

Surgical Site Skin Preparation – Current Evidence and Recommendations

Summary

- Patients should be advised to shower or bath using ordinary soap the day before or on the day of surgery
- Surgical skin preparation should be applied using a painting technique, from the site of proposed incision to the periphery using gentle friction. The solution should be allowed to completely air dry
- Prepare the skin at the surgical site immediately before incision using an antiseptic (aqueous or alcohol-based) preparation: povidone iodine or chlorhexidine are most suitable but alcohol-based solutions may be more effective than aqueous solutions
- Evidence may suggest that alcoholic 2% chlorhexidine gluconate is the most effective preparatory solution
- Cervical preparation (if used) should be with a solution containing no or low levels of alcohol
- For head and neck surgery, clinicians should assess the potential risk of pooling and chemical eye burn when using chlorhexidine gluconate against the lack of data and antimicrobial effect of normal saline.

Introduction

Contamination of surgical wounds with bacteria is a precursor of surgical site infection (SSI). The risk of contamination progressing to clinical infection is mediated by:

- The dose of bacterial contamination
- The virulence of the bacteria, and
- The patient's innate immunological defences.

In most SSI cases, the source of bacterial contamination is the patient's endogenous flora from skin, mucous membranes or hollow viscera e.g. vagina. The organisms are usually aerobic Gram-positive cocci (e.g. staphylococci) but may include faecal flora (e.g. anaerobic bacteria and Gram-negative aerobes) when the incision is made near the perineum or groin.¹

The aim of skin disinfection is to remove and rapidly kill skin flora at the site of a planned surgical incision. Any skin disinfectant should be:²



Pre-operative Showering/Washing

Recommendation: Patients should be advised to shower or have a bath (or be helped to have a shower, bath or bed bath) using soap, either the day before, or on the day of, surgery.^{5,6}

Preoperative showering/washing with soap removes gross contamination (e.g. dirt, soil or any other debris) which is an essential step prior to surgical skin preparation and it may decrease bacterial counts. Antiseptic solutions (e.g. Chlorhexidine) are known to reduce bacterial skin counts but this has not been shown to definitively correlate with reduced SSI.^{3,4} There is insufficient evidence to recommend antiseptic washes prior to surgery but NICE do recommend skin cleansing with standard soap.^{5,6}

Application of Surgical Skin Preparation

Recommendation: Using a painting technique, apply the antiseptic from the site of proposed incision to the periphery using gentle friction. Do not blot or wipe off solution but allow to completely air dry.

Most guidelines recommend a paint technique for applying antiseptic.¹ Spraying has little antimicrobial effect.^{1,7} Solutions should be applied with light pressure as friction increases the antibacterial effect of an antiseptic.¹

- Antiseptics should be applied with sterile supplies and gloves or by a non-touch technique, moving from the incision area to the periphery⁷
- Lint free cloths, sponges and applicators should be used
- Always prep from “clean to soiled” areas taking care not to transfer microorganisms from the periphery back to the proposed incision site
- Do not “back track” over an area that has already been prepped with the same applicator
- Do not blot or wipe off prepping solution. Allow prepping solution to dry through evaporation prior to draping and if diathermy is to be used, ensure no pooling of alcohol-based preparations⁵

Choice of Surgical Skin Preparation

Recommendation: Prepare the skin at the surgical site immediately before incision using an antiseptic (aqueous or alcohol-based) preparation: povidone-iodine or chlorhexidine are most suitable but alcohol-based solutions may be more effective than aqueous solutions.^{5,6}

NICE reviewed this guidance in 2013 and concluded that there was insufficient evidence to recommend a specific solution but introduced the caveat that alcohol-based solutions may be more effective than aqueous solutions.

Is One Surgical Preparation Solution Demonstrably Better Than Another?

There is a lack of good quality, controlled studies comparing skin preparation regimes and SSI outcomes in surgery. The actions and efficacy of commonly used preparations are shown in the table below (adapted from ⁸).

E= Excellent, G= Good		Action			Rapidly of Action	Residual Activity	Toxicity
		G+ve	G-ve	Virus			
Alcohol	Denature proteins	E	E	G	Rapid	None	Drying, volatile
Aqueous CHG	Disrupt cell membrane	E	G	G	Intermediate	Excellent	Ototoxicity, Keratitis
Aqueous-Iodine / Iodophors	Oxidation/substitution protein/DNA damage	E	G	G	Intermediate	Minimal	Absorption from skin with possible toxicity, inactivated by blood/debris
Alcoholic-Iodine / Iodophors	Denature proteins, protein/DNA damage	E	E	G	Rapid	Moderate	
Alcoholic-CHG	Denatures proteins, Disrupt cell membrane	E	E	G	Rapid	Excellent	

Alcohols: Alcohols are an accepted antiseptic agent; however, they should not be used as a single agent but as part of the skin prep regimen. Alcohols (Isopropyl Alcohol (IPA) or Ethyl Alcohol (EtOH)) are rapid acting and evaporate readily. They are minimally toxic to the skin, do not stain and the uptake of alcohol by intact skin is negligible. Optimal alcohol concentrations are between 60–90% by volume with IPA providing slightly more bactericidal activity than EtOH.^{1,8}

