Surgical hand antisepsis to reduce surgical site infection (Review)

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[Intervention Review]

Surgical hand antisepsis to reduce surgical site infection

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ABSTRACT

Background

Surgical hand antisepsis, to destroy transient micro-organisms and inhibit the growth of resident micro-organisms, is routinely carried out before undertaking invasive procedures. Antisepsis may reduce the risk of surgical site infections in patients.

Objectives

To determine the effects of surgical hand antisepsis on the number of surgical site infections (SSIs) in patients. The secondary objective is to determine the effects of surgical hand antisepsis on the numbers of colony forming units (CFUs) of bacteria on the hands of the surgical team.

Search methods

We searched the Cochrane Wounds Group Specialised Register (June 2007), the Cochrane Central Register of Controlled Trials (Issue 2, 2007), MEDLINE (Week 5, 2007), CINAHL (June 2007), EMBASE (Week 23, 2007) and ZETOC (2005).

Selection criteria

Randomised controlled trials comparing surgical hand antisepsis of varying duration, methods and antiseptic solutions.

Data collection and analysis

Three authors independently assessed studies for selection, trial quality and extracted data.

Main results

Ten trials were included in this review. Only one trial reported the primary outcome, rates of SSIs, and nine trials measured numbers of CFUs.

One trial involving 4387 patients found alcohol rubs with additional active ingredients were as effective as aqueous scrubs in reducing SSIs.

Four trials compared different alcohol rubs containing additional active ingredients with aqueous scrubs for numbers of CFUs on hands. One trial found N-duopropenide more effective than chlorhexidine and povidone iodine aqueous scrubs. One trial found 45% propanol-2, 30% propanol-1 with 0.2% ethylhexadecyldimethyl ammonium ethylsulfate more effective than chlorhexidine scrubs. One trial found no difference between 1% chlorhexidine gluconate in 61% ethyl alcohol or zinc pyrithione in 70% ethyl alcohol against

aqueous povidone iodine. A fourth trial found 4% chlorhexidine gluconate scrubs more effective than chlorhexidine in 70% alcohol rubs.

Four trials compared the relative effects of different aqueous scrubs in reducing CFUs on hands. Three trials found chlorhexidine gluconate scrubs were significantly more effective than povidone iodine scrubs. One trial found no difference between chlorhexidine gluconate scrubs and povidone iodine plus triclosan scrubs.

Two trials found no evidence of a difference between alternative alcohol rubs in terms of the number of CFUs.

Four trials compared the effect of different durations of scrubs and rubs on the numbers of CFUs on hands. One trial found no difference after the initial scrub but found subsequent three minute scrubs using chlorhexidine significantly more effective than subsequent scrubs lasting 30 seconds. One trial found that following a one minute hand wash, a three minute rub appears to be more effective than the five minute rub using alcohol disinfectant. The other comparisons demonstrated no difference.

Authors' conclusions

Alcohol rubs used in preparation for surgery by the scrub team are as effective as aqueous scrubbing in preventing SSIs however this evidence comes from only one, equivalence, cluster trial which did not appear to adjust for clustering.

Four comparisons suggest that alcohol rubs are at least as, if not more, effective than aqueous scrubs though the quality of these is mixed and each study presents a different comparison, precluding meta analysis. There is no evidence to suggest that any particular alcohol rub is better than another. Evidence from 4 studies suggests that chlorhexidine gluconate based aqueous scrubs are more effective than povidone iodine based aqueous scrubs in terms of the numbers of CFUs on the hands.

There is limited evidence regarding the effects on CFUs numbers of different scrub durations. There is no evidence regarding the effect of equipment such as brushes and sponges.

PLAIN LANGUAGE SUMMARY

Surgical hand antisepsis to reduce surgical site infection.

Members of the surgical team routinely use antiseptic solutions as either scrubs or hand rubs with the aim of reducing the chance of the patient developing an infection following surgery. There was no difference between alcohol rubs which contain additional active ingredients and aqueous scrubs in reducing surgical site infections. However several studies measure the amount of bacteria on the hands before and after the surgical procedure and found that when using aqueous scrubs chlorhexidine was more effective in reducing the amount of bacteria than povidone iodine. The evidence from comparisons of aqueous scrubs with alcohol rubs which contain additional active ingredients is mixed, there is evidence from studies in favour of both forms of antisepsis.

BACKGROUND

The inadvertent transfer of micro organisms to patients during surgery can result in post operative surgical site infections. Surgical site infections (SSIs) are the commonest form of hospital acquired infection for surgical patients in the UK (NINSS 2001) and the USA (Mangram 1999). Approximately 10% of patients each year in the UK and 38% of patients in the USA experience SSIs (Mangram 1999; NINSS 2001). Surgical site infections result in delayed wound healing, increased hospital stays, increased use of antibiotics, unnecessary pain and in extreme cases the death of the patient (Plowman 2000).

Micro-organisms which cause surgical site infections come from a variety of sources within the hospital. One source is the operating room environment which includes the surgical team. Members of the surgical team wear sterile gloves to prevent transferring bacteria from their hands to patients. However gloves can become perforated during surgery and it is therefore necessary to have hands as germ-free as possible. This is achieved by conducting surgical hand antisepsis immediately before donning sterile gloves prior to commencing surgical or invasive procedures. While hand wash-

ing removes transient micro organisms, surgical hand antisepsis is undertaken to remove or destroy transient micro organisms and inhibit the growth of resident microorganisms. This is achieved using antiseptic agents which kill and inhibit bacteria, fungi, protozoa and bacterial spores. An ideal antiseptic agent would be fast acting, persistent (effective for a number of hours), cumulative (repeated exposure inhibits bacterial growth for a number of days), have a broad spectrum of activity and be safe to use.

There are three types of antiseptic solutions available for surgical hand antisepsis:

- Aqueous scrubs;
- Alcohol rubs;
- Alcohol rubs containing additional active ingredients

Aqueous scrubs

Aqueous scrubs are water based solutions containing active ingredients. The aqueous scrubs used most commonly contain chlorhexidine gluconate or povidone iodine. Disinfecting the hands with an aqueous scrub requires performing a 'surgical scrub'. Scrubbing involves wetting the hands and forearms with water, applying an aqueous scrub using either hands or sponges, rinsing under running water then repeating this process.

Alcohol rubs

Alcohol rubs are alcohol based solutions which are usually available in preparations of 60% to 90% strength. The three main alcohols used are ethanol, isopropanol and n-propanol and some rubs may contain a mixture of these. Disinfecting the hands with an alcohol rub requires performing a 'rub'. This involves a simple hand wash at the start of the day or whenever hands are visibly soiled to remove any dirt, then applying alcohol solution and allowing it to evaporate.

Alcohol rubs containing additional active ingredients

These are alcohol based solutions which contain an additional active ingredient such as chlorhexidine gluconate. The active ingredient is referred to as an additional ingredient as the alcohol itself is active. Alcohol rubs containing additional active ingredients combine the rapid bacteriocidal effect of alcohol with the persistent chemical activity of aqueous scrubs. Disinfecting hands using alcohol rubs containing an additional active ingredient requires the same application process as an alcohol rub.
The following active ingredients, with the exception of alcohol, can be added to water to make aqueous scrubs or added to alcohol to make alcohol rubs containing additional active ingredients.

Alcohol

Alcohol is effective against a wide range of gram positive and gram negative bacteria, mycobacterium tuberculosis and many fungi and viruses. Compared with other common antiseptic products alcohol is associated with the most rapid and greatest reduction in microbial count (Lowbury 1974a), but it does not remove surface dirt as it does not contain surfactants or have a foaming action (Hobson 1998). Alcohols have little or no residual effect and the concentration rather than the type of alcohol is thought to be most important in determining its effectiveness (Larson 1995).

Iodophors

Iodophors are effective against a wide range of gram positive and gram negative bacteria, mycobacterium tuberculosis, fungi and viruses (Joress 1962). Iodophors contain iodine with a carrier such as polyvinylpyrrolidone (PVP). PVP, also known as povidone, is a polymer which detoxifies and prolongs the activities of drugs. PVP prolongs the activity of iodine by releasing it slowly. A combination of PVP and iodine, known as povidone iodine (PI), is less irritant than earlier solutions of tincture of iodine (Joress 1962). Iodophors rapidly reduce transient and colonising bacteria but have little or no residual effect (Larson 1990).

Biguanides

Chlorhexidine gluconate is a biguanide. It is effective against a wide range of gram positive and gram negative bacteria, lipophilic viruses and yeasts (Hibbard 2002a). It binds to the outermost layer of skin, the stratum corneum, which results in a persistent activity (Larson 1990). Over time, repeated exposure can lead to a cumulative effect where both transient and resident organisms are reduced (Larson 1990). Chlorhexidine gluconate is effective in the presence of blood and other protein rich biomaterials (Hibbard 2002a).

Phenolic compounds

Hexachlorophane and triclosan are the most widely used bis-phenols and chloroxylenol is the key halophenol. Hexachlorophene is a slow acting antiseptic which forms a film over the skin (Crowder 1967). The film retains bacteriostatic properties and is effective against gram positive bacteria but is less effective with gram negative bacteria and fungi (Crowder 1967). A report of toxicity in neonates (Kimborough 1973) has led to restricted usage and hexachlorophene has mostly been replaced by triclosan (2,4,4,trichloro 2 hydroxydiphenyl ether). Triclosan inhibits staphylococci, coliforms, enterobacteria, and a wide range of gram negative intestinal and skin flora (Bartzokas 1983). Most strains of pseudomonas are resistant and Triclosan has only

fair activity against mycobacterium tuberculosis and poor activity against fungi (Faoagali 1995). Chloroxylenol (PCMX)(4-chloro-3,5-dimethylphenol; p-chloro-m-xylenol) kills bacteria but *Psuedomonas aeruginosa* and many moulds are highly resistant (McDonnell 1999).

There are a number of variables associated with surgical antisepsis. These include: the selection of antiseptic agent, the pre-antisepsis hand wash, the duration of the process and the use of brushes, sponges or nail picks.

Numerous organisations provide guidelines for surgical hand antisepsis including the Centers for Disease Control (Mangram 1999), the Association for Professionals in Infection Control and Epidemiology (Larson 1995), the Association of periOperative Registered Nurses (AORN 2004), the Association for Perioperative Practice (NATN 2004) the Australian College of Operating Room Nurses (ACORN 2004) and the Hospital Infection Society (HIS 2001). However, there are variations in their recommendations.

The Association for periOperative Registered Nurses (AORN 2004) recommends a simple hand wash prior to antisepsis and that the antiseptic agent complies with Food and Drug Administration regulations. Brushes are not recommended and sponges are only required according to manufacturers' instructions. AORN 2004 states that timed scrubs may be used but does not state what the recommended duration is, though the Association cites studies which show a three to four minute scrub to be as effective as a five minute scrub. AORN 2004 states that alcohol hand rubs (following a hand wash with soap) are an acceptable alternative to surgical scrubs.

The Centers for Disease Control and Prevention (Mangram 1999) recommend conducting a simple hand wash before using alcohol rubs, and that the surgical scrub should last between two and six minutes. The Association for Perioperative Practice (AfPP) (NATN 2004) recommends a simple hand wash prior to the first scrub of the day using plain or antimicrobial soap and running water. Scrubbing brushes are not necessary and antiseptic solutions should be antiseptic or alcohol based and have a broad spectrum of activity and a residual effect. They also state that a two minute scrub is sufficient. Some organisations, including AfPP, differentiate between the first (initial) antisepsis of the day and subsequent antisepsis. AfPP state that alcohol hand rubs are an acceptable alternative for subsequent scrubs but not the initial scrub (NATN 2004). However, AfPP also states that subsequent scrubs should be the same as initial scrubs to reduce confusion and assist with compliance (NATN 2004). The Hospital Infection Society (HIS 2001) presents only two recommendations: that a two minute scrub is sufficient and that alcohol hand rubs are an acceptable alternative to surgical scrubs.

The Australian College of Operating Room Nurses (ACORN 2004) states that all antiseptic solutions must be approved by the Therapeutic Goods Administration and used in accordance with manufacturers' instructions. Antiseptics must have a broad spectrum of activity in reducing growth and inhibiting numbers of transient and resident micro-organisms, be fast acting and have a persistent effect. The ACORN guidelines suggest that antiseptics should have a cumulative effect (repeated exposure inhibits bacterial growth for a number of days). They also state that in the absence of research evidence regarding the length of the surgical scrub, skin contact time with antiseptics should comply with manufacturers' instructions and standardised antiseptic procedures should be implemented. A five minute scrub is recommended for the first scrub of the day followed by three minute subsequent scrubs. If alcohol hand rubs are used these should be performed as per manufacturers' instructions. ACORN do not state if alcohol hand rubs are alternatives to initial scrubs or just subsequent scrubs.

