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[Intervention Review]

Skin preparation for preventing infection following caesarean section

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ABSTRACT

Background

The risk of maternal mortality and morbidity (particularly postoperative infection) is higher for caesarean section (CS) than for vaginal birth. With the increasing rate of CS, it is important to minimise the risks to the mother as much as possible. This review focused on different forms and methods of preoperative skin preparation to prevent infection. This review is an update of a review that was first published in 2012, and updated in 2014.

Objectives

To compare the effects of different antiseptic agents, different methods of application, or different forms of antiseptic used for preoperative skin preparation for preventing postcaesarean infection.

Search methods

For this update, we searched Cochrane Pregnancy and Childbirth's Trials Register, [ClinicalTrials.gov](https://www.clinicaltrials.gov), the WHO International Clinical Trials Registry Platform ([ICTRP](https://www.who.int/clinicaltrialsregistryplatform)) (27 November 2017), and reference lists of retrieved studies.

Selection criteria

Randomised and quasi-randomised trials, evaluating any type of preoperative skin preparation agents, forms, and methods of application for caesarean section.

Comparisons of interest in this review were between different antiseptic agents used for CS skin preparation (e.g. alcohol, povidone iodine), different methods of antiseptic application (e.g. scrub, paint, drape), different forms of antiseptic (e.g. powder, liquid), and also between different skin preparations, such as a plastic incisional drape, which may or may not be impregnated with antiseptic agents.

Only studies involving the preparation of the incision area were included. This review did not cover studies of preoperative handwashing by the surgical team or preoperative bathing.

Data collection and analysis

Three review authors independently assessed all potential studies for inclusion, assessed risk of bias, and extracted the data using a predesigned form. We checked data for accuracy. We assessed the quality of the evidence using the GRADE approach.

Main results

For this update, we included 11 randomised controlled trials (RCTs), with a total of 6237 women who were undergoing CS. Ten trials (6215 women) contributed data to this review. All included studies were individual RCTs. We did not identify any quasi- or cluster-RCTs. The trial dates ranged from 1983 to 2016. Six trials were conducted in the USA, and the remainder in Nigeria, South Africa, France, Denmark, and Indonesia.

The included studies were broadly methodologically sound, but raised some specific concerns regarding risk of bias in a number of cases.

Drape versus no drape

This comparison investigated the use of a non-impregnated drape versus no drape, following preparation of the skin with antiseptics. For women undergoing CS, low-quality evidence suggested that using a drape before surgery compared with no drape, may make little or no difference to the incidence of surgical site infection (risk ratio (RR) 1.29, 95% confidence interval (CI) 0.97 to 1.71; 2 trials, 1294 women), or length of stay in the hospital (mean difference (MD) 0.10 day, 95% CI -0.27 to 0.46; 1 trial, 603 women).

One-minute alcohol scrub with iodophor drape versus five-minute iodophor scrub without drape

One trial compared an alcohol scrub and iodophor drape with a five-minute iodophor scrub only, and reported no surgical site infection in either group (79 women, very-low quality evidence). We were uncertain whether the combination of a one-minute alcohol scrub and a drape reduced the incidence of endomyometritis when compared with a five-minute scrub, because the quality of the evidence was very low (RR 1.62, 95% CI 0.29 to 9.16; 1 trial, 79 women).

Parachlorometaxylenol with iodine versus iodine alone

We were uncertain whether parachlorometaxylenol with iodine before CS made any difference to the incidence of surgical site infection (RR 0.33, 95% CI 0.04 to 2.99; 1 trial, 50 women), or endometritis (RR 0.88, 95% CI 0.56 to 1.38; 1 trial, 50 women) when compared with iodine alone, because the quality of the evidence was very low.

Chlorhexidine gluconate versus povidone iodine

Low-quality evidence suggested that chlorhexidine gluconate before CS, when compared with povidone iodine, may make little or no difference to the incidence of surgical site infection (RR 0.80, 95% CI 0.62 to 1.02; 6 trials, 3607 women). However, surgical site infection appeared to be slightly reduced for women for whom chlorhexidine gluconate was used compared with povidone iodine after we removed four trials at high risk of bias for outcome assessment, in a sensitivity analysis (RR 0.59, 95% CI 0.37 to 0.95; 2 trials, 1321 women).

Low-quality evidence indicated that chlorhexidine gluconate before CS, when compared with povidone iodine, may make little or no difference to the incidence of endometritis (RR 1.01, 95% CI 0.51 to 2.01; 2 trials, 2079 women), or to reducing maternal skin irritation or allergic skin reaction (RR 0.60, 95% CI 0.22 to 1.63; 2 trials, 1521 women).

One small study (60 women) reported reduced bacterial growth at 18 hours after CS for women who had chlorhexidine gluconate preparation compared with women who had povidone iodine preparation (RR 0.23, 95% CI 0.07 to 0.70).

None of the included trials reported on maternal mortality or repeat surgery.

Chlorhexidine 0.5% versus 70% alcohol plus drape

One trial, which was only available as an abstract, investigated the effect of skin preparation on neonatal adverse events, and found cord blood iodine concentration to be higher in the iodine group.

Authors' conclusions

There was insufficient evidence available from the included RCTs to fully evaluate different agents and methods of skin preparation for preventing infection following caesarean section. Therefore, it is not yet clear what sort of skin preparation may be most effective for preventing postcaesarean surgical site infection, or for reducing other undesirable outcomes for mother and baby.

Most of the evidence in this review was deemed to be very low or low quality. This means that for most findings, our confidence in any evidence of an intervention effect is limited, and indicates the need for more high-quality research.

This field needs high quality, well designed RCTs, with larger sample sizes. High priority questions include comparing types of antiseptic (especially iodine versus chlorhexidine), and application methods (scrubbing, swabbing, or draping). We found four studies that were ongoing; we will incorporate the results of these studies in future updates of this review.

PLAIN LANGUAGE SUMMARY

Skin preparation for preventing infection following caesarean section

This review is an update of a review that was first published in 2012, and updated in 2014.

What is the issue?

The aim of this Cochrane Review was to find out what methods of skin preparation before caesarean section were most effective in preventing infection after the operation. We collected and analysed all studies that assessed the effectiveness of antiseptics used to prepare the skin before making an incision (or cut) for the caesarean section. We only included analysis of preparations that were used to prepare the surgical site on the abdomen before caesarean section; we did not look at handwashing by the surgical team, or bathing the mother.

Why is this important?

Infections of surgical incisions are the third most frequently reported hospital-acquired infections. Women who give birth by caesarean section are exposed to infection from germs already present on the mother's own skin, or from external sources. The risk of infection following a caesarean section can be 10 times that of vaginal birth. Therefore, preventing infection by properly preparing the skin before the incision is made is an important part of the overall care given to women prior to caesarean birth. An antiseptic is a substance applied to remove bacteria that can cause harm to the mother or baby when they multiply. Antiseptics include iodine or povidone iodine, alcohol, chlorhexidine, and parachlorometaxyleneol. They can be applied as liquids or powders, scrubs, paints, swabs, or on impregnated 'drapes' that stick to the skin, which the surgeon then cuts through. Non-impregnated drapes can also be applied, once the skin has been scrubbed or swapped, with the aim of reducing the spread of any remaining bacteria during surgery. It is important to know if some of these antiseptics or methods work better than others.

What evidence did we find?

This updated review included 11 trials with 6237 women. Six trials were conducted in the United States; the remaining trials were in Nigeria, South Africa, France, Denmark, and Indonesia. The review looked at what was best for women and babies when it came to important outcomes including: infection of the site where the surgeon cut the woman to perform the caesarean section; inflammation of the lining of the womb (metritis and endometritis); how long the woman stayed in hospital; and any other adverse effects, such as irritation of the woman's skin, or any reported impact on the baby. Not all of the 11 trials explored all of these outcomes, and the evidence for each outcome was usually based on results from far fewer than 6237 women.

Much of the evidence we found was of relatively poor quality, due to limits in the ways that the studies were conducted. This means that we could not be certain about most of the findings, even when we combined the results from a number of different studies. The evidence suggested that there was probably little or no difference between the various antiseptics in the incidence of surgical site infection, endometritis, skin irritation, or allergic skin reaction in the mother. However, in one study, there was a reduction in bacterial growth on the skin at 18 hours after caesarean section for women who received a skin preparation with chlorhexidine gluconate compared with women who received the skin preparation with povidone iodine, but more data are needed to see if this actually reduces infections for women.

What does this mean?

The available evidence from the trials that have been conducted was insufficient to tell us the best type of skin preparation for preventing surgical site infection following caesarean section. More high-quality research is needed. We found four studies that were still ongoing. We will incorporate the results of these studies into this review in future updates.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Drape compared to no drape before caesarean section for preventing infection

Drape compared to no drape

Population: women undergoing caesarean section

Settings: hospitals in Denmark (8 trials), and South Africa (1 trial)

Intervention: antiseptic application using drape

Comparison: no drape

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Risk with no drape	Risk with drape				
Surgical site infection	Study population		RR 1.29 (0.97 to 1.71)	1294 (2 RCTs)	⊕⊕⊕⊖ LOW ^{a,b}	
	112 per 1000	144 per 1000 (109 to 191)				
Metritis or endometritis, or both	-	-	-	-	-	This outcome was not reported in any of the included studies.
Length of stay (days)	The mean length of stay with no drape was 5.7 days	The mean number of days with a drape was 0.1 higher (0.27 days lower to 0.46 days higher)	-	603 (1 RCT)	⊕⊕⊕⊖ MODERATE ^b	
Adverse events (maternal or neonatal)	-	-	-	-	-	This outcome was not reported in any of the included studies.

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence

High quality: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

^a Selection bias was unclear and blinding of outcome assessor was at high risk of bias (risk of bias -1)

^b Wide 95% CI (imprecision -1)

Summary of findings 2. One-minute alcohol scrub with iodophor drape compared to five-minute iodophor scrub without drape for preventing infection following caesarean section

One-minute alcohol scrub with iodophor drape compared to five-minute iodophor scrub without drape

Population: women undergoing caesarean section

Settings: a university hospital in the USA

Intervention: one-minute alcohol scrub with iodophor drape

Comparison: five-minute iodophor scrub without drape

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Risk with 5-minute iodophor scrub without drape	Risk with 1-minute alcohol scrub with iodophor drape				
Surgical site infection	Study population		not estimable	79 (1 RCT)	⊕⊕⊕⊕ VERY LOW ^{a,b}	There were no surgical site infections in either group.
	0 per 1000	0 per 1000 (0 to 0)				
Endomyometritis	Study population		RR 1.62 (0.29 to 9.16)	79 (1 RCT)	⊕⊕⊕⊕ VERY LOW ^{a,c}	
	49 per 1000	79 per 1000 (14 to 447)				
Length of stay	-	-	-	-	-	This outcome was not reported in the included study.
Adverse events (maternal or neonatal)	-	-	-	-	-	This outcome was not reported in the included study.

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; RR: Risk ratio;

GRADE Working Group grades of evidence

High quality: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

^a Allocation concealment and blinding of outcome assessor was unclear risk of bias (risk of bias -1)

^b The number of event was 0 in each group, small sample size (imprecision -2)

^c Small sample size with wide 95% CI (imprecision -2)

Summary of findings 3. Parachlorometaxylenol with iodine versus iodine alone for preventing infection following caesarean section

Parachlorometaxylenol with iodine versus iodine alone

Population: women undergoing caesarean section

Settings: a hospital in USA

Intervention: parachlorometaxylenol with iodine

Comparison: iodine alone

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Risk with iodine alone	Risk with parachlorometaxylenol with iodine				
Surgical site infection	Study population		RR 0.33 (0.04 to 2.99)	50 (1 study)	⊕⊕⊕⊕ VERY LOW ^{a,b}	
	120 per 1000	40 per 1000 (5 to 359)				
Endometritis	Study population		RR 0.88 (0.56 to 1.38)	50 (1 study)	⊕⊕⊕⊕ VERY LOW ^{a,b}	
	640 per 1000	563 per 1000 (358 to 883)				
Length of stay	-	-	-	-	-	This outcome was not reported in the included study.

Adverse events (maternal or neonatal)	-	-	-	-	-	-	This outcome was not reported in the included study.
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*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

^a Wide confidence interval crossing the line of no effect and small sample size (imprecision -2)

^b Blinding of outcome assessor was at high risk of bias (risk of bias -1).

Summary of findings 4. Chlorhexidine gluconate compared to povidone iodine for preventing infection following caesarean section

Chlorhexidine gluconate compared to povidone iodine

Population: women undergoing caesarean section

Settings: single-centre or multicenter trials in Nigeria, USA, and Indonesia

Intervention: chlorhexidine gluconate

Comparison: povidone iodine

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Risk with povidone iodine	Risk with chlorhexidine gluconate				
Surgical site infection	Study population		RR 0.80 (0.62 to 1.02)	3607 (6 RCTs)	⊕⊕⊕⊖ LOW ^{a,b}	
	70 per 1000	56 per 1000 (44 to 72)				
Endometritis	Study population		RR 1.01 (0.51 to 2.01)	2079 (2 RCTs)	⊕⊕⊕⊖ LOW ^{a,b}	
	15 per 1000	15 per 1000 (8 to 31)				

Length of stay	-	-	-	-	-	This outcome was not reported in any of the included studies.
Adverse events (maternal) - skin irritation or allergic skin reaction	Study population		RR 0.60 (0.22 to 1.63)	1521 (2 RCTs)	⊕⊕⊕⊖ LOW ^{a,b}	No neonatal adverse events were reported in any of the included studies.
	13 per 1000	8 per 1000 (3 to 21)				

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence

High quality: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

^a Wide 95% CI overlapped line of no effect (imprecision -1)

^b Selection bias and blinding of outcome assessment was at high risk of bias (risk of bias -1)

BACKGROUND

Description of the condition

Caesarean section is an increasingly common major surgical procedure performed on women ([WHO 2015](#)). For example, in 2015, every third birth (32%) in the United States was a caesarean delivery ([Martin 2015](#)). The increasing rate of caesarean birth worldwide in both high- and low-income countries, is well established, and a concern to many ([Thomas 2001](#)). Between 2004 and 2011, an overall increase of the global rate of caesarean section, of up to 31.2%, was reported ([Vogel 2015](#)). The risk of maternal morbidity and mortality is higher in caesarean section than in vaginal birth; postoperative infection is a common component of morbidity. With the increase in caesarean section, it is important that the risks to the mother are minimised as far as possible ([Thomas 2001](#)). This review focused on different forms and methods for preoperative skin preparation to prevent infection; it did not include studies of preoperative handwashing of the surgical team and preoperative bathing.

Women who give birth by caesarean section are exposed to both endogenous (internal) and exogenous (external) sources of infection during birth. Exposure to a hospital environment places these women at risk of developing hospital-acquired infections. The rate of postcaesarean infection has been estimated to be 10 times greater than that after vaginal birth ([Henderson 1995](#)).