Chlorhexidine Gluconate (CHG): Alcoholic preparations of CHG have been shown to have better antibacterial activity than detergent-based formulations⁹ with a residual action of 6-48 hours. Incidence of hypersensitivity and skin irritation is low, but severe allergic reactions including anaphylaxis have been reported. There is no evidence

that CHG is toxic if absorbed through the skin, although it should not be used on eyes (keratitis) or in the middle ear (ototoxicity). CHG is not inactivated by blood or serum proteins.^{1,8}

Iodines/Iodophors: Iodophors (Iodine with a solubilizing agent) have essentially replaced aqueous iodine and tincture as antiseptics. The most commonly used iodophor is povidone–iodine. The risk of side-effects (staining, tissue irritation, resorption) is lower with iodophors than with aqueous iodine. However, free iodine absorption is possible and increased patient serum iodine (and iodide) levels have been seen. Severe local and systemic allergic reactions have been observed in some patients. Iodophors have little if any residual effect and may be inactivated by blood or serum proteins.^{1,8}

Iodophors versus Chlorhexidine Gluconate

A 2013 Cochrane review analysed 13 studies with 2,623 participants comparing clean surgery skin preparation regimes.¹⁰ 11 comparisons were made involving iodine solutions in at least one arm of the study (often comparing different preparations of iodine). No trial demonstrated superiority of one surgical skin preparation with the exception of 0.5% chlorhexidine in methylated spirits compared with an alcohol based povidone-iodine solution (concentration not specified) which was associated with a reduced risk of SSI: RR 0.47 (95% CI 0.27 to 0.82).

In a multi-centre study, alcoholic-CHG (2% CHG / 70% IPA) has been shown to be superior to aqueous 10% povidone-iodine in a prospective randomised clinical trial of clean surgery (n=849).¹¹ The overall rate of SSI was significantly lower in the alcoholic-CHG group (9.5% vs. 16.1%; P = 0.004; RR 0.59; 95% CI 0.41 to 0.85). Alcoholic-CHG was significantly more protective than aqueous povidone–iodine against both superficial incisional infections (4.2% vs. 8.6%, P = 0.008) and deep incisional infections (1% vs. 3%, P = 0.05) but not against organ-space infections (4.4% vs. 4.5%) which are likely to be unrelated to skin preparation. Adverse events were similar in the two study groups.

There is substantial evidence supporting the use of alcoholic-CHG prior to central and peripheral venous catheter insertion, as skin preparation prior to cannulation and phlebotomy and for cleaning arterial, venous and urinary catheter hubs which may influence practice.^{12,13}

Alcohol Containing Preparations may be Superior to Aqueous Based Preparations

The superior study performance of some products may relate to the presence of alcohol in the antiseptic when compared to aqueous solutions.¹⁴

A Cochrane review suggested that alcohol-containing products had the highest probability of being effective - however, the quality of this evidence was low.¹⁰

A prospective orthopaedic clinical study indicated that alcohol-based solutions with Iodophors or CHG may have improved efficacy at reducing bacterial counts in “moist” surgical sites or body regions with increased endogenous bacterial colonization. The sites treated with alcohol-based solutions had on average a 50% reduction in positive cultures compared with those treated with traditional aqueous antiseptic agents.¹⁵ These findings are supported by studies examining skin preparation for blood cultures where alcoholic-CHG is superior in preventing contamination to aqueous povidone–iodine alone (RR: 0.45; 95% CI: 0.32–0.63) but not when sequential alcohol and iodine application is used.¹⁶⁻¹⁹ Alcohol containing solutions may also be more cost effective due to shorter application and drying times than aqueous products.²⁰

There have been a few reports of operating room fires originating from alcohol-based skin preparation. Flammability can be avoided by allowing skin to completely dry and avoiding preparation of areas with excessive body hair that can delay alcohol vaporization.^{5,8}

2% CHG with 70% IPA may be more effective than 0.5% CHG and 70% IPA

A single randomised trial²¹ comparing 0.5% and 2% CHG (both with 70% IPA) during vein harvesting showed:

- a non-significant trend to a greater reduction in the total numbers of bacteria present on the skin two minutes post-skin preparation with the stronger solution of CHG (99.9% vs 97.3% p=0.07)
- with 2% CHG, surgical dressings removed at 24 hours showed a significantly lower number of microorganisms than those in the 0.5% CHG cohort (p=0.02 (absorbent) and p=0.007 (adhesive), respectively)
- Fewer patients in the 2% CHG group developed a superficial SSI post discharge at 30 days than those in the 0.5% group (0% versus 20.8%, p=0.0502).

Due to the small number of patients (n=46), the study lacks power to definitively demonstrate 2% CHG is superior to 0.5% CHG but may suggest a dose-response effect.

Head and Neck Minor Surgery

Current training on local minor surgery courses advises the use of normal saline for head and neck preparation due to reported cases of chemical eye burn due to CHG as a result of solution ingress into the eyes. Normal saline irrigation may cause bacterial dilution but no supporting evidence for surgical site efficacy, bacterial reduction or prevention of infection could be found. Clinicians should assess the potential risk of pooling and chemical eye burn when using CHG against the lack of data and antimicrobial effect but increased safety of normal saline.

Surgical Preparation for Vaginal Procedures (e.g. insertion of intrauterine devices)

The efficacy of cleansing the cervix before fitting intrauterine contraception has not been adequately assessed. Cleansing is still common practice and preparation solutions with no or low levels of alcohol remain the agents of choice.²²⁻²⁴

Supporting Evidence

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