The guidelines for surgical antisepsis produced by the national associations also include recommendations regarding jewellery, artificial nails and nail polish (Mangram 1999; HIS 2001; NATN 2004; AORN 2004). The impact of these factors, including rings, on surgical site infection, is the focus of another Cochrane review (Arrowsmith 2003).

There are concerns that excessive scrubbing and frequent hand washing cause skin damage and dermatological problems for staff (Larson 2001). This skin damage may lead to changes in normal bacterial hand flora and the shedding of more organisms which may potentially increase the risk of transferred infections from staff to patients. In addition, performing hand antisepsis uses personnel time. Therefore it is necessary to evaluate the clinical impact of surgical hand antisepsis.

There are many recommendations for practice which practitioners must consider and a review of the evidence will enable practitioners to be guided as to the most effective way of undertaking a surgical antisepsis which leads to a reduction in surgical site wound infection.

In this review surgical hand antisepsis is used as an encompassing term to describe both methods of surgical antisepsis: scrubbing and rubbing. The very first antisepsis of the day is referred to as the initial antisepsis. Scrubs or rubs performed after an initial antisepsis but still during the same day are referred to as subsequent antisepsis.

OBJECTIVES

To determine the effects of surgical hand antisepsis on the number of surgical site infections (SSIs) in patients. The secondary objective is to determine the effects of surgical hand antisepsis on the number of bacteria colony forming units (CFUs) present on the hands of the surgical team.

METHODS

Criteria for considering studies for this review

Types of studies

All published and unpublished randomised controlled trials (RCTs) of surgical hand antiseptic techniques were included. Controlled clinical trials were to be considered in the absence of RCTs. Two possible units of randomisation were considered: the scrub team or individual members of the scrub team.

Types of participants

All members of the scrub team or personnel working within the operating theatre or day case setting.

Types of interventions

This review will include comparisons of the following with each other and/or placebo and/or no antisepsis:

- Surgical hand antisepsis;
- Aqueous scrub solutions;
- Alcohol rubs;
- Alcohol rubs containing additional active ingredients;
- Surgical hand antisepsis of different durations;
- Surgical hand antisepsis different equipment e.g., brush, sponge, nail pick.

Types of outcome measures

Primary outcomes

Post-operative surgical site infection (SSI) rate

Secondary outcomes

Number of bacterial CFUs found on the hands of the surgical team at the end of an operation.
Rates of septicaemia

Search methods for identification of studies

Electronic searches

We searched the following databases:
Cochrane Wounds Group Specialised Register (Searched 12/6/07)
CENTRAL - The Cochrane Library 2007, Issue 2
Ovid MEDLINE - 2005 to May Week 5 2007
Ovid EMBASE - 2005 to 2007 Week 23
Ovid CINAHL - 2005 to June Week 2 2007
ZETOC database of conference proceedings was searched from 1993 to 2005.
The Cochrane Wounds Group Specialised Register has been compiled through searching the major health databases including MEDLINE, CINAHL and EMBASE and is regularly updated through searching the Cochrane Central Register of Controlled Trials, hand searching wound care journals and relevant conference proceedings.
The following search strategy was used for searching CENTRAL:
1 MeSH descriptor Surgical Wound Infection explode all trees
2 surgical NEAR infection*
3 surgical NEAR wound*
4 (post-operative or postoperative) NEAR (wound NEXT infection*)
5 MeSH descriptor Preoperative Care explode all trees
6 MeSH descriptor Perioperative Care explode all trees
7 preoperative or pre-operative
8 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7)
9 MeSH descriptor Skin explode all trees
10 MeSH descriptor Antisepsis explode all trees
11 (#9 AND #10)
12 antisepsis
13 MeSH descriptor Iodine explode all trees
14 MeSH descriptor Iodophors explode all trees
15 MeSH descriptor Povidone-Iodine explode all trees
16 MeSH descriptor Chlorhexidine explode all trees
17 MeSH descriptor Alcohols explode all trees
18 MeSH descriptor Soaps explode all trees
19 MeSH descriptor Detergents explode all trees
20 MeSH descriptor Disinfection explode all trees
21 iodophor* or povidone-iodine or betadine or chlorhexidine or alcohol or alcohols or antiseptic* or soap* or detergent* or disinfect*
22 (#11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR
#20 OR #21)
23 MeSH descriptor Handwashing explode all trees
24 hand or hands or handwash* or surgical scrub*)
25 (#23 OR #24)
26 (#8 AND #22 AND #25)

Searching other resources

The bibliographies of all retrieved and relevant publications identified by these strategies were searched for further studies. There were no restrictions based on language or date of publication.

Data collection and analysis

Selection of studies

Three authors independently assessed the titles and abstracts of potentially relevant studies identified through the search strategy, using the selection criteria. All studies that potentially met the criteria were retrieved in full. If it was unclear from the title or abstract whether a study met the criteria or there was a disagreement over the eligibility, the study was retrieved in full. The three authors then decided independently whether to include or exclude a study. There were no disagreements among authors regarding which studies to include.

Attempts were made to contact seven authors to obtain further information (Gupta 2007, Hajipour 2006; Herruzo 2000; Kappstein 1993; Pereira 1997; Pietsch 2001; Sensoz 2003). Five authors responded (Hajipour 2006; Herruzo 2000; Kappstein 1993; Pereira 1997; Sensoz 2003). Hajipour 2006, Herruzo 2000, Pereira 1997 and Pietsch 2001 are included in the review. Gupta 2007 is also included in the review, though the findings presented are those reported by Gupta and have not been subject to independent analysis. Sensoz 2003 is awaiting assessment until additional information data is obtained. One study published in German was translated and subsequently included in the review (Kappstein 1993).

Excluded studies along with the reasons for their exclusion are listed in the Characteristics of excluded studies.

Data extraction and management

A standardised data extraction form was piloted and used. Two authors independently extracted data from eligible studies onto data extraction forms. The extracted data was cross-checked by a third author. Data extracted included:

Trial data extracted

- Duration of surgical antisepsis
- Antiseptic solution used
- Equipment used e.g. brush, sponge, nail pick
- Role of the person carrying out the hand antisepsis - for example, scrub nurse or surgeon
- Scrub history of the person scrubbing - for example, initial or subsequent scrub
- Surgical specialty - for example, orthopaedics, ophthalmics, urology etc
- Type of surgical procedure: elective or emergency
- Duration of surgical procedure
- Surgical glove material
- Size of groups
- Method of surgical site infection detection
- Duration of follow up

Trial outcomes

- Post-operative SSI rates
- Numbers of bacteria on hands of surgical team (CFUs)
- Rates of septicaemia

Assessment of risk of bias in included studies

Quality assessment

1. Adequacy of the randomisation process

A - Adequate - sequence generation was regarded as using random number tables, computer random number generation, coin tossing, or shuffling.

B - Did not specify one of the adequate reported methods in (A) but mentioned randomisation method.

C - Other methods of allocation that appear to be biased.

2. Adequacy of allocation concealment

A - Adequate - allocation concealment was regarded as a procedure that would not allow investigator/participant to know or influence intervention group before eligible participant entered in the study, such as central randomisation; serially numbered, opaque, sealed envelopes;

B - Unclear - unclearly concealed trials in which the author either did not report an allocation concealment approach at all, or reported an approach that did not fall into one of the categories in (A);

C - Inadequate - Inadequately concealed trials in which method of allocation is not concealed, such as alteration methods or use of case record numbers or unsealed envelopes; any information in the study that indicated that investigators or participants could influence intervention group.

3. Blinding

A - Blinding of treatment providers: Yes/No/Not stated

B - Blinding of participants: Yes/No/Not stated

C - Blinding of outcome assessor: Yes/No/Not stated

D - Blinding of data analysis: Yes/No/Not stated

4. Intention-to-treat analysis (ITT)

A - Yes: If specifically reported by authors that ITT was undertaken and this was confirmed on study assessment, or not stated but evident from study assessment that ITT was undertaken;

B - Unclear. Reported but unable to confirm on study assessment, or not reported and unable to confirm by study assessment;

C - No: Lack of ITT confirmed on study assessment (patients who were randomised were not included in the analysis because they did not receive the study intervention, they withdrew from the study or were not included because of protocol violation) regardless of whether ITT reported or not.

5. Completeness of follow up: percentage of participants for whom data was complete at defined study end-point.

6. Pre-trial sample size calculations reported: Yes / No

7. Use of clear inclusion and exclusion criteria: Yes / No

Data synthesis

Data were entered onto Cochrane RevMan 4.2 software and analysed using Cochrane MetaView. Continuous outcomes (CFUs) are reported as weighted mean difference with 95% confidence intervals (CI). Dichotomous outcomes (surgical site infections,

presence of septicaemia) are presented as relative risk (RR) with 95% CI. Clinical and statistical heterogeneity were considered. We examined clinical heterogeneity by looking at the type of intervention. Before pooling was carried out we considered the statistical heterogeneity and I^2 values (Higgins 2003). No trials were considered sufficiently homogenous to be pooled. Study information is presented as a narrative overview.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification.
See also Characteristics of included studies
Ten eligible trials were identified and included in this review. One trial reported rates of SSI; the primary outcome (Parienti 2002). The remaining nine trials reported the secondary outcome; numbers of CFUs. Four trials measured the relative effects of different aqueous scrub solutions (Furukawa 2005; Herruzo 2000; Pereira 1990a; Pereira 1997). Two trials measured the relative effect of alcohol rubs containing additional active ingredients (Gupta 2007; Pereira 1997). Six trials determined the effect of performing an aqueous scrub compared with an alcohol rub containing additional active ingredients (Gupta 2007; Hajipour 2006; Herruzo 2000; Parienti 2002; Pereira 1997; Pietsch 2001). Four trials explored the duration of the surgical scrub (Kappstein 1993; Pereira 1990a; Pereira 1997; Wheelock 1997). No trials compared surgical hand antisepsis with no surgical hand antisepsis. No trials compared alcohol only rubs. No trials determined the effect of using a brush, sponge or nail pick during antisepsis. No trials measured septicaemia. One trial (Sensoz 2003) is awaiting assessment until further information is obtained.

Setting and participants

All ten trials took place in operating departments. Two trials took place in the USA (Gupta 2007, Wheelock 1997), two in Germany (Kappstein 1993; Pietsch 2001), one in France (Parienti 2002), one in Spain (Herruzo 2000), one in England (Hajipour 2006), one in Japan (Furukawa 2005) and two in Australia (Pereira 1990a; Pereira 1997). All ten trials used surgeons and, or, operating room staff though the staff in Pereira 1990a were anaesthetic, recovery and ward staff as opposed to scrub staff.

Type of surgery

Participants took part in surgical procedures in five trials (Gupta 2007; Hajipour 2006; Herruzo 2000; Parienti 2002; Pietsch 2001). Parienti 2002 provided detailed information on the nature of the surgery (a mix of gynaecological, obstetric, abdominal, otolaryngology, urology, and orthopaedic procedures). Ophthalmic, podiatric and general surgery was carried out in Gupta 2007. The participants in Herruzo 2000 took part in plastic surgery and traumatology and the participants in Hajipour 2006 worked in the trauma operating theatre. Pietsch 2001 did not provide details of the type of surgery undertaken.
Participants in five trials did not take part in any surgical procedures (Furukawa 2005; Kappstein 1993; Pereira 1990a; Pereira 1997; Wheelock 1997). In three trials (Pereira 1990a; Pereira 1997; Wheelock 1997) the participants waited for between 30 minutes to two hours before the post scrubbing test samples were taken. During this time these participants undertook non scrub activities only while continuing to wear sterile gloves. Pereira 1990a does not state what staff did during their two hour wait, however as participants were not members of the scrub team it is safe to assume that they would not have assisted at the operating table. In Kappstein 1993 samples were taken immediately after antisepsis. Furukawa 2005 states that samples were taken after the scrub. No details are given of how long after scrub or what participants did during this time.

Baseline information

Most trials reported some details of baseline demographics. Parienti 2002 provided detailed information on the surgical procedure, the wound classification, duration of surgery and patient's ASA (American Society of Anesthesiologists) grading. Wheelock 1997 provided some information on the gender, age, hand size and skin condition of participants. Pereira 1990a gave details of the gender, age, ethnicity and hand dominance of the participants. Hajipour 2006 provided details of the grade of the operating surgeon, the patient's order on the operating list and the length of the operative procedure. Pereira 1997 provided minimal details of participant demographics. Gupta 2007 also presented minimal data regarding the participants though he states that none of them were receiving antibiotics. Herruzo 2000 did not provide any demographics for the study participants. Pietsch 2001 did not give any information on the participants or surgical procedures involved. The only information provided by Furukawa 2005 and Kappstein 1993 were pre-scrubbing bacterial counts. The one trial measuring SSIs in patients (Parienti 2002) did not state if patients were given antibiotic prophylaxis prior to surgery.

