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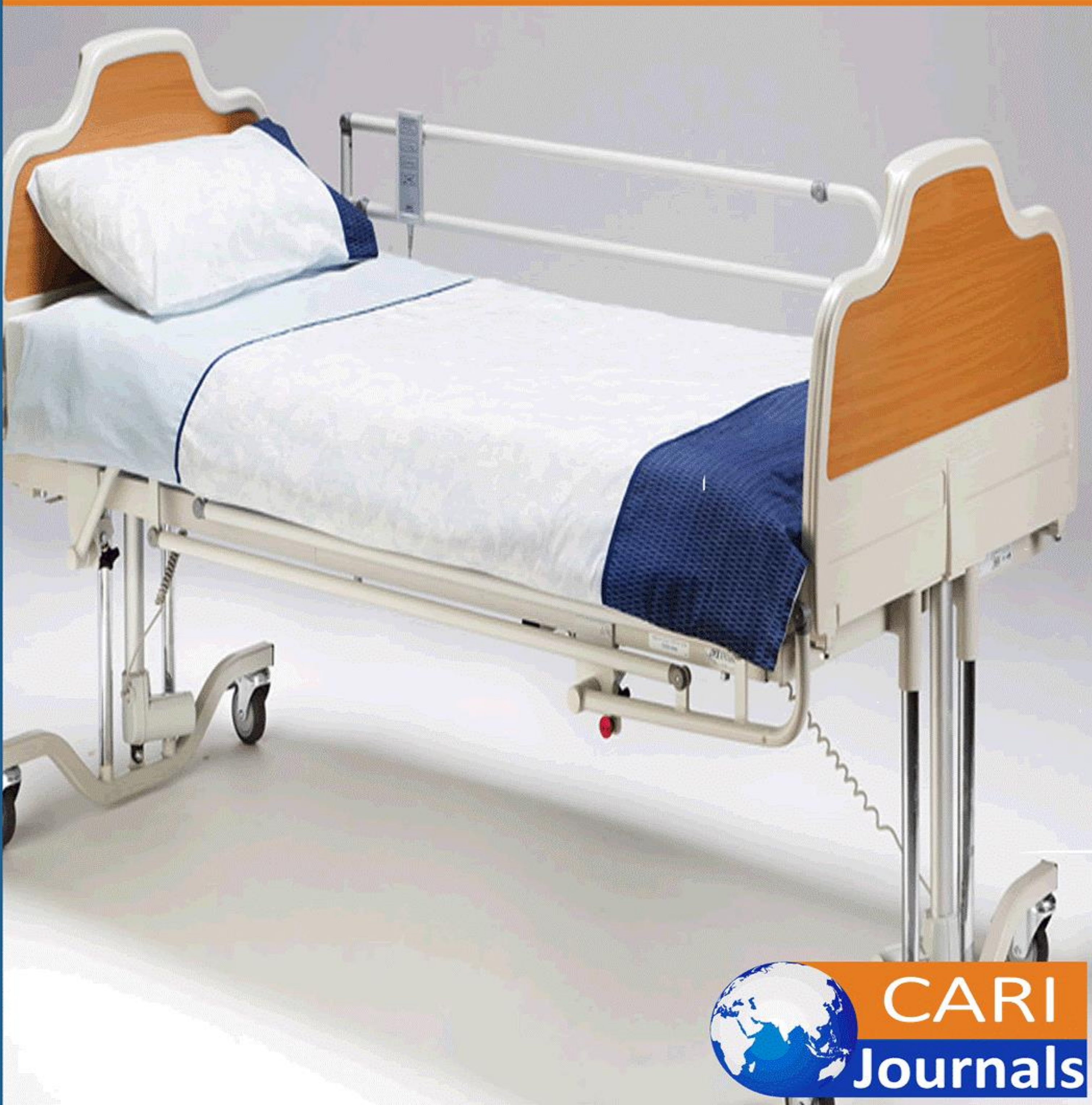

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Skin Preparation in Prevention of Surgical Site Infection in Paediatric Abdominal Surgeries at The University of Port Harcourt Teaching Hospital, Nigeria.

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Abstract

Purpose: Many studies on preoperative antiseptic agents are inconclusive. This study attempts to find the more effective combination antiseptic agent in pediatric surgical patients.