The Centers for Disease Control and Prevention (CDC) estimates that 27 million surgical procedures are performed in the United States each year. The CDC's National Nosocomial Infections Surveillance system reports that surgical site infections are the third most frequently reported nosocomial infection, accounting for 14% to 16% of all such infections ([CDC 2005](#)). Preventing infection by properly preparing the skin before incision is thus a vital part of the overall care given to women during caesarean birth.

The incidence of abdominal incisional infections following caesarean section ranges from 3% to 15%. A postcaesarean surgical site infection is a bacterial infection in the surgical incision following an abdominal birth. Women who develop a postcaesarean surgical site infection typically experience a temperature of 38.0°C (100.4°F) or higher and lower abdominal pain ([Cunningham 2018](#)). Abdominal incisional abscesses that develop following caesarean birth usually cause fever on about the fourth postoperative day. In many cases, these are preceded by uterine infection, and fever persists from the first or second postoperative day. Wound redness (erythema) and drainage may also be present. Organisms causing these infections are usually the same as those isolated from amniotic fluid at caesarean birth, but hospital-acquired pathogens may also be the cause ([Lewis 2013](#)).

Some women are more likely than others to develop a postcaesarean surgical site infection. Women at increased risk include those who are obese; have diabetes or an immunosuppressive disorder (HIV infection); have chorioamnionitis (infection of the amniotic fluid and fetal membrane) during labour; anaemia; or are taking corticosteroids (by mouth or intravenously ([Cunningham 2018](#))).

In addition to surgical site infections, another common source of morbidity is postcaesarean metritis, including endometritis, an infection that develops within the lining of the uterus after

birth. Despite the use of routine antibiotics before or during surgery (perioperative prophylaxis), estimates of metritis following caesarean range from 10% to 20% ([Normand 2001](#)).

Description of the intervention

Proper preparation of an incision site involves removing surface dirt and oil with a soap or detergent scrub plus applying a topical antimicrobial agent that will reduce the bacterial population to a minimal level. In surgical patients, the choice of surgical scrub and the duration of scrubbing have not been shown to make any significant difference in the rate of surgical site infection in either clean or clean-contaminated wounds (such as caesarean skin incision ([Dumville 2015](#); [Mangram 1999](#))).

Antiseptics to prevent infection have been in use for over 150 years. Antiseptic handwash solution was first introduced by Semmelweis, in 1847, at the Vienna Maternity Hospital, to reduce maternal mortality due to puerperal sepsis ([Loudon 2002](#)). Later, in 1864, Lister introduced carbolic acid spray preparation for the operative site. Since then, many solutions (including alcoholic iodine, mercuric compounds, and ether) have been used to prepare the operative site. However, as another Cochrane review has shown, there is uncertainty about which antiseptic skin preparation is the most effective for preventing postoperative surgical site infections ([Dumville 2015](#)).

There are six types of antiseptics that are designed for topical application: iodine or iodophors, alcohol, chlorhexidine gluconate, hexachlorophene, parachlorometaxyleneol, and triclosan ([Dumville 2015](#); [Larson 1988](#)). For the purpose of this review, antiseptic agents can be applied in the form of liquids, solutions, or powders, or delivered on impregnated drapes.

How the intervention might work

The removal of transient bacteria and reduction of the number of existing organisms by antiseptic is recommended prior to surgery by several organisations, for example, the Royal College of Surgeons of England ([Leaper 2001](#)), the Centers for Disease Control and Prevention ([Mangram 1999](#)), and the Association of Operating Room Nurses ([AORN 2002](#)). Several antiseptic agents are available for preoperative preparation of skin at the incision site. [Leclair 1990](#) described an antiseptic as 'a chemical agent that reduces the microbial population on the skin'. It is suggested that the ideal agent would kill all bacteria, fungi, viruses, protozoa, tubercle bacilli, and spores; be nontoxic, hypoallergenic, and safe to use in all body regions; not be absorbed; have residual activity, and be safe for repetitive use ([Dumville 2015](#); [Hardin 1997](#)).

Antiseptics for preoperative skin preparation should be broad-spectrum and fast-acting, and contain an antimicrobial ingredient that results in significant reduction in the number of micro-organisms on intact skin ([Larson 1988](#)). The primary action of antiseptics includes both the mechanical removal and chemical killing, and the inhibition of both contaminating and colonising flora.

Why it is important to do this review

There is a Cochrane Review on the use of preoperative skin antiseptics for preventing infections ([Dumville 2015](#)). However, although the scope of the [Dumville 2015](#) review included clean and clean-contaminated surgical operations, including caesarean

section, the focus was solely on preventing surgical site infections. In our review, the focus extended to preventing all types of infection, such as endometritis or metritis. In this review, we did not look at different methods of surgical incision for caesarean, because that was the topic of another Cochrane Review ([Mathai 2013](#)).

OBJECTIVES

To compare the effects of different antiseptic agents, different methods of application, or different forms of antiseptic used for preoperative skin preparation for preventing postcaesarean infection.

METHODS

Criteria for considering studies for this review

Types of studies

All published and unpublished randomised and quasi-randomised trials, including cluster-randomised trials, evaluating any described type of preoperative skin preparation agents, forms, and methods of application for caesarean section were eligible for inclusion. No quasi or cluster-RCTs were identified for inclusion. Cross-over studies were not eligible for inclusion. We included studies presented only as abstracts, if they provided enough information.

Types of participants

Pregnant women undergoing elective or emergency caesarean section.

Types of interventions

Comparisons between different antiseptic agents used for caesarean section skin preparation (e.g. alcohol, povidone iodine), different methods of antiseptic application (e.g. scrub, paint, drape), or different forms of antiseptic (e.g. powder, liquid).

We only included studies involving the preparation of the incision area. We excluded studies of preoperative handwashing of the surgical team and preoperative bathing. Other Cochrane Reviews cover other methods for preventing infection at caesarean section (e.g. antimicrobial application, skin shaving).

A related Cochrane Review covers vaginal preparation with antiseptics before caesarean section ([Haas 2018](#)).

Types of outcome measures

Primary outcomes

1. Surgical site infection (as defined by trialists)
2. Metritis or endometritis, or both

Secondary outcomes

1. Length of stay
2. Maternal mortality
3. Repeat surgery
4. Re-admission resulting from infection
5. Reduction of skin bacteria colony count*
6. Adverse events (maternal or neonatal)*

*Outcome not prespecified in our published protocol ([Hadiati 2008](#)); see [Differences between protocol and review](#).

Search methods for identification of studies

The following search methods section of this review is based on a standard template used by Cochrane Pregnancy and Childbirth.

Electronic searches

For this update, we searched Cochrane Pregnancy and Childbirth's Trials Register by contacting their Information Specialist (27 November 2017)

The Register is a database containing over 25,000 reports of controlled trials in the field of pregnancy and childbirth. It represents over 30 years of searching. For full current search methods used to populate Pregnancy and Childbirth's Trials Register including the detailed search strategies for CENTRAL, MEDLINE, Embase and CINAHL; the list of handsearched journals and conference proceedings, and the list of journals reviewed via the current awareness service, please follow this [link](#)

Briefly, Cochrane Pregnancy and Childbirth's Trials Register is maintained by their Information Specialist and contains trials identified from:

1. monthly searches of the Cochrane Central Register of Controlled Trials (CENTRAL);
2. weekly searches of MEDLINE (Ovid);
3. weekly searches of Embase (Ovid);
4. monthly searches of CINAHL (EBSCO);
5. handsearches of 30 journals and the proceedings of major conferences;
6. weekly current awareness alerts for a further 44 journals plus monthly BioMed Central email alerts.

Search results are screened by two people and the full text of all relevant trial reports identified through the searching activities described above is reviewed. Based on the intervention described, each trial report is assigned a number that corresponds to a specific Pregnancy and Childbirth review topic (or topics), and is then added to the Register. The Information Specialist searches the Register for each review using this topic number rather than keywords. This results in a more specific search set that has been fully accounted for in the relevant review sections ([Included studies](#); [Excluded studies](#); [Ongoing studies](#)).

In addition, we searched [ClinicalTrials.gov](#) and the WHO International Clinical Trials Registry Platform (ICTRP) for unpublished, planned, and ongoing trial reports (27 November 2017) using the methods detailed in [Appendix 1](#).

Searching other resources

We searched the reference lists of all included studies and review articles.

We did not apply any language restrictions.

Data collection and analysis

For methods used in the previous version, please see [Hadiati 2012](#).

For this update, we used the following methods, which are based on a standard template used by the Cochrane Pregnancy and Childbirth.

Selection of studies

Three review authors independently assessed all the potential studies we identified as a result of the search strategy, for inclusion. We resolved any disagreement through discussion, or consulted a fourth person if required.

Data extraction and management

We designed a form to extract data. We also extracted information on the dates of the study, sources of trial funding, and the trial authors' declarations of interest. For eligible studies, at least two review authors extracted the data, using the agreed form. We resolved discrepancies through discussion, or consulted a third person, if required. We entered data into Review Manager 5 software, and checked for accuracy (RevMan 2014).

Assessment of risk of bias in included studies

Two review authors independently assessed the risk of bias for each study, using the criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). We resolved any disagreement by discussion with the third review author.

(1) Random sequence generation (checking for possible selection bias)

For each included study, we described the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.

We assessed the method as:

- low risk of bias (any truly random process, e.g. random number table; computer random number generator);
- high risk of bias (any non-random process, e.g. odd or even date of birth; hospital or clinic record number);
- unclear risk of bias.

(2) Allocation concealment (checking for possible selection bias)

For each included study, we described the method used to conceal the allocation sequence and determine whether intervention allocation could have been foreseen in advance of, or during recruitment, or changed after assignment.

We assessed the methods as:

- low risk of bias (e.g. telephone or central randomisation; consecutively numbered sealed opaque envelopes);
- high risk of bias (open random allocation; unsealed or non-opaque envelopes, alternation; date of birth);
- unclear.

(3.1) Blinding of participants and personnel (checking for possible performance bias)

For each included study, we described the method used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. We considered that studies were at low risk of bias if they were blinded, or if we judged that

the lack of blinding could not have affected the results. We assessed blinding separately for different outcomes or classes of outcomes.

We assessed the methods as:

- low, high, or unclear risk of bias for participants;
- low, high, or unclear risk of bias for personnel.

(3.2) Blinding of outcome assessment (checking for possible detection bias)

For each included study, we described the method used, if any, to blind outcome assessors from knowledge of which intervention a participant received. We assessed blinding separately for different outcomes or classes of outcomes.

We assessed methods used to blind outcome assessment as:

- low, high, or unclear risk of bias.

(4) Incomplete outcome data (checking for possible attrition bias through withdrawals, dropouts, protocol deviations)

For each included study, and for each outcome or class of outcomes, we described the completeness of data, including attrition and exclusions from the analysis. We stated whether attrition and exclusions were reported, the numbers included in the analysis at each stage (compared with the total randomised participants), reasons for attrition or exclusion where reported, and whether missing data were balanced across groups, or were related to outcomes. Where sufficient information was reported, we re-included missing data in the analyses that we undertook. We assessed methods as:

- low risk of bias (e.g. no missing outcome data; missing outcome data balanced across groups);
- high risk of bias (e.g. numbers or reasons for missing data imbalanced across groups; 'as treated' analysis done with substantial departure of intervention received from that assigned at randomisation);
- unclear risk of bias.

(5) Selective reporting bias

For each included study, we described how we investigated the possibility of selective outcome reporting bias, and what we found.

We assessed the methods as:

- low risk of bias (where it was clear that all of the study's prespecified outcomes and all expected outcomes of interest to the review were reported);
- high risk of bias (where not all the study's prespecified outcomes were reported; one or more reported primary outcomes were not prespecified; outcomes of interest were reported incompletely and so could not be used; study failed to include results of a key outcome that would have been expected to have been reported);
- unclear risk of bias.

(6) Other sources of bias

For each included study, we reported any important concerns we had about other possible sources of bias.

We assessed whether each study was free of other problems that could put it at risk of bias:

- low risk of bias;
- high risk of bias;
- unclear whether there is risk of other bias.

(7) Overall risk of bias

We made explicit judgements about whether studies were at high risk of bias, according to the criteria given in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). With reference to (1) to (6) above, we assessed the likely magnitude and direction of the bias, and whether we considered it was likely to impact on the findings. We explored the impact of the level of bias by undertaking sensitivity analyses (see [Sensitivity analysis](#)).

Assessment of the quality of the evidence using the GRADE approach

We used the GRADE approach to evaluate the quality of the evidence, as outlined in the GRADE Handbook (GRADE Handbook; GRADE Working Group 2004). The GRADE approach uses five considerations (study limitations, consistency of effect, imprecision, indirectness, and publication bias) to assess the quality of the body of evidence for specific outcomes. The evidence can be downgraded from 'high quality' by one level for serious (or by two levels for very serious) limitations, depending on assessments for risk of bias, indirectness of evidence, serious inconsistency, imprecision of effect estimates, or potential publication bias (GRADE Working Group 2004; Schünemann 2009). In this review, we used the GRADE approach to assess the following outcomes for all comparisons in the review.

1. Surgical site infection
2. Metritis or endometritis, or both
3. Length of stay*
4. Adverse events (maternal or neonatal)*

*Outcome for GRADE assessment was not prespecified in our previous review (Hadiati 2014); see [Differences between protocol and review](#).

We used GRADEpro GDT to import data from Review Manager 5 to create a 'Summary of findings' table, which presents a summary of the intervention effect and a measure of quality according to the GRADE approach for each of the outcomes listed above (GRADEpro GDT; RevMan 2014).

Measures of treatment effect

Dichotomous data

For dichotomous data, we presented results as summary risk ratio with 95% confidence intervals.

Continuous data

For continuous outcomes, we used the mean difference with 95% confidence intervals, as outcomes were measured in the same way between trials. In future updates of this review, if there are trials that measure the same outcome, but use different methods, we will use the standardised mean difference.

Unit of analysis issues

Cluster-randomised trials

We did not identify any cluster-randomised trials for inclusion in our review. In future updates, if we identify any cluster-randomised trials, we will include them in the analyses along with individually-randomised trials. We will consider it reasonable to combine the results from both if there is little heterogeneity between the study designs and the interaction between the effect of intervention and the choice of randomisation unit is considered to be unlikely. We will adjust their sample sizes using the methods described in the *Cochrane Handbook for Systematic Reviews of Interventions*, using an estimate of the intracluster correlation co-efficient (ICC) derived from the trial (if possible), from a similar trial, or from a study of a similar population (Higgins 2011). If we use ICCs from other sources, we will report this, and conduct sensitivity analyses to investigate the effect of variation in the ICC.

We will also acknowledge heterogeneity in the randomisation unit, and perform a sensitivity analysis to investigate the effects of the randomisation unit.

Cross-over trials

Cross-over trials were not eligible for inclusion in this review.

Studies with more than two intervention arms

If studies included multiple intervention groups, we included only the arms relevant to our research question and each arm was included in the analysis only once (Higgins 2011).

Dealing with missing data

For included studies, we noted levels of attrition. We explored the impact of including studies with high levels of missing data in the overall assessment of treatment effect with a sensitivity analysis.