Definition of scrub procedure

Five trials gave detailed protocols for their antisepsis techniques (Furukawa 2005; Parienti 2002; Pereira 1990a; Pereira 1997; Wheelock 1997). Seven trial authors reported using a brush or sponge (Gupta 2007; Furukawa 2005; Herruzo 2000; Parienti 2002; Pereira 1990a; Pereira 1997; Wheelock 1997). Parienti 2002 and Wheelock 1997 stated that antisepsis protocols met with na-

tional guidelines. Five of the trials employed a supervisor to observe compliance with the antisepsis protocol (Furukawa 2005; Parienti 2002; Pereira 1990a; Pereira 1997; Wheelock 1997). Two trial presented minimal details of the antisepsis protocol (Gupta 2007; Hajipour 2006) and the remaining three trials (Herruzo 2000; Kappstein 1993; Pietsch 2001) did not comment on antisepsis techniques.

Outcome measure

Parienti 2002 was the only trial to measure SSI rates and patients were followed up for 30 days via direct observation, case note review, outpatient visits or a telephone call. SSI was defined using CDC guidelines and had to be confirmed by a surgeon.

The remaining nine trials measured bacterial counts. Hajipour 2006 and Herruzo 2000 measured bacterial counts using the finger press method onto agar plates which were incubated for 24 and 48 hours prior to colony counting. Gupta 2007, Furukawa 2005, Kappstein 1993, Pereira 1990a, Pereira 1997, Pietsch 2001 and Wheelock 1997 all used the glove juice method to test for numbers of bacteria. The glove juice method is the standard test for the effectiveness of antiseptic solutions (FDA 1978). All the trials using the glove juice method present number of CFUs as log 10 counts.

Pietsch 2001 tested participants' hands before antisepsis, immediately after antisepsis and immediately after taking part in a surgical procedure. Pereira 1990a tested both hands of each participant immediately before antisepsis, the non dominant hand immediately after the initial antisepsis, the dominant hand two hours after the initial antisepsis and the dominant hand two hours after the first subsequent antisepsis. Wheelock 1997 tested one hour after antisepsis. The participants in the Pereira 1997 study carried out each intervention for one week. Participants were tested before antisepsis, immediately after antisepsis and two hours after antisepsis on day one and day five of the intervention week. Participants in Gupta 2007 also carried out each intervention for one week and were tested before antisepsis, immediately after antisepsis on day one, and at the end of days two and five. Furukawa 2005 trial lasted one day only and participants were tested before and after antisepsis. In Kappstein 1993 samples were taken before and immediately after antisepsis. Hajipour 2006's participants were tested at the end of each surgical procedure.

Risk of bias in included studies

Randomisation

Reporting of randomisation was poor, with the exception of Parienti 2002 who used random number tables to randomise each surgical service and Hajipour 2006 who also used number tables to randomise individual participants. The trial by Parienti 2002 was complicated in design, being an equivalence, cluster, crossover trial where the unit of randomisation was the surgical service. Each surgical service carried out one intervention for one month and then switched to the alternative intervention the following month. In Pietsch 2001's crossover trial each unit was randomised to conduct one intervention for four weeks. Following a one week gap, each unit then crossed over to an alternative intervention for four weeks. Wheelock 1997 randomised individual staff to use one of two interventions. Staff then crossed over to the alternative intervention a minimum of seven days later. Details of the method of randomisation are not given. Pereira 1990a and Pereira 1997 do not provide any details of the randomisation other than participants were randomly assigned and took part in a Latin square design with four and five arms respectively. Similarly, participants in Gupta 2007's trial were assigned at random to one of three groups. Each group rotated through three interventions. In Furukawa 2005's study nurses were 'randomly divided' into two groups. Herruzo 2000 does not explicitly state whether the study was randomised and the author was contacted for further information. Further communication via e-mail revealed that 'minimal randomisation was achieved'. Kappstein 1993 does not provide details of the randomisation. The participants in Kappstein 1993's study carried out all three interventions in a random sequence.

Allocation Concealment

The method of allocation concealment was not reported in any of the ten trials.

Blinding

Three trials commented on blinding (Gupta 2007; Hajipour 2006; Parienti 2002). Parienti 2002 stated it was not possible during the inpatient follow up phase of the study to blind testers as SSIs had to be confirmed by surgeons and all the surgeons were involved in the study. However, if patients reported infections post discharge then these were validated by investigators using CDC guidelines who were unaware of the group allocation. Gupta 2007 stated it was not possible to blind participants as the antiseptic solutions were obviously different. The microbiologist conducting the laboratory tests in Hajipour 2006's study was unaware of the group allocation of each sample.

Sample sizes

The study carried out by Parienti 2002 included 4387 patients (excluding drop outs) but was powered to show equivalence. One hundred and fifty four members of the surgical team took part in Herruzo 2000 carrying out 55 surgical procedures. All other sample sizes were small (Furukawa 2005 - 22 staff divided into two groups; Gupta 2007 - 18 staff rotating through each of three interventions; Kappstein 1993 - 24 staff rotating through three groups; Wheelock 1997 - 25 staff in a two arm crossover study;

Pereira 1990a - 34 staff rotating in a four arm study; Pereira 1997- 23 staff rotating in a five arm study). Seventy five surgeons took part in Pietsch 2001. In all the above trials the participants were tested once during each intervention, however Hajipour 2006 randomised four surgeons to one of two interventions a total of 53 times.

Gupta 2007, Kappstein 1993, Parienti 2002 and Wheelock 1997 reported carrying out a priori sample size calculations. Parienti 2002 provides a detailed description of this process, stating expected levels of SSIs for the control group and the maximum expected difference in SSIs for the experimental group. Kappstein 1993's sample size was based on a pilot study. Wheelock 1997 does not provide any data used as a basis for the sample size calculation. Gupta 2007 determined that a minimum of six participants would be required to scrub for five days to be able to detect a 15% difference between groups. Furukawa 2005, Herruzo 2000, Pereira 1990a, Pereira 1997 and Pietsch 2001 made no reference to sample size calculations.

Withdrawals

Seven trials reported participants who dropped out (Gupta 2007; Furukawa 2005; Herruzo 2000; Parienti 2002; Pereira 1990a; Pereira 1997; Wheelock 1997). Two participants withdrew from Pereira 1990a citing skin reactions. Two participants who reported skin rashes, burning sensation on their hands, palpitations and a metallic taste in their mouths were withdrawn from Gupta 2007's trial. Nine participants dropped out of Pereira 1997. Reasons for dropping out included sensitivity to an antiseptic and absences from work. No participants dropped out in Furukawa 2005, Herruzo 2000 or Wheelock 1997. None of the patients in Parienti 2002 were reported dropping out though 385 patients were excluded for having contaminated or dirty-contaminated surgery (the trial included patients having clean or clean/contaminated surgery only) and 51 patients were lost during follow up.

Intention to treat analysis

One trial (Parienti 2002) reported conducting an intention to treat analysis, imputing missing patients as having developed SSIs in the alcohol hand rub group and missing patients as having no SSI in the aqueous scrub group. However the use of ITT analysis in an equivalence study is not always appropriate and in addition a per protocol analysis should have been conducted (Jones 1996).

Clear inclusion and exclusion criteria

Gupta 2007 and Parienti 2002 were the only trials to report exclusion criteria.

Effects of interventions

Ten trials are included in this review;

* Surgical hand antisepsis compared with no surgical antisepsis (0 trials)
* Comparisons between different aqueous scrubs (4 trials: Furukawa 2005; Herruzo 2000; Pereira 1990a; Pereira 1997)
* Comparisons between different alcohol rubs (0 trials)
* Comparisons between different alcohol rubs containing additional active ingredients (2 trials: Gupta 2007; Pereira 1997)
* Aqueous scrubs compared with alcohol rubs (0 trials)
* Aqueous scrubs compared with alcohol rubs containing additional active ingredients (5 trials: Gupta 2007; Hajipour 2006; Herruzo 2000; Parienti 2002; Pietsch 2001)
* Antisepsis of varying duration (4 trials: Kappstein 1993; Pereira 1990a; Pereira 1997; Wheelock 1997)
* Surgical hand antisepsis using different equipment (0 trials).

One study (Parienti 2002) measured the primary outcome (SSI). The remaining nine trials measured CFUs and had small sample sizes. Herruzo 2000 and Hajipour 2006 used the finger press method of testing rather than the recognised glove juice method. No trials reported data on septicaemia rates.

Results of continuous data (CFUs) are presented with weighted mean difference 95% CI. Results of dichotomous variables (SSI) are presented with RR 95% CI. All trials measuring bacterial counts, with the exception of Hajipour 2006 and Herruzo 2000, present numbers of CFUs as $\log_{10}$ counts.

Surgical hand antisepsis compared with no surgical hand antisepsis

No trials compared performing surgical antisepsis with no surgical antisepsis.

Comparison between different aqueous scrub solutions: chlorhexidine gluconate compared with povidone iodine (4 trials)

Four studies compared chlorhexidine gluconate with povidone iodine but different regimens were used (Furukawa 2005; Herruzo 2000; Pereira 1990a; Pereira 1997). Pereira 1990a randomly assigned 34 participants to one of four groups and each group was assigned to one of four interventions each lasting one week. The interventions were 4% chlorhexidine gluconate (Hibiclens) or 7% povidone iodine (Betadine) using a five minute initial and three minute subsequent scrub; 4% chlorhexidine gluconate (Hibiclens) or 7% povidone iodine (Betadine) using a three minute initial and 30 second subsequent scrub. Participants were anaesthetic, recovery and ward staff rather than scrub staff and the staff did not participate in any actual surgery. Control of the order of interventions was through a Latin square design. Hand bacterial samples were taken immediately after the initial scrub, two hours after the initial scrub and two hours after the subsequent scrub. Furukawa 2005

compared 4% chlorhexidine gluconate (Hibiscrub) with 7.5% povidone iodine (Isodine) using a three minute scrub and Herruzo 2000 compared three intervention groups; aqueous chlorhexidine gluconate 4%, aqueous povidone iodine 7.5%, and an alcohol rub with N-duopropenide with each scrub or rub lasting three minutes. Pereira 1997 compared 4% chlorhexidine gluconate (Hibiclens) with 5% povidone iodine plus 1% triclosan (Microshield PVP) using a three minute initial and two and a half minute subsequent scrub.

Post operative surgical site infection

Not reported

Number of colony forming units (CFUs)

Chlorhexidine gluconate compared with povidone iodine

Pooling the three trials (four comparisons) (Furukawa 2005; Herruzo 2000; Pereira 1990a; Pereira 1990b) was considered, however in the light of a high degree of heterogeneity (I^2 = 99.8%) this was not undertaken.

Pereira 1990a compared 4% chlorhexidine gluconate (Hibiclens) with 7% povidone iodine (Betadine) using a five minute initial and three minute subsequent scrub. Chlorhexidine was significantly more effective than povidone iodine in reducing the number of CFUs immediately after scrubbing (WMD -0.34: 95% CI -0.64 to -0.04)(Analysis 1.1), two hours after the initial scrub (WMD -0.75: 95% CI -1.06 to -0.44)(Analysis 1.2) and two hours after the subsequent scrub (WMD -1.10: 95% CI -1.42 to -0.78)(Analysis 1.3).

Pereira 1990b compared 4% chlorhexidine gluconate (Hibiclens) with 7% povidone iodine (Betadine) using a three minute initial and 30 second subsequent scrub. There was no significant difference in CFUs immediately post scrubbing (WMD -0.13: 95% CI -0.45 to 0.19)(Analysis 1.1). There were significantly fewer CFUs in the chlorhexidine group compared with the povidone iodine group two hours after the initial scrub (WMD -0.40: 95% CI -0.71 to -0.09)(Analysis 1.2) and two hours after the subsequent scrub (WMD -0.65: 95% CI -0.92 to -0.38)(Analysis 1.3).

Furukawa 2005 compared 4% chlorhexidine gluconate (Hibiscrub) with 7.5% povidone iodine (Isodine) using a three minute scrub. Twenty two scrub nurses were randomised to one of the two intervention groups. Each nurse took part only once. The nurses did not take part in any actual surgery. Hand bacterial samples were taken before and after the scrub and found there were significantly fewer CFUs in the chlorhexidine gluconate group after scrubbing (WMD -2.40: 95% CI -3.26 to -1.54)(Analysis 1.1).

