Antimicrobial Activity of Iodophor and Chlorhexidine in Surgical Preparation of Skin

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Authors’ contributions

This work was carried out in collaboration between both authors. Author TJ designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. NPM managed the analyses of the study. Author NPM managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

An effective pre surgical preparation is important step in preventing surgical wound contamination and post operative infection. Preparing a 100% sterile surgical environment is one of the biggest challenges of surgery. Since skin is the most common source of pathogen they make the skin preparation at the time of procedure critical. The most common skin preparation agents are iodophors and chlorhexidine. The aqueous based iodophors are, such as povidone iodine is one of the few products that can be safely used on mucous membrane. Iodophor and chlorhexidine are quick sustained and durable with broader spectrum antimicrobial activity. These agents are ideal for longer open surgeries. There is a need for comparison of antimicrobial activity of iodophor and chlorhexidine. In surgical preparation of the skin, in this study we used iodophor and chlorhexidine to check their antimicrobial activity in surgical preparation of skin. A square of area 10 sq cm was drawn on the surface of the skin on arm and divided into upper half and lower half. 2 sterilised cotton swabs were taken and were moistened with saline water. First swab was taken before applying the disinfectant and the second swab was taken 2 mins after applying the disinfectant.

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Both swabs were spread in the TSA agar. Total bacterial count was counted in the before and after swab. Iodine was used as disinfectant in 5 people and chlorhexidine was used as disinfectant in 5 people. Iodophor had a better activity against the micro organisms than that of the chlorhexidine.

Keywords: Antimicrobial activity; iodophor; chlorhexidine; disinfectant.

1. INTRODUCTION

Surgical site infections are the most common type of nosocomial Infections in the surgical patients. The surgical site infection increases the complexity of healing and at lead to Longer and costlier hospitalisation of the patient [1,2]. It severe condition it may lead to death [3,4]. The most common causes of surgical site infections are the ineffective pre surgical preparation of the skin. The pathogenic bacteria of the skin can be responsible for postoperative wound infection and every effort is made to minimize the risk of clinical infection by utilizing an effective skin antiseptic. The presence of bacteria in the hair follicles and sebaceous glands of the skin, however, makes eradication of all skin bacteria difficult by topically-applied antiseptics, and leaves as a practical objective a bacteria-free skin surface during operative procedures. To achieve this, the antiseptic agent should not only rapidly destroy all pathogenic species of bacteria encountered on the skin but keep the skin surface adjacent to the wound free of bacteria throughout an operative procedure. The bactericidal action of iodine has long been recognized but its topical use in alcoholic vehicles was associated with a significant incidence of local skin reactions. The development of water-soluble complexes of iodine, referred to as iodophors, has minimized this cutaneous toxicity [3,4].

The most common skin preparation agents are iodophors and chlorhexidine. Iodophor has been widely used as a disinfectant and as a pre-operative skin preparation. Pre-operative skin-preparation solutions such as PVP-I scrub and paint solutions are commonly used to disinfect the surgical site prior to surgery [5–8]. Existing iodophor skin-preparation solutions typically include iodine, surfactant and a buffer system to provide appropriate pH in an aqueous system. The solutions typically contain an active ingredient of 7.5% to 10.0% povidone iodine. These concentrations of iodine are desirable to provide effective and extended killing of microorganisms [9–12]. It provides a film texture allowing the antimicrobial to localize at the desirable surgical incision site without reducing the thickness of iodine from the site [13–15]. It can effectively remove the microorganisms from the skin surface as mentioned in Table 1. Typically, the iodine content of the gel form is about 10.0% w/v or the effect of antimicrobial activity would not be prominent [16–19].

The aqueous based iodophors are, such as povidone iodine is one of the few products that can be safely used on mucous membranes. It has lower activity against viruses. Iodophor and chlorhexidine are quick sustained and durable with broader spectrum anti microbial activity. These agents are ideal for longer open surgeries. Iodine or iodophors Eq: povidone iodine, has been widely used as an antiseptic for prevention of surgical site infection. It is highly efficient microbicidal with wide antimicrobial spectrum and its efficiency against clinically significant pathogens, such as methicillin resistant staphylococcus aureus and enterococcus species [20,21]. Iodine is an oxidising agent, and it’s bactericides activity involves the inorganic form of iodine [22] essentially no development of resistance by microorganisms has been determined. povidone iodine is a stable chemical complexes polyvinylpyrrolidone and elemental iodine is less toxic has been used in infected wounds and treatment of burns [23,24].

Chlorhexidine is an important medical, dental and pharmaceutical, antiseptic, disinfectant and preservative and bactericides and fungicial but does not kill Spores and mycobacteria although inhibit its growth. In recent days chlorhexidine is also a commonly used disinfectant in skin preparation of skin. It is commonly used as the antimicrobial agent in surgical preparations and it is effective in removing microorganisms from the skin as mentioned in Table 2. This is due to its broad spectrum antimicrobial efficacy and substantively for the skin, but the irritability is noted in some cases [25–27]. Chlorhexidine uptake by the microorganisms is very rapid and the maximum Effect occur within 20s [28]. It causes damage to the outer cell layers. Damage to the delicate semipermeable membrane is followed by leakage of intracellular constituent [29]. The main disadvantage of chlorhexidine is it does not have sporidical activity. Even at high
concentration they do not affect the viability of spores at ambient temperatures [30], although a marked sporicidal effect is achieved at elevated temperature [31,32].

