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The Effectiveness of Pre-operative Bath with 4% Chlorhexidine Gluconate for Prevention of Surgical Site Infection at the Universitas Sumatera Utara Hospital

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Abstract

BACKGROUND: Elective surgery is a type of surgery that can be postponed or planned without endangering the patient's life. Every operation, the slightest, can pose a risk of infection. Surgical site infection (SSI) is still a global problem that can increase morbidity and mortality rates, prolong the time and cost of hospitalization. chlorhexidine gluconate (CHG) 4% is an antiseptic with broad-spectrum antimicrobial ability that can be used as an effort to prevent SSI.

AIM: This study aims to analyze the effectiveness of preoperative antimicrobial baths using 4% CHG in an effort to prevent the incidence of SSI in Universitas Sumatera Utara hospitals.

METHODS: The design used in this study was a quasi-experimental method with a nonequivalent control group posttest only design method. The total sample in this study was 60 respondents according to the inclusion criteria. Bivariate analysis using Chi-square statistical test.

RESULTS: A total of 60 samples that met the research criteria were then divided into the pre-operative bath intervention group with 4% CHG (n = 30) and the control group was not given any treatment (n = 30). In the pre-operative bath intervention group with 4% CHG, there was no incidence of SSI, while in the control group, 5 (n = 8.3%) respondents experienced SSI. Pre-operative bath with 4% CHG was statistically more effective than not given pre-operative bath with 4% CHG in preventing the incidence of SSI (p = 0.02).

CONCLUSION: Pre-operative bath with 4% CHG is effective in preventing SSI because 4% CHG is bactericidal, bacteriostatic, lasts a long time on the skin thereby reducing the number of bacterial colonies 9 times and increasing the skin's ability to be antiseptic for longer.

Introduction

Surgical site infection (SSI) is an infection that occurs at the site or area of the incision due to a surgical procedure that is obtained within 30–90 days after surgery, in open and closed wounds [1]. The overall prevalence of SSI in clean and contaminated elective surgeries is estimated to be 6% [2]. SSI increases mortality, length of stay, and costs of hospitalization. Complications from SSI can increase the cost of treatment from $3000 to $29,000 [3].

In the Global Guidelines for the Prevention of SSI, the use of chlorhexidine gluconate (CHG) can reduce the number of bacterial colonies 9 times and increase the skin's ability to resistant antiseptics for longer (residual effect). CHG is effective against fungi and Gram-positive and Gram-negative bacteria, including methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant Enterococci, *Pseudomonas aeruginosa*, and other multidrug-resistant pathogens [1].

With the incidence of SSI can significantly increase the length of hospital stay, costs, and patient morbidity and mortality. Hence, this can be detrimental to patients, especially related to costs and damage the quality of service in hospitals. SSI occurs due to three main risk factors, namely, the ability of the pathogen to cause infection (virulence), the area around the wound, and the body's ability to fight infection. Signs of SSI such as fever, skin redness, and pain in the area around the surgical incision, the presence of purulent pus that comes out of the incision area during hospitalization [4].

SSI due to surgery can be prevented, one of which is the use of antiseptics before performing surgical procedures. CHG is one of the antiseptic materials that can be used for disinfection of the operating area. CHG is effective against fungi and Gram-positive and Gram-negative bacteria. The mechanism of action of CHG is highly variable and has high concentrations on the skin surface. The CHG cation molecules that bind to the bacterial cell wall and extramicrobial complexes will cause a bactericidal effect. At low concentrations, CHG causes changes in the osmotic balance of bacterial cell walls resulting in leakage of potassium and phosphorus and inhibits bacterial growth. At high concentrations, CHG produces a rapid bactericidal effect which causes the cytoplasmic components of bacterial cells to precipitate and cause cell death [5].

A study that tested the effectiveness of bathing with 2% CHG on the incidence of SSI significantly reduced the incidence of SSIs [6]. Another study found that bathing with 4% CHG before surgery was effective in reducing skin staphylococcus colonization compared to using Povidone-iodine or antiseptic bar soap. Repeated 4% CHG baths were better than single use in reducing skin staphylococcal contamination. Evidenced-based clinical literature in 2010 supports the use of 4% CHG soap before hospital admission as a strategy to reduce postoperative SSI [7]. Bathing with 4% CHG, 3 h before the surgical procedure is expected to be able to reduce the number of microorganism colonies before skin preparation for surgery so as to prevent the incidence of Infection in the Operating Area in the Universitas Sumatera Utara Hospital.

