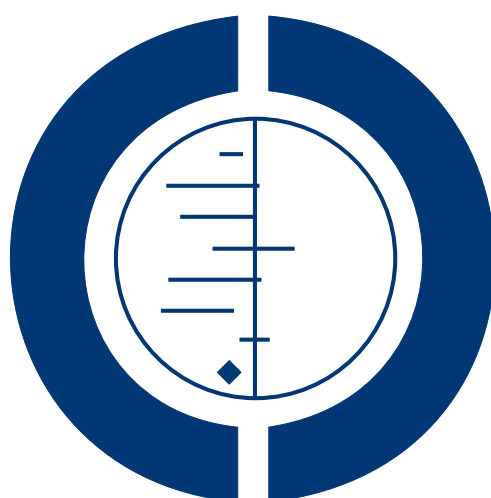


Preoperative hair removal to reduce surgical site infection (Review)

Tanner J, Norrie P, Melen K



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[Intervention Review]

Preoperative hair removal to reduce surgical site infection

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ABSTRACT

Background

Although preparation of people for surgery has traditionally included removal of hair from the incision site, some studies claim that preoperative hair removal is harmful, causes surgical site infections (SSIs), and should be avoided.

Objectives

To determine if routine pre-operative hair removal (compared with no removal) and the timing or method of hair removal influence rates of SSI.

Search strategy

For this second update we searched the Cochrane Wounds Group Specialised Register (searched 12 August 2011); The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2011, Issue 3); Ovid MEDLINE (1950 to August Week 1 2011); Ovid MEDLINE (In-Process & Other Non-Indexed Citations August 11, 2010); Ovid EMBASE (1980 to 2011 Week 31) and EBSCO CINAHL (1982 to 11 August 2011). No date or language restrictions were applied.

Selection criteria

Randomised controlled trials (RCTs) or quasi randomised trials (QRCTs) that compared:

- 1) hair removal with no hair removal;
- 2) different methods of hair removal;
- 3) hair removal at different times before surgery; and,
- 4) hair removal in different settings (e.g. ward, anaesthetic room).

Data collection and analysis

Three authors independently assessed relevance and quality of each trial. Data were extracted independently by two authors and cross-checked.

Main results

We included 14 trials (17 comparisons) in the review; three trials involved multiple comparisons. Six trials, two of which had three comparison arms, (972 participants) compared hair removal (shaving, clipping, or depilatory cream) with no hair removal and found no statistically significant difference in SSI rates however the comparison is underpowered. Three trials (1343 participants) that compared shaving with clipping showed significantly more SSIs associated with shaving (RR 2.09, 95% CI 1.15 to 3.80). Seven trials (1213 participants) found no significant difference in SSI rates when hair removal by shaving was compared with depilatory cream (RR 1.53, 95% CI 0.73 to 3.21), however this comparison is also underpowered. One trial compared two groups that shaved or clipped hair on the day of surgery compared with the day before surgery; there was no statistically significant difference in the number of SSIs between groups however this comparison was also underpowered.

We identified no trials that compared clipping with depilatory cream; or investigated application of depilatory cream at different pre-operative time points, or hair removal in different settings (e.g. ward, anaesthetic room).

Authors' conclusions

Whilst this review found no statistically significant effect on SSI rates of hair removal insufficient numbers of people have been involved in this research to allow confidence in a conclusion. When it is necessary to remove hair, the existing evidence suggests that clippers are associated with fewer SSIs than razors. There was no significant difference in SSI rates between depilatory creams and shaving, or between shaving or clipping the day before surgery or on the day of surgery however studies were small and more research is needed.

PLAIN LANGUAGE SUMMARY

No evidence that routine preoperative hair removal reduces surgical site infection

Traditionally, patients undergoing surgery have hair removed from the site of the incision, as this is thought to reduce the chance of the surgical site becoming infected. Hair can be removed by several different methods which include shaving, clipping the hair and using a cream which dissolves the hair. Existing research studies are too small and methodologically flawed to allow us to draw strong conclusions; on the basis of existing evidence it is not clear whether hair removal pre-operatively affects rates of surgical site infections. However if hair has to be removed to facilitate surgery or the application of adhesive dressings, clipping rather than shaving appears to result in fewer surgical site infections.

BACKGROUND

Description of the condition

The preparation of people for surgery has traditionally included the routine removal of body hair from the intended site of surgical incision. Hair is removed because its presence can interfere with the exposure of the incision and subsequent wound, the suturing of the incision and the application of adhesive drapes and wound dressings (Hallstrom 1993; Miller 2001). Hair is also perceived to be associated with a lack of cleanliness, and the removal of hair is thought to reduce the risk of surgical site infections (SSIs) (Kumar 2002). There are studies, however, which claim that preoperative hair removal is not beneficial, perhaps causes SSIs, and should not be done (Alexander 1983; Court Brown 1981; Horgan 1997).

The Center for Disease Control (CDC) categorises SSIs as: superficial, deep incisional or organ-space, and states that the presence of infection should be identified using both clinical and laboratory findings, and may include the presence of at least one of the following; pus, pain, tenderness, swelling or redness (Mangram 1999). SSIs are experienced by around 10% of patients in the UK each year (NINSS 2001), and can result in delayed wound healing, increased hospital stays, unnecessary pain, and, in extreme cases, the death of the patient (Emmerson 1996; Plowman 2000).

Description of the intervention

Three methods of hair removal are currently used; shaving, clipping and chemical depilation. Shaving is the commonest and cheapest method of hair removal. This method uses a sharp blade,

held within the head of a razor, which is drawn over the patient's skin to cut hair close to the surface of the skin.

Clippers use fine teeth to cut hair close to the patient's skin, leaving a short stubble that is usually around one millimetre in length. The heads of clippers can be disposed of between patients to minimise the risks of cross infection.

Depilatory creams are chemicals which dissolve the hair itself. This is a slower process than either shaving or clipping, as the cream has to remain in contact with the hair for between five and 20 minutes. In addition, there is a risk of irritant or allergic reactions to the cream, so patch tests should be carried out 24 hours before the cream is applied for the first time.

How the intervention might work

During the process of shaving, the skin may experience microscopic cuts and abrasions. It is believed that micro-organisms are able to enter and colonise these cuts, thus contaminating the surgical incision site and causing SSIs (Briggs 1997). In addition, abrasions may exude tissue fluid, which provides a culture medium for micro-organisms (Seropian 1971). Since clippers do not come into contact with the patient's skin, they are thought to reduce the risk of cuts and abrasions (Fogg 1999).

Shaving and clipping can be carried out in operating theatres, anaesthetic rooms, wards or in people's homes by theatre staff, ward staff, or by patients themselves. Chemical depilation is usually carried out on wards, or in the home, as it requires more time. Research has suggested, however, that hair removal should not take place in the operating theatre as loose hair may contaminate the sterile surgical field (Mews 2000). Others have suggested that hair removal should be carried out by skilled personnel to prevent abrasion injuries (Hallstrom 1993; Small 1996).

Why it is important to do this review

Preoperative hair removal practices vary throughout the world. For example, the Center for Disease Control (CDC) strongly recommends that hair should not be removed preoperatively unless the hair at or around the incision site will interfere with the operation (Mangram 1999). This recommendation differs from the Norwegian Centre for Health Technology Assessment (NOKC 2000), which states that *'contrary to the recommendations given by CDC, it is not strongly recommended to avoid preoperative hair removal'*. The Norwegian Centre for Health Technology Assessment found that strong evidence does not exist either in favour of, or against, preoperative hair removal, while the British Hospital Infection Society Working Party guidelines recommend that *'only the area to be incised needs to be shaved'* and that shaving should be avoided if possible (Hospital Infection Society 2003).

A systematic review of preoperative shaving was published in 2002 (Kjonnixsen 2002). The search strategy for this review included

both randomised and observational studies published up to 1999. Evidence for not removing hair came only from observational studies. Strong evidence was found in support of clipping in preference to shaving. Observational studies supported depilation rather than shaving. Moderate evidence, based on observational studies and a randomised study (though this was not statistically significant) found that removal of hair should be done as close to surgery as possible. The recommendations of the Norwegian Centre for Health Technology Assessment are based on the findings of the Kjonnixsen review (Kjonnixsen 2002; NOKC 2000).

If removal of hair is necessary, for example if the surgical site is located in an area covered by thick, dense, or long body hair, the three organisations recommend slightly different methods of removal. The CDC guidelines recommend removal of hair immediately before surgery, and preferably with clippers (Mangram 1999); the Norwegian Centre for Health Technology Assessment guidelines recommend using clippers or cream as close to the surgery as possible (NOKC 2000); and the Hospital Infection Society Working Party guidelines recommend using cream the day before surgery (Hospital Infection Society 2003).

Having a hairless surgical site may ease surgery, the application of dressings and reduce potential infection, as hair is a source of bacteria, but the process of removing hair may cause primary infection because of microscopic cuts to the skin. This review will assess the relative benefits and harms of hair removal, the different methods of hair removal, and the effect of timing of hair removal. The Cochrane review of preoperative hair removal was first published in 2006 (Tanner 2006). This review is the first update of the original review and four new trials have been included (Abouzari 2009; Nascimento 1991; Celik 2007; Ilankovan 1992); with Ilankovan 1992 having been previously excluded. One trial which was previously included has been excluded (Ko 1992). The original Cochrane review of preoperative hair removal has been published as a journal article (Tanner 2007) and a Joanna Briggs Best Practice paper (Hemingway 2007).

OBJECTIVES

Primary question

Does preoperative hair removal influence the rate of SSIs?

Secondary question

What are the effects of different methods of hair removal on SSI? Specifically to determine:

- the relative effects on SSI rates of shaving, clipping and depilatory creams, compared with each other or no hair removal;

- the effect of hair removal immediately before surgery compared with hair removal undertaken more than four hours before surgery on SSI rates;
- the effects of where hair is removed on SSI rates.

METHODS

Criteria for considering studies for this review

Types of studies

RCTs or QRCTs comparing:

- hair removal by any method (shaving, clipping, cream) with no hair removal;
- hair removal by any method (shaving, clipping, cream) compared with hair removal by any other method (shaving, clipping, cream);
- hair removal carried out at different times prior to surgery; and,
- hair removal carried out in different settings (e.g. operating room, anaesthetic room, ward, or the home).

Trials were classified as RCTs if authors had provided sufficient written detail about randomisation to satisfy the reviewers that participants had been allocated randomly into groups. QRCTs were also included and were trials which did not conceal allocation, such as allocation by bed numbers.

Types of participants

Adult patients undergoing surgery in a designated operating theatre. It was anticipated that, where appropriate, studies would be grouped and analysed by type of surgery/anatomical site of surgery.

Types of interventions

We planned to include comparisons between any of the following:

- no preoperative hair removal;
- wet shaving;
- dry shaving;
- clipping;
- depilatory creams;
- hair removal in different environments;
- hair removal conducted at different times preoperatively.

Types of outcome measures

Primary outcomes

The primary outcome is the proportion of patients who develop SSIs.

Secondary outcomes

Secondary outcomes include:

- incidence of wound complications, such as dehiscence or stitch abscesses;
- length of hospital stay;
- cost of hair removal.

Search methods for identification of studies

Electronic searches

The search methods section of the first update of this review can be found in [Appendix 1](#).

For this second update we searched the following databases:

- Cochrane Wounds Group Specialised Register (searched 12 August 2011);
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2011, Issue 3);
- Ovid MEDLINE (1950 to August Week 1 2011);
- Ovid MEDLINE (In-Process & Other Non-Indexed Citations August 11, 2010);
- Ovid EMBASE (1980 to 2011 Week 31);
- EBSCO CINAHL (1982 to 11 August 2011).