For all outcomes, we carried out analyses, as far as possible, on an intention-to-treat basis, i.e. we included all participants randomised to each group in the analyses, and all participants were analysed in the group to which they were allocated, regardless of whether or not they received the allocated intervention. The denominator for each outcome in each trial was the number randomised minus any participants whose outcomes were known to be missing.

Assessment of heterogeneity

We assessed statistical heterogeneity in each meta-analysis using the τ^2 , I^2 , and χ^2 statistics. We regarded heterogeneity as substantial if the I^2 was greater than 30%, and either the τ^2 was greater than zero, or there was a low P value (less than 0.10) in the χ^2 test for heterogeneity.

Assessment of reporting biases

In future updates, if there are 10 or more studies in the meta-analysis, we will investigate reporting biases (such as publication bias) using funnel plots. We will assess funnel plot asymmetry visually. If asymmetry is suggested by a visual assessment, we will perform exploratory analyses to investigate it (Sterne 2017).

Data synthesis

We carried out statistical analysis using Review Manager 5 software ([RevMan 2014](#)). We used fixed-effect meta-analysis for combining data where it was reasonable to assume that studies were estimating the same underlying treatment effect: i.e. where trials were examining the same intervention, and the trials' populations and methods were judged to be sufficiently similar. In future updates, if there is sufficient clinical heterogeneity to expect that the underlying treatment effects differ between trials, or if we detect substantial statistical heterogeneity, we will use a random-effects meta-analysis to produce an overall summary, if we consider an average treatment effect across trials is clinically meaningful. We will treat the random-effects summary as the average range of possible treatment effects, and we will discuss the clinical implications of treatment effects differing between trials. If the average treatment effect is not considered to be clinically meaningful, we will not combine trials.

In future updates, if we use random-effects analyses, we will present the results as the average treatment effect with its 95% confidence interval, and the estimates of τ^2 and I^2 .

Subgroup analysis and investigation of heterogeneity

We did not identify substantial heterogeneity. If we do so in future updates of this review, we will investigate it using subgroup analyses and sensitivity analyses. We will consider whether an overall summary is meaningful, and if it is, use random-effects analysis to produce it.

In future updates, we will carry out the following subgroup analyses.

1. Risk of infection (high versus low risk)
2. Duration of skin preparation
3. Dose of preparation

We will restrict subgroup analyses to the primary outcomes.

We will assess differences between subgroups by using interaction tests, as described in the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2011](#)).

Sensitivity analysis

We carried out a sensitivity analysis to explore the effects of blinded outcome assessment on the results of the review. Studies in which blinded outcome assessment (for surgical site infection) was inadequate (i.e. high risk of bias) were excluded from the analysis to assess for any substantive difference to the overall result.

In future updates, we will also carry out sensitivity analysis to explore the effect of allocation concealment on the results of the review, and exclude studies with are high risk for this domain. We will also carry out a sensitivity analysis to explore the effects of fixed-effect or random-effects analyses for outcomes with statistical heterogeneity. If, in future updates, we include cluster-randomised trials along with the individually-randomised trials, we will carry out sensitivity analysis to investigate the effect of the randomisation unit.

RESULTS

Description of studies

Results of the search

See: [Figure 1](#).

Figure 1. Study flow diagram

For this update, we assessed 18 new trial reports, and reassessed the three that were ongoing in the previous version of the review (NCT00528008; NCT01472549; NCT01870583). We included five new trials (Aworinde 2016; Fahmi 2017; Ngai 2015; Springel 2017; Tuuli 2016) and excluded one (Nili 2015).

In this review, we included a total of 11 trials comparing different kinds of skin preparation for preventing infection following caesarean section. We obtained full data from nine studies, but only the abstract was available for two studies (Fahmi 2017; Pello 1990). We excluded six trials in total (Brown 1984; Kosus 2010;

[NCT01700803](#); [NCT02027324](#); [Nili 2015](#); [Robins 2005](#)). Four studies are still ongoing ([NCT00528008](#); [NCT01870583](#); [NCT02396329](#); [NCT02402907](#)).

Included studies

We included 11 trials with a total of 6237 women. See [Characteristics of included studies](#).

Method, trial dates, and sample sizes

All of the included studies were randomised controlled trials (RCTs ([Aworinde 2016](#); [Cordtz 1989](#); [Fahmi 2017](#); [Kunkle 2014](#); [Lorenz 1988](#); [Magann 1993](#); [Ngai 2015](#); [Pello 1990](#); [Springel 2017](#); [Tuuli 2016](#); [Ward 2001](#))). We did not include any quasi- or cluster-RCTs. The trials were conducted between 1983 and 2016. The trial dates were not provided in three studies ([Fahmi 2017](#); [Magann 1993](#); [Pello 1990](#)). Sample sizes ranged from 22 women ([Pello 1990](#)), to 1404 women ([Ngai 2015](#)).

Settings

Six studies were conducted in the United States ([Kunkle 2014](#); [Lorenz 1988](#); [Magann 1993](#); [Ngai 2015](#); [Springel 2017](#); [Tuuli 2016](#)), one study in Denmark ([Cordtz 1989](#)), one in France ([Pello 1990](#)), one in Nigeria ([Aworinde 2016](#)), one in South Africa ([Ward 2001](#)), and one study was conducted in Indonesia ([Fahmi 2017](#)). Of the included trials, eight were single-centre trials ([Aworinde 2016](#); [Kunkle 2014](#); [Lorenz 1988](#); [Magann 1993](#); [Ngai 2015](#); [Springel 2017](#); [Tuuli 2016](#); [Ward 2001](#)), two were conducted in multiple centres ([Cordtz 1989](#); [Fahmi 2017](#)), and one trial did not provide any details about the facility ([Pello 1990](#)).

Participants

In [Aworinde 2016](#), women who had elective caesarean section with no overt risk for surgical site infections were included in this trial. [Cordtz 1989](#), [Fahmi 2017](#), [Lorenz 1988](#), [Magann 1993](#), [Springel 2017](#), [Tuuli 2016](#), and [Ward 2001](#) included all women undergoing scheduled caesarean section in their trials. [Kunkle 2014](#) recruited women aged 18 to 45 years undergoing scheduled caesarean delivery at 36 gestational weeks or greater. Participants in [Ngai 2015](#) were all women in their 37th week of gestation, who were undergoing scheduled or non-emergent caesarean delivery. [Pello 1990](#) included women with a male fetus, who were undergoing caesarean section. Most trials stated that they excluded women undergoing emergency caesarean section, with a known sensitivity or allergy to one of the antiseptics used. Three trials gave no or insufficient information about the type of caesarean section (i.e. scheduled or emergency ([Cordtz 1989](#); [Pello 1990](#); [Ward 2001](#))). [Tuuli 2016](#) and [Fahmi 2017](#) included women undergoing both scheduled and emergency caesarean section.

Interventions and comparisons

Drape versus no drape

Two trials compared the use of drape versus no drape, and in both studies, the drapes used were not impregnated with an antiseptic agent ([Cordtz 1989](#); [Ward 2001](#)). [Cordtz 1989](#) assessed the effect of incisional plastic drapes versus no drape, combined with standard iodine disinfection with 2.5% iodine in 70% ethanol for all women. For the purpose of this review, we did not include data from this trial relating to additional arms in which women were re-disinfected, because this secondary disinfection of the skin around the incision took place shortly before skin closure, not before skin incision.

[Ward 2001](#) compared plastic incisional drape with no drape. Before surgery in all women, the abdomen was washed with chlorhexidine soap, and then swabbed with 0.5% chlorhexidine in 80% alcohol solution for 30 seconds.

Different antiseptic preparations

Four different antiseptic preparation comparisons were made in the remaining nine trials. In the [Lorenz 1988](#) trial, the comparison of skin preparation for caesarean section was between a one-minute scrub with 70% isopropyl alcohol followed by application of iodophor-impregnated adhesive film in the experimental group, versus a five-minute iodophor scrub followed by application of iodophor solution in the control group. The [Magann 1993](#) trial compared a five-minute scrub with parachlorometaxylenol followed by a 10% povidone-iodine scrub and normal saline irrigation of the pelvis and subcutaneous tissue at uterine closure and fascial closure (special preparation) in the experimental group, versus a 7.5% povidone-iodine surgical scrub followed by 10% povidone iodine and normal saline irrigation of the pelvis and subcutaneous tissue at uterine closure and fascial closure (standard preparation) in the control group. The [Pello 1990](#) trial compared two skin preparations using different agents and either drape or no drape (chlorhexidine 0.5% versus 70% alcohol plus an IOBAN 2 drape). Six trials compared preoperative application of chlorhexidine gluconate (2% chlorhexidine gluconate with 70% isopropyl alcohol) versus povidone iodine 10%, without the use of a drape in either the intervention or control arms ([Aworinde 2016](#); [Fahmi 2017](#); [Kunkle 2014](#); [Ngai 2015](#); [Springel 2017](#); [Tuuli 2016](#)).

Outcomes

Surgical site infection (as defined by trialists)

Ten studies reported on our primary outcome of surgical site infection ([Aworinde 2016](#); [Cordtz 1989](#); [Fahmi 2017](#); [Kunkle 2014](#); [Lorenz 1988](#); [Magann 1993](#); [Ngai 2015](#); [Springel 2017](#); [Tuuli 2016](#); [Ward 2001](#)). Surgical site infection was assessed from delivery to 30 days postoperative in [Aworinde 2016](#), [Springel 2017](#), and [Tuuli 2016](#); at three and seven days postoperative in [Fahmi 2017](#); at three days and two weeks in [Kunkle 2014](#); on two separate measurements at least 24 hours postoperative in [Lorenz 1988](#); on two separate occasions six hours apart after the first 24 hours in [Magann 1993](#); and at two and six weeks postcaesarean in [Ngai 2015](#). [Cordtz 1989](#) did not describe the time of assessment of surgical site infection. Trials used various definitions for surgical site infections. [Cordtz 1989](#) defined a possible wound infection as localised erythema, serous secretion, or both without the presence of pus, and infected as the presence of pus regardless of the results of bacteriological examination. [Kunkle 2014](#) defined surgical site infection as the presence of purulent drainage, cellulitis, or the need for incision and drainage, or treatment with antibiotics for a clinical diagnosis of infection. In [Lorenz 1988](#), surgical site infection was defined as infectious morbidity with (1) erythema and tenderness of the wound or separation of skin edges, and (2) no uterine tenderness or malodorous, discoloured lochia. [Magann 1993](#) defined this outcome as hyperemic skin incision and a fluctuant mass, which when opened, contained purulent material. In [Ward 2001](#), surgical site infection was diagnosed if two of three features were present: (1) erythematous cellulitis, (2) seropurulent discharge from the wound, and (3) positive swab culture (organisms and leucocytes). [Fahmi 2017](#), [Ngai 2015](#), [Springel 2017](#), and [Tuuli 2016](#) based the diagnosis of surgical site infection on Centers for Disease Control

and Prevention (CDC) criteria. One trial did not define surgical site infection in the report ([Aworinde 2016](#)).

Metritis or endometritis, or both

Four trials reported on endometritis ([Lorenz 1988](#); [Magann 1993](#); [Springel 2017](#); [Tuuli 2016](#)). In [Lorenz 1988](#), endomyometritis was defined as infectious morbidity with either (1) uterine tenderness on bimanual examination, or (2) no other site of infection identified on physical examination, urinalysis, or urine culture, and if indicated, a chest roentgenogram. In [Magann 1993](#), endometritis was identified through physical examination, urine, and blood cultures. [Springel 2017](#) followed the definition of endometritis according to the CDC, and [Tuuli 2016](#) did not provide any definition for this outcome.

Length of stay

[Tuuli 2016](#) and [Ward 2001](#) reported our secondary outcome, length of stay. However, [Tuuli 2016](#) reported only median length of hospital stay, so we only described data narratively.

Re-admission resulting from infection

Two trials reported on re-admission resulting from infection ([Springel 2017](#); [Tuuli 2016](#)).

Reduction of skin bacteria colony count

[Lorenz 1988](#) reported on reduction of skin bacteria colony counts, and [Kunkle 2014](#) reported on bacterial growth at 18 hours.

Adverse events (maternal or neonatal)

Two trials reported on maternal adverse events involving skin reactions, with both reporting on erythema and skin irritation ([Aworinde 2016](#); [Tuuli 2016](#)). Only one trial reported on neonatal adverse events, which was the concentration of iodine in the cord blood ([Pello 1990](#)). No other maternal or neonatal adverse events were reported.

The other outcomes investigated by this review, maternity mortality and repeated surgery, were not been reported in any of the included trials.

Sources of trial funding

Seven trials did not mention source of funding ([Cordtz 1989](#); [Fahmi 2017](#); [Lorenz 1988](#); [Magann 1993](#); [Ngai 2015](#); [Pello 1990](#); [Ward 2001](#)).

The Obafemi Awolowo University Teaching Hospital Complex, Nigeria supported [Aworinde 2016](#). The University of Southern California supported [Kunkle 2014](#), and Edward Henry Springel, MD supported [Springel 2017](#). [Tuuli 2016](#) received funding from the Women's Reproductive Health Research Career Development grant from the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health, and the Department of Obstetrics and Gynecology, Washington University School of Medicine in St. Louis.

Trialists' declarations of interest

Eight studies did not report declarations of interest ([Aworinde 2016](#); [Cordtz 1989](#); [Fahmi 2017](#); [Lorenz 1988](#); [Magann 1993](#); [Ngai 2015](#); [Pello 1990](#); [Ward 2001](#)). Two studies stated no conflict of interest ([Kunkle 2014](#); [Springel 2017](#)). In [Tuuli 2016](#), the first author reported having received a grant from the National Institutes of Health during the conduct of the study, but all other authors declared no conflict of interest.

Excluded studies

We excluded six trials ([Brown 1984](#); [Kosus 2010](#); [NCT01700803](#); [NCT02027324](#); [Nili 2015](#); [Robins 2005](#)). The [Brown 1984](#) study was excluded as the trial did not present the results for caesarean section cases separately from other surgical cases. The [Kosus 2010](#) trial was excluded as they used an antibiotic compared with or without Rifamycin SV (250 mg) before closure of subcutaneous tissue, in addition to povidone iodine 10% for preoperative antisepsis and after closure of the skin. Two trials ([NCT01700803](#); [NCT02027324](#)) were excluded as they focused on preoperative handwashing of the surgical team. We excluded one study because it was a cohort study and not a randomised controlled trial ([Nili 2015](#)). [Robins 2005](#) compared the effectiveness of chlorhexidine spray and single use sachets for skin preparation before regional nerve blockade, not for the preparation of the incision site before caesarean section.

For further details of the excluded studies, see [Characteristics of excluded studies](#).

Risk of bias in included studies

See 'Risk of bias' tables and figures for the 11 included studies in [Characteristics of included studies](#), [Figure 2](#), and [Figure 3](#).