Herruzo 2000 compared three intervention groups; aqueous chlorhexidine gluconate 4%, aqueous povidone iodine 7.5%, and an alcohol rub with N-duopropenide. Each scrub or rub lasted three minutes. One hundred and fifty four members of the surgical team were randomised for 55 operations. CFUs were measured before antisepsis, immediately after antisepsis and at the end of the surgical procedure. A three minute aqueous scrub using chlorhexidine gluconate is significantly more effective in reducing CFUs on hands than a three minute aqueous scrub using povidone iodine immediately after antisepsis (WMD -48.00: 95% CI -50.57 to -45.4) and at the end of a surgical procedure (WMD -132.0: 95% CI -141.20 to -122.80)(Analysis 1.4).

Chlorhexidine gluconate compared with povidone iodine plus triclosan (Analysis 2.1)

Pereira 1997 compared 4% chlorhexidine gluconate (Hibiclens) with 5% povidone iodine plus 1% triclosan (Microshield PVP) using a three minute initial and two and a half minute subsequent scrub. Twenty three operating room nurses were randomised to carry out each of five interventions for one week each. The order of interventions was controlled through a Latin square design. Participants did not take part in any actual surgery. Hand bacterial samples were carried out immediately after the first antisepsis, two hours after the first antisepsis and two hours after the subsequent antisepsis.

No statistically significant differences in the number of CFUs were found immediately after the first antisepsis or two hours after the first antisepsis. A statistically significant difference in favour of chlorhexidine was found two hours after the subsequent antisepsis (WMD -0.69: 95% CI -1.13 to -0.25). This difference is perhaps due to chance or may suggest a cumulative effect.

Comparison of different alcohol rubs

No trials compared alcohol only rubs.

Comparison of different alcohol rubs containing additional active ingredients

Two trials (Gupta 2007; Pereira 1997) compared different alcohol rubs containing additional active ingredients.

Pereira 1997 compared 0.5% chlorhexidine gluconate in isopropanol compared with 0.5% chlorhexidine gluconate in ethanol. The alcohol rubs were used immediately after an aqueous scrub and also as the subsequent antiseptic agent. The active ingredient in both alcohol rubs was the same, i.e. 0.5% chlorhexidine gluconate, and both preparations had 70% strength alcohol, the only difference being the alcohol (isopropanol vs ethanol). Four percent chlorhexidine gluconate scrub followed by an application of 70% isopropanol and 0.5% chlorhexidine gluconate (Hibicol) with subsequent rubs of 70% isopropanol and 0.5% chlorhexidine gluconate, was compared with 4% chlorhexidine gluconate scrub followed by an application of 70% ethanol and 0.5% chlorhexidine gluconate (Microshield Handrub) with subsequent rubs of 70% ethanol and 0.5% chlorhexidine gluconate. Scrubs lasted for two minutes, the initial and subsequent applications of alcohol

rubs lasted for 30 seconds. Twenty three operating room nurses were randomised to carry out each of five interventions for one week each.

Gupta 2007 compared three 2ml aliquots of 1% chlorhexidine gluconate in 61% ethyl alcohol (Avagard) against a three minute application of zinc pyrithione in 70% ethyl alcohol (Triseptin). The 61% alcohol solution is a waterless product and the 70% alcohol solution is a water aided product which requires rinsing with water. Eighteen operating room staff used each product for five consecutive days. Testing was carried out immediately before and after antisepsis on day one, and at the end of days two and five

Post operative surgical site infection

Not reported

Number of colony forming units

0.5% chlorhexidine gluconate in isopropanol compared with 0.5% chlorhexidine gluconate in ethanol (Analysis 3.1)

Pereira 1997 found no statistically significant differences between the isopropanol and ethanol based rubs in terms of the number of CFUs immediately after the first antisepsis (WMD 0.00: 95% CI -0.57 to 0.57), two hours after the first antisepsis (WMD 0.07: 95% CI -0.45 to 0.59) or two hours after the subsequent antisepsis (WMD 0.11: 95% CI -0.49 to 0.71).

1% chlorhexidine gluconate in 61% ethyl alcohol compared with against zinc pyrithione in 70% ethyl alcohol

Gupta 2007 presented insufficient raw data in the trial report to be able to conduct independent statistical analysis, the author has been contacted. In the interim Gupta 2007's own analysis is presented. When the CFUs were compared over the duration of the study Gupta 2007 found no statistical significant difference between the solutions (p=0.21). It must be noted that this analysis has not been independently verified.

There is no evidence that one alcohol rub is better than another, but only two trials were identified which compared different rubs.

Aqueous scrubs compared with alcohol only rubs

No trials compared aqueous scrubs with alcohol only rubs.

Aqueous scrubs compared with alcohol rubs containing additional active ingredients

Five studies compared traditional scrubs with alcohol rubs containing additional active ingredients (Gupta 2007; Hajipour 2006; Herruzo 2000; Parienti 2002; Pietsch 2001). The five trials used different antiseptic solutions therefore it was not appropriate to perform a meta analysis. Each trial is considered separately.

Post operative surgical site infection

Aqueous povidone iodine or chlorhexidine gluconate compared with 75% propanol-1, propanol-2 plus mecetronium ethylsulfate

Parienti 2002 compared a five minute scrub using either 4% povidone iodine (Betadine) or 4% chlorhexidine gluconate (Hibiscrub) against a five minute hand rub using 75% propanol-1, propanol-2 with mecetronium ethylsulfate (Sterillium). Participants in the aqueous scrub group were allowed to choose between chlorhexidine gluconate or povidone iodine scrubs. Participants in the hand rubbing group carried out a single hand wash for one minute with non antiseptic soap at the start of each day.

This was an equivalence, cluster randomised cross over trial. Six surgical services were randomised to use one of the two interventions. The intervention was used for one month and at the end of the month each hospital switched to the alternative intervention. The trial ran for 16 months swapping between groups every month. The entire scrub team in each hospital took part. 4387 consecutive patients undergoing clean and clean contaminated surgery were included in the trial. SSI was assessed at 30 days using the CDC definition. Whilst random number tables were used to generate the randomisation sequence, it is unclear if the trialists accounted for the clustering in the analysis. It is also important to recognise that this is an equivalence trial and is therefore designed to demonstrate the equivalence of the interventions not to demonstrate a statistically significant difference.

Parienti 2002 reported that 2.5% (53/2135) patients developed SSIs in the scrub group compared with 2.4% (55/2252) in the hand rub group, (RR 1.02; 95% CI 0.70 to 1.48). The difference between the SSI rate with scrub and with hand rub was 0.04% (95% CI -0.88 to 0.96). The equivalence of the two protocols in preventing SSI was accepted.

Number of colony forming units

Aqueous chlorhexidine gluconate compared with N-duopropenide (Analysis 4.1)

Herruzo 2000 compared three intervention groups; chlorhexidine gluconate scrub, povidone iodine scrub, and an alcohol rub with N-duopropenide. Each scrub or rub lasted three minutes. Herruzo 2000 was contacted by the review authors and provided additional information regarding sample size. One hundred and fifty four members of the surgical team were randomised for 55 operations. CFUs were measured before antisepsis, immediately after antisepsis and at the end of the surgical procedure.

For the comparison of aqueous chlorhexidine scrub with N-duopropenide rub, Herruzo 2000 found that after antisepsis 50 participants in the chlorhexidine group had a mean CFU log $_{10}$ 18 SD = 6 and 55 participants in the N-duopropenide group had a mean CFU log $_{10}$ <1 SD = 0. After surgery 50 participants in the chlorhexidine group had a mean CFU log $_{10}$ 37 SD =11 and 55 participants in the N-duopropenide group had a mean CFU log $_{10}$ <1 SD = 0. Using bivariate analysis Herruzo 2000 reports that

N-duopropenide is statistically significantly more effective than chlorhexidine in reducing the number of CFUs on participants hands immediately after antisepsis (P value <0.01) and at the end of a surgical procedure (P value <0.01).

Aqueous povidone iodine compared with N-duopropenide (Analysis 5.1)

For the comparison of aqueous povidone iodine scrub with N-duopropenide rub, Herruzo 2000 found that after antisepsis, 49 participants in the povidone iodine group had a mean CFU log $_{10}$ 66 SD = 7 and 55 participants in the N-duopropenide group had a mean CFU log $_{10}$ <1 SD = 0. After surgery 49 participants in the povidone iodine group had a mean CFU log $_{10}$ 169 SD = 31 and 55 participants in the N-duopropenide group had a mean CFU log $_{10}$ <1 SD = 0. Using bivariate analysis Herruzo 2000 reports that N-duopropenide is statistically significantly more effective than povidone iodine in reducing the number of CFUs on participants hands immediately after antisepsis (P value <0.01) and at the end of a surgical procedure (P value <0.01).

Aqueous chlorhexidine gluconate compared with 45% propanol-2, 30% propanol-1 plus 0.2% ethylhexadecyldimethyl ammonium ethylsulfate (Sterillium)(Analysis 6.1)

Pietsch 2001 compared scrubbing using 4% chlorhexidine gluconate (Hibiscrub) with hand rubbing using an alcoholic solution of 45% propanol-2, 30% propanol-1 plus 0.2% ethylhexadecyldimethyl ammonium ethylsulfate (Sterillium). Seventy five surgeons in one hospital participated in this randomised crossover trial using one product for four weeks then changing to the alternative product following a rest week. CFUs were measured before antisepsis, immediately after antisepsis and after the surgical procedure.

Rubbing using 45% propanol-2, 30% propanol-1 with 0.2% ethylhexadecyldimethyl ammonium ethylsulfate (Sterillium) is significantly more effective than scrubbing using 4% chlorhexidine gluconate in reducing CFUs on participants hands immediately after antisepsis (WMD 1.27: 95% CI 1.23 to 1.31) and at the end of the surgical procedure (WMD 1.07: 95% CI 1.03 to 1.11).

Aqueous 4% chlorhexidine gluconate compared with 0.5% chlorhexidine gluconate in 70% alcohol (Analysis 7.1)

Hajipour 2006 compared a 3 minute 4% chlorhexidine gluconate scrub with a 3 minute chlorhexidine in alcohol rub (Hydrex). Hajipour 2006 was contacted by the review authors and provided additional study details. Following an aqueous chlorhexidine scrub at the start of each day, four surgeons were randomised a total of 53 times to one or other intervention. Testing was carried out using the finger press method at the end of each surgical procedure. CFUs were statistically significantly higher in the alcohol rub group (WMD -135.60: 95% CI -153.39 to -117.81) showing the aqueous scrub to be more effective. The findings of this trial are limited, the four participants were not blinded and the same participants were repeatedly randomised.

Aqueous povidone iodine compared with 61% ethyl alcohol and 70% ethyl alcohol

Gupta 2007 compared 7.5% povidone iodine aqueous scrub against two alcohol rubs; three 2ml aliquots of 1% chlorhexidine gluconate in 61% ethyl alcohol (Avagard) and a three minute application of zinc pyrithione in 70% ethyl alcohol (Triseptin). No further details are provided regarding the application of the products. Eighteen operating room staff used each of the three products for five consecutive days. Testing was carried out immediately before and after antisepsis on day one, and at the end of days two and five.

Gupta 2007 presents insufficient raw data to be able to conduct independent statistical analysis and was contacted to request additional data. In the interim Gupta 2007's own analysis is presented. When CFUs were compared collectively from all the sample times Gupta 2007 found no statistically significant difference between the solutions (p=0.21). It must be noted that this analysis has not been independently verified.

Alcohol only rubs compared with alcohol rubs containing additional active ingredients

No trials compared alcohol only rubs against alcohol rubs containing additional active ingredients

Duration of surgical antisepsis

Four trials compared surgical antisepsis of different durations (Kappstein 1993; Pereira 1990a; Pereira 1997; Wheelock 1997). The four trials were of different durations and used different antiseptic agents so it was not possible to perform a meta analysis, each trial is considered separately.

Post operative surgical site infection

Not reported

Number of colony forming units

Two minute scrub compared with three minute scrub (Analysis 8.1)

Wheelock 1997 randomised twenty five operating room nurses and surgical technologists to either a two minute or a three minute scrub. After carrying out the trial scrub the participant changed to the alternative intervention after leaving a gap of one week, though they continued to undertake scrubbing as part of their usual work. Though the intention of the trial authors was for participants to use aqueous 4% chlorhexidine gluconate (Hibiclens), participants with a history of skin irritation (15/25 participants) used either 2% chlorhexidine gluconate or parachlorometaxylenol (PCMX). CFUs were measured one hour after the surgical scrub.