The following search strategy was used in the Cochrane Central Register of Controlled Trials (CENTRAL):

```
#1 MeSH descriptor Hair Removal explode all trees
#2 hair NEAR/3 remov*
#3 shav*
#4 clip*
#5 depilat*
#6 (#1 OR #2 OR #3 OR #4 OR #5)
#7 MeSH descriptor Surgical Wound Infection explode all trees
#8 MeSH descriptor Surgical Wound Dehiscence explode all trees
#9 surg* NEAR/5 infection*
#10 surg* NEAR/5 wound*
#11 wound* NEAR/5 infection*
#12 (postoperative or post-operative) NEAR/5 infection*
#13 (#7 OR #8 OR #9 OR #10 OR #11 OR #12)
#14 (#6 AND #13)
```

The search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL are available in [Appendix 2](#), [Appendix 3](#) and

[Appendix 4](#) respectively. The Ovid MEDLINE search was combined with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximizing version (2008 revision) Ovid format ([Lefebvre 2011](#)). The EMBASE and CINAHL searches were combined with the trial filters developed by the Scottish Intercollegiate Guidelines Network (SIGN) ([SIGN 2009](#)). No date or language restrictions were applied.

Data collection and analysis

Selection of studies

Three review authors independently assessed the titles and abstracts of potentially relevant studies identified through the search strategy, using the selection criteria listed above. If it was unclear from the title or abstract whether a study met the criteria, or there was a disagreement over eligibility, the study was retrieved in full and further assessed by three review authors independently as to whether to include or exclude it.

Data extraction and management

We piloted, then used, a standardised data extraction form. Two review authors independently extracted details from eligible studies onto the data extraction forms. The extracted data were cross-checked by a third review author. The data was checked again by one review author after it had been entered into MetaView. Any studies published in duplicate were maximally extracted and the primary study identified. We extracted the following data:

- method of hair removal;
- use of co-interventions e.g., shaving creams;
- setting of hair removal (e.g. ward, anaesthetic room, operating theatre);
- timing of hair removal (e.g. the day before surgery, the hour before surgery);
- type of surgery;
- area of the body depilated;
- role of the person removing the hair (e.g. patient, nurse or surgeon);
- number of postoperative SSIs;
- number of postoperative wound complications (including stitch abscesses, dehiscence or wound breakdown);
- length of postoperative hospital stay;
- cost of hair removal method;
- number of people in each group.

Assessment of risk of bias in included studies

For this review update, two review authors independently assessed each included study using the Cochrane Collaboration tool for

assessing risk of bias ([Higgins 2011](#)). This tool addresses six specific domains, namely sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting and other issues (e.g. extreme baseline imbalance)(see [Appendix 5](#) for details of criteria on which the judgement will be based). Blinding and completeness of outcome data were assessed for each outcome separately. We completed a risk of bias table for each eligible study and discussed any disagreement amongst all review authors to achieve a consensus. We presented an assessment of risk of bias using a 'risk of bias summary figure', which presents all of the judgments in a cross-tabulation of study by entry. This display of internal validity indicates the weight the reader may give the results of each study.

Data synthesis

Data were entered into the Cochrane Collaboration's RevMan 5 software. Results are presented with 95% confidence intervals (CI). All outcomes are dichotomous, and are reported as risk ratio (RR). We examined clinical heterogeneity, looking at the setting of the study, the type of surgery, type of intervention, the sample size and the quality of the study. Before we pooled data, we also considered statistical heterogeneity looking at sample sizes and I^2 values ([Higgins 2003](#)). In the presence of statistical heterogeneity - but where clinical factors suggested pooling was appropriate - a random-effects model was used. A fixed-effect model was used in the absence of both clinical and statistical heterogeneity.

RESULTS

Description of studies

See: [Characteristics of included studies](#); [Characteristics of excluded studies](#); [Characteristics of studies awaiting classification](#).

There were no disagreements between review authors regarding study inclusion. A total of fourteen randomised, or quasi randomised, controlled trials met the inclusion criteria and were included in this review. Thirteen of the trials examined hair removal with different methods. Eleven of these trials involved two arm comparisons; [Balthazar 1983](#) compared razors with clippers. [Breiting 1981](#), [Goeau-Brissonniere 1987](#), [Powis 1976](#), [Seropian 1971](#), [Thorup 1985](#) and [Thur de Koos 1983](#) compared razors with depilatory cream. [Celik 2007](#), [Ilankovan 1992](#), [Nascimento 1991](#) and [Rojanapirom 1992](#) compared hair removal by razor with no hair removal. Two of these trials had three arms; [Abouzari 2009](#) compared razors, clippers and no hair removal. [Court Brown 1981](#) compared razors, depilatory cream and no hair removal. No trials comparing clipping with depilatory cream were identified. One trial examined hair removal at differing times before surgery; this trial, [Alexander 1983](#), had four comparison arms (clipping the day

before surgery, clipping on the morning of surgery, shaving the day before surgery and shaving the morning of surgery). No trials compared hair removal in different settings.

Eight of the articles identified through the search strategy were published in languages other than English and required translation. These articles were published in Danish (Breiting 1981; Thorup 1985), French (Goeau-Brissonniere 1987), German (Westermann 1979), Portuguese (Nascimento 1991), and Chinese (Chen 2002; Wang 1990; Wang 1999). After translation, four of these trials were considered eligible for inclusion in the review (Breiting 1981; Goeau-Brissonniere 1987; Nascimento 1991; Thorup 1985); the remaining four trials were excluded as they did not meet the inclusion criteria (Chen 2002; Wang 1990; Wang 1999; Westermann 1979) (see [Characteristics of excluded studies](#)). Three new trials were included for this update (Abouzari 2009; Celik 2007; Nascimento 1991), and on further assessment one previously excluded trial was included (Ilankovan 1992); and one trial which was previously included was excluded (Ko 1992). The review team agreed that Ilankovan 1992 had met the primary outcome of assessing SSI and Ko 1992 was excluded because patients in each arm received co interventions which were not similar (i.e., the hair removal was not the only systematic difference between the groups). In addition four trials previously excluded because they did not report surgical site infection as an outcome measure (Fraser 1978a; Kovavisarach 2005a; Menéndez 2004a; Menéndez López 2004a) have been added to [Characteristics of studies awaiting classification](#) for consideration at the next update. Forty six trials were excluded after assessment of the full text. Thirty nine were not randomised or quasi randomised controlled trials, these were: Adeleye 2008; Bekar 2001; Bird 1984; Braun 1995; Chen 2002; Clarke 1983; Cruse 1973; Finkelstein 2005; Hallstrom 1993; Howell 1988; Idali 2004; Korfali 1994; Kumar 2002; Le Roux 1975; Maksimovic 2008; Masterson 1984; McIntyre 1994; Mehta 1988; Miller 2001; Mishriki 1990; Moro 1996; Ratanalert 1999; Ratanalert 2004; Scherpereel 1993; Sellick 1991; Sheinberg 1999; Siddique 1998; Small 1996; Stephens 1966; Tang 2001; Vestal 1952; Viney 1992; Waddington 2008; Wang 1990; Wang 1999; Westermann 1979; Winfield 1986; Winston 1992; Zentner 1987. Other reasons for exclusion included contamination between randomised groups in that some people allocated to non shaving were shaved but remained in the non shaved group (Hoe 1985; Lui 1984), not evaluating hair removal (Horgan 1997), and different co-interventions (Ko 1992). Details of the excluded studies are listed in [Characteristics of excluded studies](#).

Hair removal product details

Razors (shaving)

Of the 13 trials that evaluated shaving, two stated use of disposable razors (Court Brown 1981; Thorup 1985), one referred to safety

razors (Balthazar 1983), and one stated that either disposable razors or safety razors with disposable blades were used (Powis 1976). The remaining nine trials did not describe the razors used. Four of the 13 shaving trials stated that they used a wet shaving technique (Balthazar 1983; Court Brown 1981; Goeau-Brissonniere 1987; Thur de Koos 1983). The remaining nine trials did not specify whether the shaving method was wet or dry.

Depilatory cream

Seven trials used depilatory creams, and all seven provided details of the trade name or active ingredients in the creams. These were as follows:

- Veeto: potassium thioglycollate and calcium hydroxide (Court Brown 1981);
- Ipso: calcium thioglycollate trihydrate, calcium hydroxide and strontium hydroxide (Powis 1976);
- Preprep: calcium thioglycollate and calcium hydroxide (Breiting 1981);
- Pilidan: calcium glycolate (Thorup 1985);
- Immac: thioglycolic acid in the form of sodium and calcium (Goeau-Brissonniere 1987);
- Neet: cetyl alcohol, thioglycolic acid (Thur de Koos 1983);
- Calcium thioglycollate, calcium hydroxide, strontium hydroxide (Seropian 1971).

Clippers

Three trials evaluated clippers. Balthazar 1983 used 'ordinary barbers' electric clippers' which were wiped (not sterilised) between patients, but Abouzari 2009 and Alexander 1983 did not provide details of the clippers used.

Type of surgery

Eight trials recruited patients undergoing general surgery (Alexander 1983; Balthazar 1983; Court Brown 1981; Nascimento 1991; Powis 1976; Rojanapirom 1992; Thorup 1985; Thur de Koos 1983); one patients having spinal surgery (Celik 2007), another patients having orthopaedic surgery (Breiting 1981), and two patients undergoing cranial surgery (Abouzari 2009), and maxillo facial surgery (Ilankovan 1992). Two trials provided details of surgical procedures that were excluded from the trial. Goeau-Brissonniere 1987 excluded amputations, vaginal, urological and gynaecological procedures, and Seropian 1971 excluded burns, skin grafts, proctological, circumcisions, abscesses and vaginal surgery.

Timing of hair removal

Ten of the fourteen trials provided some information about the timing of hair removal. In two trials it was done the evening before surgery (Goeau-Brissonniere 1987; Rojanapirom 1992). In four

trials there was a mixture of the evening before surgery and the morning of surgery (Alexander 1983; Court Brown 1981; Powis 1976; Thur de Koos 1983). Three trials stated that hair removal occurred immediately before surgery (Balthazar 1983; Celik 2007; Ilankovan 1992), while another allowed it up to two hours before surgery (Nascimento 1991). One trial compared shaving, or clipping, the evening before surgery with shaving, or clipping, on the day of surgery (Alexander 1983).

Trial setting

Only five trials specified where hair removal took place; e.g. in the operating theatre, the ward or the patient's home. These stated that shaving was carried out on the ward (Breiting 1981; Nascimento 1991; Rojanapirom 1992), or on the operating table (Celik 2007; Ilankovan 1992). No trials compared hair removal in different settings.

Sample size

The sample sizes of the trials varied. The seven smallest trials included 50 to 100 participants (Breiting 1981; Goeau-Brissonniere 1987; Ilankovan 1992; Nascimento 1991; Powis 1976; Rojanapirom 1992; Thorup 1985). Five medium sized trials included 200 to 400 participants (Abouzari 2009; Balthazar 1983; Court Brown 1981; Seropian 1971). The two largest trials had 789 participants (Celik 2007) and 1013 participants (Alexander 1983). No trials reported calculating a required sample size *a priori* on the basis of a clinically significant effect.

Outcome measures

Nine trials provided a definition of infection (Abouzari 2009; Alexander 1983; Balthazar 1983; Celik 2007; Court Brown 1981; Goeau-Brissonniere 1987; Ilankovan 1992; Nascimento 1991; Powis 1976). None of the definitions were recognisable as internationally accepted definitions such as that of the CDC (CDC 2008). The remaining five trials did not give a definition of wound infection (Breiting 1981; Rojanapirom 1992; Seropian 1971; Thorup 1985; Thur de Koos 1983). Eleven trials described how infections were assessed. Seven trials described using bacterial swabs, as well as a visual assessment, to determine infection (Abouzari 2009; Balthazar 1983; Court Brown 1981; Goeau-Brissonniere 1987; Powis 1976; Rojanapirom 1992; Thur de Koos 1983). Four trials appeared to describe infection using a visual assessment only (Alexander 1983; Breiting 1981; Seropian 1971; Thorup 1985). The time at which wound assessment was undertaken varied. Goeau-Brissonniere 1987 and Powis 1976 both assessed at days two and five postoperatively; Balthazar 1983 at day five; Ilankovan 1992 at day seven; Thorup 1985 at day ten; Alexander 1983 at day 30 and at patient discharge; while Abouzari 2009 assessed every three to four weeks until wound healing was complete or an infection had been identified. Court Brown 1981 assessed people daily

while they remained on the ward, and then on day 28; Breiting 1981 assessed at patient discharge and at the first outpatient visit; Rojanapirom 1992 at days two and three and at suture removal on days seven to ten. Nascimento 1991 assessed the surgical incision site from day one to discharge or removal of the sutures on days eight to ten. Celik 2007, Seropian 1971 and Thur de Koos 1983 did not report the timing of assessments.