Figure 2. 'Risk of bias' graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

Figure 3. 'Risk of bias' graph: review authors' judgements about each risk of bias item for each included study

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Aworinde 2016	+	+	+	-	+	+	+
Cordtz 1989	?	?	+	-	+	?	+
Fahmi 2017	+	?	+	+	+	?	+
Kunkle 2014	?	?	+	-	+	+	+
Lorenz 1988	+	?	+	-	+	?	+
Magann 1993	+	?	+	-	+	?	+
Ngai 2015	+	+	+	-	+	+	+
Pello 1990	?	?	?	+	?	?	?
Springel 2017	?	?	+	-	+	+	+
Tuuli 2016	+	?	+	+	+	-	+
Ward 2001	+	+	+	+	+	?	+

Allocation

Sequence generation

Sequence generation (computer-generated sequence) was adequate in seven trials (Aworinde 2016; Fahmi 2017; Lorenz 1988; Magann 1993; Ngai 2015; Tuuli 2016; Ward 2001). The remaining four trials provided insufficient or no details about sequence generation, and therefore, we judged them to be of unclear risk of bias (Cordtz 1989; Kunkle 2014; Pello 1990; Springel 2017).

Allocation concealment

The majority of included trials provided insufficient or no details regarding the measures taken to ensure that the treatment allocation could not be foreseen, and so we assessed them as unclear risk of bias for this item (Cordtz 1989; Fahmi 2017; Kunkle 2014; Lorenz 1988; Magann 1993; Pello 1990; Springel 2017; Tuuli 2016). In three trials, allocation concealment was performed using

sequentially numbered sealed envelopes, so we assessed the trials at low risk of bias (Aworinde 2016; Ngai 2015; Ward 2001).

Blinding

Blinding of participants and personnel (performance bias)

Although blinding was not reported in most of the trials, it was unlikely that this lack of blinding could have caused different treatments or behaviour between groups, such that outcomes would be affected, and therefore, we judged performance bias to be low in 10 trials (Aworinde 2016; Cordtz 1989; Fahmi 2017; Kunkle 2014; Lorenz 1988; Magann 1993; Ngai 2015; Springel 2017; Tuuli 2016; Ward 2001). In Pello 1990, the information provided was too limited to exclude any performance bias.

Blinding of outcome assessment (detection bias)

Seven trials were at high risk of detection bias (Aworinde 2016; Cordtz 1989; Kunkle 2014; Lorenz 1988; Magann 1993; Ngai 2015; Springel 2017). In these trials, outcome assessors were not blinded, and some outcomes involved an important element of subjective assessment. It was possible that lack of blinding could have caused differences in the reported outcomes, especially with respect to our primary outcome of surgical site infection, and therefore, this brings into question the certainty of the estimated treatment effect. Outcome assessment was blinded in three trials, so we judged them at low risk of bias (Fahmi 2017; Tuuli 2016; Ward 2001). In Pello 1990, blinding of outcome assessment was not described, but lack of blinding was unlikely to affect the outcome because it was objectively measured, and therefore was at low risk of bias.

Incomplete outcome data

In 10 trials, we judged attrition bias to be low, as all women were followed up until the end of the study, or the number of missing participants was balanced between intervention groups, and it was unlikely that the missing data substantially influenced the outcomes (Aworinde 2016; Cordtz 1989; Fahmi 2017; Kunkle 2014; Lorenz 1988; Magann 1993; Ngai 2015; Springel 2017; Tuuli 2016; Ward 2001). Only one study out of the 11 included studies was judged as unclear risk of bias, because the number of women in each group was not reported (Pello 1990).

Selective reporting

We found no evidence of selective reporting in four trials, and assessed them at low risk of bias (Aworinde 2016; Kunkle 2014; Ngai 2015; Springel 2017). Protocols were not available for us to assess originally planned outcomes in six trials, and so these we assessed as unclear risk of reporting bias (Cordtz 1989; Fahmi 2017; Lorenz 1988; Magann 1993; Pello 1990; Ward 2001). We judged the Tuuli 2016 study as being at a high risk of reporting bias, because some prespecified outcomes were not reported in the trial report.

Other potential sources of bias

Overall, we judged all the included trials to be at low risk of bias for other potential sources of bias. In the Cordtz 1989 trial, antibiotics for prophylaxis therapy were given to about 10% of the women in the study. Even though more women in the drape group (10.7%) received antibiotics than in the group without drapes (8.2%), infections were more common in the drape group. Therefore, the 'real' effect of skin preparation may have been different, but this was likely to be small, because of the overall small difference between groups. In the Lorenz 1988, Magann 1993, and Kunkle 2014 trials, the use of prophylaxis antibiotics was not specified in the study report. Pello 1990 did not provide enough information to exclude other bias.

Effects of interventions

See: [Summary of findings for the main comparison](#) Drape compared to no drape before caesarean section for preventing infection; [Summary of findings 2](#) One-minute alcohol scrub with iodophor drape compared to five-minute iodophor scrub without drape for preventing infection following caesarean section; [Summary of findings 3](#) Parachlorometaxylenol with iodine versus iodine alone for preventing infection following caesarean section; [Summary of findings 4](#) Chlorhexidine gluconate compared to

povidone iodine for preventing infection following caesarean section

We included 11 trials, involving 6237 women, in this review. One small study, involving 22 women, only reported neonatal outcomes, and did not contribute any data towards any of the prespecified outcomes of this review (Pello 1990). We were only able to conduct meta-analyses for comparisons one (two trials) and four (six trials).

Comparison 1: Drape versus no drape

Two trials, involving 1945 women, contributed data to this comparison (Cordtz 1989; Ward 2001). See [Summary of findings for the main comparison](#)

Primary outcomes

Surgical site infection

For women undergoing caesarean section, low-quality evidence suggested that using a drape before surgery compared with no drape may make little or no difference to surgical site infection (risk ratio (RR) 1.29, 95% CI 0.97 to 1.71; 2 trials, 1294 women; low-quality evidence; [Analysis 1.1](#)).

Metritis or endometritis, or both

No data were reported for metritis, endometritis, or both, in either of the included studies for this comparison.

Secondary outcomes

Length of stay

The length of stay was measured in one trial involving 603 women, which compared the use of a drape with no drape (Ward 2001). Moderate-quality evidence suggested that the use of a drape probably makes little or no difference to the length of time spent in hospital (mean difference (MD) 0.10 day, 95% CI -0.27 to 0.46; [Analysis 1.2](#)).

Maternal mortality

No data were reported for maternal mortality in either of the included studies.

Repeat surgery

No data were reported for repeated surgery in either of the included studies.

Re-admission resulting from infection

No data were reported for re-admission resulting from infection in either of the included studies.

Reduction of skin bacteria colony count

No data were reported for skin bacteria colony count in either of the included studies.

Adverse events (maternal or neonatal)

No data were reported for adverse events for mother or baby in either of the included studies.

Comparison 2: One-minute alcohol scrub with iodophor drape versus five-minute iodophor scrub without drape

One trial, involving 79 women, assessed the effects of a one-minute alcohol scrub with an iodophor drape compared with a five-minute iodophor scrub without a drape before caesarean section (Lorenz 1988). See [Summary of findings 2](#)

Primary outcomes

Surgical site infection

There were no surgical site infections in either the group that received an alcohol scrub and iodophor drape or those who received an iodophor scrub only (1 trial, 79 women; very low-quality evidence; [Analysis 2.1](#)).

Metritis or endometritis, or both

We were uncertain whether the combination of a one-minute alcohol scrub with an iodophor drape clearly reduced the occurrence of endomyometritis when compared with a five-minute iodophor scrub, because the quality of the evidence was very low (RR 1.62, 95% CI 0.29 to 9.16; 1 trial, 79 women; very low-quality evidence; [Analysis 2.2](#)).

Secondary outcomes

Length of stay

No data were reported for length of stay.

Maternal mortality

No data were reported for maternal mortality.

Repeat surgery

No data were reported for repeated surgery.

Re-admission resulting from infection

No data were reported for re-admission resulting from infection.

Reduction of skin bacteria colony count

The single trial providing data on this comparison suggested that there may be little or no difference between groups for reduced skin bacteria colony counts (MD 0.07 colony forming unit per plate, 95% CI -0.34 to 0.48; 1 trial, 79 women; [Analysis 2.3](#)).

Adverse events (maternal or neonatal)

No adverse events were reported for mother or baby in the included study.

Comparison 3: Parachlorometaxylenol with iodine versus iodine alone

One trial, involving 50 women, contributed data to this comparison (Magann 1993). See [Summary of findings 3](#)

Primary outcomes

Surgical site infection

We were uncertain if parachlorometaxylenol with iodine made any clear difference to the reduction of surgical site infection when compared with iodine alone, because the quality of the evidence was very low (RR 0.33, 95% CI 0.04 to 2.99; 1 trial, 50 women; very low-quality evidence; [Analysis 3.1](#)).

Metritis or endometritis, or both

We were uncertain if parachlorometaxylenol with iodine made any difference to the reduction of metritis, endometritis, or both, when compared with iodine alone, because the quality of the evidence was very low (RR 0.88, 95% CI 0.56 to 1.38; 1 trial, 50 women; very low-quality evidence; [Analysis 3.2](#)).

Secondary outcomes

Length of stay

No data were reported for length of stay.

Maternal mortality

No data were reported for maternal mortality.

Repeat surgery

No data were reported for repeated surgery.

Re-admission resulting from infection

No data were reported for re-admission resulting from infection.

Reduction of skin bacteria colony count

No data were reported for reduction of skin bacteria colony count.

Adverse events (maternal or neonatal)

No adverse events were reported for mother or baby in the included study.

Comparison 4: Chlorhexidine gluconate versus povidone iodine

Six trials, involving 4091 women, contributed data to this comparison (Aworinde 2016; Fahmi 2017; Kunkle 2014; Ngai 2015; Springel 2017; Tuuli 2016). See [Summary of findings 4](#)

Primary outcomes

Surgical site infection

Low-quality evidence suggested that there may be little or no difference between chlorhexidine gluconate and povidone iodine applied before caesarean section in reducing surgical site infection (RR 0.80, 95% CI 0.62 to 1.02; 6 trials, 3607 women; low-quality evidence; [Analysis 4.1](#)). However, surgical site infection appeared to be slightly reduced for women who were prepared with chlorhexidine gluconate compared with povidone iodine (RR 0.59, 95% CI 0.37 to 0.95; $P = 0.03$; 2 trials, 1321 women) after removing four trials at high risk of bias for outcome assessment in a sensitivity analyses (Aworinde 2016; Kunkle 2014; Ngai 2015; Springel 2017).

Metritis or endometritis, or both

Low-quality evidence indicated that using chlorhexidine gluconate before caesarean section, when compared with povidone iodine, may make little or no difference to the reduction of endometritis (RR 1.01, 95% CI 0.51 to 2.01; 2 trials, 2079 women; low-quality evidence; [Analysis 4.2](#)).

Secondary outcomes

Length of stay

In Tuuli 2016, a median length of hospital stay of four days (interquartile range three to four days) was reported for both the chlorhexidine gluconate group and the povidone-iodine group; there was no difference in these reported data between groups.

Maternal mortality

No data were reported for maternal mortality in any of the included studies.

Repeat surgery

No data were reported for repeated surgery in any of the included studies.

Re-admission resulting from infection

The results from two trials reporting on this outcome suggested that there may be little or no difference in re-admissions due to infection between the chlorhexidine gluconate and the povidone-iodine groups (RR 0.71, 95% CI 0.43 to 1.19; 2 trials, 2079 women; [Analysis 4.3](#)).

Reduction of skin bacteria colony count

Results from one small trial suggested that women who received chlorhexidine gluconate skin preparation may have slightly reduced bacterial growth at 18 hours after caesarean section compared with women who received skin preparation with povidone iodine (RR 0.23, 95% CI 0.07 to 0.70; 1 trial, 60 women; [Analysis 4.4](#)).

Adverse events (maternal or neonatal)

Low-quality evidence suggested that there may be little or no difference in skin reactions between those who had chlorhexidine gluconate skin preparation before caesarean section compared with those who had povidone skin preparation (RR 0.79, 95% CI 0.32 to 1.96; 1 trial, 374 women), in erythema (RR 1.13, 95% CI 0.57 to 2.26; 2 trials, 1521 women), or in skin irritation or allergic skin reaction (RR 0.60, 95% CI 0.22 to 1.63; 2 trials, 1521 women; low-quality evidence; [Analysis 4.5](#)). No neonatal adverse events were reported in the included studies.

Comparison 5: Chlorhexidine 0.5% versus 70% alcohol plus drape

One trial involving 22 women assessed this comparison ([Pello 1990](#)).

Primary outcomes

Surgical site infection

No data were reported for surgical site infection.

Metritis or endometritis, or both

No data were reported for metritis or endometritis, or both.

Secondary outcomes

Length of stay

No data were reported for length of stay.

Maternal mortality

No data were reported for maternal mortality.

Repeat surgery

No data were reported for repeated surgery.

Re-admission resulting from infection

No data were reported for re-admission resulting from infection.

Reduction of skin bacteria colony count

No data were reported for reduction of skin bacteria colony count.

Adverse events (maternal or neonatal)

[Pello 1990](#) compared skin preparation with chlorhexidine 0.5% and 70% alcohol with a drape (IOBAN 2), and reported the newborn's exposure to iodine. Cord blood iodine concentration (CBI) was higher in the IOBAN 2 drape group (18.38 ± 20.34 versus 6.44 ± 0.66 µg/100 mL; $P < 0.05$). There was no clear difference between the two groups in 48-hour urine iodine excretion or thyroid-stimulating hormone (TSH) blood concentration on the fifth day. No maternal adverse events were reported in the included study.

DISCUSSION

Summary of main results

This updated review included 11 trials and 6237 women, 10 trials and 6215 women of which contributed data to the meta-analyses. In relation to the primary outcomes of surgical site infection, and metritis or endometritis, our analyses suggested that there may be little or no difference between different skin preparations for caesarean section. One comparison, where we found that there was probably little or no difference between chlorhexidine gluconate and povidone iodine in preventing surgical site infection, was based on six trials including 3607 women. We assessed the evidence for this result to be of low quality due to a wide confidence interval, indicating that the true effect might in fact be substantially different. However, surgical site infection appeared to be slightly reduced for patients receiving chlorhexidine gluconate skin preparation rather than povidone iodine, after our sensitivity analysis removed four trials at high risk of bias for outcome assessment ([Aworinde 2016](#); [Kunkle 2014](#); [Ngai 2015](#); [Springel 2017](#)). The evidence for the other comparisons between skin preparations in this review all came from only one or two trials, involved small numbers of women, and also yielded effect estimates with wide confidence intervals in most cases. There were also wide-ranging methodological concerns regarding study design. In some studies, it was not possible to know whether randomisation processes were adequate, and we were particularly concerned about the high number of studies where there was no blinding of subjective assessments relating to infection. Moreover, in assessing surgical site infection, pooled results may have also been only indirectly comparable, due to variability between the included studies in the criteria used to assess surgical site infection.

Regarding the secondary outcomes, we found that there may be little or no difference between chlorhexidine gluconate and povidone iodine for maternal skin irritation or allergic skin reaction. However, the included trials provided either very little or no data for almost all of our specified secondary outcomes, most notably, adverse neonatal effects, maternal mortality, or repeat surgery. Therefore, this review was limited in its power to detect meaningful differences between antiseptic agents and methods of skin preparation, with respect to most of the outcomes under consideration.