There is no difference in the number of CFUs on hands between a two or a three minute scrub (WMD 0.29: 95% CI -0.13 to 0.71).

Five minute rub compared with a three minute rub (Analysis 9.1)
Kappstein 1993 compared a five minute rub with a three minute rub using alcoholic disinfectant. The disinfectant is not identified. Both rubs follow one minute hand washes using soap and water. Twenty four surgeons carried out each of three intervention groups once in a random order. Samples were taken before and immediately after antisepsis (Outcome 01). Immediately after antisepsis there were significantly fewer CFUs after the shorter three minute rub than after the five minute rub (WMD 0.26 95% CI 0.14 to 0.38). Following a one minute hand wash a three minute rub appears to be more effective than the five minute rub.
Five minute initial and three minute subsequent scrub compared with a three minute initial and 30 second subsequent scrub using chlorhexidine (Analysis 10.1)
Pereira 1990a compared a five minute initial and three minute subsequent scrub with a three minute initial and 30 second subsequent scrub using chlorhexidine gluconate. Thirty four participants were randomly assigned to one of four groups and each group was assigned to one of four interventions each lasting one week.
There was no difference in the number of CFUs for either duration of scrub immediately after the initial scrub (WMD -0.19 95% CI -0.51 to 0.13) or two hours after the initial scrub (WMD -0.23: 95% CI -0.52 to 0.06). However, significantly more CFUs were found two hours after the subsequent scrub when using the 30 second subsequent scrub compared with the three minute subsequent scrub (WMD -0.58: 95% CI -0.92 to -0.24). This shows a 30 second subsequent scrub was less effective than a three minute subsequent scrub with chlorhexidine in reducing the number of CFUs.
Five minute initial and three minute subsequent scrub compared with a three minute initial and 30 second subsequent scrub using povidone iodine (Analysis 11.1)
In the same trial Pereira 1990a compared a five minute initial and three minute subsequent scrub with a three minute initial and 30 second subsequent scrub using povidone iodine.
There was no difference in the number of CFUs immediately after the initial scrub (WMD 0.02: 95% CI -0.28 to 0.32) or two hours after the initial scrub (WMD 0.12: 95% CI -0.21 to 0.45) when using povidone iodine for either a five or a three minute regimen. There is no difference in CFUs between a five minute and a three minute initial scrub when using povidone iodine. There was no difference in the number of CFUs two hours after the subsequent scrub (WMD -0.13: 95% CI -0.37 to 0.11) for either a three minute or a 30 second regimen. There is no difference in CFUs on hands between subsequent scrubs for three minutes and 30 seconds when using povidone iodine.
Five minute initial and three and a half minute subsequent scrub compared with a three minute initial and two and a half minute subsequent scrub using chlorhexidine (Analysis 12.1)
Pereira 1997 compared a five minute initial and a three and a half minute subsequent scrub with a three minute initial and a two and a half minute subsequent scrub using 4% chlorhexidine gluconate. Twenty three operating room nurses were randomised to carry out each of five interventions for one week each.
No statistically significant differences in the number of CFUs were found on participants' hands immediately after the initial antisepsis (WMD 0.08: 95% CI -0.44 to 0.60) or two hours after the initial antisepsis (WMD -0.19: 95% CI -0.78 to 0.40). There is no difference in the number of CFUs on hands between a five minute initial scrub or a three minute initial scrub using chlorhexidine. No statistically significant differences were found in the number of CFUs on participants hands two hours after the subsequent antisepsis (WMD -0.17: 95% CI -0.71 to 0.37). There is no difference in the number of CFUs on hands between a three and a half minute subsequent scrub and a two and a half minute subsequent scrub when using chlorhexidine.

Surgical hand antisepsis using a nail pick compared with surgical hand antisepsis not using a nail pick

No trials determined the effect of using a nail pick during the surgical scrub

Surgical hand antisepsis using a brush compared with surgical hand antisepsis not using a brush

No trials determined the effect of using a brush during the surgical scrub

Surgical hand antisepsis using a sponge compared with surgical hand antisepsis not using a sponge

No trials determined the effect of using a sponge during the surgical scrub

DISCUSSION

This body of evidence is difficult to interpret due to the use of surrogate outcomes and the lack of replication of comparisons.

Ten trials met the inclusion criteria and were included in this review.

Only one trial (Parienti 2002) measured SSI, the primary outcome for this review, and demonstrated equivalence between an alcohol rub of 75% propanol-1, propanol-2 with mecetronium ethylsulfate and aqueous scrubs, in terms of the number of subsequent SSIs.

The remaining nine trials measured hand contamination by the number of CFUs; a surrogate outcome.

Three out of 4 trials comparing aqueous scrub solutions with those containing povidone iodine found chlorhexidine gluconate to be significantly more effective in reducing the number of CFUs on participants' hands (Furukawa 2005; Herruzo 2000; Pereira 1990a). One trial found no difference between an aqueous scrub of chlorhexidine gluconate and an aqueous scrub of povidone iodine plus triclosan (Pereira 1997). High levels of heterogeneity precluded meta analysis.

Results of studies comparing alcohol rubs with aqueous scrubs are mixed and it is not possible to draw firm conclusions. Two trials found alcohol rubs containing additional active ingredients, such as N-duopropenide (Herruzo 2000) and 45% propanol-2, 30% propanol-1 with 0.2% ethylhexadecyldimethyl ammonium ethylsulfate (Pietsch 2001) to be more effective than aqueous scrubs in reducing the number of CFUs on hands. One trial (Gupta 2007) found no difference between povidone iodine scrubs and ethyl alcohol based rubs of 61% and 70%. One trial (Hajipour 2006) found chlorhexidine aqueous scrubs more effective than chlorhexidine in alcohol rubs.

Two trials found no difference in alcohol rubs of 70% isopropanol and 70% ethanol (Pereira 1997), and no difference between a 61% ethyl alcohol and 70% ethyl alcohol rub (Gupta 2007).

Following a one minute hand wash with soap, a three minute alcohol rub was more effective than a five minute alcohol rub (Kappstein 1993). But no difference was found in the number of CFUs on hands when performing aqueous scrubs for different durations (varying from two minutes to five minutes)(Pereira 1990a; Pereira 1997; Wheelock 1997) when using either chlorhexidine or povidone iodine aqueous scrubs. However, subsequent scrubs lasting 30 seconds were less effective in reducing the number of CFUs on hands than three minute subsequent scrubs using aqueous chlorhexidine (Pereira 1990a).

OUTCOME MEASURES

Surgical hand antisepsis is carried out to reduce the number of bacteria on the hands of the surgical team so that in the event of a breach in glove barrier protection, the risk of transferring infections to patients is reduced. Therefore, the most appropriate outcome measure for a study of surgical hand antisepsis is post operative surgical site infection. Only one study used this measure (Parienti 2002), the remaining ten trials measured colony forming units. Colony forming units are a surrogate outcome and the relationship between numbers of CFUs on the hands of the surgical team and risk of surgical site infection in patients is not known. It is assumed that interventions showing no difference in CFUs on hands will also show no difference in SSIs. However it is not known whether interventions which result in a difference in CFUs on hands will also result in a difference in SSIs. There was considerable variation in the timing of outcome assessment for measuring CFUs.

SAMPLE SIZES

The one trial measuring SSIs carried out a priori sample size calculations and included 4387 patients, this was an equivalence trial (Parienti 2002). Three trials measuring CFUs carried out sample size calculations (Gupta 2007; Kappstein 1993; Wheelock 1997) and included 18, 24 and 25 staff respectively. Of the nine trials measuring CFUs the largest included 154 participants (Herruzo 2000) and the smallest included 4 participants (Hajipour 2006). Trials measuring surgical site infection require large sample sizes as SSIs are relatively low. The number of CFUs on hands are high, as evidenced by the use of logarithms to present data. The sample sizes required to detect differences in CFUs may be considerably smaller than those detecting differences in SSI, although this does depend ultimately on the size of the difference the trialists are trying to detect. There was a concern that participants in some trials were randomised and tested several times.

FINDINGS OF THIS REVIEW AND NATIONAL GUIDELINES

Three trials comparing aqueous scrubs (Furukawa 2005; Pereira 1990a; Pereira 1997) show that aqueous chlorhexidine gluconate is significantly more effective than povidone iodine in reducing CFUs on hands, and one trial (Pereira 1997) found no difference between aqueous chlorhexidine and povidone iodine plus triclosan. However it is not known whether a significant difference in CFUs has an impact on surgical site infection. National Association guidelines do not recommend one antiseptic solution over another (ACORN 2004; AORN 2004; Mangram 1999; NATN 2004), stating instead that antiseptic solutions used should comply with licensing agencies, such as the Food and Drugs Administration. A recent national survey of antisepsis practices in the UK found aqueous solutions of chlorhexidine gluconate were the most widely used (49%), followed by aqueous solutions of povidone iodine (35%) (Tanner 2007). Future guidelines should report the superior effect of chlorhexidine gluconate over povidone iodine aqueous scrub in reducing CFUs on hands, but highlight that the clinical impact on SSI is not known.

One trial (Pereira 1997) found a 70% strength isopropanol rub to be as effective as a 70% strength ethanol rub in reducing CFUs on hands. This supports the statement in the APIC Hand Washing Guidelines (Larson 1995) that the concentration of alcohol is more important than the nature of the alcohol. However another trial found no difference between two rubs with different additional active ingredients and alcohol concentrations (Gupta 2007).

One trial (Parienti 2002) measuring SSI demonstrated equivalence between alcohol rubs containing additional active ingredients and aqueous scrubs. In addition, two trials (Herruzo 2000; Pietsch 2001) measuring CFUs found alcohol rubs to be significantly more effective than aqueous scrubs and a third trial found no difference between aqueous scrubs and alcohol rubs (Gupta 2007). A forth trial (Hajipour 2006) found chlorhexidine scrubs

more effective than chlorhexidine in alcohol rubs. The AORN and HIS guidelines state that alcohol rubs are as effective as aqueous scrubs and the NATN guidelines advocate using alcohol rubs for subsequent antisepsis only. As the relationship between CFUs and SSIs is not known it would seem safe to confirm that alcohol rubs containing additional active ingredients can be used as an alternative to all (not just subsequent) aqueous scrubs.

Four trials compared antisepsis of different durations (Kappstein 1993; Pereira 1990a; Pereira 1997; Wheelock 1997). A three minute initial alcohol rub was shown to be more effective in reducing CFUs on hands than a five minute initial alcohol rub. However a 30 second subsequent aqueous scrub using chlorhexidine resulted in significantly more CFUs on hands than a three minute subsequent scrub (Pereira 1990a). The guidelines of a number of organisations recommend varying durations for the aqueous scrub. NATN 2004 and HIS 2001 both recommend timed scrubs of two minutes, AORN 2004 states that three to four minutes are as effective as five minutes, ACORN 2004 recommends a five minute scrub for the first scrub of the day and three minutes for subsequent scrubs and CDC recommends two to six minutes (Mangram 1999).

AORN 2004 and NATN 2004 state that brushes are not necessary but recommend the use of nail picks. No evidence was found in this review to support or reject these statements.

AORN 2004, Mangram 1999 and NATN 2004 recommend a simple hand wash with plain soap at the start of the day. None of the trials reported conducting start of day hand washes with soap. Two trials reported carrying out a simple hand wash before using an alcohol rub (Kappstein 1993; Parienti 2002).

COMPARISON WITH OTHER SYSTEMATIC REVIEWS

One other systematic review of surgical scrubbing was found (Hsieh 2006) which includes three trials (Bryce 2001; Larson 2001b: Wheelock 1997). Hsieh 2006's review was published prior to the publication of Gupta 2007 and Hajipour 2006. This Cochrane review also included Wheelock 1997's study but excluded Bryce 2001 and Larson 2001b as they were not randomised. Six of the eight trials published before 2006 included in this Cochrane review were not identified by Hsieh 2006 (Furukawa 2005; Herruzo 2000; Kappstein 1993; Pereira 1990a; Pereira 1997; Pietsch 2001). One trial (Parienti 2002) included in this review was excluded by Hsieh 2006 because it measured SSIs rather than CFUs.

The review by Hsieh 2006 draws two conclusions: that surgical hand rubs using alcohol based products are more effective than six minute scrubs using 4% chlorhexidine and that there is no evidence that a two minute scrub is more effective than a three minute scrub using 4% chlorhexidine.

This Cochrane review summarises the most up to date available evidence.