Some trials assessed additional outcomes. One study measured the length of hospital stay for people with deep infections, superficial infections and people with stitch abscesses (Alexander 1983). Ilankovan 1992 assessed patient and surgeon satisfaction. Three trials reported the financial costs of using razors, clippers and cream (Alexander 1983; Powis 1976; Thorup 1985).

Use of clear inclusion and exclusion criteria

Eight of the trials reported explicit inclusion or exclusion criteria (Abouzari 2009; Alexander 1983; Balthazar 1983; Celik 2007; Court Brown 1981; Goeau-Brissonniere 1987; Rojanapirom 1992; Seropian 1971). These tended to focus on types of surgery to be excluded, for example, proctology, toe amputations and burns. Balthazar 1983, Celik 2007 and Nascimento 1991 stated that people taking antibiotics prior to surgery would be excluded, and Rojanapirom 1992 stated that the participants had to be over 12 years old, with no underlying diseases. Goeau-Brissonniere 1987 and Seropian 1971 stated that people who did not require hair removal were excluded from the study.

Risk of bias in included studies

Method of randomisation

Four trials provided sufficient details for reviewers to confirm that randomisation had taken place (Celik 2007; Balthazar 1983; Goeau-Brissonniere 1987; Ilankovan 1992) therefore these are reported here as RCTs. Seven trials described their allocation to groups as being randomised, but did not provide sufficient detail to allow the reviewers to form a valid judgment as to whether appropriate methods had been used (Abouzari 2009; Alexander 1983; Court Brown 1981; Nascimento 1991; Rojanapirom 1992; Seropian 1971; Thorup 1985). One study allocated to group by day of hospital admission (Breiting 1981), one by using the last digit of the hospital name band (Powis 1976) and one used the participant's bed number (Thur de Koos 1983).

Allocation concealment

Only Alexander 1983 described the allocation process in a way which satisfied us that the allocation was concealed, namely sealed envelopes.

Blinding

Two trials stated that the assessor was unaware of the group allocation status of the patient (Powis 1976; Thorup 1985). Breiting 1981 stated that the same surgeons removed hair and assessed wounds, and made it clear that the assessors were not blinded. The remaining 11 trials did not report sufficient information to assess whether adequate blinding had been achieved.

Patient withdrawal and drop-out rates

Abouzari 2009 and Court Brown 1981 reported the number of people who died postoperatively, and these people were excluded from the studies. Thorup 1985 excluded two people whose hair removal had not followed the protocol, and one person who was incorrectly registered. Forty-seven patients from the shaving group in Celik 2007 were lost through incomplete follow-up. The review authors contacted Celik 2007 for further information; the trial author replied that patients from the non-shaved group were also lost to follow-up, but did not provide the number.

Duration of follow-up

Duration of follow-up was variously five days (Goeau-Brissonniere 1987; Powis 1976), seven days (Ilankovan 1992), until suture removal (around ten days) (Nascimento 1991; Rojanapirom 1992; Thorup 1985), two weeks after surgery (Balthazar 1983), 28 days (Court Brown 1981), 30 days (Alexander 1983), and culminating in Abouzari 2009 who followed-up at three to four weekly intervals until the wound had healed or an infection developed. Four trials did not provide details of the duration of follow-up (Breiting 1981, Celik 2007; Seropian 1971; Thur de Koos 1983).

Other bias

None of the trials reported any sponsorship or funding by manufacturers.

Effects of interventions

Primary objective: does preoperative hair removal result in more SSIs than no hair removal?

Six trials, two of which had three comparison arms, compared preoperative hair removal (shaving with a razor) with no hair removal (Abouzari 2009; Celik 2007; Court Brown 1981; Ilankovan 1992; Nascimento 1991; Rojanapirom 1992). One trial compared clippers with no hair removal (Abouzari 2009), and one compared cream with no hair removal (Court Brown 1981).

Clipping compared with no hair removal (1 trial)

One study compared clipping with no hair removal (Abouzari 2009), and was conducted on patients having hair removed from the scalp for cranial surgery. Details of randomisation, allocation concealment or blinding were not given, though there was a clear definition of infection and patients were followed up for at least 21 days. One out of 65 patients in the clipping group developed an infection compared with one out of 65 patients in the group that had no hair removal. There was no statistically significant difference between the two groups in the rates of SSI (RR 1.00; 95% CI 0.06 to 15.65) (Analysis 1.1).

Shaving compared with no hair removal (6 trials)

Six trials compared shaving with no hair removal (Abouzari 2009; Celik 2007; Court Brown 1981; Ilankovan 1992; Nascimento 1991; Rojanapirom 1992). Four trials removed body hair (Celik 2007; Court Brown 1981; Nascimento 1991; Rojanapirom 1992), and two trials removed scalp hair (Abouzari 2009; Ilankovan 1992). Of the four trials removing body hair, three were conducted in general surgery (Court Brown 1981; Nascimento 1991; Rojanapirom 1992), and one in spinal surgery (Celik 2007). The trials involving removal of scalp hair were conducted in cranial surgery (Abouzari 2009), and maxillo facial surgery (Ilankovan 1992). The trials involving body hair were initially considered separately from those involving scalp hair (this was pre-specified in the protocol). The trial in spinal surgery was excluded from the body hair meta-analysis because of confusion regarding incomplete patient follow-up (Celik 2007). Celik 2007 stated that 47 patients in the shaving group were lost to follow-up. Subsequently, the trial author provided the additional information that an unspecified number of patients were also lost to follow-up in the non-shaving group, therefore, the total number of patients included in the trial was not known. Celik 2007 reported 4/371 infections in the shaved group and 1/418 infections in the non-shaved group. While the three remaining body hair trials in general surgery used similar definitions of infection (Court Brown 1981; Nascimento 1991; Rojanapirom 1992), none reported details of the method of randomisation, allocation concealment and blinding. Meta-analysis of these three trials found that 9.5% (21/221) of patients shaved with a razor developed an SSI compared with 5.8% (13/224) who were not shaved. Pooling these three trials using a fixed-effect model ($I^2=0\%$) gave an RR of 1.65 (95% CI 0.85 to 3.19) (Analysis 2.1). This analysis showed no statistically significant difference in the risk of SSI between shaving and no hair removal.

Two trials removed scalp hair rather than body hair (Abouzari 2009; Ilankovan 1992). The trial report by Ilankovan 1992 did not provide sufficient detail about the infection rate to be included in a meta-analysis, simply stating that 'there was no difference in the incidence of infection between the two groups'. The remaining trial was conducted among patients having cranial surgery (Abouzari

2009), and details of randomisation, allocation concealment and blinding were not given, though there was a clear definition of infection and patients were followed up for at least 21 days. Three out of 65 patients in the clipping group developed an infection compared with one out of 65 in the group with no hair removal. There was no statistically significant difference in rates of SSI (RR 3.00, 95% CI 0.32 to 28.09) (Analysis 2.2).

A meta-analysis combining the studies measuring body hair removal (Court Brown 1981; Nascimento 1991; Rojanapirom 1992), and scalp hair removal (Abouzari 2009), did not find a statistically significant difference in risk of SSI between patients who had hair removed and patients who did not (RR 1.75, 95% CI 0.93 to 3.28, $I^2=0\%$) (Analysis 2.3).

Depilatory cream compared with no hair removal (1 trial)

One trial compared the effects on rates of SSI of depilatory cream with no hair removal (Court Brown 1981). This trial was carried out in patients undergoing abdominal surgery, and did not provide details about methods of randomisation, allocation concealment or blinding. Similar numbers of patients who had hair removed using depilatory cream acquired an SSI, 7.9% (10/126), compared with 7.8% (11/141) patients who had no hair removed (RR 1.02, 95% CI 0.45 to 2.31, no statistically significant difference) (Analysis 3.1).

Secondary objective: what are the relative effects of shaving, clipping and depilatory creams on SSI?

A total of ten trials addressed this question. Three trials compared shaving with clipping (Abouzari 2009; Alexander 1983; Balthazar 1983). Seven trials compared shaving with cream (Breiting 1981; Court Brown 1981; Goeau-Brissonniere 1987; Powis 1976; Seropian 1971; Thorup 1985; Thur de Koos 1983). No studies were identified which compared clipping with depilatory cream.

Shaving compared with clipping (3 trials)

Three trials randomised participants to either shaving or clipping prior to surgery (Abouzari 2009; Alexander 1983; Balthazar 1983). One trial on cranial surgery involved removal of scalp hair (Abouzari 2009), the other two trials in clean surgery involved removal of body hair (Alexander 1983; Balthazar 1983). For this reason, we considered Abouzari 2009 separately. In Abouzari 2009 details of randomisation, allocation concealment and blinding were not given, though there was a clear definition of infection and patients were followed up for at least 21 days. Three out of 65 patients shaved with a razor developed an infection compared with one out of 65 patients in the clipping group; this difference was not statistically significant (RR 3.00, 95% CI 0.32 to 28.09) (Analysis 4.1).

Meta-analysis of the other two trials (Alexander 1983; Balthazar 1983) showed that 5.1% (33/637) of patients who were shaved prior to surgery developed an SSI compared with 2.6% (15/576) of patients who were clipped prior to surgery. The two trials involved similar types of surgery and were pooled using a fixed-effect model ($I^2 = 0\%$); significantly more people developed an SSI when shaved rather than clipped prior to surgery (RR 1.97, 95% CI 1.08 to 3.58) (Analysis 4.2).

Pooling all three trials (removal of body hair (Alexander 1983; Balthazar 1983) and scalp hair since $I^2 = 0$ (Abouzari 2009), showed that clipping resulted in statistically significantly fewer SSIs than shaving (RR 2.03, 95% CI 1.1 to 3.61) (Analysis 4.3).

Shaving compared with cream (7 trials)

Seven trials, involving 1213 participants, compared the effects of shaving with depilatory cream (Breiting 1981; Court Brown 1981; Goeau-Brissonniere 1987; Powis 1976; Seropian 1971; Thorup 1985; Thur de Koos 1983). Most trials included people undergoing a range of surgical procedures. There was variation with respect to the timing of outcome assessment: three trials did not report the point at which the outcome assessment was made (Breiting 1981; Seropian 1971; Thur de Koos 1983), two assessed at days two and five (Goeau-Brissonniere 1987; Powis 1976), one at day ten (Thorup 1985), and one trial daily whilst the participant was on the ward and also at day 28 (Court Brown 1981). The data extracted from these studies for pooling were from the latest reported wound assessment. The trials were of variable quality. Whilst two trials undertook blinded outcome assessment (Powis 1976; Thorup 1985), one trial reported that outcome assessors were not blinded (Breiting 1981) and the remaining trials did not report clearly on blinding. Overall, 7% (42/670) of patients who were shaved acquired an SSI compared with 3.8% (21/543) of patients whose hair was removed with a depilatory cream. The trials were pooled using a random-effects model and whilst more people who were shaved developed an SSI compared with those who used depilatory cream, the difference was not statistically significant ($I^2 = 33\%$; RR 1.53, 95% CI 0.73 to 3.21) (Analysis 5.1).

Secondary objective: what is the effect on SSI rates of hair removal immediately before surgery compared with hair removal more than four hours before surgery?

One trial compared clipping the day before surgery with clipping on the day of surgery (Alexander 1983), and also compared shaving the night before surgery with shaving on the day of surgery.

