CHAPTER **51**

SKIN PREPARATION FOR SURGERY: A Literature Review

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INTRODUCTION

The Centers for Disease Control and Prevention report that more than 27 million surgical procedures are performed each year and of those performed, almost 300,000 cases lead to a surgical site infection (SSI).[1] To reduce the risk of a SSI, prevention control is paramount and begins in the operating room. A thorough knowledge of available and effective antiseptics is necessary to ensure every precaution is met when preparing the skin. Currently, there are many available agents and several combinations exist on the market. However, there is no standard to which all surgeons agree. A recent literature review is presented below, along with a brief overview of the most common antiseptics available.

COMMON ANTISEPTICS

Alcohol-containing products are the most routinely used antiseptic due to their ease of use and the rapid broad-spectrum antimicrobial activity that they exhibit. Most commonly used in the US are ethyl alcohol, which is more potent against viruses, and isopropyl alcohol, which is considered more efficacious against bacteria due to its greater lipophilic properties.[2,3] There are also studies that show equal effectiveness of alcohol-containing products against gram-positive and gram-negative organisms when compared with chlorhexidine gluconate.[4] When using alcohol-containing products, the most optimal concentration is between 60-90%, at which cell membrane damage and denaturation of proteins occur, leading to cell lysis.[5] Alcohols are effective against many bacteria, fungi and viruses and it is common practice for alcohol hand rub solutions to be used between successive cases.

Chlorhexidine gluconate (CHG) is found in a variety of forms and has been cited in numerous studies for its bactericidal effect. CHG disrupts cell membrane potential, causing an imbalance in the osmotic equilibrium, ultimately resulting in cell death.[5,6] Some studies discuss a fairly rapid onset in certain bacteria, with a maximum effect occurring within 20 seconds against *S. aureus, E. coli* and yeasts.[7,8] The broad-spectrum of efficacy make for a popular choice but it should be noted that CHG is not sporicidal, and mycobacteria are highly resistant.[5]

Neveretheless, the effective interaction with non-sporulating bacteria and the low rate of irritation on skin make for a promising choice of antiseptic. Of interest is the excellent residual activity that CHG exhibits, with some formulations allowing for a duration of antimicrobial protection of 6 hours.

Iodine is found in numerous forms, including ointments, scrubs, topical gels, and solutions. It is a broad-spectrum biocidal agent used in the treatment of a wide array of bacteria, viruses, fungi, protozoa, and spores. In solution, several complex iodine species are present with molecular iodine (I_2) being responsible for antimicrobial activity.[5] It is for this reason that iodophors were developed to act as iodine carriers, most notably, povidone-iodine (PVI). Iodine penetrates cells and affects proteins, nucleotides and fatty acids, causing oxidative damage with free iodine.[5] As opposed to CHG, iodophors have been shown to be inactivated by blood or serum proteins and they have been associated with skin staining and irriation.[9] Similar to CHG, PVI has been prepared with other antiseptics allowing for increased biocidal activity.

LITERATURE REVIEW

Over two-dozen studies were reviewed that evaluated the efficacy of the previously described antiseptics. Combination products also reviewed include Duraprep (0.7% iodine and 74% isopropyl alcohol), TechniCare (3.0% chloroxylenol), ChloraPrep (2% CHG and 70 % isopropyl alcohol), and other solutions with varying concentrations of CHG, PVI, and alcohol.

Although only a few cases compared the efficacy of CHG with that of PVI when used alone, an overwhelming majority of studies that involved CHG combinations were significant in reducing colony forming units (CFUs). In a recent study, Paochareoen et al divided 500 surgical patients into 2 random groups and showed a reduction in colonization of bacteria and postoperative surgical wound infection when using 4% CHG.[10] Another study in Japan compared 0.5% CHG with 10% PVI for cutaneous disinfectants when placing central venous catheters in 584 patients.[11] There was no significant difference in catheter-related bloodstream infection when using either preparation.

When considering PVI solution alone as a preferred method of sterilization, only one recent study found it to be superior to CHG. Yokoyama evaluated 159 patients who underwent cataract surgery and separated patients into 2 groups.[12] The eyelids of 1 group were disinfected with 0.05% CHG solution and the other group was disinfected with 10% PVI solution. After the procedure, wound samples from the eyelids were taken and there was a higher bacterial load found within the CHG group, 39 of 107 versus 19 of 103. Although this was not significantly different, it was felt that PVI had a superior effect compared with CHG.