Overall completeness and applicability of evidence

Of the 11 included trials, five were reasonably large, while the other six trials each recruited only small numbers of women. Ten trials contributed to the evaluation of four main comparisons, limiting the ability to pool results (we were only able to carry out

meta-analysis for two comparisons). Ten trials reported on surgical site infection, while four trials reported on endometritis; only one to two trials reported on the remaining outcomes, or not at all. Therefore, it was not possible to fully address the objectives of this review.

Quality of the evidence

We are unable to draw robust conclusions regarding the different agents and methods of skin preparation for preventing infection following caesarean section. The body of evidence was too small; although we included 11 studies involving 6237 women, the evidence available for each comparison and outcome under investigation reported on too few women and was too limited in scope.

The included studies were subject to some important methodological limitations. Regarding the primary outcome of surgical site infection, most of the studies did not blind outcome assessors, and we could not always be confident in the adequacy of randomisation processes. When we assessed the quality of the evidence using GRADE criteria, we found it ranged from very low to moderate. For surgical site infection, we found low quality-evidence when comparing chlorhexidine gluconate with povidone iodine, due to a wide 95% confidence interval and lack of blinding for outcome assessment ([Summary of findings 4](#)). We found low-quality and moderate-quality evidence when comparing the use of a drape versus no drape, and very-low quality evidence when comparing parachlorometaxylenol with iodine versus iodine alone, due to wide confidence intervals crossing the line of no effect and small sample sizes, and lack of blinding of outcome assessment ([Summary of findings for the main comparison](#); [Summary of findings 3](#)). We found very low-quality evidence for a one-minute alcohol scrub plus an iodophor drape versus a five-minute iodophor scrub without a drape, due to unclear risk of bias for allocation concealment and blinding of outcome assessment, and small sample size with no events ([Summary of findings 2](#)).

Potential biases in the review process

We believe it is unlikely that we missed any eligible published studies, because of the comprehensive search strategy employed by Cochrane Pregnancy and Childbirth. However, there may be relevant unpublished trials that we were unable to locate. Screening of the studies and data extraction were carried out independently by at least two review authors, therefore ensuring reliable data were available for the review. Hadiati is a named author on [Fahmi 2017](#), but was not involved in the screening process and risk of bias assessment.

Agreements and disagreements with other studies or reviews

The Cochrane Review of skin preparation for clean surgery found preoperative skin preparation with 0.5% chlorhexidine in methylated spirits was associated with lower rates of surgical site infections following clean surgery than alcohol-based povidone iodine, which is consistent with our findings ([Dumville 2015](#)). Rather than iodine alone, alternate chlorhexidine might be effective, although the evidence for both comparisons was low quality. We need to interpret the results with caution. However, caesarean section is regarded as 'clean-contaminated' surgery, and so the effect of antiseptic skin preparation may be more evident for this type of surgery because of exposure to both internal and external

sources of infection during birth. Because of the limited quality of the evidence presently available, we were unable to explore this hypothesis further in this review.

AUTHORS' CONCLUSIONS

Implications for practice

From the included studies, we found insufficient evidence to determine what types of skin preparations may be most effective for preventing postcaesarean wound and surgical site infections.

Most of the evidence in this review was deemed to be very low or low quality. This means that for most findings, our confidence in any evidence of an intervention effect is limited, and indicates the need for more high-quality research.

We found four studies that were ongoing; we will incorporate the results of these studies in future updates of this review.

Implications for research

There is a need for high-quality, well-designed, randomised controlled trials in this field, with larger sample sizes. Proper randomisation, adequate allocation concealment, blinding of participants, clinicians, outcome assessors (especially where outcomes involve subjective assessment) and data analysts, plus clear attrition policies are essential to ensure appropriate comparisons between groups. The priority comparisons in superiority or non-inferiority trials could include type of antiseptic (especially iodine versus chlorhexidine), the timing and duration of applying the antiseptic (especially previous night versus day of surgery), and application methods (scrubbing, swabbing, and draping). Various maternal and neonatal outcome measurements could be considered, i.e. length of stay, maternal mortality, repeat surgery, and re-admission resulting from infection, including surgical site infection, and any adverse events. Furthermore, there is a need for consistency of definitions in future trials for outcomes, such as surgical site infection.

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REFERENCES

References to studies included in this review

Aworinde 2016 {published data only}

* Aworinde O, Olufemi-Aworinde K, Fehintola A, Adeyemi B, Owonikoko M, Adeyemi AS. Antiseptic skin preparation for preventing surgical site infection at caesarean section. *Open Journal of Obstetrics and Gynecology* 2016;**6**:246-51.

PACTR201401000697382. Comparative study of antiseptic skin preparation for preventing surgical site infection at caesarean section: a randomised control trial. pactr.org/ATMWeb/appmanager/atm/atmregistry?dar=true&tNo=PACTR201401000697382 (first received 5 November 2013).

Cordtz 1989 {published data only}

Cordtz T, Schouenborg L, Laursen K, Daugaard HO, Buur K, Munk Christensen B, et al. The effect of incisional plastic drapes and disinfection of operation site on wound infection following caesarean section. *Journal of Hospital Infection* 1989;**13**(3):267-72. [PUBMED: 2567756]

Fahmi 2017 {published data only}

Fahmi MN, Hadiati DR, Widad S. Comparison of skin preparation with alcohol-chlorhexidine versus alcohol-povidone iodine on surgical site infection following caesarean section. *Journal of Obstetrics and Gynaecology Research* 2017;**43**:38.

Kunkle 2014 {published data only}

* Kunkle CM, Marchan J, Safadi S, Whitman S, Chmait RH. Chlorhexidine gluconate versus povidone iodine at cesarean delivery: a randomized controlled trial. *Journal of Maternal-Fetal & Neonatal Medicine* 2015; Vol. 28, issue 5:573-7. [DOI: [10.3109/14767058.2014.926884](https://doi.org/10.3109/14767058.2014.926884)]

Murray C, Marchan J, Safadi S, Oppen N, Yedigaraova L, Chmait R. Efficacy of chlorhexidine gluconate versus povidone iodine for skin disinfection at cesarean section: a randomized controlled trial. *American Journal of Obstetrics and Gynecology* 2012;**206**(Suppl 1):S152-3.

NCT01975805. Chlorhexidine gluconate versus povidone iodine at cesarean delivery: a randomized controlled trial. clinicaltrials.gov/ct2/show/NCT01975805. (first received 5 November 2013).

Lorenz 1988 {published data only}

Lorenz RP, Botti JJ, Appelbaum PC, Bennett N. Skin preparation methods before cesarean section. *Journal of Reproductive Medicine* 1988;**33**(2):202-4.

Magann 1993 {published data only}

Magann EF, Dodson MK, Ray MA, Harris RL, Martin JN, Morrison JC. Preoperative skin preparation and intraoperative pelvic irrigation: impact on endometritis following Cesarean delivery. 41st Annual Clinical Meeting of the American College of Obstetricians and Gynecologists; 1993 May 3-6; Washington DC, USA. 1993:11.

* Magann EF, Dodson MK, Ray MA, Harris RL, Martin JN, Morrison JC. Preoperative skin preparation and intraoperative pelvic irrigation: impact on post-cesarean endometritis and wound infection. *Obstetrics and Gynecology* 1993;**81**(6):922-5. [PUBMED: 8497357]

Ngai 2015 {published data only}

Maiwald M. Skin preparation for prevention of surgical site infection after cesarean delivery: a randomized controlled trial. *Obstetrics and Gynecology* 2017;**129**(4):750-1.

Ngai I, Govindappagari S, Van Arsdale A, Judge NE, Neto N, Bernstein J, et al. Skin preparation in cesarean birth for prevention of surgical site infection (SSI): a prospective randomized clinical trial. *American Journal of Obstetrics and Gynecology* 2015;**212**(1 Suppl 1):S424.

* Ngai IM, Van Arsdale A, Govindappagari S, Judge NE, Neto NK, Bernstein J, et al. Skin preparation for prevention of surgical site infection after cesarean delivery: a randomized controlled trial. *Obstetrics and Gynecology* 2015;**126**(6):1251-7.

Pello 1990 {published data only}

* Pello JY, Pons G, Leger FA, Moisson-Tardieu MT, Dailhe-Dupont D, Francoual C, et al. Ioban 2 for cesarean section operative field: study of innocuity for the newborn. *Therapie* 1990;**45**:85.

Springel 2017 {published data only}

NCT02202577. Chlorhexidine-alcohol versus povidone-iodine for surgical site antisepsis prior to cesarean delivery. clinicaltrials.gov/ct2/show/NCT02202577 (first received 29 July 2014).

Springel EH, Sarfoh V, Stetzer B, Weight S, Mercer B, Wang XY. A randomized controlled trial of chlorhexidine-alcohol versus povidone-iodine for cesarean antisepsis. *American Journal of Obstetrics and Gynecology* 2017;**216**(1 Suppl):S30, Abstract no: 42. [NCT02202577]

* Springel EH, Wang XY, Sarfoh VM, Stetzer BP, Weight SA, Mercer BM. A randomized open-label controlled trial of chlorhexidine-alcohol versus povidone-iodine for cesarean antisepsis: the CAPICA trial. *American Journal of Obstetrics and Gynecology* 2017;**217**:463.e1-8.

Tuuli 2016 {published data only}

NCT01472549. Antiseptic skin preparation for preventing surgical site infection at cesarean delivery: a randomized comparative effectiveness trial. clinicaltrials.gov/show/NCT01472549 (first received November 2011).

Stout MJ, Martin S, Cahill AG, Macones GA, Tuuli MG. Impact of chlorhexidine-alcohol versus iodine-alcohol skin antisepsis on methicillin-resistant staphylococcus aureus infection after cesarean. *American Journal of Obstetrics and Gynecology* 2016;**214**(1 Suppl):S119, Abstract no: 194. [NCT01472549]

Temming LA, Raghuraman N, Carter EB, Stout MJ, Rampersad RM, Macones GA, et al. Impact of evidence-based interventions on wound complications after cesarean delivery.

American Journal of Obstetrics & Gynecology 2017; Vol. 217, issue 4:449.e1-9.

Temming LA, Raghuraman N, Stout MJ, Cahill AG, Macones GA, Tuuli MG. Impact of evidence based interventions on wound complications after cesarean. *American Journal of Obstetrics and Gynecology* 2017;**216**(1):S106, Abstract no: 158.

Tuuli MG, Liu J, Stout MJ, Martin S, Cahill AG, Colditz G, et al. Chlorhexidine-alcohol compared with iodine-alcohol for preventing surgical-site infection at cesarean: a randomized controlled trial. *American Journal of Obstetrics and Gynecology* 2016;**214**(1 Suppl):S3, Abstract no: 4.

* Tuuli MG, Liu J, Stout MJ, Martin S, Cahill AG, Odibo AO, et al. A randomized trial comparing skin antiseptic agents at cesarean delivery. *New England Journal of Medicine* 2016;**374**(7):647-55.

Tuuli MG, Woolfolk C, Stout MJ, Temming L, Cahill AG, Macones GA. Does the relative efficacy of chlorhexidine-alcohol versus iodine-alcohol antiseptics differ between unscheduled and scheduled cesareans?. *American Journal of Obstetrics and Gynecology* 2016;**214**(1 Suppl):S120, Abstract no: 196. [NCT01472549]

Ward 2001 {published data only}

Ward HRG, Jennings OGN, Potgieter P, Lombard CJ. Do adhesive plastic drapes prevent post caesarean wound infection?. *Journal of Hospital Infection* 2001;**47**:230-4.

References to studies excluded from this review

Brown 1984 {published data only}

Brown TR, Ehrlich CE, Stehman FB, Golichowski AM, Madura JA, Eitzen HE. A clinical evaluation of chlorhexidine gluconate spray as compared with iodophor scrub for preoperative skin preparation. *Surgery, Gynecology and Obstetrics* 1984;**158**(4):363-6.

Kosus 2010 {published data only}

Kosus A, Kosus N, Guler A, Capar M. Rifamycin SV application to subcutaneous tissue for prevention of post-cesarean surgical site infection [Sezaryen sonrası kesi yeri enfeksiyonunu önlemek için ciltaltı rifamisin SV uygulanması]. *European Journal of General Medicine* 2010;**7**(3):269-76.

NCT01700803 {published data only}

NCT01700803. Povidone iodine and cesarean section wound infections. clinicaltrials.gov/ct2/show/NCT01700803 (first received 4 October 2012).

NCT02027324 {published data only}

NCT02027324. Prevention of surgical site infection after cesarean delivery (CAPISSI). clinicaltrials.gov/ct2/show/NCT02027324 (first received 6 January 2014).

Nili 2015 {published data only}

IRCT201204289568N1. Studying the relationship between neonatal hypothyroidism and using iodine and non iodine containing disinfectants before caesarian section in icteric neonates that refer to clinic of neonates in Valiasr hospital. en.irct.ir/trial/10126 (first registered 07 July 2012).

Nili F, Hantoushzadeh S, Alimohamadi A, Shariat M, Rezaeizadeh G. Iodine-containing disinfectants in preparation for caesarean section: impact on thyroid profile in cord blood. *Postgraduate Medical Journal* 2015;**91**:681-84.

Robins 2005 {published data only}

Robins K, Wilson R, Watkins EJ, Columb MO, Lyons G. Chlorhexidine spray versus single use sachets for skin preparation before regional nerve blockade for elective caesarean section: an effectiveness, time and cost study. *International Journal of Obstetric Anesthesia* 2005;**14**(3):189-92.

References to ongoing studies

NCT00528008 {published data only}

NCT00528008. A comparison of surgical preparations and wound infection rates for elective cesarean sections. clinicaltrials.gov/ct2/show/NCT00528008 (first received 11 September 2007).

NCT01870583 {published data only}

NCT01870583. Comparison of surgical skin preps during cesarean deliveries. clinicaltrials.gov/ct2/show/record/NCT01870583 (first received 6 June 2013).

NCT02396329 {published data only}

NCT02396329. Chlorhexidine versus povidone-iodine antiseptics for reduction of post cesarean section surgical site infection rate: a randomized controlled trial. clinicaltrials.gov/ct2/show/NCT02396329 (first received 1 March 2015).

NCT02402907 {published data only}

NCT02402907. A randomized trial to determine if a pre-operative wash with a chlorhexidine cloth reduces infectious morbidity in patients undergoing cesarean section. clinicaltrials.gov/ct2/show/NCT02402907 (first received 30 March 2015).

Additional references

AORN 2002

Association of Operating Room Nurses. Recommended practices for skin preparation of patients. *AORN Journal* 2002;**75**:184-7.

CDC 2005

Centers for Disease Control and Prevention. Data and statistics for surgical site infections. www.cdc.gov/ncidod/dhqp/dpac_ssi_data.html (accessed: 5 August 2008).

Cunningham 2018

Cunningham FG, Leveno KJ, Bloom SL, Spong CY, Dashe JS, Hoffman BL, et al. Puerperal complications. In: Hoffman BL editor(s). *Williams Obstetrics*. 25th Edition. McGraw-Hill Education, 2018.