Shaving on the day of surgery compared with shaving one day preoperatively (1 trial)

One study compared shaving on the day of surgery with shaving one day preoperatively in 537 patients undergoing elective clean surgery (Alexander 1983). SSIs were measured on days 15 and 30. Fifteen days postoperatively 5.1% (14/271) of patients who shaved the day before surgery had developed an SSI compared with 6.5% (17/266) of patients shaved on the day of surgery (this difference was not statistically significant; RR 0.81, 95% CI 0.41 to 1.61) (Analysis 6.1). At 30 days postoperatively, 8.8% (23/260) of patients shaved the day before surgery had developed an SSI compared with 10% (26/260) of patients shaved on the day of surgery. There was no statistically significant difference between these two groups with respect to the risk of developing SSI (RR 0.88, 95% CI 0.52 to 1.51) (Analysis 6.2).

Clipping on the day of surgery compared with clipping one day preoperatively

The Alexander 1983 study also compared clipping on the day of surgery with clipping one day preoperatively in 476 patients undergoing elective clean surgery. SSIs were measured on days 15 and 30. Fifteen days postoperatively 4.0% (10/250) of patients clipped one day preoperatively had developed an SSI compared with 1.7% (4/226) of patients clipped on the day of surgery (RR 2.26, 95% CI 0.72 to 7.11) (Analysis 7.1); this difference was not statistically significant. At 30 days post operatively, 7.4% (18/241) of patients clipped one day preoperatively had developed an SSI compared with 3.2% (7/216) of patients clipped on the day of surgery (RR 2.30, 95% CI 0.98 to 5.41) (Analysis 7.2); this difference was not statistically significant either.

Secondary objective: what is the effect of hair removal in different settings on SSI rates?

No trials were found that compared hair removal in different settings.

DISCUSSION

Looking firstly at the evidence for pre-operative hair removal by any method versus no hair removal, whilst we found no statistically significant difference in SSI rates in the existing 4 trials, there were more SSIs in the shaving group and this comparison is likely to be underpowered, with only 38 events in the whole comparison. We therefore cannot confidently exclude the possibility of an effect of hair removal in either direction and current evidence (which is also at risk of bias) suggests a possible increase in SSIs after hair removal. The recommendations of the CDC (Mangram 1999), and the Hospital Infection Society (Hospital Infection Society 2003), strongly recommend that shaving should be avoided unless completely necessary. The earlier systematic review (Kjonnixsen 2002), and the Norwegian Centre for Health

Technology Assessment (NOKC 2000), state that no strong evidence exists in favour of, or against, preoperative hair removal.

Looking at alternative methods of hair removal, we found evidence to suggest that clipping rather than shaving results in fewer SSIs; supporting the recommendations of the CDC (Mangram 1999), and The Norwegian Health Technology Assessment (NOKC 2000).

Whilst the Hospital Infection Society recommends that depilatory cream should be used instead of shaving with a razor (Hospital Infection Society 2003), we did not find a significant difference in SSI rates from the seven existing trials comparing creams and razors although more SSIs occurred in the shaving group. Again we must emphasise that this is an underpowered comparison with only 65 SSIs in total across the seven trials. No trials compared the relative effects of clipping and depilatory cream.

We did not find a significant effect of the timing of hair removal on SSI rates, however this comparison is also underpowered and we cannot exclude the possibility of an effect. No trial compared use of depilatory cream on the day of surgery with use one day preoperatively. Evidence from randomised controlled trials in this review does not support either the CDC recommendations (Mangram 1999), or the Norwegian Health Technology Assessment (NOKC 2000), both of which advocate hair removal immediately before surgery. It is not possible to support, or refute, the recommendations of the Hospital Infection Society (Hospital Infection Society 2003), which recommends using depilatory cream the day before surgery in order to reduce SSIs.

No trials were identified for inclusion in the review that evaluated the effect on SSIs of hair removal in different settings.

Comparison with earlier systematic review

The search strategy for the previous systematic review covered the period up to 1999 (Kjonnixsen 2002), and the review included nine RCTs and 12 observational studies. The observational studies included controlled studies, quasi-experimental studies and non-experimental observational studies. A comparison between the review by Kjonnixsen 2002 and this review revealed some differences in which studies were included. Kjonnixsen 2002 classified the study by Seropian 1971 as an observational study due to uncertainties regarding randomisation, however Seropian 1971 reported group allocation by patient number, which was accepted as a suitable method of quasi randomisation and was thus included in this review. Using this method participants were allocated to two groups (shaving and cream) but the publication also reported data for people who were excluded from the study as a third group. This review included data from the two groups that were subject to the allocation procedure, and excluded data relating to people who were not (Seropian 1971). Kjonnixsen 2002 included Hoe 1985 as a randomised study, but attributed this study less

importance due to its method of design. Our review did not include [Hoe 1985](#), as people within the non-shaving group were shaved, if necessary, and, therefore, there was contamination. Unlike [Kjonniksen 2002](#), our review rejected the study by [Ko 1992](#) because the patients in the intervention groups had hair removed, and also underwent irrigation with antiseptic. [Kjonniksen 2002](#) did not include the study by [Ilankovan 1992](#). It was included in this review because the authors did measure surgical site infection but provided limited detail as to the incidence of SSI. [Kjonniksen 2002](#) described the [Powis 1976](#) study as irrelevant, as it only included a limited number of people, but our review includes [Powis 1976](#). [Kjonniksen 2002](#) did not identify three RCTs that are included in this review ([Breiting 1981](#); [Nascimento 1991](#); [Thorup 1985](#)). [Breiting 1981](#) and [Thorup 1985](#) were both published in Danish, and [Nascimento 1991](#) in Portuguese.

Methodological quality of the studies

Fourteen eligible trials were included in this review. The methodological quality and the reporting of methods for most of these trials was poor. None of the trials was identified as being at low risk of bias. Four of the trials provide sufficient details of the process of randomisation or allocation to allow us to judge their adequacy ([Celik 2007](#); [Balthazar 1983](#); [Goeau-Brissonniere 1987](#); [Ilankovan 1992](#)), the rest did not. Similarly, the study setting and timing of hair removal relative to surgery were often poorly reported. Often the identity of the outcome assessor and the timing of assessment were not clear. Most of the trials provided information on the sex, age and the surgical procedure carried out ([Abouzari 2009](#); [Alexander 1983](#); [Balthazar 1983](#); [Breiting 1981](#); [Celik 2007](#); [Court Brown 1981](#); [Goeau-Brissonniere 1987](#); [Ilankovan 1992](#); [Nascimento 1991](#); [Rojanapirom 1992](#); [Thorup 1985](#); [Thur de Koos 1983](#)), which allowed baseline comparisons to be made.

Outcome measures

All trials reported reduction of SSIs as an objective, although their definitions of infection varied. Five trials did not provide any definition for an SSI ([Breiting 1981](#); [Rojanapirom 1992](#); [Seropian 1971](#); [Thorup 1985](#); [Thur de Koos 1983](#)), but the remaining trials did provide a definition of an infection; e.g. presence of pus. None of the trials referred to standardised definitions of SSIs such as those published by the [CDC 2008](#).

More than half the trials used bacterial swabs and a visual assessment to determine the presence of infection, while the remaining trials used visual assessment only. Some trials did not state when the assessments were carried out, and there was little parity among the trials that did provide details. Though most trial reports stated that assessment was carried out at patient discharge, this was not defined in terms of number of postoperative days.

Duration of follow-up was short in several trials. Follow-up for SSI should be for 30 days, as advocated by the [CDC 2008](#).

The secondary outcomes of this review, wound complications, length of hospital stay and financial cost of hair removal method, were poorly addressed. One trial discussed the length of hospital stay and, while three studies provided details of the cost of the hair removal products ([Court Brown 1981](#); [Thorup 1985](#); [Powis 1976](#)), additional information about costs such as time required by hospital staff to use either method, additional dressings for infected wounds or additional costs incurred by extended hospital stay due to SSIs were not given.

Limitations of trials

All trials included in this review had limitations. Reporting of the trial design was usually poor, in that most authors did not provide details of the method used to generate the randomisation sequence, the method of allocation concealment, and whether blinding of outcome assessors was undertaken. Few trials explicitly stated drop-out rates. Review authors should consider contacting trial authors as a matter of routine to obtain further information on trial design. Accepted definitions of SSI and follow-up periods could have been referred to in the trials.

Publication bias

Eight articles were identified in languages other than English and required translations; four of these were included in the review ([Breiting 1981](#); [Goeau-Brissonniere 1987](#); [Nascimento 1991](#); [Thorup 1985](#)). Two of the four manufacturers we contacted provided details of trials, though all of these studies had already been identified through searching the databases. Three studies acknowledged companies for providing the depilatory cream used in their trials ([Powis 1976](#); [Seropian 1971](#); [Thorup 1985](#)).

AUTHORS' CONCLUSIONS

Implications for practice

The review found insufficient evidence for an effect of preoperative hair removal on rates of SSIs (SSIs). If it is necessary to remove hair, then clipping seems to result in fewer SSIs than shaving with a razor, although the evidence is not high quality. It is not possible to say whether use of depilatory creams is preferable to shaving with a razor as this comparison is underpowered. No trials compared clipping with depilatory cream.

There is insufficient evidence concerning the rates of SSIs when patients are shaved (or clipped) the day before surgery or on the day of surgery. There has been no research investigating the timing of hair removal when using a depilatory cream.

There is no research to indicate whether the place of hair removal (e.g. operating theatre, anaesthetic room or ward area) affects SSI rates.

Implications for research

This review demonstrates the need for trials to make the following types of comparisons:

- hair removal with no hair removal using razors, depilatory cream and clippers;
- depilatory cream with razors and depilatory cream with clippers;
- hair removal using clippers, razors and depilatory cream at different times prior to surgery;
- different settings for hair removal (operating theatre, anaesthetic room, ward, patient's home).

Furthermore, within trials:

- sample sizes need to be larger, to allow clinically important differences to be detected;

- details of randomisation, allocation concealment and blinding must be provided;
- an internationally accepted definition of SSIs - for example Centers for Disease Control (CDC 2008) should be used;
- patients need to be followed-up for recognised SSI follow-up times - see Centers for Disease Control (CDC 2008);
- length of hospital stay and wound complications should be included as outcomes.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Abouzari 2009

Methods	RCT	
Participants	195 patients undergoing cranial surgery.	
Interventions	Three preoperative surgical site treatments involving removal, or no removal, of scalp hair: Group A: removal with a razor (n = 65); Group B: removal with hair clippers (n = 65); Group C: no hair removal (n = 65).	
Outcomes	Clinical signs of infection including presence of pus, development of postoperative meningitis and microbiology	
Notes	No statistical test of significance used.	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: 'Randomly allocated'. No details given.
Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Low risk	Appeared to present findings in full.
Other bias	Low risk	No record of funding that might predispose the trial to bias

Alexander 1983

Methods	RCT	
Participants	1013 patients having elective, clean surgery.	
Interventions	Group A: clipping day before surgery (n = 249); Group B: clipping on the morning of surgery (n = 226); Group C: shaving with a razor the day before surgery (n = 271); Group D: shaving with a razor on the morning of surgery (n = 266)	
Outcomes	Wound infection defined as 'presence of pus'; checked at discharge	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Patients randomised to group by drawing sealed envelopes; detail too limited to confirm adequacy
Allocation concealment (selection bias)	Low risk	Sealed envelopes used for allocation
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Low risk	One case only lost.
Other bias	Low risk	No record of funding that might predispose the trial to bias

Balthazar 1983

Methods	RCT
Participants	200 patients having elective inguinal hernia repair.
Interventions	Group A: preoperative hair removal with a razor (n = 100); Group B: preoperative hair removal with clippers (n = 100).
Outcomes	Clinical evidence of wound infection, i.e. presence of pus, assessed by infection control nurse at day 5 postoperatively and by unspecified practitioners at 2 weeks postoperatively
Notes	All male patients; no statistical test of significance.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Patients randomised using 'standard table of random numbers'
Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No detail given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Low risk	All participants included in the results. Findings appeared to be fully reported
Other bias	Low risk	No record of funding that might predispose the trial to bias

Breiting 1981

Methods	RCT
Participants	104 male patients having elective surgery on lower legs.