Methods

The design used in this study was a quasi-experimental method with a nonequivalent control group posttest only design method. This research was conducted at the Universitas Sumatra Utara Hospital from May 2020 to January 2021. Ethical clearance permits were obtained from the Research Ethics Commission of the University of North Sumatra (Number: 72/KEP/USU/2020). A total of 60 patients who will undergo surgical procedures with clean and clean contaminated surgery types are divided into control and intervention groups. The inclusion criteria in this study were: (1) Patients with elective surgery plans who were cooperative and willing to be respondents, and (2) elective surgery types of clean surgery, namely, operations performed on areas where there is no inflammation in the pre-operative condition and does not open the respiratory tract, gastrointestinal tract, oropharyngeal tract, and urogenital tract with primary skin closure. (3) Elective surgery types of contaminated clean surgery, namely, operations that open the respiratory tract, gastrointestinal tract, oropharyngeal tract, and urogenital tract but still under controlled conditions (4) operations with intact patient skin, and (5) respondents aged over 18 years. The exclusion criteria were: (1) Operation involving genital organs, (2) surgery involving mucosa, (3) surgery was delayed more than 2 h than scheduled, (4) operation on suspected, probable, confirmed COVID-19 patients, and (5) surgery with the use of implants.

How to conduct research in the control group, namely:

(1) Respondents who have met the criteria for filling out informed consent;

(2) Respondents took a preoperative bath as usual before;

(3) Swab the skin of the area to be incised before aseptic preparation of the skin for surgery to be cultured in the microbiology laboratory with the aim of knowing the number of colonies of microorganisms;

(4) Observation of the surgical incision area for signs of infection in the operating area such as: fever, redness of the skin, pain in the area around the surgical incision, the presence of purulent pus coming out of the incision area during hospitalization at the University Hospital of North Sumatra;

(5) Respondents were monitored for 30 days after surgery to find out the incidence of SSI. 3 days after the operation, the surgical wound was observed while the patient was in the inpatient room, if no signs of infection were found, the patient would return for outpatient treatment with a recommendation to return to the hospital on the 10th day after surgery. When returning to the polyclinic, the surgical wound was treated and observed for signs of infection in the operating area. After the patient returns home, on the 20th and 30th days, the patient is contacted by telephone to find out whether there are signs of infection in the operating area.

How to conduct research in the intervention group, namely:

(1) Respondents who have met the criteria for filling out informed consent;

(2) Respondents took a preoperative bath with 4% CHG, 3 h before the surgical procedure;

(3) Swab the skin of the area to be incised prior to aseptic preparation of the skin for surgery to be cultured in the microbiology laboratory with the aim of knowing the number of colonies of microorganisms;

(4) Observation of the surgical incision area for signs of infection in the operating area such as: Fever, redness of the skin, pain in the area around the surgical incision, the presence of purulent pus coming out of the incision area during hospitalization at the University Hospital of North Sumatra;

(5) Respondents were monitored for 30 days after surgery to find out the incidence of SSI 3 days after the operation, the surgical wound was observed while the patient was in the inpatient room, if no signs of infection were found, the patient would return for outpatient treatment with a recommendation to return to the hospital on the 10th day after surgery. When returning to the polyclinic, the surgical wound

was treated and observed for signs of infection in the operating area. After the patient returns home, on the 20th and 30th days, the patient is contacted by telephone to find out whether there are signs of infection in the operating area.

The results of the study were analyzed using univariate and bivariate statistical tests. The univariate analysis used in this study is a descriptive analysis of the characteristics of the respondents, namely, age, number of colonies of microorganisms, microscopic microorganisms, and types of microorganisms. Bivariate analysis was tested by chi-square test which aims to determine the effectiveness of pre-operative bath with 4% CHG on the prevention of SSI.

Results

Characteristics of respondents from this study include age, number of microorganisms colonies (CFU/Plate), microscopic microorganisms, and types of microorganisms. in the control and intervention groups (n = 60) which is presented in Table 1 below.