Methodology: This was a prospective randomized study on paediatric patients. Preoperative skin preparation for each group was done with the assigned antiseptic combination. Patients were followed up on the 14^{th},21^{st} and 30th postoperative days. The primary outcome measures were the incidence of SSI in both groups, Secondary outcome measures was the prevalent flora in patients with SSI. The data from the folders were collected and collated. A ninety-five percent confidence interval and a p-value less than 0.05 was considered significant. Continuous variables were presented in means and standard deviation. Results were presented in tables.

Findings: The rate of SSI in the chlorhexidine–alcohol group was 6.9% and that of the povidone–iodine/alcohol group was 9.7%. The odds ratio was 0.71 in favour of the chlorhexidine/alcohol group, but the result was not statistically significant(p=0.228) Organisms isolated were mostly monomicrobial, with Escherichia coli accounting for 50% of the cases.

Unique Contributions to Theory, Policy and Practice: The study found that the patients who received chlorhexidine–alcohol as a skin antiseptic had a lower incidence of SSI than those who received povidone-iodine/alcohol; however, this was not statistically significant. Earlier studies had initially stated that the povidone-iodine/alcohol was better.

Keywords

Povidone-Iodine/alcohol, Chlorhexidine/alcohol, Surgical Site Infection, Paediatric Clean-Contaminated Wound

Introduction

Global estimates of surgical operations in health care amount to approximately 234.2 million on an annual basis with quite a number resulting in surgical site infections.[1] Surgical site infections (SSI) are largely preventable nosocomial infections. Singh et al.[2] refer to them as infections that occur within 30 days after surgery or a year in patients receiving implants which affect either the incision or deep tissue at the site of operation. At the organ level, infection may occur within 90 days if implants are left in place. Singh et al.[2] and Cui et al.[1] claim that despite modern technologies, standard operation procedures and antibiotic prophylaxis about 3-12% of patients who undergo elective surgery develop SSI accounting for 10-45% of healthcare-associated infections on a global scale. SSIs occur when infectious agents infect open tissues, organs, or open incisions that are made during surgical procedures by surgeons.[3] This could result in inconveniences, unwarranted suffering due to the need for an extended stay in hospital, more surgeries, prolonged antibiotic use, increased cost of treatment, and even loss of life with an estimated mortality of 14.5% globally.[1] In the US 77% of death of surgical patients with SSI is said to be associated with infections with severe cases of infections involving organs or spaces accessed during surgeries.[3,4] In Europe, depending on the surgical procedure an occurrence of 1.5-20% is evident.[5] A 7.6% prevalence was known in Japan in 2010[6] and a 4.5% cumulative was reported in China mainland.[7] Nigeria unlike other advanced countries with established national systems capable of monitoring SSI-related infections has no system to monitor the occurrence of the infection. A systemic meta-analysis by Olowo-Okere et al of the country's occurrence of SSI estimates an occurrence at 14.5% with the highest occurrence reported in the North-Eastern region of the country.[8]

SSI incidence tends to occur in almost all types of surgical procedures but cases in abdominal surgeries are higher; especially intraperitoneal (that involves a breach of the peritoneum).[9,10] Irrespective of advances in asepsis, antimicrobial agents, sterilization, and surgical technique, SSI continues to be a major complication of surgery.

Key strategies in reducing SSI in paediatric surgical patients involve the use of pre-operative skin preparation (antiseptic agents), the use of prophylactic antibiotics, and ensuring an aseptic technique.[3,4] Preoperative skin antisepsis is based on the knowledge that a patient's skin is a significant source of pathogens.[9] Povidone-iodine, chlorhexidine, and alcohol have proved to be effective in preoperative skin antisepsis.

A systematic review and meta-analysis conducted to determine whether povidone–iodine or chlorhexidine should be the preferred agent for cleansing the skin before clean-contaminated surgery failed to reach a definitive conclusion and recommended further primary research.[11] upon which this study is hinged.

Although research about infection control has been carried out by Brisibe et al.,[11] Abhulimen et al.[12] and Ademuyiwa et al.,[13] none of these studies concentrated on Paediatric surgery. We, therefore, carried out this study to see which of the solution is the ideal solution to use preoperatively in the paediatric population. The study will add to the already increasing knowledge base.

Materials and Methods

Study Setting.