Breiting 1981 (Continued)

Interventions	Group A: preoperative hair removal with a razor (n = 52); Group B: preoperative hair removal with depilatory cream (n = 52)	
Outcomes	Clinical evidence of superficial and deep infections assessed at discharge and outpatient visit by surgical staff	
Notes	No record of infection in either group. Paper published in Danish	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Treatments alternated by day of hospital admission.
Allocation concealment (selection bias)	High risk	Care provider aware of allocation.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	High risk	Care provider aware of allocation.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Low risk	All participants included in results. Findings appeared to be fully reported
Other bias	Low risk	No record of funding that might predispose the trial to bias

Celik 2007

Methods	RCT
Participants	789 patients undergoing spinal surgery.
Interventions	Group A: surgical site shaved with a razor immediately prior to surgery (n = 371); Group B: no hair removal (n = 418).

Celik 2007 (Continued)

Outcomes	Clinical signs of infection including pus, pain, tenderness or redness, plus signs of meningitis and haematological evidence
Notes	Incomplete follow up of 47 cases from the shaved group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	'Allocated on a 1:1 ratio on a randomisation sheet'
Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	High risk	Incomplete follow-up of 47 cases from the shaved group.
Selective reporting (reporting bias)	Unclear risk	Limited sets of data given.
Other bias	Low risk	No record of funding that might predispose the trial to bias

Court Brown 1981

Methods	RCT
Participants	418 patients undergoing abdominal surgery.
Interventions	Group A: hair removal with a razor (n = 137); Group B: hair removal with depilatory cream (n = 126); Group C: no hair removal (n = 141).
Outcomes	Wound infection assessed daily, and at 28 days postoperatively

Court Brown 1981 (Continued)

Notes	Wound infection criteria unclear - role of bacterial culture as determinant not discussed	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No description of randomisation process given.
Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Unclear risk	12 patients died and were excluded. The outcomes for two patients were missing
Selective reporting (reporting bias)	High risk	Infection status of 12 patients who died not given.
Other bias	Low risk	No record of funding that might predispose the trial to bias

Goeau-Brissoniere 1987

Methods	RCT
Participants	100 patients undergoing elective surgery, excluding amputation, vaginal, proctological, urological and gynaecological procedures
Interventions	Group A: preoperative hair removal with a razor (n = 51); Group B: preoperative hair removal with depilatory cream (n = 49)
Outcomes	Clinical evidence of wound infection assessed by 'a doctor' at day 2, and day 5 postoperatively
Notes	Paper published in French.

Goeau-Brissonniere 1987 (Continued)

<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Patients randomised using random numbers tables.
Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Low risk	All participants included in results. Findings appeared to be fully reported
Other bias	Low risk	No record of funding that might predispose the trial to bias

Ilankovan 1992

Methods	RCT
Participants	50 patients requiring zygomatic arch repair.
Interventions	Group A: preoperative removal of scalp hair with a razor (n = 25); Group B: hair parting and clamping (n = 25).
Outcomes	Ease of suture removal, signs of local infection, including pus and erythema associated with tenderness and wound breakdown
Notes	No difference in incidence of infection noted, but infection rate not given

Risk of bias

Bias	Authors' judgement	Support for judgement
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Ilankovan 1992 (Continued)

Random sequence generation (selection bias)	Low risk	Randomisation by random number sequence into two groups.
Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Outcome assessors blinded	High risk	Not feasible due to nature of intervention.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	High risk	Numbers included in analysis not given.
Selective reporting (reporting bias)	High risk	Incidence of infection not reported.
Other bias	Low risk	No record of funding that might predispose the trial to bias

Nascimento 1991

Methods	RCT
Participants	88 patients undergoing clean surgery.
Interventions	Group A: preoperative shaving with a razor (n = 44); Group B: no hair removal (n = 43).
Outcomes	Formation and discharge of pus in wound.
Notes	Paper published in Portuguese.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Lots drawn for allocation, limited data.

Nascimento 1991 (Continued)

Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Low risk	All participants included in results. Findings appeared to be fully reported
Selective reporting (reporting bias)	Unclear risk	Limited information available to reviewers.
Other bias	Low risk	No record of funding that might predispose the trial to bias

Powis 1976

Methods	RCT	
Participants	92 patients undergoing general surgery.	
Interventions	Group A: preoperative hair removal with a razor (n = 46); Group B: preoperative hair removal with depilatory cream (n = 46)	
Outcomes	Clinical evidence of wound infection assessed at day 2 and day 5 by independent observer	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Grouped according to last digit of hospital name band.
Allocation concealment (selection bias)	High risk	Grouping criterion could be observed by participants and care providers

Powis 1976 (Continued)

Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.
Blinding (performance bias and detection bias) Outcome assessors blinded	Low risk	'Independent observer who was unaware of the method of preparation'
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Low risk	All participants included in results. Findings appeared to be fully reported
Other bias	Low risk	No record of funding that might predispose the trial to bias

Rojanapirom 1992

Methods	RCT
Participants	80 acute patients undergoing appendicectomy.
Interventions	Group A: preoperative hair removal with a razor (n = 40); Group B: no hair removal (n = 40).
Outcomes	Wound infection assessed until stiches removed (days 7-10), and examined for 'signs of wound infection' and bacterial colony counts
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Details of randomisation not given - 'patients were randomly divided'
Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.

Rojanapirom 1992 (Continued)

Blinding (performance bias and detection bias) Care providers blinded	High risk	No initial sample size given in material and methods section
Blinding (performance bias and detection bias) Outcome assessors blinded	High risk	Not feasible due to nature of intervention.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	High risk	Not discussed, only partial results given.
Selective reporting (reporting bias)	Unclear risk	Limited discussion, numbers of infections given, no other data such as total numbers present at completion of study provided
Other bias	Low risk	No record of funding that might predispose the trial to bias

Seropian 1971

Methods	RCT
Participants	406 patients undergoing surgery excluding: endoscopy, burns, oral surgery, abscesses, proctological and vaginal surgery
Interventions	Group A: preoperative shaving with a razor (n = 249); Group B: preoperative hair removal with depilatory cream (n = 157)
Outcomes	Evidence of wound infection as recorded by wound infection control office; no further details given
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Patients randomised by hospital number.
Allocation concealment (selection bias)	High risk	Grouping criterion could be observed by participants and care providers
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.

Seropian 1971 (Continued)

Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Low risk	All patients appeared to be accounted for.
Selective reporting (reporting bias)	High risk	Reason for size disparity between the treatment groups not given
Other bias	Low risk	No record of funding that might predispose the trial to bias

Thorup 1985

Methods	RCT
Participants	50 patients undergoing inguinal hernia repair.
Interventions	Group A: preoperative hair removal with a razor (n = 24); Group B: preoperative hair removal with depilatory cream (n = 26)
Outcomes	Wound infection assessed immediately postoperatively and on day of suture removal
Notes	No criteria given for detection of wound infection. Paper published in Danish

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Details of randomisation not given - 'patients were randomised'
Allocation concealment (selection bias)	Unclear risk	No details given.
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.

Thorup 1985 (Continued)

Blinding (performance bias and detection bias) Outcome assessors blinded	Low risk	'The examinations on the day of operation and when the sutures were removed were carried out without any knowledge of the nature of depilation used'
Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	Unclear risk	No details given.
Other bias	Low risk	No record of funding that might predispose the trial to bias

Thur de Koos 1983

Methods	RCT
Participants	253 patients undergoing thoracic, abdominal, vascular, head and neck surgery
Interventions	Group A: preoperative hair removal with a razor (n = 137); Group B: preoperative hair removal with depilatory cream (n = 116)
Outcomes	Evidence of SSI, but no criteria given. Time of assessment not given
Notes	Sampling exclusion criteria unclear.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Patients randomised by bed number.
Allocation concealment (selection bias)	High risk	Grouping criterion could be observed by participants and care providers
Blinding (performance bias and detection bias) Participants blinded	High risk	Not feasible due to nature of intervention.
Blinding (performance bias and detection bias) Care providers blinded	Unclear risk	No details given.
Blinding (performance bias and detection bias) Outcome assessors blinded	Unclear risk	No details given.

Thur de Koos 1983 (Continued)

Incomplete outcome data (attrition bias) ITT analysis undertaken	Low risk	Participants reported in the group to which they were allocated
Incomplete outcome data (attrition bias) Drop out rate acceptable	High risk	49 cases excluded from study, criteria not given.
Selective reporting (reporting bias)	Unclear risk	49 cases excluded from study, criteria not given.
Other bias	Unclear risk	No record of funding that might predispose the trial to bias

Abbreviations

RCT = randomised controlled trial

QRCT = quasi randomised controlled trial

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Adeleye 2008	Not a randomised or quasi randomised controlled trial.
Bekar 2001	Not a randomised or quasi randomised controlled trial.
Bird 1984	Not a randomised or quasi randomised controlled trial.
Braun 1995	Not a randomised or quasi randomised controlled trial.
Chen 2002	Not a randomised or quasi randomised controlled trial.
Clarke 1983	Not a randomised or quasi randomised controlled trial.
Cruse 1973	Not a randomised or quasi randomised controlled trial.
Finkelstein 2005	Not a randomised or quasi randomised controlled trial.
Hallstrom 1993	Not a randomised or quasi randomised controlled trial.
Hoe 1985	Patients were randomised to shaved and not shaved groups, however, some of the patients in the not shaved group were shaved if their incision was in a hairy area. These patients were still included in the study, and still presented as being in the non-shaved group
Horgan 1997	Study explored shunts rather than hair removal.
Howell 1988	Not a randomised or quasi randomised controlled trial.

(Continued)

Idali 2004	Not a randomised or quasi randomised controlled trial.
Ko 1992	Patients in Group 1 had hair removal with razor plus saline intraoperative washout. Patients in Group 2 had hair removal with clipper plus povidone iodine intraoperative washout. This study had been included in the original review but on further assessment the review authors decided to exclude the study as the patients in each arm received additional interventions in the form of a washout but these interventions were not identical
Korfali 1994	Not a randomised or quasi randomised controlled trial.
Kumar 2002	Not a randomised or quasi randomised controlled trial.
Le Roux 1975	Not a randomised or quasi randomised controlled trial.
Lui 1984	The trial includes a mixture of randomised and non-randomised patients. Patients in the no hair removal group had hair cropped
Maksimovic 2008	Not a randomised or quasi randomised controlled trial.
Masterson 1984	Not a randomised or quasi randomised controlled trial.
McIntyre 1994	Not a randomised or quasi randomised controlled trial.
Mehta 1988	Not a randomised or quasi randomised controlled trial.
Miller 2001	Not a randomised or quasi randomised controlled trial.
Mishriki 1990	Not a randomised or quasi randomised controlled trial.
Moro 1996	Not a randomised or quasi randomised controlled trial.
Ratanalert 1999	Not a randomised or quasi randomised controlled trial.
Ratanalert 2004	Not a randomised or quasi randomised controlled trial.
Scherpereel 1993	Not a randomised or quasi randomised controlled trial.
Sellick 1991	Not a randomised or quasi randomised controlled trial.
Sheinberg 1999	Not a randomised or quasi randomised controlled trial.
Siddique 1998	Not a randomised or quasi randomised controlled trial.
Small 1996	Not a randomised or quasi randomised controlled trial.
Stephens 1966	Not a randomised or quasi randomised controlled trial.
Tang 2001	Not a randomised or quasi randomised controlled trial.

(Continued)

Vestal 1952	Not a randomised or quasi randomised controlled trial.
Viney 1992	Not a randomised or quasi randomised controlled trial.
Waddington 2008	Not a randomised or quasi randomised controlled trial.
Wang 1990	Patients were allocated, but not randomised or quasi randomised
Wang 1999	Patients were allocated, but not randomised or quasi randomised
Westermann 1979	Not a randomised or quasi randomised controlled trial.
Winfield 1986	Not a randomised or quasi randomised controlled trial.
Winston 1992	Not a randomised or quasi randomised controlled trial.
Zentner 1987	Not a randomised or quasi randomised controlled trial.