LIMITATIONS

The conclusions one can draw from the evidence in this review are limited for the following reasons. Nine of the 10 trials included in this review measured CFUs rather than SSIs (Furukawa 2005; Gupta 2007; Hajipour 2006; Herruzo 2000; Kappstein 1993; Pereira 1990a; Pereira 1997; Pietsch 2001; Wheelock 1997). Two of these trials used the finger press method rather then the recognised standard glove juice test (Hajipour 2006; Herruzo 2000). Participants in five studies did not actually take part in any scrub activities (Furukawa 2005; Kappstein 1993; Pereira 1990a; Pereira 1997; Wheelock 1997). Only four studies carried out a priori sample size calculations (Gupta 2007; Kappstein 1993; Parienti 2002; Wheelock 1997) and sample sizes are small in most of the trials measuring CFUs. In two trials participants in the scrub group had a choice of antiseptic solutions (Parienti 2002; Wheelock 1997) and details of the randomisation are poor in almost all of the trials. Parienti 2002 undertook an equivalence, cluster cross over trial but does not appear to have accounted for the clustering in the analysis.

PUBLICATION BIAS

We attempted to overcome potential publication bias through rigorous searching. One trial, which was included in the review, was published in German and was translated (Kappstein 1993) and three of the included trials were conducted in countries where English is not the first language (Furukawa 2005 - Japan, Herruzo 2000 - Spain, Pietsch 2001- Germany). We attempted to contact seven trial authors for additional information (Gupta 2007; Hajipour 2006; Herruzo 2000; Kappstein 1993; Pereira 1997; Pietsch 2001; Sensoz 2003). Five authors responded (Hajipour 2006; Herruzo 2000; Kappstein 1993; Pereira 1997; Sensoz 2003). Four of these trials are included in the review (Hajipour 2006; Herruzo 2000; Kappstein 1993; Pereira 1997; Pietsch 2001). Sensoz 2003's trial is under assessment until further information is obtained.

Three trials acknowledged commercial companies for supplying antiseptic products (Parienti 2002; Pereira 1990a; Pereira 1997) and one trial was led by a research employee of a commercial company (Pietsch 2001).

AUTHORS' CONCLUSIONS

Implications for practice

There is no evidence of a difference in rates of surgical site infection when surgical teams rub with alcohol containing 75% propanol-1, propanol-2 with mecetronium ethylsulfate or scrub with chlorhexidine gluconate or povidone iodine. This would suggest that alcohol rubs containing additional active ingredients are acceptable alternatives to aqueous scrubs. This finding is supported by two trials measuring CFUs. Alcohol rubs containing additional active

ingredients such as N-duopropenide and 45% propanol-2, 30% propanol-1 with 0.2% ethylhexadecyldimethyl ammonium ethylsulfate appear to be more effective than aqueous scrubs in reducing CFUs on hands, whereas ethyl alcohol based rubs were no different from aqueous povidone iodine scrubs. One small trial did find that chlorhexidine aqueous scrubs were more effective than chlorhexidine in alcohol rubs. However the other trials which compared alcohol rubs with aqueous scrubs gave mixed results.

Aqueous scrub solutions containing chlorhexidine gluconate are more effective than aqueous scrub solutions containing povidone iodine in reducing the number of colony forming units on participants' hands. It is unclear whether adding triclosan to povidone iodine improves its effectiveness. In the absence of information regarding the clinical impact of CFUs on SSI, it is tentatively suggested that aqueous scrub solutions of chlorhexidine gluconate should be used in preference to aqueous povidone iodine scrubs for surgical hand antisepsis.

There is no difference in the numbers of CFUs on hands when performing scrubs of different durations (two, three or five minutes). It was found that subsequent scrubs lasting 30 seconds were less effective in reducing CFUs on hands than three minute subsequent scrubs using aqueous chlorhexidine. It was found that following a one minute hand wash a three minute rub using alcohol disinfectant was more effective than a five minute rub.

No research has examined the role of nail brushes and other equipment in hand antisepsis.

Implications for research

Trials should attempt to measure the impact of hand antisepsis on SSIs. A recognised definition of SSI should be adhered which includes a 30 day follow up. All trials measuring CFUs should use the glove juice test method. Trials should be of adequate sample size, based on a priori sample size calculations and take account of any data clustering. It would be preferable for trial participants to take part in scrubbing activities. The following trials are needed.

- Antisepsis compared with no antisepsis.
- Relative effectiveness of aqueous scrubs compared with alcohol rubs (outcome SSI)
- Optimum duration of aqueous scrubs (outcome SSI)
- Optimum duration of alcohol rubs (outcome SSI)
- Brushes, nail picks and sponges compared with no brushes, nail picks or sponges

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Furukawa 2005

Methods	Randomised controlled trial Generation of random number sequence: no details given Allocation concealment: no details given Blinding: no details given A priori sample calculations: no Antisepsis protocol: yes Withdrawals: no details given Intention to treat analysis: no Clear inclusion or exclusion criteria: no
Participants	22 operating room nurses Baseline comparability: baseline bacterial counts
Interventions	Group 1 - Three minute scrub using aqueous chlorhexidine gluconate. Group 2 - Three minute scrub using aqueous povidone iodine
Outcomes	Outcome measure: CFUs on participants' hands Method of testing: glove juice method Timing of testing: before antisepsis and after antisepsis. (no information regarding how long after antisepsis testing was conducted)
Notes	Participants did not take part in any surgical procedures

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Gupta 2007

Methods	Randomised controlled trial Generation of random number sequence: no details given Allocation concealment: no details given Blinding: not possible to blind participants A priori sample calculations: yes Antisepsis protocol: no Withdrawals: 2 Intention to treat analysis: no Clear inclusion or exclusion criteria: yes
Participants	18 operating room staff working in ophthalmic, podiatric and general surgery Baseline comparability: baseline bacterial counts

Gupta 2007 (*Continued*)

Interventions	Group 1 - Brush application of 7.5% povidone iodine aqueous scrub Group 2 - Three 2 ml application of 1% chlorhexidine gluconate in 61% ethyl alcohol Group 3 - Three minute application of zinc pyrithione in 70% ethyl alcohol and rinsed with water
Outcomes	Outcome measure: CFUs on participants' hands Method of testing: glove juice method Timing of testing: before antisepsis and immediately after antisepsis on day 1, after 6 hours on days 2 and 5
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Hajipour 2006

Methods	Randomised controlled trial Generation of random number sequence: random number table Allocation concealment: no details given Blinding: microbiologist was blinded A priori sample calculations: no Antisepsis protocol: yes Withdrawals: no details given Intention to treat analysis: no Clear inclusion or exclusion criteria: no
Participants	4 surgeons working in a trauma surgery Baseline comparability: surgeon's grade, order of patient on the operating list, duration of surgery
Interventions	Group 1 - Three minute scrub using aqueous chlorhexidine gluconate Group 2 - Three minute application of 0.5% chlorhexidine gluconate in 70% alcohol
Outcomes	Outcome measure: CFUs on participants' hands Method of testing: finger press testing with agar plates Timing of testing: at the end of the surgical procedure
Notes	The 4 surgeons, who were not blinded, were randomised and tested 53 times

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Herruzo 2000

Methods	Randomised controlled trial Generation of random number sequence: no details given Allocation concealment: no details given Blinding: no details given A priori sample calculations: no Antisepsis protocol: minimal details Withdrawals: no details given Intention to treat analysis: no Clear inclusion or exclusion criteria: no
Participants	154 members of the surgical teams working in plastic surgery and traumatology Baseline comparability: baseline bacterial counts
Interventions	Group 1 - Three minute scrub using aqueous chlorhexidine gluconate n = 50 Group 2 - Three minute scrub using aqueous povidone iodine n = 49 Group 3 - Three minute rub with N duopropenide n = 55
Outcomes	Outcome measure: CFUs on participants' hands Method of testing: finger press testing with agar plates Timing of testing: before antisepsis, immediately after antisepsis and at the end of the surgical procedure
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Kappstein 1993

Methods	Randomised crossover trial (participants took part in each of 3 groups) Generation of random number sequence: no details given Allocation concealment: no details given Blinding: no details given A priori sample calculations: yes Antisepsis protocol: no Withdrawals: no details given Intention to treat analysis: no Clear inclusion or exclusion criteria: no
Participants	24 surgeons Baseline comparability: baseline bacterial counts
Interventions	Group 1 - One minute wash with soap and water followed by five minute rub with an alcoholic disinfectant Group 2 - One minute wash with soap and water followed by three minute rub with an alcoholic disinfectant Group 3 - One minute was with Chlorhexidine soap followed by two minutes of rubbing with 0.5% Chlorhexidine in Isopropanol

Kappstein 1993 (*Continued*)

Outcomes	Outcome measure: CFUs on participants' hands Method of testing: glove juice method Timing of testing: before antisepsis and immediately after antisepsis
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Parienti 2002

Methods	Randomised controlled equivalence trial Generation of random number sequence: random number tables Allocation concealment: no details given Blinding: discussed but only conducted during post discharge follow up A priori sample calculations: yes Antisepsis protocol: yes Withdrawals: 51 patients lost during follow up Intention to treat analysis: yes Clear inclusion or exclusion criteria: yes
Participants	Surgical teams within six hospitals were randomised. 4387 patients undergoing clean and clean contaminated surgery were included in the study. Baseline comparability: details of surgical procedures, duration of surgery, patients' ASA classifications
Interventions	Group 1 - Five minute scrub using either 4% povidone iodine or 4% chlorhexidine gluconate Group 2 - Five minute hand rub with alcohol solution containing 75% propanol-1, propanol -2 with mecetronium ethylsulfate
Outcomes	Outcome measure: SSIs in patients at 30 days using CDC definition Method of testing: Observation by surgeon or infectious disease specialist, case note review, telephone interview Timing of testing: 30 days follow up
Notes	Unclear if clustering is adjusted for in the analysis

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Pereira 1990a

Methods	Randomised controlled trial (Latin square design - participants took part in each of 4 interventions) Generation of random number sequence: no details given Allocation concealment: no details given Blinding: no details given A priori sample calculations: no Antisepsis protocol: yes Withdrawals: 2 participants withdrew Intention to treat analysis: no Clear inclusion or exclusion criteria: no
Participants	34 anaesthetic, recovery and ward nurses Baseline comparability: gender, age, ethnicity, hand dominance, baseline bacterial counts
Interventions	Group 1 - Five minute initial scrub and three minute subsequent scrub using chlorhexidine. Group 2 - Three minute initial and 30 second subsequent scrub using chlorhexidine. Group 3 - Five minute initial and three minute subsequent scrub using povidone iodine. Group 4 - Three minute initial and 30 second subsequent scrub using povidone iodine
Outcomes	Outcome measure: CFUs on participants' hands Method of testing: glove juice method Timing of testing: before antisepsis, immediately after antisepsis, two hours after initial antisepsis, two hours after subsequent antisepsis
Notes	Participants did not take part in any surgical procedures

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Pereira 1990b

Methods	Same trial as Pereira 1990a
Participants	
Interventions	
Outcomes	
Notes	Same trial as Pereira 1990a

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Pereira 1997

Methods	Randomised controlled trial (Latin square design - participants took part in each of 5 interventions) Generation of random number sequence: no details given Allocation concealment: no details given Blinding: no details given A priori sample calculations: no Antisepsis protocol: yes Withdrawals: yes details provided Intention to treat analysis: no Clear inclusion or exclusion criteria: no
Participants	23 operating room nurses Baseline comparability: age, gender, skin condition, baseline bacterial counts
Interventions	Group 1 - Five minute initial and three and a half consecutive scrub using 4% chlorhexidine. Group 2 - Three minute initial and two and half minute consecutive scrub using 4% chlorhexidine. Group 3 - Three minute initial and two and half minute consecutive scrub using povidone iodine with triclosan. Group 4 - Three minute initial scrub using 4% chlorhexidine followed by a 30 second application of isopropanol 70% and chlorhexidine 0.5%, and consecutive scrubs using 30 second application of isopropanol 70% and chlorhexidine 0.5%. Group 5 - Two minute initial scrub using 4% chlorhexidine followed by a 30 second application of ethanol 70% and chlorhexidine 0.5%, and consecutive scrubs using 30 second application of ethanol 70% and chlorhexidine 0.5%
Outcomes	Outcome measure: CFUs on participants' hands Method of testing: glove juice method Timing of testing: before antisepsis, immediately after antisepsis, two hours after initial antisepsis, two hours after subsequent antisepsis
Notes	Participants did not take part in any surgical procedures

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Pietsch 2001

Methods	Randomised crossover trial Generation of random number sequence: no details given Allocation concealment: no details given Blinding: no details given A priori sample calculations: no Antisepsis protocol: no Withdrawals: no details given Intention to treat analysis: no Clear inclusion or exclusion criteria: no
Participants	75 surgeons Baseline comparability: baseline bacterial counts
Interventions	Group 1 - Surgical scrub using 4% chlorhexidine (details of the duration are not given) Group 2 - Alcohol rub using Sterillium (details of the duration are not given)
Outcomes	Outcome measure: CFUs on participants' hands Method of testing: glove juice method Timing of testing: before antisepsis, immediately after antisepsis and after surgical procedure completed
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Wheelock 1997

Methods	Randomised crossover trial Generation of random number sequence: no details given Allocation concealment: no details given Blinding: no details given A priori sample calculations: yes Antisepsis protocol: yes Withdrawals: no details given Intention to treat analysis: no Clear inclusion or exclusion criteria: no
Participants	25 operating theatre nurses and surgical technologists Baseline comparability: age, gender, hand size, role, length of perioperative experience
Interventions	Group 1 - Three minute surgical scrub using either 4% chlorhexidine, 2% chlorhexidine or parachlorometaxylenol Group 2 - Two minute surgical scrub using either 4% chlorhexidine, 2%chlorhexidine or parachlorometaxylenol

Wheelock 1997 (*Continued*)

Outcomes	Outcome measure: CFUs on participants' hands Method of testing: glove juice method Timing of testing: one hour after antisepsis
Notes	Participants did not take part in any surgical procedures.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

CFUs: colony forming units
SSI: surgical site infection
ASA: American Society of Anesthesiologists
CDC: Centers for Disease Communications

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Aly 1983	A laboratory based study.
Aly 1988	A laboratory based study.
Aly 1998	Evaluated patient skin preparations
Arata 1993	Evaluated patient skin preparations.
Ayliffe 1984	A discussion paper.
Ayliffe 1988	A laboratory and ward study - not hand antisepsis.
Bartzokas 1983	A laboratory based study.
Beeuwkes 1986	Participants were not randomised.
Bendig 1990	A laboratory based study.
Bibbo 2005	Evaluated patient skin preparations.
Boyce 2000a	An editorial.