This study was conducted in the paediatric surgery unit of the University of Port Harcourt Teaching Hospital (UPTH). This was a prospective randomized hospital-based study of children with abdominal conditions who met the inclusion criteria. This was made up of two groups of participants aged between one month and fifteen years admitted through the paediatric surgery clinic and children's emergency ward for clean contaminated abdominal surgeries.

Patients in **group A (control),** Chlorhexidine and Alcohol antiseptics.

Patients in **group B (intervention group),** Povidone-iodine and Alcohol antiseptic

Inclusion Criteria

i. Children with abdominal surgical conditions adjudged clean-contaminated

ii. Patients who assent or whose parents/guardians give informed consent.

iii. All children aged one month to fifteen years.

Exclusion criteria; These were

i. Children less than a month old or older than fifteen years.

ii. Children with critical conditions e.g., advanced abdominal malignancy.

iii. Immunocompromised patients-those on long-term steroid use, uncontrolled Diabetes Mellitus.

iv. Patients whose parents/guardians did not give consent or opt out after giving consent.

v. Sickler's in unsteady states

Sample Size Calculation

Sample size was calculated using the formula for comparing two proportions.[14] =

$$\frac{[Z_{\alpha/2}\sqrt{2p(1-p)} + Z_{1-\beta}\sqrt{p1(1-p1) + p2\,(1-p2)}]}{(p_1-p_2)^2}$$

n = 141 Allowance for 10% non-response n = 141/1-0.9 = 156

The minimum sample size was 156 participants to compensate for 10% non-response. Thus 78 patients were allotted to each group.

Subject Selection

Study participants were drawn from the patients admitted through the Paediatric surgery clinic and the children's emergency ward of UPTH for clean-contaminated abdominal surgeries. The patients admitted for clean-contaminated abdominal surgeries (uncomplicated appendicectomy, resection and anastomosis of bowel with minimal spillage, hepatobiliary surgery, and urological surgery via abdominal route) were randomly divided into two groups: A and B using sequentially sealed opaque envelopes. Patients in group B will receive povidone-iodine and alcohol preoperative antisepsis while patients in group A will receive chlorhexidine and alcohol preoperative antisepsis. Simple randomization using the SNOSE technique (sequentially numbered, opaque, sealed envelope technique) was used for the allocation of participants into two groups of 78 each.

Surgical technique

Eligible patients were identified and recruited for this study. Meticulous history taking and physical examination and relevant investigations. Investigations such as renal function test, genotype, complete blood count and radiological (abdominal radiograph/or abdominal ultrasound scan where applicable) were performed.

Participants came into the theatre with tags on their case files allocating them into either group A or group B, only the investigator knew what each group in the study represented. All patients were positioned supine on the surgical table, with the appropriate antiseptic solution used in each group. The specific antiseptic combination was used for the patient depending on what group the patient fell into.

Postoperative

The patient/caregiver was counselled to keep the wound dressing dry. Wound dressings were inspected daily post-operatively and the wounds were inspected on the fifth postoperative day all by independent adjudicators (the unit consultants) who were blinded to the study. Infected wounds had wound swab and culture carried out. Appropriate antibiotics was used to treat the infection. Follow-up after discharge was in the paediatric surgical outpatient clinic (PSOP), an appointment was given a week after discharge, then on the thirtieth postoperative day.

Outcome Measures

The primary outcome measure was the incidence of Surgical Site Infection.

$$\frac{\text{No.of cases of SSI in participants who had chlorhexidine preoperative antisepsis}}{\text{Total Number of participants in group A}} * 100 \text{Group B} =$$

$$\frac{\text{No.of cases of SSI in participants who had Povidone−iodine preoperative antisepsis}}{\text{Total Number of participants in group B}} * 100$$

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The secondary outcome measures were.

- To determine the prevalent flora in SSI from clean contaminated paediatric abdominal surgeries using colony-forming units per culture plate agent

Data Collection

A PROFORMA (Appendix I) was used to collect data-Age, Religion, Sex, Weight, Type of surgery (emergency or elective), and post-operative date when the infection was diagnosed. Also, Perioperative data, preoperative diagnosis, and preoperative antibiotic.