2. MATERIALS AND METHODS

The study was conducted within the institute. People who volunteered and were not allergic to both iodophor and chlorhexidine were taken into study. The hairy side of the arm is considered for the study since the hair follicles in the skin may be the potent source of microbes. As it is a non-invasive procedure, done on the skin ethical clearance was not considered but the volunteers approval was taken into account. The concentration of the disinfectants used in the study are 10% povidone iodine and 2% chlorhexidine which are the standard concentration of the disinfectants used for surgical preparation of the skin. A Square of area of area 10 sq cm is drawn on the hairy side of the arm. The square is divided into upper and lower half. 2 sterilized swabs were taken and they were moistened with saline. From the upper half of the square a swab is taken before applying the disinfectant. The disinfectant is applied all over the square and allowed to dry for 2 mins, the second swab is taken from the lower half of the square. Since from the first swab the number of microorganisms in the upper half may be reduced that is why the second swab is taken from the lower half of the square. In 5 people iodophor was used as disinfectant and in other 5 chlorhexidine was used as a disinfectant. Then the 2 swabs were spread on the TSA agar. Total bacterial count before and after using the disinfectants were counted. The bacterial counting was done using a manual method. Iodophor has no allergic effect. The participants were orally asked whether they are allergic to chlorhexidine. Participants in the study showed no allergic reaction to chlorhexidine.

First swab taken before applying the disinfectant

Second swab taken after applying the disinfectant

Fig. 1. Square drawn on the skin to take the swabs

Fig. 2. The cotton swabs used for the experiments
3. RESULTS AND DISCUSSION

The Table 1 shows the bacterial count from the first skin swab taken from the participants before using any antimicrobial agent and the reduction in bacterial count in the second swab which was due to the application of iodophor one of the potent antimicrobial agent in the skin before taking the swab. This table shows the effectiveness of iodophor as a potent antimicrobial agent.

The Table 2 shows the bacterial count from the first skin swab taken from the participants before using any antimicrobial agent and the reduction in bacterial count in the second swab which was due to the application of chlorhexidine as an antimicrobial agent in the skin before taking the swab. This table shows the effect of chlorhexidine on the skin as an antimicrobial agent.

Human skin flora has various types of non pathogenic microorganisms the density of the microbial flora in the skin depends on various factors like age and environmental factors like sebum secretion, temperature and humidity [33]. The antimicrobial agents are used to reduce the density of the microorganisms but they do not completely eliminate it. Preparing a 100% sterile surgical site is the challenge in the surgery. Post operative sepsis is the biggest problem faced after the surgery mostly because of the failure to achieve 100% surgical site. Both iodophor and chlorhexidine have a very good antimicrobial activity. But the iodophor has enhanced antimicrobial activity in the skin. It has effective antimicrobial activity even against the spores [34] which chlorhexidine does not possess. Hence the 100% sterile surgical site can be achieved with the help of iodophor, which helps to minimise the various post operative problems like post operative sepsis.

**Table 1. Bacterial count before and after using iodophor as disinfectant**

| Bacterial count before using iodophor | Bacterial count after using iodophor |
|--------------------------------------|-------------------------------------|
| 88                                   | 0                                   |
| 652                                  | 9                                   |
| 327                                  | 7                                   |
| 979                                  | 4                                   |
| 985                                  | 14                                  |

**Table 2. Bacterial count before and after using chlorhexidine as disinfectant**

| Bacterial count before using chlorhexidine | Bacterial count after using chlorhexidine |
|------------------------------------------|-------------------------------------------|
| 436                                      | 17                                       |
| 342                                      | 13                                       |
| 988                                      | 29                                       |
| 127                                      | 9                                        |
| 962                                      | 31                                       |

Fig. 3. This bar graph shows correlation between the bacterial count before and after using the iodophor as disinfectant. Blue colour denotes the bacterial count before using any disinfectant in the skin. red colour indicates the bacterial count after using iodophor as disinfectant. X axis denotes the number of samples and Y axis denotes the bacterial count.
A similar study was conducted on comparing the effectiveness of chlorhexidine and povidone iodine skin preparation for surgical operations, the study states that chlorhexidine skin preparation takes lesser time than iodophor skin preparation but iodophor acted for a longer time than that of chlorhexidine and reduces the risk of surgical site infection. It also states that iodophor skin preparation achieved a lesser risk ratio for surgical site infection than that of chlorhexidine skin preparation [35].

**CONCLUSION**

In this study among the two antimicrobial agents tested, iodophor had increased antimicrobial activity than that of chlorhexidine. Antiseptics act only against organisms that reside on the patient's integument, the over all superior protection afforded by by antiseptics is attributed primarily to a reduction in the rates of superficial and deep incisional infection that were caused mostly by gram-positive skin flora. Since two thirds of surgical site infections are confined to the incision, optimising skin antisepsis before surgery could result in a significant clinical benefit.

**CONSENT**

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

**ETHICAL APPROVAL**

As per international standard or university standard, written ethical approval has been collected and preserved by the author(s).

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**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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