Dumville 2015

Dumville JC, McFarlane E, Edwards P, Lipp A, Holmes A, Liu Z. Preoperative skin antiseptics for preventing surgical wound

infections after clean surgery. *Cochrane Database of Systematic Reviews* 2015, Issue 4. [DOI: [10.1002/14651858.CD003949.pub4](https://doi.org/10.1002/14651858.CD003949.pub4)]

GRADE Handbook

Schünemann H, Brożek J, Guyatt G, Oxman A, editor(s). Handbook for grading the quality of evidence and the strength of recommendations using the GRADE approach (updated October 2013). GRADE Working Group, 2013. Handbook for grading the quality of evidence and the strength of recommendations using the GRADE approach (updated October 2013). GRADE Working Group, 2013.

GRADE Working Group 2004

GRADE Working Group. Grading quality of evidence and strength of recommendations. *BMJ* 2004;**328**:1490-4.

GRADEpro GDT [Computer program]

McMaster University (developed by Evidence Prime). GRADEpro GDT. Version accessed prior to 26 September 2018. Hamilton (ON): McMaster University (developed by Evidence Prime), 2015.

Haas 2018

Haas DM, Morgan S, Contreras K, Enders S. Vaginal preparation with antiseptic solution before cesarean section for preventing postoperative infections. *Cochrane Database of Systematic Reviews* 2018, Issue 7. [DOI: [10.1002/14651858.CD007892.pub6](https://doi.org/10.1002/14651858.CD007892.pub6)]

Hardin 1997

Hardin W, Nichols R. Handwashing and patient skin preparation. In: Malangoni MA editor(s). *Critical Issues in Operating Room Management*. Philadelphia: Lippincott-Raven, 1997:133-44.

Henderson 1995

Henderson E, Love EJ. Incidence of hospital-acquired infections associated with caesarean section. *Journal of Hospital Infection* 1995;**29**:245-55.

Higgins 2011

Higgins JPT, Green S, editor(s). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Larson 1988

Larson E. Guideline for use of topical antimicrobial agents. *American Journal of Infection Control* 1988;**16**:253-66.

Leaper 2001

Leaper DJ, Orr C, Maung Z, White A. *Inflammation and Infection: STEP 2000 Module II*. Royal College of Surgeons of England: Blackwell Science, 2001.

Leclair 1990

Leclair J. A review of antiseptics. Cleansing agents. *Today's OR Nurse* 1990;**12**(10):25-8.

Lewis 2013

Lewis SS, Moehring RW, Chen LF, Sexton DJ, Anderson DJ. Assessing the relative burden of hospital-acquired infections in a network of community hospitals. *Infection Control and*

Hospital Epidemiology 2013;**34**(11):1229-30. [PUBMED: 24113613]

Loudon 2002

Loudon I. Ignaz Phillip Semmelweis' studies of death in childbirth. www.jameslindlibrary.org (accessed: 5 August 2008).

Mangram 1999

Mangram JA, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection. *Infection Control and Hospital Epidemiology* 1999;**20**:247-78.

Martin 2015

Martin JA, Hamilton BE, Osterman MJK, Driscoll AK, Mathews TJ. Births: Final Data for 2015. *National Vital Statistics Report* 2017;**66**(1):1. [PUBMED: 28135188]

Mathai 2013

Mathai M, Hofmeyr GJ, Mathai NE. Abdominal surgical incisions for caesarean section. *Cochrane Database of Systematic Reviews* 2013, Issue 5. [DOI: [10.1002/14651858.CD004453.pub3](https://doi.org/10.1002/14651858.CD004453.pub3)]

NCT01472549

NCT01472549. Antiseptic skin preparation for preventing surgical site infection at cesarean delivery: a randomized comparative effectiveness trial. clinicaltrials.gov/show/NCT01472549 (first received November 2011).

Normand 2001

Normand MC, Damato EG. Postcesarean infection. *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing* 2001;**30**(6):642-8.

RevMan 2014 [Computer program]

Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager 5 (RevMan 5). Version 5.3. Copenhagen: Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

Schünemann 2009

Schünemann HJ. GRADE: from grading the evidence to developing recommendations. A description of the system and a proposal regarding the transferability of the results of clinical research to clinical practice [GRADE: Von der Evidenz zur Empfehlung. Beschreibung des Systems und Lösungsbeitrag zur Übertragbarkeit von Studienergebnissen]. *Zeitschrift für Evidenz, Fortbildung und Qualität im Gesundheitswesen* 2009;**103**(6):391-400. [PUBMED: 19839216]

Sterne 2017

Sterne JAC, Egger M, Moher D, Boutron I, editor(s). Chapter 10: Addressing reporting biases. In: Higgins JPT, Churchill R, Chandler J, Cumpston MS, editor(s), *Cochrane Handbook for Systematic Reviews of Interventions* version 5.2.0 (updated June 2017), Cochrane, 2017. Available from www.training.cochrane.org/handbook.

Thomas 2001

Thomas J, Paranjothy S, Royal College of Obstetricians and Gynaecologists Clinical Effectiveness Support Unit. *National Sentinel Caesarean Section Audit Report*. London: RCOG Press, 2001.

Vogel 2015

Vogel JP, Betran AP, Vindevoghel N, Souza JP, Torloni MR, Zhang J, et al. Use of the Robson classification to assess caesarean section trends in 21 countries: a secondary analysis of two WHO multicountry surveys. *Lancet Global health* 2015;**3**(5):e260-70. [DOI: [10.1016/S2214-109X\(15\)70094-X](https://doi.org/10.1016/S2214-109X(15)70094-X); PUBMED: 25866355]

WHO 2015

World Health Organization. WHO Statement on Caesarean Section Rates. www.who.int/reproductivehealth/publications/maternal_perinatal_health/cs-statement/en/ 2015.

Database of Systematic Reviews 2008, Issue 4. [DOI: [10.1002/14651858.CD007462](https://doi.org/10.1002/14651858.CD007462)]

Hadiati 2012

Hadiati DR, Hakimi M, Nurdianti DS. Skin preparation for preventing infection following caesarean section. *Cochrane Database of Systematic Reviews* 2012, Issue 9. [DOI: [10.1002/14651858.CD007462.pub2](https://doi.org/10.1002/14651858.CD007462.pub2)]

Hadiati 2014

Hadiati DR, Hakimi M, Nurdianti DS, Ota E. Skin preparation for preventing infection following caesarean section. *Cochrane Database of Systematic Reviews* 2014, Issue 9. [DOI: [10.1002/14651858.CD007462.pub3](https://doi.org/10.1002/14651858.CD007462.pub3)]

References to other published versions of this review

Hadiati 2008

Hadiati DR, Hakimi M, Nurdianti DS. Skin preparation for preventing infection following caesarean section. *Cochrane*

* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Aworinde 2016

Methods	Computer-generated randomised control trial
Participants	<p>All women (N = 374) who had elective caesarean section with no overt risk for surgical site infection were randomised into 2 groups.</p> <p>The trial was carried out in the Department of Obstetrics and Gynaecology of the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile-Ife, Osun State, Nigeria.</p>
Interventions	<p>All women had a bath with non-antiseptic soap before surgery. Shaving of the lower abdomen was done on the surgical table, just before commencing antiseptic skin preparation.</p> <p>For women who fell into the chlorhexidine-alcohol group (N = 188), skin preparation was done with gauze soaked in Valon (containing Chlorhexidine gluconate 0.3% weight/volume (w/v) and Cetrimide 3.0% w/v manufactured by Royal priesthood laboratory ltd), which was diluted with distilled water in a 1:1 ratio. A centrifugal scrubbing motion was used, starting from the area of the intended incision and covered the abdomen from the subcostal margin to the midaxillary line down to the middle of the thigh. This was repeated twice. The area was then dried with a piece of dry gauze in the same centrifugal manner. Moko® (containing Isopropyl alcohol 95% v/v manufactured by New-Health way Co. Limited) was then applied on the area in the same centrifugal manner and allowed to dry before draping of the area.</p> <p>For women in the povidone-iodine group (N = 186), Wosan® (containing 10% povidone iodine manufactured by Jawa international limited) was used. The povidone iodine was painted on the aforementioned area and then left to dry completely before draping the area and commencing the surgery.</p>
Outcomes	<p>Surgical site infections in 30 days after delivery. Bacterial culture for wounds assessed as infected. Development of skin reaction.</p> <p>Definition of surgical site infection: not provided.</p>
Notes	<p>All women were given prophylactic antibiotic (intravenous cefuroxime 750 mg immediately (stat)), administered after clamping of the cord.</p> <p>The surgery was done under spinal anaesthesia.</p> <p>Pan African Clinical Trials Registry No. PACTR201401000697382</p>

Aworinde 2016 (Continued)

Trial dates: August 2012 to July 2013

Sources of trial funding: Obafemi Awolowo University Teaching Hospital Complex, Nigeria

Trialist declarations of interest: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...computer generated random sequence".
Allocation concealment (selection bias)	Low risk	Quote: "...sequentially numbered sealed packets..." and "The sealed envelopes were placed in the labour ward theatre and were drawn from serially by the surgeons just before the procedure".
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Quote: "Blinding both patients and physicians to the antiseptic used for skin preparation (double-blinding) would have been ideal, however, it was not feasible in this trial". Comment: unlikely that this lack of blinding of participants and personnel could have caused different treatments between groups.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Quote: "Blinding both patients and physicians to the antiseptic used for skin preparation (double-blinding) would have been ideal, however, it was not feasible in this trial". Comment: it is possible that this lack of blinding of outcome assessors could account for the different treatment effects between groups, because surgical site infection involves subjective assessment.
Incomplete outcome data (attrition bias)	Low risk	Quote: "Ten were excluded from the analysis due to the fact that they were lost to follow-up or ended up having a midline scar". Comment: the number of excluded women was similar between intervention groups: chlorhexidine-alcohol group 4/192 (2.1%) and povidone-iodine group 6/192 (3.1%).
Selective reporting (reporting bias)	Low risk	The same outcomes reported in the trial registry
Other bias	Low risk	Other bias was not noticed during review

Cordtz 1989

Methods	Randomised multicentre 4-group trial
Participants	All women undergoing caesarean section (N = 1340) The trial was a Danish multicentre trial where 8 Danish hospitals participated under supervision of the National Center for Hospital Hygiene, Statens Seruminstitut.
Interventions	The study had 4 experimental groups: with or without drape and with or without re-disinfection. For the purpose of this review we only included a comparison of drapes versus no drapes, with standard disinfection, not re-disinfection.

Cordtz 1989 (Continued)

Experimental group (N = 337) incisional plastic drape was applied to the skin after preoperative skin disinfection.

Control group (N = 354) no drape was used. All women received preoperative skin disinfection of 2.5% iodine in 70% ethanol.

Outcomes	<p>Surgical site infection in 14 days after delivery</p> <p>Definition of surgical site infection: (1) Possible wound infection: localized erythema, serous secretion, or both, without presence of pus; (2) Infected: presence of pus, regardless of the results of bacteriological examination. Pus could be classified as superficially or subfascially located. Incision for drainage was also reported.</p>
Notes	<p>We did not include the re-disinfection group, as it was defined as disinfection of the skin around the incision shortly before skin closure.</p> <p>Antibiotics for prophylaxis therapy were used in 36 of 337 women (10.7%) in the drape group and 29 of 354 women (8.2%) in the no drape group.</p> <p>Trial dates: September 1985 to May 1986</p> <p>Type of anaesthesia not described</p> <p>Sources of trial funding: not reported</p> <p>Trialist declarations of interest: not reported</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	<p>Quote: "blocks of eight consecutive patient numbers were labelled... in random order".</p> <p>Comment: although the method of determining random order was not specified, given the numbers in the trial, it is probable that this was generated by computer or random tables.</p>
Allocation concealment (selection bias)	Unclear risk	Not stated
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Blinding was not described, but is likely that participant and personnel could identify different interventions. Unlikely that this lack of blinding could have caused different treatments between groups.
Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding stated, and some outcome measurements were subjective.
Incomplete outcome data (attrition bias)	Low risk	Outcome data were reported for all women.
Selective reporting (reporting bias)	Unclear risk	There was no protocol to access, so we did not know the originally planned outcomes.
Other bias	Low risk	Antibiotics for prophylaxis therapy were used in this study. Even though more women in the drape group (10.7%) received antibiotics than in the without drape group (8.2%), but there were more infections in the drape group, so we

Cordtz 1989 (Continued)

might underestimate the effect. This effect is likely to be small because of the small difference.

Fahmi 2017

Methods	Multicenter, randomised clinical trial
Participants	All women undergoing scheduled or emergency caesarean section The study was conducted in Dr Sardjito hospital and 2 affiliated hospital (Saras Husada Hospital and Panembahan Senopati Hospital), Indonesia.
Interventions	Alcohol-chlorhexidine group (N = 87) and alcohol-povidone-iodine group (N = 87)
Outcomes	Surgical site infections on day 3 and day 7 after caesarean section Definition of surgical site infection: diagnosed based on Centers for Disease Control and Prevention (CDC) criteria
Notes	We have the full thesis from the author in Indonesian All women received preoperative prophylactic antibiotic cefotaxim 1 hour before skin incision. Type of anaesthesia not described Trial dates: June 2013 to May 2014 Sources of trial funding: not reported Trialist declarations of interest: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...subjects were randomly divided into two groups...". Comment: computer-generated random sequence (information provided by trial author)
Allocation concealment (selection bias)	Unclear risk	Allocation concealment was not described.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Blinding was not described, but is likely that participants and personnel could identify different interventions. Unlikely that this lack of blinding could have caused different treatments between groups.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Researchers and outcome assessors did not know the type of intervention (information provided by trial author).
Incomplete outcome data (attrition bias)	Low risk	All women were followed until the 7th day after caesarean section.
Selective reporting (reporting bias)	Unclear risk	There was no protocol to access, so we did not know the originally planned outcomes.