A datasheet was used to collect post-surgical data on surgery/surgical procedure, type of surgical site infection, signs of surgical site infection noticed-swelling of the operation site, erythema, tenderness, Serous or purulent discharge, Separation of the deep tissues. Diagnosis of superficial /deep incisional surgical site infection was made by the investigator. Culture and sensitivity done for infected wound, cultured microorganism -mono or polymicrobial against the sensitive antibiotic(s), frequency of wound dressing date of readmission if applicable, readmission diagnosis, and post-discharge surveillance for 30 days was all captured.

Data Analysis

Data collected was analyzed using Statistical Package for Social Sciences (SPSS) Version 25.0 (IBM Corp., Armonk, NY, USA). Quantitative variables such as age etc. were summarized using mean and standard deviation. Qualitative variables such as SSI (categorized as present/absent), etc. were presented as frequencies and proportions. The differences in proportion were compared using the Chi-square test or Fisher's exact test when the expected cell value was below five in at least twenty percent of the cross cells. The strength of the association between the occurrence of SSI and the antiseptic combination preparation (groups in the study) was determined using the odds ratio. The confidence interval was set at a 95% level. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 156 children were recruited for this research, which ran from February 2021 to January 2022. 156 participants were eligible for the study and 78 were allocated to each group (PIA and CHA). A total of 12 participants were eliminated from the analysis: 8 had contaminated rather than clean-contaminated surgery, 3 were lost to follow-up, and 1 died before the 30-day follow-up period was completed from both groups.72 participants each from both groups received either PIA or CHA respectively, met the inclusion criteria, were followed up for 30 days and were included in the full analysis set.

There were 44 males (67%) and 28 females (33%) in the PIA group and 36 males (50%) and 36 females (50%) in the CHA group. Participants ages ranged from 1.5 months (6 weeks) to 180 months (15 years), with a mean age of 81.15 months (6.76 years) for the PIA group and 93.35

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months (7.78 years) for the CHA group. A total of 116 of the participants required emergency surgery, representing 80.5% of the whole participants (56 in the PIA group and 60 in the CHA group) while 28 participants underwent elective surgery (12 and 16 participants for CHA and PIA groups respectively).

Table 1: Comparison of SSI by type of surgery, surgical procedure, and duration of surgery

	CHA		PIA				**Statistical test**	**p-value**
	N	SSI (%)	n	SSI (%)	Total n (%)			
Type of Surgery								
Elective	12	1(8.3)	16	3(19)	28		0.6076	.43568
Emergency	60	4(6.7)	56	4(7.1)	116		0.0102	.91944
Surgical procedures								
Bowel resection and anastomosis	19	3(15.8)	13	3(23)	32		0.2691	.603953
Appendicectomy	44	1(2.3)	46	2(4.3)	90		0.3005	.58355
Hepatobiliary surgery	1	0	3	0	4			
Nephrectomy and pyeloplasty	8	1(12.5)	11	2(18.2)	19		0.1125	0.73737
Duration of surgeries (in minutes)	70.32±30.99		75.97±39.75		73.15±35.63			

Mean ± Standard Deviation; f=frequency, that is, the number of occurrences; n=sample size of each group analysed; %) = percentage of occurrence

Types of Surgical Procedures

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90% of the procedures were performed by the researcher, and he was directly involved as an assistant in the others. All procedures were performed via opened approach: majorly lanz, and transverse abdominal incisions. A total of 79 transverse supraumbilical incisions were performed, with 40 in the PIA group representing 50.6 percent and 39 in the CHA group representing 49.4 percent, indicating a marginal increase in the number of transverse supraumbilical incisions were performed in the PIA group. Furthermore, the overall duration of the procedures in both groups was 73.15±35.63minutes, with the average minutes for PIA and CHA being 75.97 ± 39.75 and 70.32 ± 30.99 respectively. A total of 90 participants underwent appendicectomy,46 in the PIA group and 44 in the CHA group representing 51.1% and 48.9% respectively: resulting in two cases of surgical site infections in the PIA group against one in the CHA group. The appendicectomies done were diagnosed as acute uncomplicated appendicitis or done when other procedures were carried out (as part of Ladd's procedure and manual reduction of intussusception). Details of the surgical procedure are in Table 1.