Table 1: Distribution of frequency and percentage based on characteristics of respondents (n = 60)

Characteristics	Control (n = 30)		Intervention (n = 30)	
	n	%	n	%
Age				
20–30 years	21	70.0	20	66.7
31–40 years old	8	26.7	9	30.0
41–50 years old	1	3.3	1	3.3
Mean: 1.33 SD: 0.547				
Number of Microorganism Colonies				
0	0	0	13	43.3
<300	2	6.7	9	30.0
>300	28	93.3	8	26.7
Microscopic Microorganisms				
Cocus Gram positif	15	50.0	7	23.3
Basil Gram negatif	15	50.0	9	30.0
No Bacterial Growth	0	0	14	46.7
Types of Microorganisms				
Staphylococcus hominis	6	20.0	0	0
Kocuria kristinae	4	13.3	0	0
Enterobacter aerogenes	2	6.7	0	0
Lactococcus gravieae	1	3.3	0	0
Pseudomonas oleovorans	1	3.3	0	0
Burkholderia cepacia	1	3.3	0	0
Pseudomonas fluorescens	1	3.3	0	0
Granicutela adiacens	0	0	1	3.3
Staphyococcus haemolyticus	1	3.3	1	3.3
Klebsiella pneumoniae	0	0	1	3.3
Micrococcus luteus	0	0	1	3.3
Staphylococcus aureus	0	0	1	3.3
Pseudomonas stutzeri	3	10.0	4	13.3
Sphingomonas paucimobilis	0	0	2	2.6
Acinetobacter baumannii	4	13.3	0	0
Moraxella lacunata	0	0	1	3.3
Serratia marcescens	0	0	1	3.3
Routella ornithinolytica	1	3.3	0	0
Citrobacter sedlakii	1	3.3	0	0
Staphylococcus epidermidis	2	6.7	3	10.0
Escherichia hermannii	1	3.3	0	0
Streptoccocus parasanguinis	1	3.3	0	0
No Bacterial Growth	0	0	14	46.7

Based in Table 1, the characteristics of respondents based on age in the control group are dominated by respondents in the age range of 20–30 years as many as 21 respondents (70.0%) and in the intervention group the age of respondents is 20–30 years as many as 20 respondents (66.7%). The number of colonies of microorganisms in units (CFU/Plate) that dominates in the control group is > 300 CFU/Plate as many as 28 people (93.3%) and in the intervention group the number of colonies of microorganisms is 0 CFU/Plate as many as 13 people (43.3 %).

Based on microscopic examination of microorganisms in the control group, there were 15 Gram-positive cocci (50.0%) and 15 Gram-negative bacilli (50.0%). Meanwhile, in the intervention group, the microscopic examination was dominated by the results of No Bacterial Growth as many as 14 people (46.7%). Judging from the type of microorganism in the control group, namely, *Staphylococcus hominis*, there were six people (20.0%) and the intervention group was dominated by the results of No Bacterial Growth as many as 14 people (46.7%).

The results of this study indicate that the application of a pre-operative bath with 4% CHG is effective in preventing SSI after being statistically tested using Chi-square ($p < 0.05$) between the control group and the intervention group ($p = 0.02$) on the incidence of SSI.

Discussion

The results of this study showed that bathing with 4% CHG 3 h before surgery was proven to be effective in preventing bacterial colonization as much as 43.3%, there was no bacterial growth found in the surgical incision area, as much as 30% was proven to reduce the bacterial colonization rate < 300 CFU/plate and only 26.7% bacterial colony growth > 300 CFU/plate. When compared with bathing without 4% CHG (control group), there was 93.3% bacterial colony growth > 300 CFU/plate, only 6.7% the number of bacterial colonies < 300 CFU/plate. All samples in the control group found bacterial growth. A larger sample population is required for representative results. This study did not measure confounding factors (length of bath, duration of surgery, prophylaxis, and type of wound care), but bathing with 4% CHG recommended to respondents was carried out for 2 min.

Pre-operative bathing with 4% CHG can reduce SSI and the acquisition of harmful and resistant organisms present in the hospital [8]. The effect of 4% CHG pre-operative bath has an impact on reducing the incidence of SSI and the growth of microorganisms. The incidence of SSI can increase the length of hospitalization, the cost of care, and in some cases it can increase the risk of death in the hospital [9]. One of the most common occurrences of infection is SSI [10].

Table 2: Effectiveness of Pre-operative Bath with 4% Chlorhexidine Gluconate on Prevention of Surgical Site Infection (n = 60)

Variable	Intervention		Control		pValue
	n	%	n	%	
SSI Incident					
Yes	0	0	5	8.3	0.02
No	30	50	25	41.7	

Studies comparing preoperative baths using 4% CHG with placebo baths or soap solutions have been conducted and recommended 4% CHG baths as a measure to prevent SSI [11]. Pre-operative measures for patients undergoing cardiac surgery using 4% CHG antiseptic bath soap once a day for 5 days have been shown to reduce the incidence of superficial incisional SSI and can reduce pathogens, although not in the type of deep incision or organ incision [12]. Pre-operative baths with 4% CHG reduce the spread of Healthcare Associated Infections (HAIs), namely, Carbapenem Resistant Acinetobacter Baumannii has also been shown to be a significant decrease in suppressing the growth of pathogens [13].