(*Continued*)

Boyce 2000b	Evaluated skin condition rather than SSIs or CFUs.
Breeze 1994	Discussion paper.
Brooks 2001	Evaluated patient skin preparations.
Bryce 2001	Not a randomised controlled trial. Participants used product A for 2 weeks then swapped to product B for the following 2 weeks
Cheng 2001	Literature review.
Coelho 1984	Not relevant to this review.
Cremieux 1989	A laboratory based study.
Crowder 1967	Study was not randomised. Participants performed antisepsis using their usual solution. There were no comparison groups
Culligan 2005	Randomised controlled trial comparing antiseptic solutions on patients' skin
Dahl 1990	Chlorhexidine scrub which was left on the surgeons arm was compared with a surgeons arm where the chlorhexidine scrub was rinsed off. Did not meet the objectives of this review
Deshmukh 1998	Participants were randomised to two groups. Group 1 participants were tested after 1 hour and group 2 participants were tested after 2 hours. Participants in both groups used product A one day and product B the next day
Dineen 1969	Participants' hands were covered with bacterial inoculum. A laboratory based study
Dineen 1978	A laboratory based study.
Ellenhorn 2005	Evaluated patient skin preparations.
Faogali 1995	A laboratory style study using non clinical hospital staff.
Grabsch 2004	Not randomised
Grinbaum 1995	A retrospective study.
Gruendemann 2001	Discussion paper.
Hagen 1995	Evaluated patient skin preparations.
Heeg 2001	Measured the impact of hand care products on alcohol rubs.
Hibbard 2002a	A laboratory based study.

(*Continued*)

Hibbard 2002b	A laboratory based study.
Hingst 1992	A laboratory based study.
Hobson 1998	A laboratory based study.
Hubner 2006	A laboratory based study.
Jeng 1998	A laboratory based study.
Jeng 2001	A study of skin antiseptics used on patients skin
Jones 2000	A laboratory based study and participants were not randomised
Joress 1962	No comparison group was used in the first part of the trial. Comparison groups were used in the second part of the trial but solutions were applied to the forearm rather than as surgical scrubs
Kampf 2005	A laboratory based study.
Kikuchi 1999	Measured condition of skin on hands of participants. Did not compare CFUs or SSIs
Kong 1994	Not relevant topic.
Larson 1984	Study focused on hand washing rather than hand antisepsis.
Larson 1986a	A laboratory based study.
Larson 1986b	A laboratory based study.
Larson 1990	A laboratory based study.
Larson 1993	A laboratory based study.
Larson 2001	Study of hand washing in intensive care
Larson 2001b	Not randomised to appropriate groups. Five participants were randomised to a reference group at the beginning of the study. The participants randomised to the intervention group used an alcohol rub for 3 weeks and then a surgical scrub for 3 weeks
Lilly 1978	A laboratory based study.
Loeb 1997	Study carried out on volunteers, not scrub staff in an operating theatre
Lowbury 1974a	Not relevant to this review.
Lowbury 1974b	A laboratory based study.

(*Continued*)

Lung 2004	A literature review.
Magann 1993	Evaluated patient skin preparations.
Mathias 2000	A discussion paper.
Mathias 2002	A discussion paper.
McBride 1973	A laboratory based study.
Meers 1978	Not relevant topic.
Minakuchi 1993	A study of hand washing rather than hand antisepsis.
Mulberry 2001	A laboratory based study.
Murie 1980	Crossover trial but without any randomisation.
O'Shaughnessy 1991	All participants carried out intervention 1 on day 1, intervention 2 on day 2 and intervention 3 on day 3. No randomisation
Paulson 1994	A laboratory based study.
Paulson 1999b	A laboratory based study.
Peterson 1978	A laboratory based study.
Phimolsarnti 1986	Not randomised.
Poon 1998	Not randomised.
Reverdy 1984	A laboratory based study.
Rotter 1980	A laboratory based study.
Rotter 1984	Study of hand washing rather than hand antisepsis.
Rotter 1986	A laboratory based study.
Rotter 1998	A laboratory based study.
Rotter 2005	Explores hand hygiene rather than hand antisepsis.
Sattar 2000	A laboratory based study.
Scott 1991	Evaluated user satisfaction

(*Continued)*

Shirahatti 1993	Evaluated patient skin preparations.
Springer 2002	Discussion paper.
Starr 2005	Evaluated patient skin preparations.
Tucci 1977	Not a randomised controlled trial. There was no control group
Vogt 2006	Evaluated iodine based wound dressings.
Voss 1997	Looked at compliance with various hand washing methods.
Walwaikar 2002	Each intervention group contained a scrub solution, a patient prep solution and a follow up wound cleansing product. It was not possible to look at the effect of the scrub solution on its own
Zaragoza 1999	A study of hand washing not hand antisepsis.

CFUs: colony forming units
SSIs: surgical site infection

Characteristics of studies awaiting assessment *[ordered by study ID]*

Sensoz 2003

Methods	
Participants	
Interventions	
Outcomes	
Notes	awaiting information from author

DATA AND ANALYSES

Comparison 1. Chlorhexidine versus Iodine

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs immediately after antisepsis	4		Mean Difference (IV, Random, 95% CI)	Totals not selected
2 CFUs 2 hours after initial antisepsis	2	136	Mean Difference (IV, Random, 95% CI)	-0.58 [-0.92, -0.23]
3 CFUs 2 hours after subsequent antisepsis	2	136	Mean Difference (IV, Random, 95% CI)	-0.87 [-1.31, -0.43]
4 CFUs after surgical procedure	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Comparison 2. Chlorhexidine versus Iodine plus Triclosan

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 immediately after antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.2 2 hours after initial antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.3 2 hours after subsequent antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 3. Rub versus Rub - Pereira

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 immediately after antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.2 2 hours after initial antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.3 2 hours after subsequent antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 4. Scrub versus Rub - Herruzo (Chlorhexidine)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 immediately after antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.2 after surgical procedure	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 5. Scrub versus Rub - Herruzo (Iodine)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 immediately after antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.2 after surgical procedure	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 6. Scrub versus Rub - Peitsch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 immediately after antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.2 after surgical procedure	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 7. Scrub versus Rub - Hajipour

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1	53	Mean Difference (IV, Fixed, 95% CI)	-135.6 [-153.39, -117.81]

Comparison 8. Duration - Wheelock (2 minutes versus 3 minutes)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs 1hour after antisepsis	1	50	Mean Difference (IV, Fixed, 95% CI)	0.29 [-0.13, 0.71]

Comparison 9. Duration - Kappstein (5 minutes versus 3 minutes)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs immediately after antisepsis	1	48	Mean Difference (IV, Fixed, 95% CI)	0.26 [0.14, 0.38]

Comparison 10. Duration - Periera (5+3 minutes versus 3+0.5 minutes with Chlorhexidine)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 immediately after antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.2 2 hours after initial antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.3 2 hours after subsequent antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 11. Duration - Periera (5+3 minutes versus 3+0.5 minutes with Iodine)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 immediately after antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.2 after initial antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.3 2 hours after subsequent antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 12. Duration - Pereria (5+3.5 minutes versus 3+2.5 minutes with Chlorhexidine)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 CFUs	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 immediately after antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.2 2 hours after initial antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable
1.3 2 hours after subsequent antisepsis	1		Mean Difference (IV, Fixed, 95% CI)	Not estimable

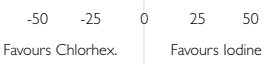
Analysis 1.1. Comparison 1 Chlorhexidine versus Iodine, Outcome 1 CFUs immediately after antisepsis.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 1 Chlorhexidine versus Iodine

Outcome: 1 CFUs immediately after antisepsis

Study or subgroup	Chlorhexidine N	Mean(SD)	Iodine N	Mean(SD)	Mean Difference IV,Random,95% CI	Mean Difference IV,Random,95% CI
Furukawa 2005	11	0.1 (0.4)	11	2.5 (1.4)		-2.40 [-3.26, -1.54]
Herruzo 2000	50	18 (6)	49	66 (7)		-48.00 [-50.57, -45.43]
Pereira 1990a	34	3.99 (0.7)	34	4.33 (0.56)		-0.34 [-0.64, -0.04]
Pereira 1990b	34	4.18 (0.64)	34	4.31 (0.7)		-0.13 [-0.45, 0.19]



Analysis 1.2. Comparison 1 Chlorhexidine versus Iodine, Outcome 2 CFUs 2 hours after initial antisepsis.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 1 Chlorhexidine versus Iodine

Outcome: 2 CFUs 2 hours after initial antisepsis

Study or subgroup	Chlorhexidine N	Mean(SD)	Iodine N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Pereira 1990a	34	3.6 (0.64)	34	4.35 (0.65)		50.1 %	-0.75 [-1.06, -0.44]
Pereira 1990b	34	3.83 (0.59)	34	4.23 (0.7)		49.9 %	-0.40 [-0.71, -0.09]
Total (95% CI)	**68**		**68**			**100.0 %**	**-0.58 [-0.92, -0.23]**

Heterogeneity: Tau² = 0.04; Chi² = 2.49, df = 1 (P = 0.11); I² =60%

Test for overall effect: Z = 3.29 (P = 0.0010)

Analysis 1.3. Comparison 1 Chlorhexidine versus Iodine, Outcome 3 CFUs 2 hours after subsequent antisepsis.