In an interesting study, Ellenhorn et al showed that PVI paint-only preparation was equivalent to a scrub-and-paint technique.[13] In a prospective randomized trial, 234 patients were placed in 2 groups. One group received a vigorous 5-minute scrub with PVI soap, followed by PVI paint. The remaining group used PVI paint only. The wound infection rate was then evaluated at 30 days postoperatively. Wound infection occurred in 12 (10%) scrub-and-paint patients and 12 (10%) paint-only patients. It was concluded that there was no difference between the 2 techniques and that the scrub-and-paint method be abandoned to save cost and time.[13]

The alcohol preparations mixed with either CHG or PVI are, by far, the most effective when compared with other preparations reviewed. In a recent study in Spain, 4 different methods of skin and nail preparation were compared on the feet of 28 individuals.[14] Bacterial load was measured before and after each preparation of 4% CHG, 70% isopropyl alcohol, and 7.5% and 10% PVI solution. While the nail fold remained contaminated in every case, the bacterial load was significantly reduced in the group in which alcohol was combined with PVI.

Similar results highlighting the efficacy of alcohol combined with CHG were also found by Bibbo et al.[15] A total of 127 patients undergoing foot and ankle surgery were prospectively randomized into 2 groups, a PVI group and a CHG scrub-isopropyl alcohol paint group. The CHG-isopropyl alcohol group showed 38% positive cultures, while the PVI group had 79% positive cultures. It should be noted, however, that no preoperative swabs were taken, so preoperative colonization is undetermined.

Cheng et al evaluated PVI 1% with isopropyl alcohol 23% compared to CHG 0.5% with 70% isopropyl alcohol in 50 patients undergoing forefoot surgery.[16] The efficacy of a bristled brush was also examined. Cultures were taken from 3 pre-assigned areas before and after skin preparation, and it was found that there was no significant difference in either solution. It was also determined that the use of a bristled brush added no additional benefit.

Ostrander et al evaluated 3 different pre-made skin preparations (Duraprep, TechniCare, and Chloraprep) in 125 patients undergoing foot and ankle surgery.[17] Cultures were taken from the hallux nailfold, the webspaces, and the anterior tibia. Of the 3 preparations used, Chloraprep (CHG and alcohol) was the most effective. Saltzman et al found similar results in 150 patients undergoing shoulder surgery.[18] Duraprep, Chloraprep, and PVI were used for skin preparations in 3 groups. Of the 3 groups, Chloraprep had the lowest positive culture at 7% compared with Duraprep (19%), and PVI (31%).

While the efficacy of combination products has been shown in numerous studies, Keblish et al showed that an isopropyl alcohol scrub with a bristled brush was superior.[19] Four skin preparation techniques were used in 2 sets of 25 patients undergoing foot and ankle surgery. Group 1 consisted of a PVI scrub and paint with soft sponges. Group 2 consisted of the same solution as group 1 with the addition of prewash with 70% isopropyl alcohol. Group 3 consisted of a PVI scrub and paint with a bristled brush, and group 4 comprised a 70% isopropyl alcohol scrub and paint utilizing a bristled brush. Cultures were taken from the nailfolds of each group at the end of the skin preparation. The first 3 groups showed a 76%, 80%, and 76% positive culture result, respectively, while group 4 had only a 12% positive culture. It was concluded that isopropyl alcohol paint and scrub with a bristled brush was superior to any other method tested.

Scrubbing the hands and forearms with an antiseptic agent has been the standard practice. However, waterless and scrubless antiseptics are now available and have proven to be valuable. Mulberry et al evaluated the effectiveness of a waterless preparation consisting of 1% CHG and 61% ethyl alcohol in comparison with 1% CHG surgical scrub and a 61% ethyl alcohol control.[20] The combination of 1% CHG and 61% ethyl alcohol was significantly greater than either 2 solutions, even at 6 hours. Similar results can be seen in a study by Nishimura, where 2 alcohol based agents were compared against PVI scrubbing in 20 volunteers.[21] While the PVI ethanol solution showed a higher reduction factor immediately after surgery, the CHG ethanol group did not show a decrease in effectiveness at 2 hours.

Parienti et al compared the traditional hand scrubbing technique to aqueous alcoholic solution in 4,387 consecutive patients and followed the infection outcomes.[22] After a 30 day follow-up, the scrubless group had a SSI rate of 2.44% and the hand scrubbing group had a SSI rate of 2.48 with no significant difference. They concluded that after a hand scrub at the beginning of the day, followed by the alcoholic hand rub for successive cases was not only effective but convenient and improved compliance. In one intriguing study, Weber et al compared the effectiveness of

a 1.5 minute hand rub versus a 3 minute hand rub using an alcohol based antiseptic in 32 surgeons.[23] They concluded that there was no significant difference between the 2 groups and the amount of CFUs.

CONCLUSION

There is currently no consensus for skin preparations prior to a surgical procedure. While there are many agents available, numerous solutions and preparations exist. However, when considering the common antiseptics discussed above, overwhelming evidence supports the use of CHG over PVI in reduction and maintenance of bacterial load postoperatively. However, with the addition of alcohol either solutions have shown equal promise in their effectiveness. Although the use of scrub brushes was discussed briefly, there is still not enough evidence to mandate a standard. Further research is needed in that regard, as well as examining the effectiveness of one particular scrub over another.

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