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

Fraser 1978

Methods	
Participants	
Interventions	
Outcomes	
Notes	previously excluded because SSI was not reported as an outcome, undergoing reassessment

Kovavisarach 2005

Methods	
Participants	
Interventions	
Outcomes	
Notes	previously excluded because SSI was not reported as an outcome, undergoing reassessment

Menéndez 2004

Methods	
Participants	
Interventions	
Outcomes	
Notes	previously excluded because SSI was not reported as an outcome, undergoing reassessment

Menéndez López 2004

Methods	
Participants	
Interventions	
Outcomes	
Notes	previously excluded because SSI was not reported as an outcome, undergoing reassessment

DATA AND ANALYSES

Comparison 1. Clipping compared with no hair removal

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	1	130	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.06, 15.65]

Comparison 2. Shaving compared with no hair removal

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection - body hair	3	445	Risk Ratio (M-H, Fixed, 95% CI)	1.65 [0.85, 3.19]
2 Surgical site infection - scalp hair	1	130	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.32, 28.09]
3 Surgical site infection - body hair and scalp hair	4	575	Risk Ratio (M-H, Fixed, 95% CI)	1.75 [0.93, 3.28]

Comparison 3. Cream compared with no hair removal

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	1	267	Risk Ratio (M-H, Fixed, 95% CI)	1.02 [0.45, 2.31]

Comparison 4. Shaving compared with clipping

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection - scalp hair	1	130	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.32, 28.09]
2 Surgical site infection - body hair	2	1213	Risk Ratio (M-H, Fixed, 95% CI)	1.97 [1.08, 3.58]
3 Surgical site infection - body hair and scalp hair	3	1343	Risk Ratio (M-H, Fixed, 95% CI)	2.03 [1.14, 3.61]

Comparison 5. Shaving compared with cream

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	7	1213	Risk Ratio (M-H, Random, 95% CI)	1.53 [0.73, 3.21]

Comparison 6. Shaving day before compared with shaving day of surgery

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection day 15	1	537	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.41, 1.61]
2 Surgical site infection day 30	1	520	Risk Ratio (M-H, Fixed, 95% CI)	0.88 [0.52, 1.51]

Comparison 7. Clipping day before compared with clipping day of surgery

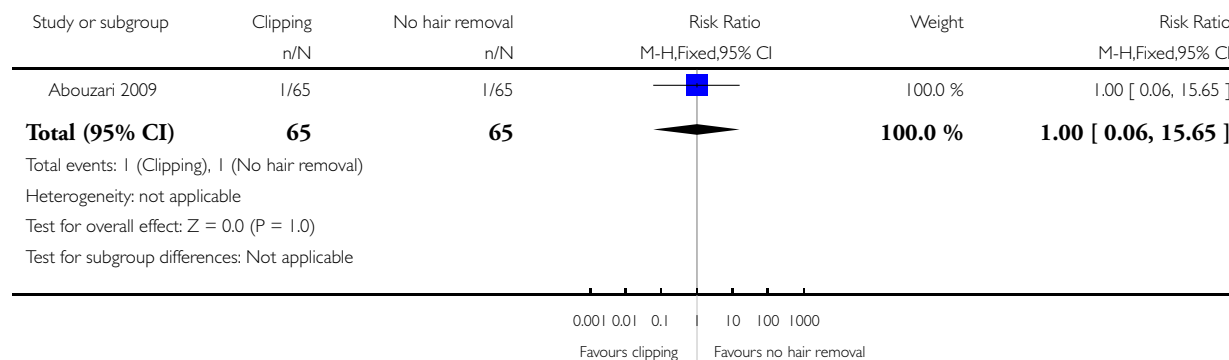
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection day 15	1	476	Risk Ratio (M-H, Fixed, 95% CI)	2.26 [0.72, 7.11]
2 Surgical site infection day 30	1	457	Risk Ratio (M-H, Fixed, 95% CI)	2.30 [0.98, 5.41]

Analysis 1.1. Comparison 1 Clipping compared with no hair removal, Outcome 1 Surgical site infection.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 1 Clipping compared with no hair removal

Outcome: 1 Surgical site infection

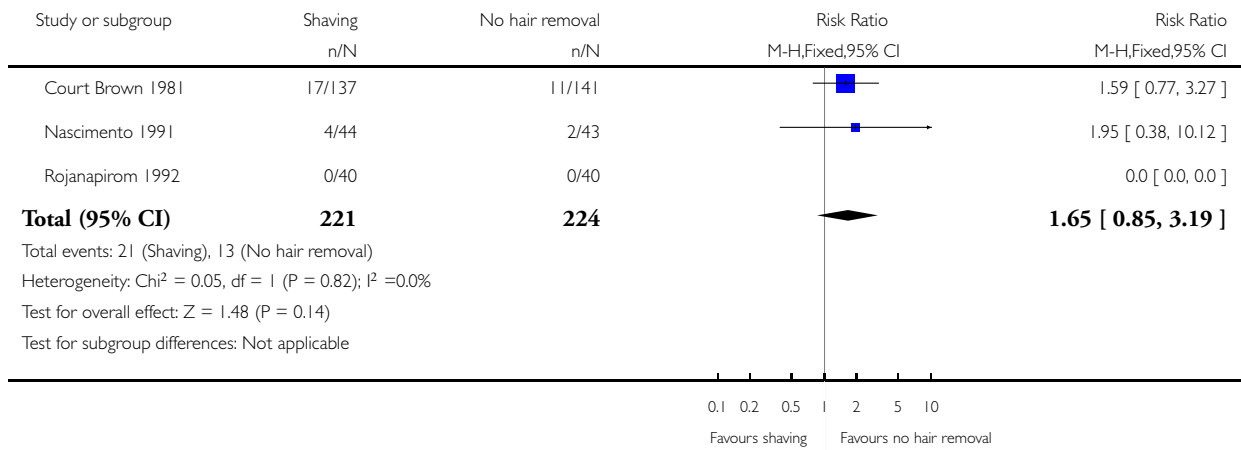


Analysis 2.1. Comparison 2 Shaving compared with no hair removal, Outcome 1 Surgical site infection - body hair.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 2 Shaving compared with no hair removal

Outcome: 1 Surgical site infection - body hair

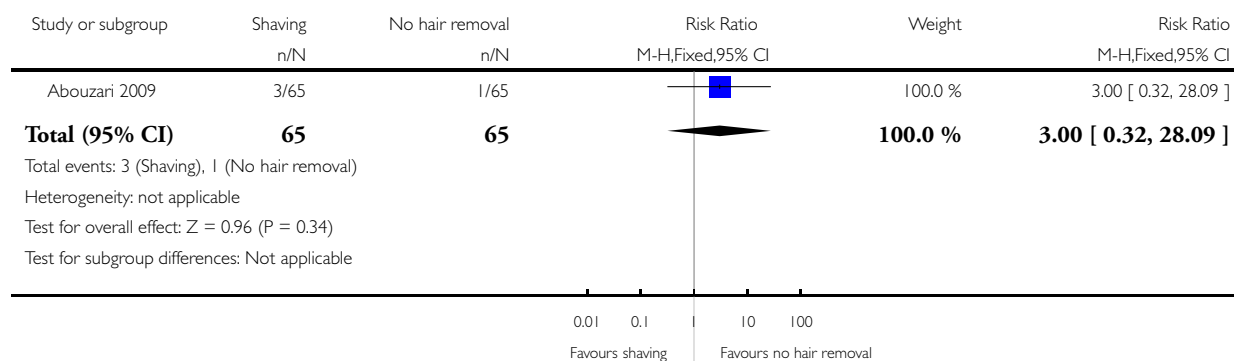


Analysis 2.2. Comparison 2 Shaving compared with no hair removal, Outcome 2 Surgical site infection - scalp hair.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 2 Shaving compared with no hair removal

Outcome: 2 Surgical site infection - scalp hair

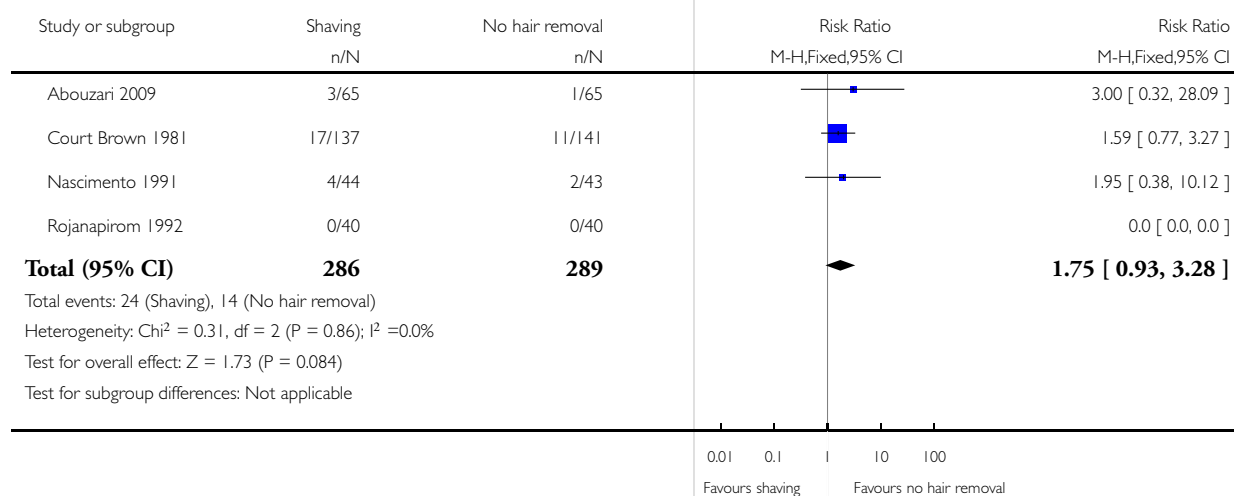


Analysis 2.3. Comparison 2 Shaving compared with no hair removal, Outcome 3 Surgical site infection - body hair and scalp hair.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 2 Shaving compared with no hair removal

Outcome: 3 Surgical site infection - body hair and scalp hair

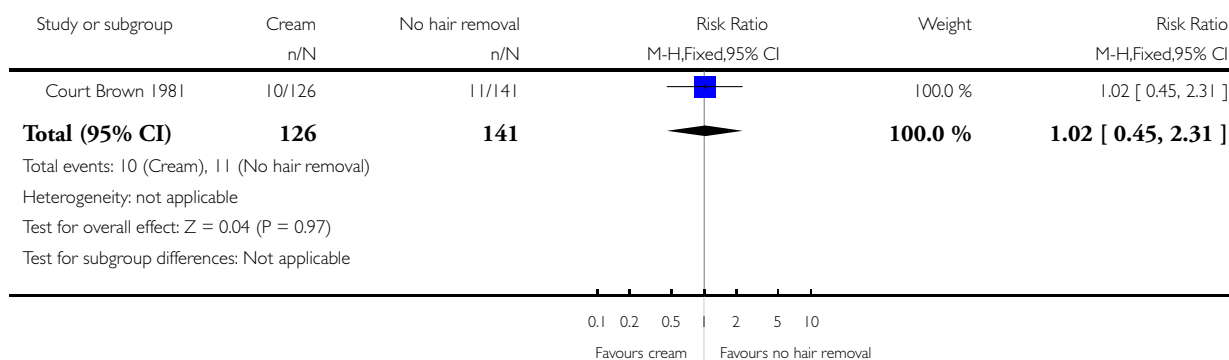


Analysis 3.1. Comparison 3 Cream compared with no hair removal, Outcome 1 Surgical site infection.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 3 Cream compared with no hair removal