Table 2: Comparison of the incidence of SSI between the two groups in the study (CHA and PIA)

Groups	SSI		
	Present n (%)	**Absent n (%)**	**Total**
Group A(CHA)	5(6.9)	67(93.1)	72(100.0)
Group B(PIA)	7(9.7)	65(90.3)	72(100.0)
Total	12(8.3)	132(91.7)	144(100.0)

Chi Square=0.3636; *p*-value=0.272 Odds Ratio =0.69(95%CI:0.21-2.29)

The Rate and Types of SSI found in the Groups

The primary outcome of overall 30-day SSI in this study occurred in 12 participants.9.7% in the PIA group and 6.9% in the CHA group (p-value=0.272, Odds Ratio =0.69(95%CI:0.21-2.29). Table 2 shows the rate of SSI found in the two groups. Most surgical site infections occurred during the first-week post-operative period- (66.7%) with no difference in the incidence of SSI in both groups (5.56% in each group). In the second week after surgery, the incidence was 4.17% and 1.39% for the PIA and CHA groups respectively. SSI was not found in the third and fourth weeks of post-operative surgery. No statistically significant difference was found in the two groups concerning SSI (P = 0.735).

Table 3: Sub-types of SSI among the two groups

Groups	CHA	PIA		X^2	p-value
	n (%)	n (%)	TOTAL		
Superficial	3(4.2)	3(4.2)	6(4.2)		
Deep	1(1.4)	2(2.8)	3(2.1)	7.070	0.314
Organ/Space	1(1.4)	2(2.8)	3(2.1)		
Total	5(6.9)	7(9.7)	12(8.3)		

n= sample size of each group analyzed, (%) = percentage of occurrence.

Most surgical site infections recorded were superficial; six participants out of a total of 12 cases with SSI had the superficial type, and they were equally distributed in both groups. 3 participants had deep SSIs. 1 was in the CHA group, representing 1.4%, and 2 were in the PIA group, representing 2.8%. Thus, most of the deep infections were found in the PIA-treated group.

Also, infections of organs/space were more common in the PIA-treated group. A total of 10 (83.3%) Thus, the results showed that the CHA-treated group had a lower SSI rate as compared to the PIA-treated group, though no statistically significant difference was found (P = 0.314).

The Prevalent Bacterial Growth of Organisms in SSI among the Groups

12 patients were adjudged to have surgical site infections, all of whom had wound swab microscopy, culture, and sensitivity test. Causative organisms were found in all 12; Escherichia coli was most prevalent,3 and 5 for CHA and PIA groups respectively. Other organisms were Staphylococcus aureus, Klebsiella spp. and Pseudomonas spp. The results show that there was no statistically significant difference in the prevalence of bacterial flora isolated from both groups. (P = 0.361).

Table 4: Prevalent Bacterial Isolated from cases with SSI

	CHA Group A		PIA Group B		Total		X^2	p-value
Total number of SSI (n=12)	f	n (%)	F	n (%)	F	(%)		

Growth of Organisms								
Polymicrobial infections (presence of multiple microbial growths)	1	1(1.4)	1	1(1.4)	2	100.0		
E. coli	3	3(4.2)	2	2(2.8)	5	100.0	4.350	.361
Staph aureus	0	0(0)	2	2(2.8)	2	100.0		
Klebsiella	0	0(0)	1	1(1.4)	1	100.0		
Pseudomonas	1	1(1.4)	1	1(1.4)	2	100.0		
Total	5	41.7	7	58.3	12	100.0		

f=frequency, that is, the number of occurrences; n=sample size of each group analysed; (%) = percentage of occurrence

Discussion

This study showed that the CHA-treated group has a lower incidence of SSI compared to the PIA-treated group. This is congruent with the findings of Park et al.[15], who found no significant difference in the outcomes of SSIs for chlorhexidine gluconate and povidone-iodine. The findings were also consistent with those of Srinivas et al.[16], who reported that SSI for clean-contaminated upper abdominal surgery was as high as 10.8 percent in the chlorhexidine-alcohol group compared to 17.9 percent in the povidone-iodine group, implying fewer surgical site infections in the CHA group compared to the PIA group.

According to Daurouiche et al.[17], the incidence of SSIs in patients who underwent clean-contaminated operations was greater in the povidone group (16.1%) than in the chlorhexidine group.[18] However, in that study, the clean-contaminated procedures were diverse (including non-abdominal surgeries). Furthermore, the comparator arms of the antisepsis were not equal (chlorhexidine and alcohol versus povidone-iodine only); because the addition of alcohol to another antiseptic agent increases the efficacy of that antiseptic agent,[19] the chlorhexidine group may have had an advantage over the povidone-iodine group.