Interestingly, as shown in Table 2, no SSI was found in the intervention group (CHG 4%), proven to have a significant effect ($p < 0.05$) between the control group and the intervention group ($p = 0.02$), with the incidence of SSI in the control group being as much as 5 (8.3%). The risk of SSI is higher in developing countries than in developed countries. A study in Ethiopia showed that more than 20% of all healthcare-associated infections in surgical patients were associated with SSI [14]. A study conducted in China reported that the incidence of SSI has decreased significantly in recent years below 10% [15]. Meanwhile, in developing countries such as Indonesia itself, the prevalence of SSI incidence from studies conducted in several hospitals is still relatively high above 13% [16].

Pre-operative bathing with 4% CHG in patients can reduce the prevalence of harmful microorganisms including antimicrobial resistant pathogens or multidrug-resistant organisms [17]. Surgery area infections caused by microorganisms have increased in prevalence so that one strategy to suppress the growth of pathogens that is considered effective is a pre-operative bath with 4% CHG which is considered to be able to prevent and control HAIs in hospital [18].

The incidence of SSI depends on the surgical procedure performed. From the results of a survey of 60 respondents at the Universitas Sumatera Utara Hospital for 30 days postoperatively, it was found that the incidence of SSI did not occur in the intervention group who was given a preoperative bath with 4% CHG, but was 8.3% in the control group who was not given any treatment. The results of this study proved that pre-operative bath with 4% CHG was able to prevent the occurrence of SSI at the Universitas Sumatera Utara Hospital ($p = 0.02$).

The growth of bacterial colonies on blood agar solid medium was marked by the appearance of colonies on the strings. Visual observations were made using a colony counter at the Microbiology Laboratory of the USU Hospital. The selection of blood agar as a growth medium, because generally all bacteria can grow on this medium as a primary culture. The growing colonies were followed by microscopic observations to classify bacteria (Gram-positive or Gram-negative), which were then identified using an automatic bacterial identification machine. Figure 1 shows the growth of bacterial colonies in each group.

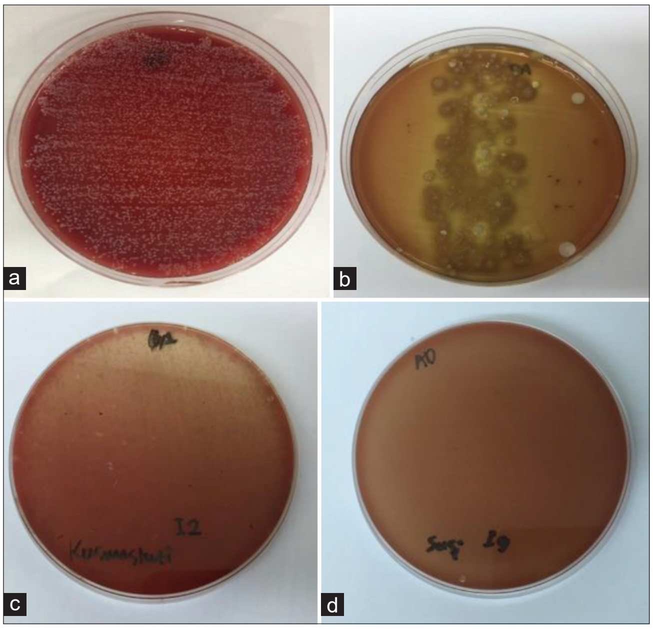

Figure 1: Overview of bacterial colony growth on blood agar medium (a and b) Control group with > 300 CFU/plate and < 300 CFU/plate, respectively, (c) intervention group with < 300 CFU/plate, (c and d) no bacterial colony growth was found

Conclusion

Pre-operative bath with 4% CHG 3 h before surgery proved to be effective in reducing the number of microorganism colonies in an effort to prevent the incidence of SSI at the Universitas Sumatra Utara Hospital. It is expected that hospitals can implement a pre-operative bath policy with 4% CHG 3 h before surgery to prevent SSI, reduce the incidence of HAIs, and improve patient safety.

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