A COMPARATIVE STUDY BETWEEN CHLORHEXIDINE 2% AND POVIDONE-IODINE 10% IN PREVENTING CATHETER-RELATED BLOOD STREAM INFECTIONS

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ABSTRACT

BACKGROUND

Invasive skin pathogens play an important role in the occurrence of infections. Intravascular catheters which are commonly used in the hospitals for patient care can lead to serious infectious complications. Use of an antiseptic solution for disinfecting the skin at the catheter insertion site helps to prevent catheter-related infections.
Cleaning of the skin with antiseptics before the surgical or cutaneous intervention clearly reduces the infection risk.

AIM

To compare the efficacy of chlorhexidine 2% and povidone-iodine 10% in preventing catheter-related blood stream infections.

MATERIALS AND METHODS

A prospective comparative study was conducted for a period of 2 months in our hospital. 100 patients who were posted for elective surgeries under epidural anaesthesia (epidural catheters) were included in our study. The patients were divided into two groups of 50 each. For group I patients, chlorhexidine was used and for group II patients, povidone-iodine was used as an antiseptic solution over the area of catheter insertion. Totally, two skin swabs were obtained from the patients in each group, one before cleansing and the other one subsequently after cleansing the area where catheter was inserted.

RESULTS

Before the antiseptic painting at the catheter site the most common organism found was CoNS, followed by micrococcus and few Gram-negative and Gram-positive bacilli among both the groups and the colonies had shown between poor-to-moderate growth. After painting the disinfectant, no organism was detected in both the chlorhexidine group and the povidone-iodine group. The povidone-iodine takes a longer time to dry when compared to chlorhexidine and the difference was found to be statistically significant.

CONCLUSION

It is recommended that either of the two agents can be used before conducting procedures such as catheterisation or venous puncture. Chlorhexidine 2%, due to its significantly shorter contact time, may be of value in emergency situations.

KEYWORDS

Chlorhexidine, Povidone-iodine, Catheter, Infection.

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INTRODUCTION: Infections are one of the most important cause for mortality and morbidity in today's world.[1,2] Infection control is a challenging area for hospitalised individuals and the patients who are undergoing surgery.[3] Infection control is consequently a major part of patient care.[4]

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Following Louis Pasteur's discovery that tissue decay was caused by microscopic organisms, Lister later theorised that the spread of these microbes through surgical wounds was responsible for the death of the patients in the postoperative period. Lister began treating wounds with carbolic acid (phenol) in an effort to prevent tissue decay and the resultant infectious complications. As a result, the incidence of surgical sepsis fell dramatically, catalysing the adoption of modern antiseptic techniques, including instrument sterilisation, the use of surgical scrub and rubber gloves, and sterile patient preparation.[5]

Invasive skin pathogens play an important role in the occurrence of infections. Intravascular catheters which are commonly used in the hospitals for patient care can lead to

serious infectious complications.[6] Healthcare-associated infections (HAIs) caused by CVCs (central venous catheters), such as catheter-related bloodstream infections (CRBSIs), are one of the major problems in healthcare settings worldwide.[7] Catheter-related bloodstream infection is associated with increased morbidity, mortality, length of hospitalisation, and medical costs.[8-10] Use of an antiseptic solution for disinfecting the skin at the catheter insertion site helps to prevent catheter-related infections.

Cleaning of the skin with antiseptics before the surgical or cutaneous intervention clearly reduces the infection risk. Currently, several methods with various antiseptics are being used for this purpose.[11,12] The skin cannot be entirely sterilised because approximately 20% of the resident flora is beyond the reach of surgical scrubs and antiseptics.[13] Over the years, a wide range of substances have been used in skin preparation, including phenol, tincture of iodine, surgical spirit/ethanol/isopropanol, Merthiolate, hexachlorophene, quaternary ammonium compounds, iodophor, chlorhexidine, and octenidine dihydrochloride/ phenoxyethanol.[14]

Among these, chlorhexidine and povidone-iodine are most frequently preferred in institutions. Chlorhexidine is a very safe, effective, and useful antiseptic as a skin

Disinfectant[14,15] povidone-iodine, a complex of polyvinylpyrrolidone and triiodide ions, is also widely used as an antiseptic for skin preparation.[15,16] Therefore, use of appropriate cutaneous antisepsis at the time of catheter insertion and subsequent catheter care are important measures for preventing such infections.