Fahmi 2017 (Continued)

Other bias	Low risk	Other bias was not noticed during review.
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Kunkle 2014

Methods	A single-centre, randomised controlled trial
Participants	Women aged 18 to 45 years, undergoing scheduled caesarean delivery at 36 gestational weeks or later. The trial was conducted at the University of Southern California Los Angeles County Medical Center, United States.
Interventions	60 participants were included: chlorhexidine gluconate group (N = 27) versus povidone-iodine group (P = 33)
Outcomes	Surgical site infection at 3 days and 2 weeks. Positive bacterial culture rates at 3 minutes and 18 hours Definition of surgical site infection: the presence of purulent drainage, cellulitis, or the need for incision and drainage, or treatment with antibiotics for a clinical diagnosis of infection
Notes	Type of anaesthesia not described. Clinical Trials.gov. identifier: NCT01975805 Trial dates: January 2010 to March 2012 Sources of trial funding: University of Southern California Trialist declarations of interest: reported, no conflict of interest

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "The choice of disinfectant was determined by simple randomization where each participant was independently assigned to either PI or CG without any regard for previous patient assignments". Comment: no specific randomisation methods stated
Allocation concealment (selection bias)	Unclear risk	Comment: no information provided
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Quote: "The operating surgeons could not be blinded because both agents possess distinctly different coloring when applied to the skin". Comment: unlikely that this lack of blinding could have caused different treatments between groups
Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding stated, but outcome assessment of surgical site infection was subjective, while bacterial culture rates were objective measurements.
Incomplete outcome data (attrition bias)	Low risk	Outcome data were reported for all women.
Selective reporting (reporting bias)	Low risk	The same outcomes reported in the trial registry

Kunkle 2014 (Continued)

Other bias	Low risk	Other bias was not noticed during review.
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Lorenz 1988

Methods	Randomised clinical trial using a table of random numbers
Participants	<p>All women undergoing caesarean section. The women were excluded if they were allergic to iodine, younger than 18 years of age, had chorioamnionitis, refused to participate, emergency clinical circumstances prevented adequate informed consent, or no culture plate available.</p> <p>The trial was conducted at Pennsylvania State University, Hersey, USA</p>
Interventions	<p>A total of 79 women were included.</p> <p>Experimental group (N = 38) received a 1-minute scrub with 70% isopropyl alcohol followed by application of iodophor-impregnated adhesive film.</p> <p>Control group (N = 41) received a 5-minute iodophor scrub followed by application of iodophor solution.</p>
Outcomes	<p>Endomyometritis, surgical site infection (assessed on 2 separate measurements at least 24 h postoperatively), and reduction of skin bacteria colony counts. All participants had skin bacterial counts before skin preparation and immediately postoperatively.</p> <p>Definition of surgical site infection: infectious morbidity (body temperature > 38°C on 2 separate measurements at least 24 h postoperatively) with (1) erythema and tenderness of the wound or separation of skin edges, and (2) uterine tenderness or malodorous, discoloured lochia</p>
Notes	<p>Type of anaesthesia not described</p> <p>Trial dates: June 1983 to April 1984</p> <p>Sources of trial funding: not reported</p> <p>Trialist declarations of interest: not reported</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Each patient was randomly assigned, using a table of random number..."
Allocation concealment (selection bias)	Unclear risk	The allocation was not described
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Blinding was not described, but is likely that participants and personnel could have identified the different interventions. It is unlikely that lack of blinding could have caused different caesarean treatment relevant to the outcomes.
Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding stated and some outcome measurements were subjective.
Incomplete outcome data (attrition bias)	Low risk	All women were followed up to the end of the study.

Lorenz 1988 (Continued)

Selective reporting (reporting bias)	Unclear risk	There was no protocol to access, so we did not know the originally planned outcomes.
Other bias	Low risk	Other bias was not noticed during review.

Magann 1993

Methods	Randomised trial using a table of random numbers
Participants	<p>All women undergoing caesarean section.</p> <p>The exclusion criteria were chorioamnionitis, emergency for caesarean section for fetal distress with inadequate time for skin preparation, and refusal to participate.</p> <p>The trial was conducted at the University of Mississippi Medical Center, USA.</p>
Interventions	<p>A total of 100 women were included and divided into 4 subgroups of 25 women. For the purpose of this review the following 2 groups were included.</p> <p>Experimental group (N = 25) received a 5-minute scrub with parachlorometaxlenol followed by povidone-iodine solution and normal saline irrigation of the pelvis and subcutaneous tissue at uterine closure and fascial closure.</p> <p>Control group (N = 25) received a povidone-iodine surgical scrub (7.5%) followed by povidone iodine (10%) and normal saline irrigation of the pelvis and subcutaneous tissue at uterine closure and fascial closure.</p>
Outcomes	<p>Endometritis and surgical site infection</p> <p>Definition of surgical site infection: hyperemic skin incision and a fluctuant mass, that when opened, contained purulent material</p>
Notes	<p>Type of anaesthesia: general, spinal or epidural</p> <p>Trial dates: not reported</p> <p>Sources of trial funding: not reported</p> <p>Trialist declarations of interest: not reported</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "This randomised study ... with group appointment derived from a random number table".
Allocation concealment (selection bias)	Unclear risk	<p>Quote: "Random assignment was achieved by card selection from sealed opaque envelopes ...".</p> <p>Comment: it was unclear what 'card selection' involved, and therefore, whether investigators could have foreseen assignment.</p>
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Blinding was not described, but it is likely that participants and personnel could identify different interventions. It is unlikely that this lack of blinding could have caused different caesarean treatment relevant to the outcomes.

Magann 1993 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding stated and some outcome measurements were subjective.
Incomplete outcome data (attrition bias)	Low risk	All women were followed up to the end of the study.
Selective reporting (reporting bias)	Unclear risk	There was no protocol to access, so we did not know the originally planned outcomes.
Other bias	Low risk	Other bias was not noticed during review.

Ngai 2015

Methods	Computer-generated randomisation through www.randomisation.com with alternating block sizes of 6 and 12	
Participants	<p>All women at 37 weeks of gestation, based on best obstetric estimate, who were undergoing scheduled or non-emergent caesarean delivery.</p> <p>Women were excluded if they had a urogenital tract infection within 2 weeks of delivery and if they were younger than 18 years old.</p> <p>The trial was conducted at 2 Montefiore Medical Center, Einstein Medical College, NY, United States.</p>	
Interventions	<p>The 1404 participants were enrolled in a 1:1:1 fashion to 1 of 3 groups: povidone iodine with alcohol group (PA group: N = 462), chlorhexidine with alcohol group (CA group: N = 467), and combination of povidone iodine with alcohol, and chlorhexidine with alcohol used together (BOTH group: N = 465).</p> <p>For the purpose of this review, we compared the PA group and CA group.</p>	
Outcomes	<p>Surgical site infections on 2 and 6 weeks postcaesarean</p> <p>Definition of surgical site infection: according to Horan and colleagues. and the Centers for Disease Control and Prevention. A surgical site infection outcome was defined as the patient reporting the requirement of antibiotic use for a wound infection, or documented wound infection in the medical record at the outpatient visit within 30 days of discharge.</p>	
Notes	<p>All women received preoperative prophylactic antibiotics within 1 hour of skin incision. Surgical drapes were placed after a minimum of 4 minutes drying time.</p> <p>All women had regional anaesthesia, a spinal, epidural, or combined spinal and epidural.</p> <p>ClinicalTrials.gov Identifier: NCT01870583</p> <p>Trial dates: January 2013 to July 2014</p> <p>Sources of trial funding: the study provided no support for a particular method of skin preparation</p> <p>Trialist declarations of interest: not reported</p>	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was computer-generated through www.randomization.com with alternating block sizes of six and 12".

Ngai 2015 (Continued)

Allocation concealment (selection bias)	Low risk	Quote: "The randomization allocation was concealed in identical, opaque, sequentially numbered, sealed envelopes".
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Blinding was not described. but it is likely that participants and personnel could identify different interventions. It was unlikely that this lack of blinding could have caused different treatments between groups.
Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding stated, but it is possible that this lack of blinding could account for the different treatment effects between groups, because surgical site infection involves subjective assessment.
Incomplete outcome data (attrition bias)	Low risk	Postrandomisation exclusions were reported in the study due to protocol breach or loss to follow-up: PA group 8/463 (1.7%), CA group 18/474 (3.8%), and BOTH group 11/467 (2.4%). It is unlikely that this number of missing participants was enough to affect the outcome of surgical site infection.
Selective reporting (reporting bias)	Low risk	The same outcomes reported in the trial registry.
Other bias	Low risk	Other bias was not noticed during review.

Pello 1990

Methods	Open comparative randomised trial
Participants	Women with male fetus undergoing caesarean section. The trial was conducted in Paris, France.
Interventions	Skin preparation with chlorhexidine 0.5% was compared with 70% alcohol plus drape (IOBAN 2). A total of 22 women were randomised, but the number allocated to each group was not stated.
Outcomes	Newborn exposure to iodine, measured from cord blood iodine concentration, 48-hour urine iodine excretion, and thyroid stimulating hormone blood concentration on the 5th day.
Notes	Only abstract available Type of anaesthesia not described Trial dates: not reported Sources of trial funding: not reported Trialist declarations of interest: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Twenty-two women had the skin preparation randomly allocated..."
Allocation concealment (selection bias)	Unclear risk	No allocation concealment stated

Pello 1990 (Continued)

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No blinding stated
Blinding of outcome assessment (detection bias) All outcomes	Low risk	No blinding stated. Evaluation of outcome was diagnosed by objective signs.
Incomplete outcome data (attrition bias)	Unclear risk	Number of women in each group not reported
Selective reporting (reporting bias)	Unclear risk	Only abstract available, so we did not know the originally planned outcomes. The key outcome for this review was not reported (i.e. surgical site infection) by this study, however the abstract made it clear that the study examined the effect of iodine on newborns, so the lack of data reporting on women was not deemed to be of concern.
Other bias	Unclear risk	There was too little information provided to exclude other bias.

Springel 2017

Methods	Open-label, parallel-design, unmasked randomised controlled trial
Participants	<p>All women undergoing caesarean section, who met eligibility criteria: caesarean delivery, age 18 to 65 years, and ability to consent in English or Spanish</p> <p>Exclusion criteria were: inability or unwillingness to consent to study participation in English or Spanish, current incarceration, pre-operative diagnosis of chorioamnionitis, perceived inability to complete follow-up for data collection, or any prior known allergy or adverse reaction to either study preparation</p> <p>The trial was conducted in an urban tertiary care institution (MetroHealth Medical Center, Cleveland, OH), United States</p>
Interventions	932 women were randomly assigned to either chlorhexidine-isopropyl alcohol (CA group, N = 461) or povidone-iodine scrub and paint (PI group, N = 471). Both interventions were applied to the skin pre-operatively for surgical site anti-sepsis.
Outcomes	<p>Surgical site infection (composite SSI) occurring within 30 days, endometritis, re-admission to hospital for management of SSI, non-SSI wound complications</p> <p>Definition of surgical site infection: > 1 of superficial, deep, and organ space (endometritis in the case of caesarean delivery) infection as defined by the US National Healthcare Safety Network (NHSN) of the CDC</p>
Notes	<p>General anaesthesia for some women</p> <p>ClinicalTrials.gov Identifier: NCT02202577</p> <p>Trial dates: February 2013 to May 2016</p> <p>Sources of trial funding: Edward Henry Springel, MD</p> <p>Trialist declarations of interest: reported, no conflict of interest</p>

Risk of bias

Springel 2017 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "... subjects were ... randomized ..." Comment: random sequence generation was not described
Allocation concealment (selection bias)	Unclear risk	Allocation concealment was not described.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Quote: "Masking: none (open-label)". Comment: blinding of participants and personnel was not done, but it is unlikely that this lack of blinding could have led to different treatments between groups.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Quote: "Masking: none (open-label)". Blinding of outcome assessment was not done, and it was possible that this lack of blinding could account for the different treatment effects between groups, because assessment of surgical site infection involved subjective assessment.
Incomplete outcome data (attrition bias)	Low risk	Quote: "Rates of follow-up for evaluation after 30 days were 97% in the CA group and 96% in the PI group". Comment: the loss to follow-up was balanced between the 2 intervention groups
Selective reporting (reporting bias)	Low risk	The same outcomes reported in the trial registry.
Other bias	Low risk	Other bias was not noticed during review.

Tuuli 2016

Methods	Single-center, randomised, controlled trial
Participants	This study recruited pregnant women undergoing scheduled or unscheduled caesarean delivery at Washington University Medical Center in St. Louis, United States. Women who had known allergy to chlorhexidine, alcohol, iodine, or shellfish, or who had a skin infection adjacent to the operative site were excluded.
Interventions	1147 women were randomly assigned to receive preoperative skin preparation with either chlorhexidine–alcohol (N = 572 women) or iodine–alcohol (N = 575). Chlorhexidine–alcohol combination contained 2% chlorhexidine gluconate with 70% isopropyl alcohol, and iodine–alcohol combination contained 8.3% povidone–iodine with 72.5% isopropyl alcohol.
Outcomes	Primary outcome: superficial or deep surgical site infection within 30 days after caesarean delivery Prespecified secondary outcomes: length of hospital stay, physician office visits and hospital readmissions for infection-related complications, endometritis, positive wound culture, skin irritation, and allergic reaction Posthoc secondary outcomes: other wound complications (including skin separation, seroma, hematoma, and cellulitis), emergency department visits for wound complications, additional wound surgery, use of home health services or services of a wound clinic, and duration of wound care

Tuuli 2016 (Continued)

Definition of surgical site infection: on the basis of the National Healthcare Safety Network definitions of the Centers for Disease Control and Prevention (CDC)

Notes

Women also received standard infection-prevention measures, including body weight-based preoperative antibiotic prophylaxis.

Type of anaesthesia not described

ClinicalTrials.gov Identifier: NCT01472549

Trial dates: September 2011 to June 2015

Sources of trial funding: supported by a Women's Reproductive Health Research Career Development grant from the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health (1K12HD063086-01, to Drs Tuuli and Macones), and the Department of Obstetrics and Gynecology, Washington University School of Medicine in St. Louis

Trialist declarations of interest: reported. Dr Tuuli reported grant support from the National Institutes of Health during the conduct of the study. All other authors declared no conflict of interest.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote "... computer-generated random sequence produced by the study statistician".
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	Low risk	No blinding of participants and personnel, but it is unlikely that this lack of blinding could have caused different treatments between groups.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "The diagnosis of surgical-site infection within 30 days after cesarean delivery "... was made by the treating physician and verified by means of chart review by the principal investigator, who was unaware of the study-group assignments".
Incomplete outcome data (attrition bias)	Low risk	Quote: "A similar number of participants in each group — 34 (5.9%) in the chlorhexidine-alcohol group and 31 (5.4%) in the iodine-alcohol group — were lost to follow-up". Comment: reason for loss to follow-up were 'did not have postoperative follow-up' or 'discontinued study'. Numbers in each group, and for each reason, were similar between the 2 interventions.
Selective reporting (reporting bias)	High risk	Compared to the trial registration, more outcomes were reported in the final report, and some predefined outcomes, such as proportion of women with skin contamination after skin prep or cost savings were not reported.
Other bias	Low risk	Other bias was not noticed during review.

