื้อผิวหนังซ้ำอีกครั้งหลังทาน้ำยาฆ่าเชื้อในทันทีที่น้ำยาฆ่าเชื้อที่ผิวหนังแห้งในตำแหน่งที่วางแผนจะแทงเข็ม spinal จากนั้น วิสัญญีแพทย์ดำเนินการทำหัตถการให้ยาระงับความรู้สึกเฉพาะส่วนตามปกติ*

ผลการศึกษา: *การเก็บรวบรวมข้อมูลสมบูรณ์ในผู้ป่วย 98 ราย ผลการตรวจเพาะเชื้อผิวหนังตำแหน่งที่วางแผนจะแทงเข็ม spinal ก่อนทาน้ำยาฆ่าเชื้อ ผู้ป่วยทุกรายพบเชื้อแบคทีเรียและส่วนใหญ่เป็น coagulase negative Staphylococci (ร้อยละ 78.6) และผลการตรวจเพาะเชื้อผิวหนังตำแหน่งที่วางแผนจะแทงเข็ม spinal หลังทาน้ำยาฆ่าเชื้อพบว่า กลุ่มที่ 2 ซึ่งใช้น้ำยาฆ่าเชื้อ povidone iodine พบเชื้อแบคทีเรีย ร้อยละ 35 ส่วนกลุ่มที่ 1 ซึ่งใช้น้ำยาฆ่าเชื้อ alcohol-based chlorhexidine พบเชื้อแบคทีเรีย ร้อยละ 10 และมีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($p = 0.003$) การใช้น้ำยาฆ่าเชื้อ alcohol-based chlorhexidine สามารถลดเชื้อแบคทีเรียที่ผิวหนังในตำแหน่งที่วางแผนจะแทงเข็ม spinal ด้วย absolute risk reduction (ARR) เท่ากับ 0.25, a relative risk reduction (RRR) เท่ากับร้อยละ 71 และ number need to treat (NNT) เท่ากับ 4*

สรุป: *การลดเชื้อแบคทีเรียที่ผิวหนังในการทำหัตถการให้ยาระงับความรู้สึกเฉพาะส่วน ด้วยการใช้น้ำยาฆ่าเชื้อ alcohol-based chlorhexidine สามารถลดเชื้อแบคทีเรียที่ผิวหนังในตำแหน่งที่วางแผนจะแทงเข็ม spinal ได้มากกว่าการใช้น้ำยาฆ่าเชื้อ povidone iodine*