AIM: To compare the efficacy of chlorhexidine 2% and povidone-iodine 10% in preventing catheter-related blood stream infections.

METHODOLOGY: A prospective comparative study was conducted for a period of 2 months in our hospital. 100 patients who were posted for elective surgeries epidural catheters were included in our study. Patients who had history of allergy to antiseptics, patients with localised infection and patients who are on anticoagulants were excluded from the study. The patients were divided into two groups of 50 each. For group I patients, chlorhexidine was used and for group II patients, povidone-iodine was used as an antiseptic solution over the area of catheter insertion. Proper aseptic precautions such as thorough scrubbing, sterile gown, cap, mask and gloves were assured. Totally, two skin swabs were obtained from the patients in each group, one before cleansing and the other one subsequently after cleansing the area where catheter is inserted.

The first skin swab was obtained from the site of insertion of the catheter soon after positioning the patient and then skin was cleaned thoroughly with antiseptic solution selected for that group over an area of approximately 500 cm^2 for at least 15 seconds and the solution was allowed to dry. A second swab was taken after wiping the area with a sterile gauze piece. This was then followed by the routine surgical procedure. The contact time for each disinfectant was recorded.

The labelled paired swabs were sent to the Microbiology laboratory for immediate processing. The samples were incubated on MacConkey agar and blood agar at 37°C for 24 to 48 hours and the growth in any of the medium was graded as follows:

1. <10 colonies-poor growth.
2. 10-50 colonies-moderate growth.
3. >50 colonies-heavy growth.

And the various organisms grown were also noted.

ETHICS: The study was conducted after obtaining consent from our Institutional Ethical Committee.

STATISTICS: All the data were entered in SPSS version 16, Chi Square test and student T test were used for deriving the statistical inference.

RESULTS: The demographic characteristic of the study population is shown in table 1. It is seen from the table that in the chlorhexidine group and the povidone-iodine group, the age and sex wise distribution were almost equal in numbers. The mean age and weight of the study subjects in the chlorhexidine group was 46.6 years and 65.5 kg and that of povidone-iodine group it was 45.6 years and 66.5 kg. There was no statistical significant difference between the two groups with respect to the demographic characteristics.

Before the antiseptic painting at the catheter site, the skin swab was taken and was cultured. In the culture, the most common organism found was CoNS(Coagulase-Negative Staphylococcus), followed by micrococcus and few Gram-negative and Gram-positive bacilli and this distribution of the organism was almost equal in number in both the groups. Among the chlorhexidine group, only 10 swabs had nil growth and among the povidone-iodine group, it was 12 (table 2). Among the microorganism colonies, majority of the colonies were between poor-to-moderate in both the groups and only 9 patients in chlorhexidine group and 8 patients in povidone-iodine group had heavy colonies (Table 3).

Demographic variable		Chlorhexidine group (n=50)		Povidone-iodine group (n=50)		P value
		Male	Female	Male	Female	
Age group	<30	4	0	2	6	0.783
	31–40	6	2	6	5	
	41–50	6	11	8	4	
	51–60	9	12	8	11	
Mean age		44.4±2.46	49.7±3.34	45.6±3.45	43.8±3.21	0.854
Mean weight		65.5±3.65	67.4±4.53	66.54±4.5	68.4±3.6	0.756

Table 1: Demographic characteristics of the study population

Organism detected	Chlorhexidine group (n=50)	Povidone-iodine group (n=50)	P value
CoNS	20	18	0.784
Gram negative bacteria	3	4	0.729
Gram positive bacteria	4	4	1.000
Micrococcus	10	12	0.836
Staph. aureus	3	0	0.352
Nil	10	12	0.728