Outcome: 1 Surgical site infection

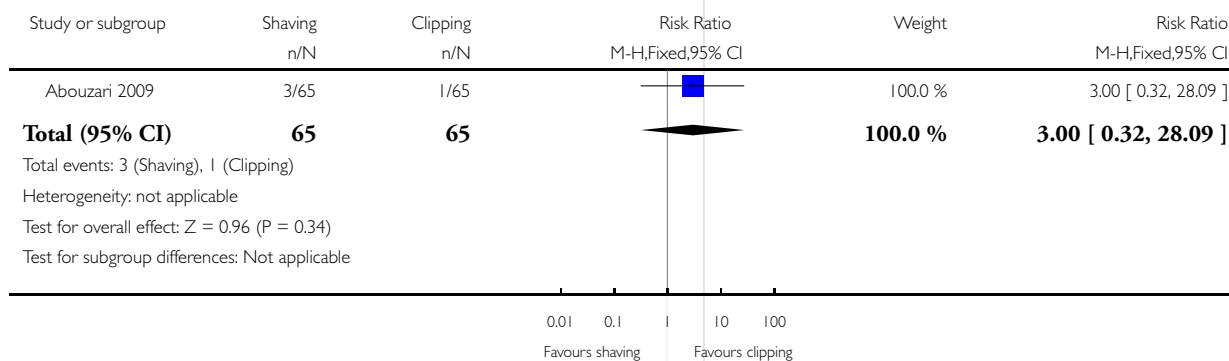


Analysis 4.1. Comparison 4 Shaving compared with clipping, Outcome 1 Surgical site infection - scalp hair.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 4 Shaving compared with clipping

Outcome: 1 Surgical site infection - scalp hair

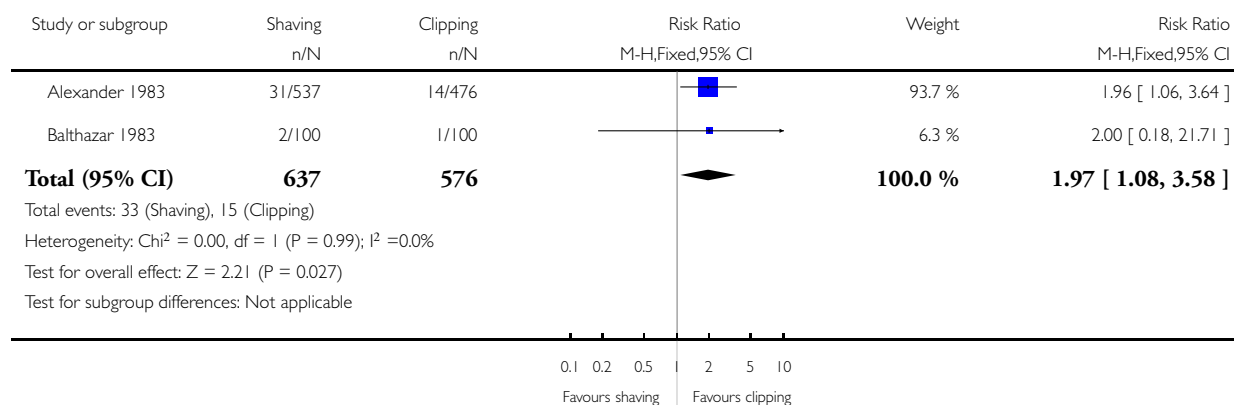


Analysis 4.2. Comparison 4 Shaving compared with clipping, Outcome 2 Surgical site infection - body hair.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 4 Shaving compared with clipping

Outcome: 2 Surgical site infection - body hair

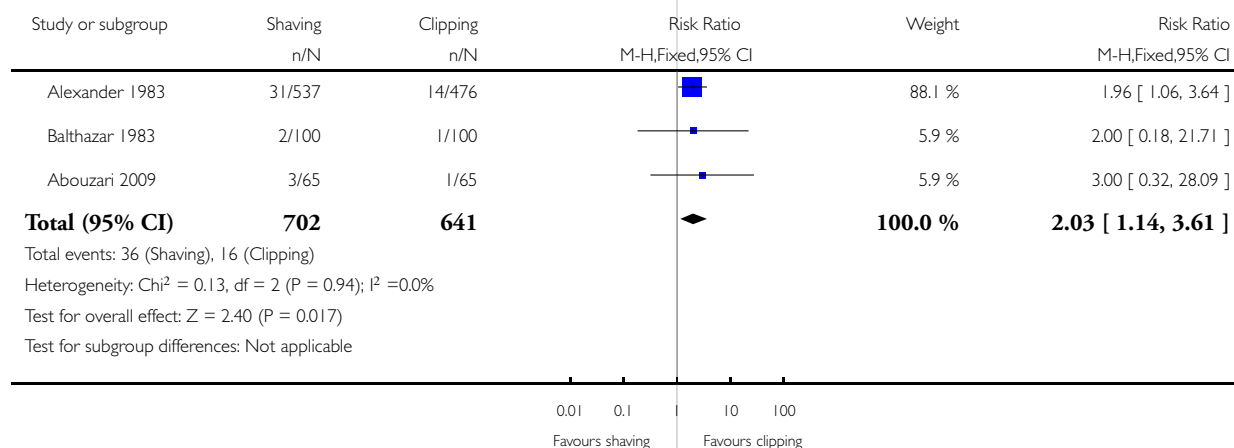


Analysis 4.3. Comparison 4 Shaving compared with clipping, Outcome 3 Surgical site infection - body hair and scalp hair.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 4 Shaving compared with clipping

Outcome: 3 Surgical site infection - body hair and scalp hair

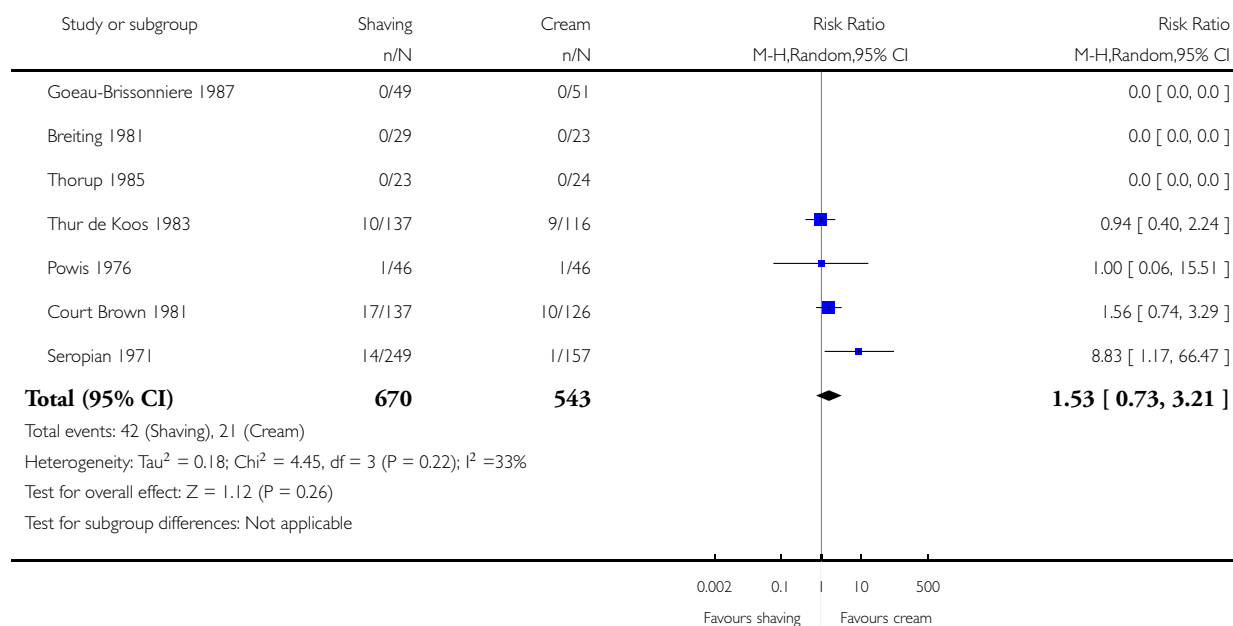


Analysis 5.1. Comparison 5 Shaving compared with cream, Outcome 1 Surgical site infection.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 5 Shaving compared with cream

Outcome: 1 Surgical site infection

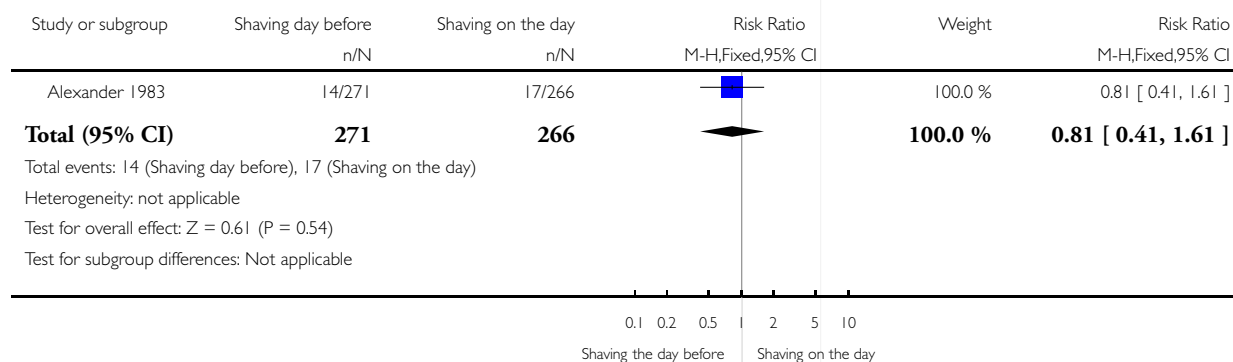


Analysis 6.1. Comparison 6 Shaving day before compared with shaving day of surgery, Outcome 1 Surgical site infection day 15.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 6 Shaving day before compared with shaving day of surgery

Outcome: 1 Surgical site infection day 15

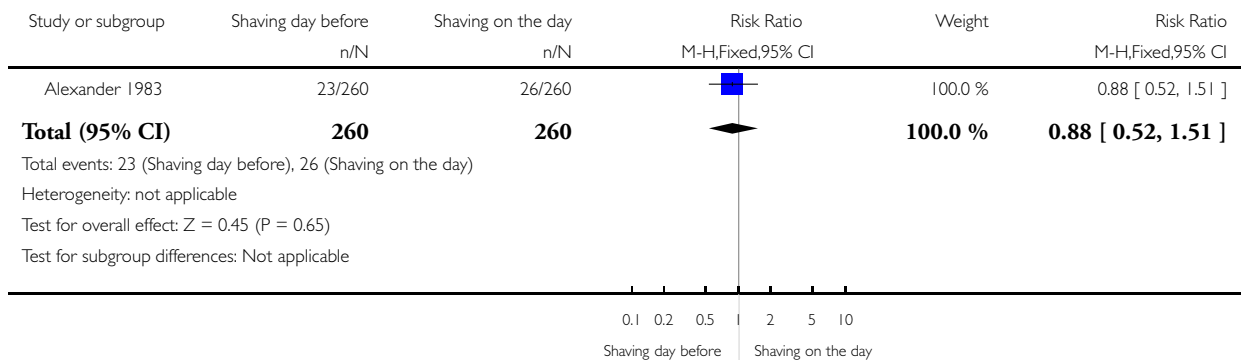


Analysis 6.2. Comparison 6 Shaving day before compared with shaving day of surgery, Outcome 2 Surgical site infection day 30.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 6 Shaving day before compared with shaving day of surgery

Outcome: 2 Surgical site infection day 30

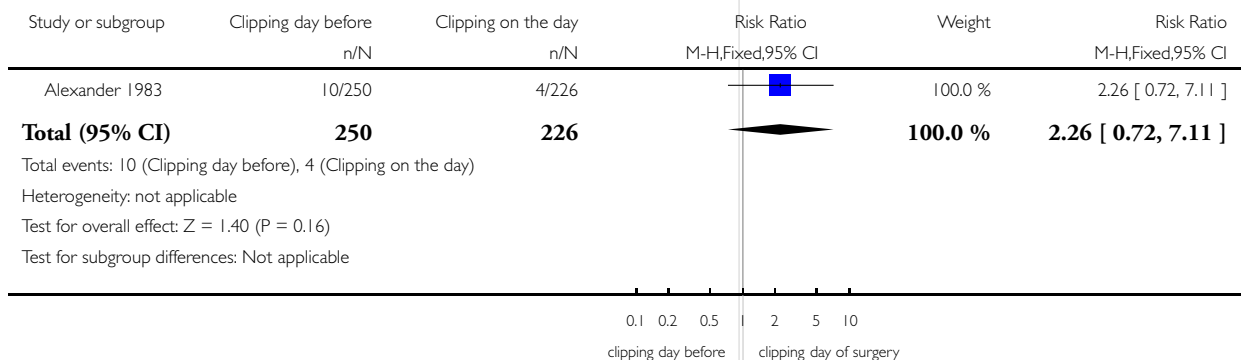


Analysis 7.1. Comparison 7 Clipping day before compared with clipping day of surgery, Outcome 1 Surgical site infection day 15.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 7 Clipping day before compared with clipping day of surgery