Review: Surgical hand antisepsis to reduce surgical site infection

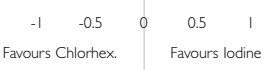
Comparison: 1 Chlorhexidine versus Iodine

Outcome: 3 CFUs 2 hours after subsequent antisepsis

Study or subgroup	Chlorhexidine N	Mean(SD)	Iodine N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Pereira 1990a	34	3.44 (0.81)	34	4.54 (0.48)		48.4 %	-1.10 [-1.42, -0.78]
Pereira 1990b	34	4.02 (0.62)	34	4.67 (0.53)		51.6 %	-0.65 [-0.92, -0.38]
Total (95% CI)	**68**		**68**			**100.0 %**	**-0.87 [-1.31, -0.43]**

Heterogeneity: Tau² = 0.08; Chi² = 4.44, df = 1 (P = 0.04); I² =77%

Test for overall effect: Z = 3.86 (P = 0.00011)



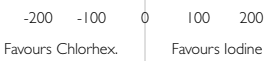
Analysis 1.4. Comparison 1 Chlorhexidine versus Iodine, Outcome 4 CFUs after surgical procedure.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 1 Chlorhexidine versus Iodine

Outcome: 4 CFUs after surgical procedure

Study or subgroup	Chlorhexidine N	Mean(SD)	Iodine N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
Herruzo 2000	50	37 (11)	49	169 (31)		-132.00 [-141.20, -122.80]



Analysis 2.1. Comparison 2 Chlorhexidine versus Iodine plus Triclosan, Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 2 Chlorhexidine versus Iodine plus Triclosan

Outcome: 1 CFUs

Study or subgroup	Chlorhexidine N	Mean(SD)	Iodine triclosan N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 immediately after antisepsis						
Pereira 1997	23	4.41 (0.73)	23	4.79 (0.86)		-0.38 [-0.84, 0.08]
2 2 hours after initial antisepsis						
Pereira 1997	23	4.05 (0.98)	23	4.43 (0.8)		-0.38 [-0.90, 0.14]
3 2 hours after subsequent antisepsis						
Pereira 1997	23	4.13 (0.88)	23	4.82 (0.64)		-0.69 [-1.13, -0.25]

Analysis 3.1. Comparison 3 Rub versus Rub - Pereira, Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 3 Rub versus Rub - Pereira

Outcome: 1 CFUs

Study or subgroup	Isopropanol N	Mean(SD)	Ethanol N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 immediately after antisepsis						
Pereira 1997	23	3.96 (0.96)	23	3.96 (1.01)		0.0 [-0.57, 0.57]
2 2 hours after initial antisepsis						
Pereira 1997	23	3.52 (0.82)	23	3.45 (0.97)		0.07 [-0.45, 0.59]
3 2 hours after subsequent antisepsis						
Pereira 1997	23	3.87 (0.96)	23	3.76 (1.11)		0.11 [-0.49, 0.71]

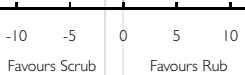
Analysis 4.1. Comparison 4 Scrub versus Rub - Herruzo (Chlorhexidine), Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 4 Scrub versus Rub - Herruzo (Chlorhexidine)

Outcome: 1 CFUs

Study or subgroup	Chlorhexidine Scrub N	Mean(SD)	N duo-propenide Rub N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 immediately after antisepsis						
Herruzo 2000	50	18 (6)	55	1 (0)		0.0 [0.0, 0.0]
2 after surgical procedure						
Herruzo 2000	50	37 (11)	55	1 (0)		0.0 [0.0, 0.0]



Analysis 5.1. Comparison 5 Scrub versus Rub - Herruzo (Iodine), Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 5 Scrub versus Rub - Herruzo (Iodine)

Outcome: 1 CFUs

Study or subgroup	Iodine Scrub N	Mean(SD)	N duo-propenide Rub N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 immediately after antisepsis						
Herruzo 2000	49	66 (7)	55	1 (0)		0.0 [0.0, 0.0]
2 after surgical procedure						
Herruzo 2000	49	169 (31)	55	1 (0)		0.0 [0.0, 0.0]

Analysis 6.1. Comparison 6 Scrub versus Rub - Peitsch, Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 6 Scrub versus Rub - Peitsch

Outcome: 1 CFUs

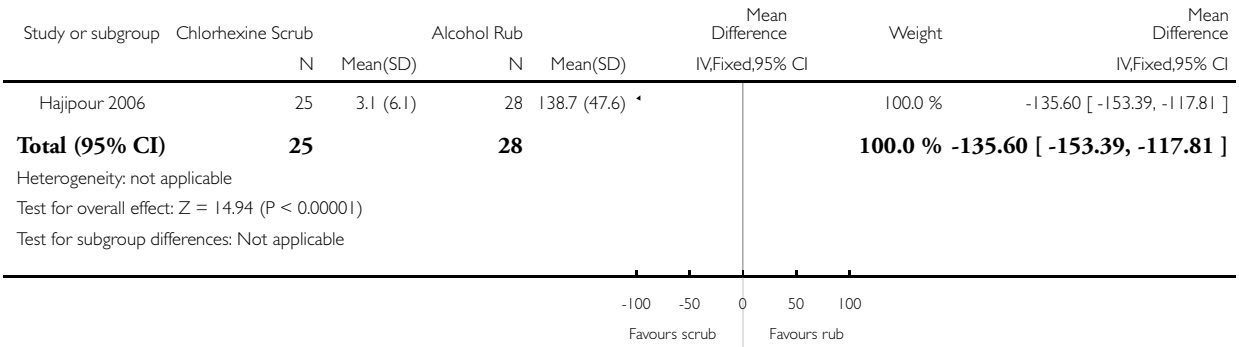
Study or subgroup	Scrub N	Mean(SD)	Rub N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 immediately after antisepsis						
Pietsch 2001	75	4.21 (0.12)	75	2.94 (0.13)		1.27 [1.23, 1.31]
2 after surgical procedure						
Pietsch 2001	75	4.61 (0.09)	75	3.54 (0.13)		1.07 [1.03, 1.11]

Analysis 7.1. Comparison 7 Scrub versus Rub - Hajipour, Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 7 Scrub versus Rub - Hajipour

Outcome: 1 CFUs

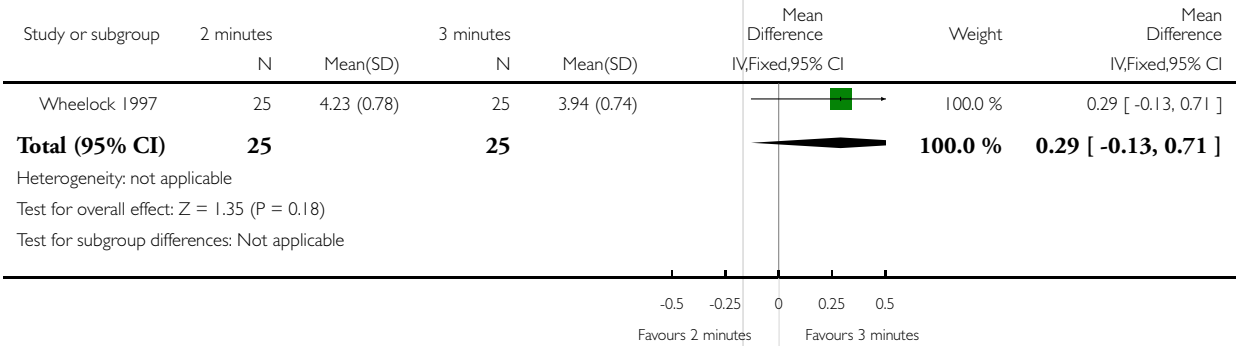


Analysis 8.1. Comparison 8 Duration - Wheelock (2 minutes versus 3 minutes), Outcome 1 CFUs 1hour after antisepsis.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 8 Duration - Wheelock (2 minutes versus 3 minutes)

Outcome: 1 CFUs 1hour after antisepsis



Analysis 9.1. Comparison 9 Duration - Kappstein (5 minutes versus 3 minutes), Outcome 1 CFUs immediately after antisepsis.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 9 Duration - Kappstein (5 minutes versus 3 minutes)

Outcome: 1 CFUs immediately after antisepsis

Study or subgroup	5 minutes N	Mean(SD)	3 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Kappstein 1993	24	4.84 (0.21)	24	4.58 (0.22)		100.0 %	0.26 [0.14, 0.38]
Total (95% CI)	**24**		**24**			**100.0 %**	**0.26 [0.14, 0.38]**

Heterogeneity: not applicable

Test for overall effect: Z = 4.19 (P = 0.000028)

Test for subgroup differences: Not applicable

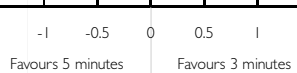
Analysis 10.1. Comparison 10 Duration - Periera (5+3 minutes versus 3+0.5 minutes with Chlorhexidine), Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 10 Duration - Periera (5+3 minutes versus 3+0.5 minutes with Chlorhexidine)

Outcome: 1 CFUs

Study or subgroup	5 minutes N	Mean(SD)	3 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 immediately after antisepsis						
Pereira 1990a	34	3.99 (0.7)	34	4.18 (0.64)		-0.19 [-0.51, 0.13]
2 2 hours after initial antisepsis						
Pereira 1990a	34	3.6 (0.64)	34	3.83 (0.59)		-0.23 [-0.52, 0.06]
3 2 hours after subsequent antisepsis						
Pereira 1990a	34	3.44 (0.81)	34	4.02 (0.62)		-0.58 [-0.92, -0.24]



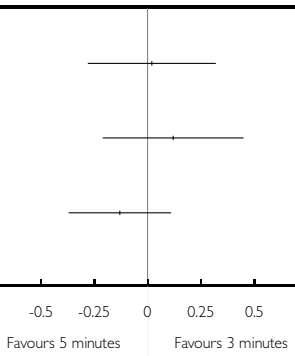
Analysis 11.1. Comparison 11 Duration - Periera (5+3 minutes versus 3+0.5 minutes with Iodine), Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 11 Duration - Periera (5+3 minutes versus 3+0.5 minutes with Iodine)

Outcome: 1 CFUs

Study or subgroup	5 minutes N	Mean(SD)	3 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 immediately after antisepsis						
Pereira 1990a	34	4.33 (0.56)	34	4.31 (0.7)		0.02 [-0.28, 0.32]
2 after initial antisepsis						
Pereira 1990a	34	4.35 (0.65)	34	4.23 (0.74)		0.12 [-0.21, 0.45]
3 2 hours after subsequent antisepsis						
Pereira 1990a	34	4.54 (0.48)	34	4.67 (0.53)		-0.13 [-0.37, 0.11]



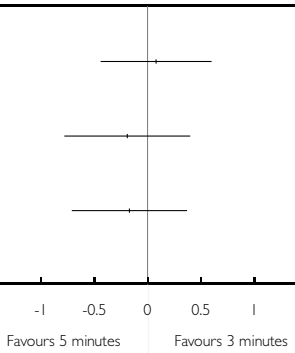
Analysis 12.1. Comparison 12 Duration - Pereria (5+3.5 minutes versus 3+2.5 minutes with Chlorhexidine), Outcome 1 CFUs.

Review: Surgical hand antisepsis to reduce surgical site infection

Comparison: 12 Duration - Pereria (5+3.5 minutes versus 3+2.5 minutes with Chlorhexidine)

Outcome: 1 CFUs

Study or subgroup	5 minutes N	Mean(SD)	3 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Mean Difference IV,Fixed,95% CI
1 immediately after antisepsis						
Pereira 1997	23	4.49 (1.03)	23	4.41 (0.73)		0.08 [-0.44, 0.60]
2 2 hours after initial antisepsis						
Pereira 1997	23	3.86 (1.13)	23	4.05 (0.89)		-0.19 [-0.78, 0.40]
3 2 hours after subsequent antisepsis						
Pereira 1997	23	3.96 (1)	23	4.13 (0.88)		-0.17 [-0.71, 0.37]



F E E D B A C K

Enquiry about status of any ongoing trials, 11 August 2008

Summary

The authors conclusions include suggestions for trials that are needed. Ecolab Ltd would like to know if any of the trials have or are being carried out?
Submitter has modified conflict of interest statement: I certify that I have affiliations with an organization or entity with a financial interest in the subject matter of my feedback.

Reply

Tanner conducted a randomised controlled trial in April to June 2008 comparing nail brushes and nail picks with 164 operating room staff. This study found no difference in the number of colony forming units on the hands of the scrub staff one hour after they had scrubbed with antiseptic solution and a nail pick, antiseptic solution and a nail brush or antiseptic solution alone. The authors of this review have not been informed of other studies in this field.
New searches have been conducted for this review which is currently being updated.

Contributors

Author of feedback: Alex Haworth Occupation Business Development Manager, Ecolab Ltd.
Review author: Judith Tanner

WHAT'S NEW

Last assessed as up-to-date: 3 October 2007.

Date	Event	Description
26 August 2008	Feedback has been incorporated	Response to enquiry regarding the status of ongoing trials.

HISTORY

Protocol first published: Issue 3, 2003

Review first published: Issue 1, 2008

Date	Event	Description
8 August 2008	Amended	Converted to new review format.
4 October 2007	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

JT wrote the protocol, screened citations for eligibility, contacted authors, checked extracted data, entered data into RevMan and wrote the review. SS commented on the protocol, screened citations for eligibility, extracted data and commented on the review. JS commented on the protocol, screened citations for eligibility, extracted data and commented on the review

DECLARATIONS OF INTEREST

JT received payment from Molnlycke Health Care for speaking at study days. Molnlycke Health Care manufactures antiseptic solutions.

SOURCES OF SUPPORT

Internal sources

- Derby Hospitals NHS Foundation Trust, UK.
- De Montfort University, UK.
- University Hospitals of Leicester, UK.

External sources

- Association for Perioperative Practice, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

*General Surgery; Anti-Infective Agents, Local [*administration & dosage]; Antisepsis [*methods]; Colony Count, Microbial; Hand [*microbiology]; Randomized Controlled Trials as Topic; Surgical Wound Infection [epidemiology; *prevention & control]

MeSH check words

Humans