Table 2 : Organisms detected from the skin swab before the antiseptic painting among both the groups

Colonies detected	Chlorhexidine group	Povidone group	P value
Moderate	15	11	0.589
Heavy	9	8	0.891
Poor	16	19	0.741
Nil	10	12	0.732

Table 3: Colonies present in the skin swab before the antiseptic painting among both the groups

The catheter site for majority of the patients was lumbar region, followed by lower thoracic and upper thoracic and in both the groups, the number of patients were almost similar with respect to the catheter site (Table 4). After painting the disinfectant before the catheter insertion, one more skin swab was taken and it was cultured and the culture report had shown that there was no organism detected in both the chlorhexidine group and the povidone-iodine group. Compared to the number of organisms detected before the antiseptic painting there was a statistically significant difference in both the groups after the antiseptic application, whereas the inter-group comparison did not show any significant difference with regards to the organism detected after the antiseptic application (table 5).

Catheter site	Chlorhexidine group (n=50)	Povidone-iodine group (n=50)	P value
Upper thoracic	8	5	0.712
Lower thoracic	14	14	1.000
Lumbar	28	31	0.652

Table 4: Distribution of the study population based on the various catheter sites

Organisms	Chlorhexidine group		Povidone group		P value (Inter-group comparison for after application)
	Before application	After application	Before application	After application	
CONS	20	0	18	0	1.000
Gram negative bacteria	3	0	4	0	
Gram positive bacteria	4	0	4	0	
Micrococcus	10	0	12	0	
Staph. aureus	3	0	0	0	
Nil	10	50	12	50	
P value (Intra-group comparison)	<.0001		<.0001		

Table 5: Organisms detected after the application of disinfectant at the catheter site

The mean time of contact of the disinfectant for at the catheter site in the chlorhexidine group was 74.5 secs and with that of povidone-iodine group it was 170.5 secs. The povidone-iodine takes a longer time to dry when compared to chlorhexidine and the difference was found to be statistically significant (Table 6).

Time for drying (in secs)	Chlorhexidine group	Povidone group	P Value (by applying T test)
Mean	74.5	170.5	<.0001
SD	11.5	26.6	
95% CI	71.2–77.8	162.8–177.8	

Table 6: Time of contact of the disinfectant at the catheter site

DISCUSSIONS: The results of our study had shown that almost 80% of the swabs taken from both the group of patients before the application of antiseptics had shown microorganism growth and after the application of the antiseptic either 2% chlorhexidine or 10% povidone-iodine the skin swab did not show any growth. The drying time of the antiseptics was faster for chlorhexidine than the povidone-iodine. Chlorhexidine is a broad-spectrum biocide effective against Gram-positive bacteria, Gram-negative bacteria and fungi.

Chlorhexidine inactivates microorganisms with a broader spectrum than other antimicrobials (e.g. antibiotics) and has a quicker kill rate than povidone-iodine. It has both bacteriostatic and bactericidal mechanisms of action, depending on its concentration. Chlorhexidine kills by disrupting the cell membrane.[17] Upon application in vitro, chlorhexidine can kill nearly 100% of Gram-positive and Gram-negative bacteria within 30 seconds.[18] Since chlorhexidine formulations can destroy the majority of categories of microbes, there is limited risk for the development of opportunistic infections. In topical applications, chlorhexidine is shown to have the unique

ability to bind to the proteins present in human tissues such as skin and mucous membranes with limited systemic or bodily absorption. Protein bound chlorhexidine releases slowly leading to prolonged activity. This phenomenon is known as substantivity and allows for a longer duration of antimicrobial action against a broad spectrum of bacteria and fungi.[19] In fact, chlorhexidine's antimicrobial activity has been documented to last for at least 48 hours on the skin. Unlike povidone-iodine, chlorhexidine is not affected by the presence of body fluids such as blood.[18]