Chlorhexidine-alcohol and povidone iodine-alcohol are conventionally used in skin antisepsis with broad-spectrum antibacterial activity for preventing SSI. However, the efficacy of povidone-iodine is reduced in the presence of organic material like blood. Several investigations have shown that chlorhexidine was more effective and superior to povidone-iodine as a preoperative skin antisepsis agent. [20,21]

Ademuyiwa et al.[13] discovered that chlorhexidine was more efficient and superior to povidone-iodine in the prevention of postoperative SSI in meta-analytical research. Though the incidence of superficial incisional SSI was higher than other forms of SSI in this study as reflected in the study by Dorfel et al[21], the incidence of superficial incisional SSI was equally distributed in both groups. Deep SSIs were more with the povidone-iodine/alcohol (PIA) group. Moreso, the slightly higher incidence of deep/organ space SSIs in the PIA group may be because more Anderson-Hynes procedures which were more likely to be complicated by organ space SSI were done in the group compared to the CHA group.

Despite chlorhexidine-alcohol being more effective and causing fewer SSI infections, the hypothetical testing revealed that there was no statistically significant difference between the two antiseptic agents. However, Abdeyazdan et al.[14] reported that povidone-iodine was superior to chlorhexidine in their multicenter prospective randomized controlled experiment evaluating the effects of povidone-iodine and chlorhexidine solutions on skin bacterial flora among hospitalized newborns. Moreso, Swenson et al[19] concluded that iodine-based skin antisepsis was superior in patients undergoing general surgery.

Both the CHA and PIA groups had a total of 12 patients with infected surgical sites. Escherichia coli, Staphylococcus aureus, Klebsiella, and Pseudomonas aeruginosa were among the bacteria flora found. These results were in line with earlier research that investigated cases that were comparable to this one. [17,22,23] E. coli, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, and *Citrobacter spp*. were among the aerobic bacteria that Begum et al. isolated from SSI.[17] In a similar investigation, Dessalegn et al.[24] found Klebsiella pneumonia, Staphylococcus aureus, Pseudomonas aeruginosa, Acinetobacter species, and E. coli. Although those studies were cross-sectional in nature, all surgical patients (both pediatric and adult), regardless of the kind of operation performed (clean, clean-contaminated, contaminated, and dirty), who acquired SSI throughout the research periods were included.

In this study, E. coli was the most often detected bacterium. This outcome was consistent with previous research both in Nigeria and elsewhere.[17, 25-27] In Nigeria, Ameh et al.[25] and Nwanko et al[26] found that the most common organism isolated from SSI was E. coli. These were independent and prospective non-randomized studies carried out in two different institutions in the northern parts of Nigeria on paediatric and non-paediatric populations, respectively, to determine the incidences and various types of pathogens involved in SSI. They were both quiet on the sort of preoperative antiseptic agents utilized.

Similarly, Dessalegn et al[24]. stated that E. coli was the most common bacterium discovered in their investigation, accounting for more than 60% of the total. Srinivas et al[16] reported that surgical wound swabs from patients with SSI revealed gram-negative organisms in most cases. Their results agreed with this study, in that most frequent organisms originated from hollow viscera. This may be attributed to minor leaks from the viscera during the surgical procedure. However, in a prospective descriptive investigation spanning all age groups, Ussiri et al[28] discovered staphylococcus aureus to be the main bacterial flora identified from SSI patients. Further analysis revealed that there was no statistically significant difference in microbial flora isolated from patients with SSI between the two groups (P = 0.361).

CONCLUSION

Chlorhexidine and alcohol antisepsis used sequentially was superior to povidone-iodine and alcohol antisepsis (used sequentially) in preventing postoperative SSI in clean-contaminated surgery. However, this was not statistically significant. The rate of SSI for clean abdominal surgeries varied based on the heterogeneous nature of clean contaminated abdominal procedures.

RECOMMENDATIONS

I recommend the use of chlorhexidine in combination with alcohol as an antiseptic skin preparatory agent to prevent surgical site infections; However, multicentre studies with various types of surgeries should be undertaken to validate the claim of this study or to further collaborate the result of this research.

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