Outcome: 1 Surgical site infection day 15

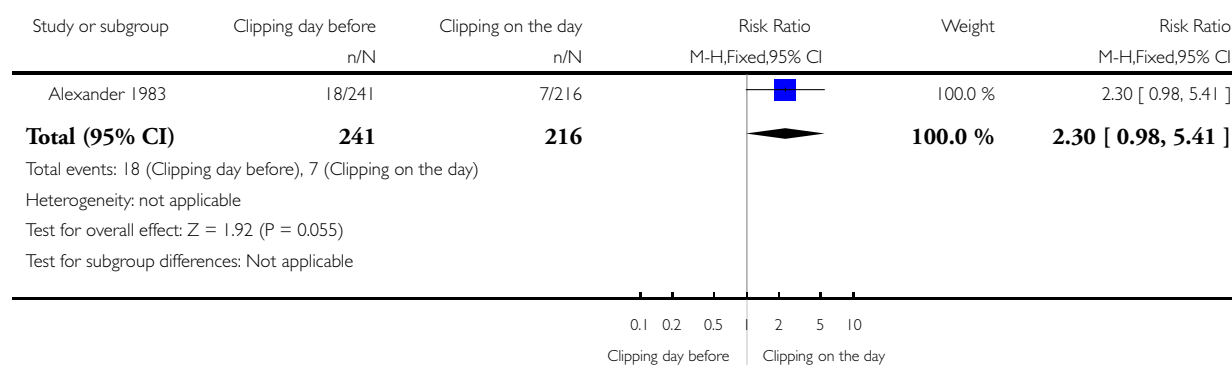


Analysis 7.2. Comparison 7 Clipping day before compared with clipping day of surgery, Outcome 2 Surgical site infection day 30.

Review: Preoperative hair removal to reduce surgical site infection

Comparison: 7 Clipping day before compared with clipping day of surgery

Outcome: 2 Surgical site infection day 30



APPENDICES

Appendix I. Search strategy - first update 2006

We searched the following databases:

Cochrane Wounds Group Specialised Register to October 2005;

The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* Issue 3, 2005);

MEDLINE 1966 to 2005;

EMBASE 1980 to 2005;

CINAHL 1982 to 2005;

ZETOC database of conference proceedings 1993 to 2005.

We used the following search strategy to search CENTRAL:

1. HAIR REMOVAL explode all trees (MeSH)
2. HAIR PREPARATIONS explode tree 1 (MeSH)
3. (hair and remov*)
4. (hair and preparation)
5. shav*
6. hair and clip*
7. depilat*
8. (#1 or #2 or #3 or #4 or #5 or #6 or #7)

9. SURGICAL WOUND INFECTION explode all trees (MeSH)
10. WOUND INFECTION single term (MeSH)
11. INFECTION CONTROL explode all trees (MeSH)
12. (wound* near infect*)
13. (surg* near infect*)
14. (surg* near wound*)
15. (surg* near complication*)
16. POSTOPERATIVE COMPLICATIONS explode all trees (MeSH)
17. PREOPERATIVE CARE explode all trees (MeSH)
18. INTRAOPERATIVE CARE explode all trees (MeSH)
19. PERIOPERATIVE CARE explode all trees (MeSH)
20. (perioperative near care)
21. (preoperative near care)
22. (intraoperative near care)
23. (skin near preparation)
24. (#9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23)
25. (#8 and #24)

We searched the bibliographies of all retrieved and relevant publications identified by these strategies for further studies. In addition, we contacted the following manufacturers of hair removal products to obtain information of any unpublished studies; Cardinal Health, Alliance Medical, Hallstar and 3M Health Care Ltd. Both 3M Health Care Ltd and Cardinal Health responded and provided articles on hair removal. All of the articles provided by the manufacturers had already been obtained through the search strategy. There were no restrictions based on language or date of publication.

Appendix 2. Ovid MEDLINE search strategy

- 1 exp Hair Removal/
- 2 (hair adj3 remov\$).ti,ab.
- 3 (shav\$ or clip\$ or depilat\$).ti,ab.
- 4 or/1-3
- 5 exp Surgical Wound Infection/
- 6 exp Surgical Wound Dehiscence/
- 7 (surg\$ adj5 infection\$).ti,ab.
- 8 (surg\$ adj5 wound\$).ti,ab.
- 9 (wound\$ adj5 infection\$).ti,ab.
- 10 ((postoperative or post-operative) adj5 infection\$).ti,ab.
- 11 or/5-10
- 12 4 and 11

Appendix 3. Ovid EMBASE search strategy

- 1 exp Hair Removal/
- 2 (hair adj3 remov\$).ti,ab.
- 3 (shav\$ or clip\$ or depilat\$).ti,ab.
- 4 or/1-3
- 5 exp Surgical Infection/
- 6 exp Wound Dehiscence/
- 7 (surg\$ adj5 infection\$).ti,ab.
- 8 (surg\$ adj5 wound\$).ti,ab.
- 9 (wound\$ adj5 infection\$).ti,ab.
- 10 ((postoperative or post-operative) adj5 infection\$).ti,ab.
- 11 or/5-10
- 12 4 and 11

Appendix 4. EBSCO CINAHL search strategy

S12 S4 and S11

S11 S5 or S6 or S7 or S8 or S9 or S10

S10 TI (postoperative infection* or post operative infection*) or AB (postoperative infection* or post operative infection*)

S9 TI wound* N5 infection* or AB wound* N5 infection*

S8 TI surg* N5 wound* or AB surg* N5 wound*

S7 TI surg* N5 infection* or AB surg* N5 infection*

S6 (MH "Wound Infection")

S5 (MH "Surgical Wound Infection")

S4 S1 or S2 or S3

S3 TI (shav* or clip* or depilat*) or AB (shav* or clip* or depilat*)

S2 TI hair N3 remov* or AB hair N3 remov*

S1 (MH "Hair Removal")

Appendix 5. Criteria for judgments for the sources of bias:

1. Was the allocation sequence randomly generated?

Low risk of bias

The investigators describe a random component in the sequence generation process such as: referring to a random number table; using a computer random number generator; coin tossing; shuffling cards or envelopes; throwing dice; drawing of lots.

High risk of bias

The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach, for example: sequence generated by odd or even date of birth; sequence generated by some rule based on date (or day) of admission; sequence generated by some rule based on hospital or clinic record number.

Unclear

Insufficient information about the sequence generation process to permit judgement of low or high risk of bias.

2. Was the treatment allocation adequately concealed?

Low risk of bias

Participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation: central allocation (including telephone, web-based and pharmacy-controlled randomisation); sequentially-numbered drug containers of identical appearance; sequentially-numbered, opaque, sealed envelopes.

High risk of bias

Participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias, such as allocation based on: using an open random allocation schedule (e.g. a list of random numbers); assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or non opaque or not sequentially numbered); alternation or rotation; date of birth; case record number; any other explicitly unconcealed procedure.

Unclear

Insufficient information to permit judgement of low or high risk of bias. This is usually the case if the method of concealment is not described or not described in sufficient detail to allow a definite judgement, for example if the use of assignment envelopes is described, but it remains unclear whether envelopes were sequentially numbered, opaque and sealed.

3. Blinding - was knowledge of the allocated interventions adequately prevented during the study?

Low risk of bias

Any one of the following.

- No blinding, but the review authors judge that the outcome and the outcome measurement are not likely to be influenced by lack of blinding.
- Blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken.
- Either participants or some key study personnel were not blinded, but outcome assessment was blinded and the non-blinding of others unlikely to introduce bias.

High risk of bias

Any one of the following.

- No blinding or incomplete blinding, and the outcome or outcome measurement is likely to be influenced by lack of blinding.
- Blinding of key study participants and personnel attempted, but likely that the blinding could have been broken.
- Either participants or some key study personnel were not blinded, and the non-blinding of others likely to introduce bias.

Unclear

Any one of the following.

- Insufficient information to permit judgement of low or high risk of bias.
- The study did not address this outcome.

4. Were incomplete outcome data adequately addressed?

Low risk of bias

Any one of the following.

- No missing outcome data.
- Reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias).
- Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups.
- For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate.
- For continuous outcome data, plausible effect size (difference in means or standardised difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size.
- Missing data have been imputed using appropriate methods.

High risk of bias

Any one of the following.

- Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups.
- For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate.

- For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size.
- 'As-treated' analysis done with substantial departure of the intervention received from that assigned at randomisation.
- Potentially inappropriate application of simple imputation.

Unclear

Any one of the following.

- Insufficient reporting of attrition/exclusions to permit judgement of low or high risk of bias (e.g. number randomized not stated, no reasons for missing data provided).
- The study did not address this outcome.

5. Are reports of the study free of suggestion of selective outcome reporting?

Low risk of bias

Any of the following.

- The study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way.
- The study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon)

High risk of bias

Any one of the following.

- Not all of the study's pre-specified primary outcomes have been reported.
- One or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. subscales) that were not pre-specified.
- One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect).
- One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis.
- The study report fails to include results for a key outcome that would be expected to have been reported for such a study.

Unclear

Insufficient information to permit judgement of low or high risk of bias. It is likely that the majority of studies will fall into this category.

6. Other sources of potential bias

Low risk of bias

The study appears to be free of other sources of bias.

High risk of bias

There is at least one important risk of bias. For example, the study:

- had a potential source of bias related to the specific study design used; or
- had extreme baseline imbalance; or
- has been claimed to have been fraudulent; or
- had some other problem.

Unclear

There may be a risk of bias, but there is either:

- insufficient information to assess whether an important risk of bias exists; or
- insufficient rationale or evidence that an identified problem will introduce bias.

WHAT'S NEW

Last assessed as up-to-date: 11 August 2011.

Date	Event	Description
14 September 2011	New citation required but conclusions have not changed	New author added to the review team
12 August 2011	New search has been performed	Second update, new search, three new trials included (Abouzari 2009 ; Celik 2007 ; Nascimento 1991), as a result of further assessment one trial which was previously excluded has been included in this update (Ilankovan 1992) and one trial which was previously included has now been excluded (Ko 1992). The conclusions of this update remain unchanged.

HISTORY

Protocol first published: Issue 2, 2003

Review first published: Issue 2, 2006

Date	Event	Description
21 September 2010	New search has been performed	Converted to new review format.
21 April 2006	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

JT wrote the protocol, screened citations for eligibility, arranged translations, contacted authors, checked extracted data, entered data into RevMan and wrote the review.

PN screened citations for eligibility, extracted data, entered data into RevMan, commented on trial design and commented on the review.

KM commented on the protocol, screened citations for eligibility, extracted data, contacted manufacturers and commented on the review.

Contributions of editorial base:

Nicky Cullum: edited the review, advised on methodology, interpretation and review content. Approved the final review and review update prior to submission.

Sally Bell-Syer: coordinated the editorial process. Advised on methodology, interpretation and content. Edited and copy edited the review and the updated review.

Ruth Foxlee: designed the search strategy, ran the searches and edited the search methods section for the update.

DECLARATIONS OF INTEREST

Judith Tanner has received payment for presenting the findings of this Cochrane review at conferences.

SOURCES OF SUPPORT

Internal sources

- De Montfort University, UK.

External sources

- The Theatre Nurses' Trust Fund, UK.
- The Association for Perioperative Practice, UK.
- NIHR/Department of Health (England), (Cochrane Wounds Group), UK.

INDEX TERMS

Medical Subject Headings (MeSH)

*Hair Removal [adverse effects; methods]; Preoperative Care; Randomized Controlled Trials as Topic; Surgical Wound Infection [etiology; *prevention & control]; Time Factors

MeSH check words

Humans