PVP iodine is a loose complex of elemental iodine with a neutral, amphipathic organic compound, polyvinyl pyrrolidone, which serves as a sustained release reservoir of iodine. PVP-I is a broad spectrum biocidal agent which is highly soluble than other iodine compounds like tincture of iodine and Lugol's solution. The disinfecting characteristics of iodine arise from its ability to substitute for covalently bound hydrogens in compounds containing -OH, -NH, -SH, or CH functional groups.[20] PVP-I being a polymeric iodophor, reacts with oxygen containing functional groups. The difference between a conventional iodine solution and an iodophor is that the latter carries practically all the iodine in a complex form so that the concentration of the free iodine in the solution is always very low. This property has the effect of reducing the drawbacks associated with the presence of elemental iodine i.e. high toxicity, high level of irritation and staining power.[21]

Despite increasing evidence for newer skin antiseptic cleansing agents, there is still clinical equipoise concerning which agent is associated with a lower risk of postoperative surgical site infection. In the present study, we had compared the efficacy between chlorhexidine and povidone-iodine. All our patients were immunocompetent and were given preoperative antibiotics, where the confounding action of this factor is ruled out as the first skin swab which was taken before the application of antiseptic solution had shown growth of microorganisms, whereas after the application of the antiseptic solution no growth was recorded.

The literature on efficacy of these agents is conflicting. Some studies[22,23] found alcohol based chlorhexidine (0.5-2%) to be superior to povidone-iodine 10% for cutaneous antisepsis. Mimoz et al[22] assigned patients to skin preparation with 0.5% chlorhexidine in alcohol or povidone-iodine in an aqueous solution. The contamination rates were much lower in the chlorhexidine group when compared to the povidone-iodine group. A meta-analysis study done by Firas Ayoub,[24] taking into account 6 different RCT's, concluded that chlorhexidine treated patients had shown lesser incidence of SSI when compared to povidone-iodine group and the same was also told by the reviews conducted by Maiwald and Chan in 2012.[25]

Studies done by Zahra Abdeyazdan,[26] Kasuda and colleagues[27] and a meta-analysis by Chaiyakunapruk[28] had shown povidone-iodine as a better antiseptic than chlorhexidine in reducing the number of pathogens after application of the antiseptic solution. Few studies had also shown that application of both the agents was found to be more effective than either of the agents used alone.[29]

Staphylococcus epidermidis is the most common skin commensal. However, Staphylococcus aureus was the most common causative organism in epidural infections in a large systematic review on epidural abscesses.[30] In CRBSI, Coagulase-Negative Staphylococci are responsible for 37-60% of infections. In our study, CoNS was found to be the most common organism detected before the application of the antiseptics and the swab taken after the application did not show the growth of any organisms. The residual effect is more with respect to chlorhexidine gluconate when compared to povidone-iodine. This prolonged residual effect of chlorhexidine is due to its adherence to the stratum corneum, which extends its duration of action for several hours after its application.[31]

The cost wise analysis had also shown that there is only very minimal difference (50 paise) in the cost between the two antiseptics. So cost need not be taken as a factor in deciding the type of antiseptic among these two.

The contact time (application to drying) in our study was much shorter with chlorhexidine when compared to povidone-iodine and it was also found to be statistically significant. This time taken to achieve antisepsis is important in emergency situations like trauma or emergency caesarean section where epidural or spinal anaesthesia needs to be carried out in a faster manner, so in those situations chlorhexidine may be preferred to povidone-iodine. Studies had shown that both the antiseptic solutions can lead to allergic reactions like cutaneous hypersensitivity, but in our study we did not observe any of these reactions in either of the group.

CONCLUSION: The results of the present study had shown that there is no statistically significant difference in bacterial flora after the application of chlorhexidine and povidone-iodine. Thus, it can be recommended that either of the two agents can be used before conducting procedures such as epidural catheterisation or venous puncture. Chlorhexidine 2%, due to its significantly shorter contact time, may be of value in emergency situations. Large multicentric studies carried out with clinical relevant end points like CRBSI are required to further substantiate our findings.

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