Ward 2001
Methods

Randomisation using a table of random numbers

Ward 2001 (Continued)

Participants	<p>All women undergoing caesarean section</p> <p>The trial was conducted at Livingston Hospital, Eastern Province of South Africa.</p>
Interventions	<p>All women (N = 605) were prepared before the incision by washing the abdomen and perineum with 4% chlorhexidine soap. On the operating table, the abdomen was swabbed with 0.5% chlorhexidine in 80% alcohol solution for 30 seconds. After the preparation:</p> <p>the experimental group (N = 305) received incisional plastic drape;</p> <p>the control group (N = 300) did not receive a drape.</p>
Outcomes	<p>Surgical site infection and length of hospital stay</p> <p>Definition of surgical site infection: diagnosed if 2 of 3 features were present: (1) erythematous cellulitis, (2) seropurulent discharge from the wound, (3) positive swab culture (organisms and leucocytes).</p>
Notes	<p>All women received preoperative antibiotics administration of 1 g cephazolin intravenously, unless antibiotics were already being administered. In addition, a 1 g metronidazole suppository was inserted preoperatively, and repeated after 12 hours.</p> <p>Women received general anaesthesia</p> <p>Trial dates: August 1992 to January 1993</p> <p>Sources of trial funding: not reported</p> <p>Trialist declarations of interest: not reported</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...taken from a random number table".
Allocation concealment (selection bias)	Low risk	Quote: "On deciding that a woman was to undergo caesarean section, the surgeon removed an opaque unmarked envelope from a box of identical envelopes. Inside was a card, inscribed with an integer taken from a random number table. If the number was even, a drape was to be used and if odd, then no drape was used. The card was then resealed in the envelope and stapled to the patient's folder, and opened only when she left the study".
Blinding of participants and personnel (performance bias) All outcomes	Low risk	<p>Quote: "...patients received general anesthesia as part of normal hospital practice and the drape was applied after induction and removed before extubation".</p> <p>Comment: although not explicitly stated in the study, we assumed that the medical personnel were not blinded, as they could see the different interventions. It was unlikely that this lack of blinding could have caused different caesarean treatment relevant to the outcomes.</p>
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Assessor bias was avoided because postoperative care was conducted by staff unrelated to surgery".
Incomplete outcome data (attrition bias)	Low risk	<p>Postrandomisation exclusions were reported in the study, 15 (2.4%) in total were excluded due to critical data missing, 2 additional women from the control group were excluded: 1 due to ruptured appendix and another who requested early discharge on day 2 after caesarean section. Based on a sensi-</p>

Ward 2001 (Continued)

		tivity analysis, it was unlikely that this number of missing participants was enough to affect the outcome of surgical site infection.
Selective reporting (reporting bias)	Unclear risk	Selective reporting was not noticed during review, but we were unable to consult the trial registry.
Other bias	Low risk	Other bias was not noticed during review.

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Brown 1984	Trial compared antiseptics for general surgery that included cases of caesarean section, but the trial did not report separate results for the caesarean section cases.
Kosus 2010	Intervention was different. Rifamycin is an antibiotic, not an antiseptic agent.
NCT01700803	Intervention was different. This study focused on preoperative handwashing by the surgical team.
NCT02027324	Intervention was different. This study focused on preoperative handwashing by the surgical team.
Nili 2015	This is not an RCT but a cohort study.
Robins 2005	Trial compared the effectiveness of chlorhexidine spray and single-use sachets for skin preparation before regional nerve blockade, not for preparation of the incision site before caesarean section.

Characteristics of ongoing studies [ordered by study ID]

[NCT00528008](#)

Trial name or title	A comparison of surgical preparations and surgical site infection rates for elective caesarean sections
Methods	Randomised controlled study
Participants	Pregnant women at term, over 19 years old, who booked elective caesarean section
Interventions	Comparator A = povidone iodine Comparator B = chlorhexidine gluconate
Outcomes	Primary outcome; the rate of surgical site infection Secondary outcomes (within 6 weeks of caesarean section operation): readmission to hospital, extended length of admission, need for intravenous antibiotics, need for repeat procedure, such as drainage, increased outpatient surveillance
Starting date	December 2007
Contact information	PI: Dr Paula Mallaley, Obstetrics and Gynaecology, Memorial University of Newfoundland
Notes	NCT Number; NCT00528008

NCT01870583

Trial name or title	Comparison of surgical skin preparations during caesarean deliveries
Methods	Prospective randomised observational study
Participants	Women undergoing non-emergency indication for caesarean at term
Interventions	Iodine povidone versus chlorhexidine versus combination iodine and chlorhexidine
Outcomes	Primary outcome: caesarean surgical site infection (42 days after delivery); surgical site infection will follow CDC guidelines
Starting date	February 2013
Contact information	Dr David J Garry, Montefiore Medical Center
Notes	NCT Number; NCT01870583

NCT02396329

Trial name or title	Chlorhexidine versus povidone-iodine antiseptics for reduction of post caesarean section surgical site infection
Methods	Single blinded (participants) randomised controlled trial conducted in Egypt
Participants	<p>Inclusion criteria:</p> <ol style="list-style-type: none"> 1. Patient 18 years of age or older, who are at term (37 to 41 weeks of gestation), who will undergo caesarean deliveries 2. Body mass index between 20 to 35 kg/m² 3. Able to communicate well with the investigator, and to comply with the requirements of the entire study <p>Exclusion criteria:</p> <ol style="list-style-type: none"> 1. Rupture of membranes 2. Women who have history of allergy to chlorhexidine, alcohol, and iodophors 3. Documented concomitant infections, like: chorioamnionitis, pyelonephritis, urinary tract infection, mastitis
Interventions	Chlorhexidine versus povidone iodine
Outcomes	<p>Primary outcome: surgical site infection within 1 week after surgery (time frame: 1 week).</p> <p>Secondary outcomes: surgical site infection within 30 days after surgery (time frame: 30 days), long hospital stay, more than 5 days (time frame: 30 days), hospital readmission (time frame: 30 days) due to sepsis, febrile morbidity (time frame: 10 days) with an oral temperature of 38.0 degree Celsius or more, on any 2 of the first 10 days postpartum, exclusive of the first 24 hours</p>
Starting date	June 2014
Contact information	AMR HELMY YEHIA, Ain Shams Maternity Hospital
Notes	NCT Number; NCT02396329

NCT02402907

Trial name or title	STRIPES Study: Study To Reduce Infection Post caEsarean Section
Methods	Masked randomised controlled trial conducted in the United States
Participants	Women (18 years or older) > 24 weeks' gestation, scheduled for a primary or repeat caesarean section. Exclusion criteria: allergy to chlorhexidine, unplanned or emergency caesarean section
Interventions	2% chlorhexidine gluconate cloth versus placebo cloth
Outcomes	Primary outcomes: rate of infectious morbidity (time frame: up to 6 weeks) Secondary outcomes: incidence of neonatal intensive care unit admissions (time frame: up to 6 weeks), maternal length of stay (time frame: up to 6 weeks), incidence of maternal readmissions (time frame: up to 6 weeks)
Starting date	April 2015
Contact information	Contact: Brittany Noel Robles, MD
Notes	NCT Number; NCT02402907

CDC: Centers for Disease Control and Prevention

DATA AND ANALYSES

Comparison 1. Drape versus no drape

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	2	1294	Risk Ratio (M-H, Fixed, 95% CI)	1.29 [0.97, 1.71]
1.1 Iodine	1	691	Risk Ratio (M-H, Fixed, 95% CI)	1.42 [0.98, 2.04]
1.2 Chlorhexidine	1	603	Risk Ratio (M-H, Fixed, 95% CI)	1.11 [0.70, 1.76]
2 Length of stay	1	603	Mean Difference (IV, Fixed, 95% CI)	0.10 [-0.27, 0.46]

Analysis 1.1. Comparison 1 Drape versus no drape, Outcome 1 Surgical site infection.

Study or subgroup	Drape n/N	No drape n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.1.1 Iodine					
Cordtz 1989	58/337	43/354		58.02%	1.42[0.98,2.04]
Subtotal (95% CI)	337	354		58.02%	1.42[0.98,2.04]
Total events: 58 (Drape), 43 (No drape)					
			Favours drape		Favours no drape

Analysis 1.2. Comparison 1 Drape versus no drape, Outcome 2 Length of stay.

Comparison 2. One-minute alcohol scrub with iodophor drape versus five-minute iodophor scrub without drape

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	1	79	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Endomyometritis	1	79	Risk Ratio (M-H, Fixed, 95% CI)	1.62 [0.29, 9.16]
3 Reduction of skin bacteria colony counts	1	79	Mean Difference (IV, Fixed, 95% CI)	0.07 [-0.34, 0.48]

Analysis 2.1. Comparison 2 One-minute alcohol scrub with iodophor drape versus five-minute iodophor scrub without drape, Outcome 1 Surgical site infection.

Analysis 2.2. Comparison 2 One-minute alcohol scrub with iodophor drape versus five-minute iodophor scrub without drape, Outcome 2 Endomyometritis.

Analysis 2.3. Comparison 2 One-minute alcohol scrub with iodophor drape versus five-minute iodophor scrub without drape, Outcome 3 Reduction of skin bacteria colony counts.

Comparison 3. Parachlorometaxylenol with iodine versus iodine alone

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	1	50	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.04, 2.99]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Endometritis	1	50	Risk Ratio (M-H, Fixed, 95% CI)	0.88 [0.56, 1.38]

Analysis 3.1. Comparison 3 Parachlorometaxyleneol with iodine versus iodine alone, Outcome 1 Surgical site infection.

Analysis 3.2. Comparison 3 Parachlorometaxyleneol with iodine versus iodine alone, Outcome 2 Endometritis.

Comparison 4. Chlorhexidine gluconate versus povidone iodine

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	6	3607	Risk Ratio (M-H, Fixed, 95% CI)	0.80 [0.62, 1.02]
2 Endometritis	2	2079	Risk Ratio (M-H, Fixed, 95% CI)	1.01 [0.51, 2.01]
3 Re-admission resulting from infection	2	2079	Risk Ratio (M-H, Fixed, 95% CI)	0.71 [0.43, 1.19]
4 Bacterial growth 18 hours	1	60	Risk Ratio (M-H, Fixed, 95% CI)	0.23 [0.07, 0.70]
5 Adverse events (maternal)	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
5.1 Any skin reaction	1	374	Risk Ratio (M-H, Fixed, 95% CI)	0.79 [0.32, 1.96]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
5.2 Erythema	2	1521	Risk Ratio (M-H, Fixed, 95% CI)	1.13 [0.57, 2.26]
5.3 Skin irritation or allergic skin reaction	2	1521	Risk Ratio (M-H, Fixed, 95% CI)	0.60 [0.22, 1.63]

Analysis 4.1. Comparison 4 Chlorhexidine gluconate versus povidone iodine, Outcome 1 Surgical site infection.

Analysis 4.2. Comparison 4 Chlorhexidine gluconate versus povidone iodine, Outcome 2 Endometritis.

Analysis 4.3. Comparison 4 Chlorhexidine gluconate versus povidone iodine, Outcome 3 Re-admission resulting from infection.

Analysis 4.4. Comparison 4 Chlorhexidine gluconate versus povidone iodine, Outcome 4 Bacterial growth 18 hours.

Analysis 4.5. Comparison 4 Chlorhexidine gluconate versus povidone iodine, Outcome 5 Adverse events (maternal).

APPENDICES

Appendix 1. Search methods for ClinicalTrials.gov and ICTRP

ClinicalTrials.gov

Advanced search

Type of study: Interventional

Condition/disease: Infection; Cesarean Section

Intervention: Iodine; Chlorhexidine; Anti-infective

Type of study: Interventional

Condition/disease: Cesarean Section Complications

Other terms: skin preparation; antiseptics; skin cleansing

ICTRP

Each line was run separately

cesarean AND preparation

caesarean AND preparation

cesarean AND prep

caesarean AND prep

cesarean AND cleansing

caesarean AND cleansing

cesarean AND iodine

caesarean AND iodine

cesarean AND chlorhexidine

caesarean AND chlorhexidine

cesarean AND antiseptic(s)

caesarean AND and antiseptic(s)

WHAT'S NEW

Date	Event	Description
27 November 2017	New citation required but conclusions have not changed	Conclusions have not been changed.
27 November 2017	New search has been performed	Search updated. We included five new studies (Aworinde 2016 ; Fahmi 2017 ; Ngai 2015 ; Springel 2017 ; Tuuli 2016) (including one previous ongoing trial: Tuuli 2016) and excluded one new study (Nili 2015). We also identified two new ongoing trials (NCT02402907 ; NCT02396329).

HISTORY

Protocol first published: Issue 4, 2008

Review first published: Issue 9, 2012

Date	Event	Description
26 June 2014	New citation required but conclusions have not changed	The inclusion of one new trial did not change the conclusions.
26 June 2014	New search has been performed	Search updated: one new trial added (Kunkle 2014), three new ongoing trials added and three new trials excluded. Methods updated. 'Summary of findings' tables incorporated for this update.

CONTRIBUTIONS OF AUTHORS

Diah Hadiati wrote the first draft of the protocol. Detty Nurdianti and Hakimi Mohammad contributed to defining the selection criteria and commented on the draft. All authors contributed to data extraction, preparation of results, and finalisation of the report.

For the 2014 update, Erika Ota prepared the first draft, incorporated the results of the additional new study, and prepared the 'Summary of findings' tables. All authors approved the final version of the update for publication.

For the 2018 update, Diah Hadiati, Mohammad Hakimi, and Detty S Nurdianti incorporated results of additional new studies. Katharina da Silva Lopes extracted data and assessed risk of bias for newly added studies, incorporated the results of the additional studies, and prepared the manuscript. Erika Ota rechecked extracted data and risk of bias assessment, prepared the 'Summary of finding' tables, and edited the review text. All authors approved the final version of the update for publication.

DECLARATIONS OF INTEREST

Diah R Hadiati: Diah Hadiati is a named author on [Fahmi 2017](#), but was not involved in the screening process and risk of bias assessment.

Mohammad Hakimi: none known

Detty S Nurdianti: none known

Erika Ota: none known

Katharina da Silva Lopes: none known

SOURCES OF SUPPORT

Internal sources

- Universitas Gadjah Mada, Indonesia.
- St.Luke's international university, Japan.

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- Wellcome Trust (SEA-ORCHID Project), UK.
- UNDP-UNFPA-UNICEF-WHO-World Bank Special Programme of Research, Development and Research Training in Human Reproduction (HRP), Department of Reproductive Health and Research (RHR), World Health Organization, Switzerland.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The methods have been updated to reflect the latest *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011), and Cochrane Pregnancy and Childbirth's methodological guidelines. We added two secondary outcomes; reduction of skin bacteria colony counts and adverse effects. We used GRADE to assess the quality of the evidence and included 'Summary of findings' tables.

In the 2018 update, we added a co-author (Katharina da Silva Lopes). We also added a search of [ClinicalTrials.gov](https://clinicaltrials.gov) and the WHO International Clinical Trials Registry Platform (ICTRP).

We also assessed the quality of the evidence for two new outcomes, using GRADE criteria.

1. Length of stay
2. Adverse events (maternal or neonatal)

We assessed the quality of, and added the two outcomes to the 'Summary of findings' table because length of stay indicates the severity of the infection, which prolongs the hospital stay after caesarean section, and adverse events are important outcomes for women's decision making.

In this update, we provided additional information about the included studies: trial dates, sources of trial funding, and trial authors' declarations of interest.

INDEX TERMS

Medical Subject Headings (MeSH)

Anti-Infective Agents, Local [*therapeutic use]; Bandages; Cesarean Section [*adverse effects]; Chlorhexidine [therapeutic use]; Endometritis [*prevention & control]; Ethanol [therapeutic use]; Iodine [therapeutic use]; Iodophors [therapeutic use]; Length of Stay; Povidone-Iodine [therapeutic use]; Preoperative Care [methods]; Randomized Controlled Trials as Topic; Surgical Drapes; Surgical Wound Infection [*prevention & control]; Xylenes [therapeutic use]

MeSH check words

Adult; Female; Humans; Pregnancy