WHO Surgical Site Infection Prevention Guidelines

Web Appendix 2

Summary of a systematic review on preoperative bathing

1. Introduction

Whole-body bathing or showering with a skin antiseptic to prevent surgical site infections (SSI) is a usual practice before surgery in settings where it is affordable. The aim is to make the skin as clean as possible by removing transient flora and some resident flora. Chlorhexidine gluconate (CHG) 4% combined with a detergent or in a triclosan preparation is generally used for this purpose [1,2]. Preoperative showering with antiseptic agents is a well-accepted procedure for reducing skin microflora [3-5], but it is less clear whether this procedure leads to a lower incidence of SSI [4,5]. A cause for concern is the potential for patient hypersensitivity and allergic reactions to CHG are not uncommon [6]. However, the most relevant question is whether preoperative bathing or showering with an antiseptic soap is more effective than plain soap to reduce the occurrence of SSI.

Several organizations have issued recommendations regarding preoperative bathing. The care bundles proposed by the United Kingdom (UK) High impact intervention initiative and Health Protection Scotland recommend bathing with soap prior to surgery [7,8]. The Royal College of Surgeons of Ireland recommends bathing on the day of surgery or before the procedure with soap [9]. The United States of America (USA) Institute of Healthcare Improvement bundle for hip and knee arthroplasty recommends preoperative bathing with CHG soap [10]. Finally, the UK-based National Institute for Health and Care Excellence (NICE) guidelines recommend bathing to reduce the microbial load, but not necessarily SSI. In addition, NICE states that the use of antiseptics is inconclusive in preventing SSI and that soap should be used [11].

The purpose of this systematic review is to assess the effectiveness of preoperative bathing or showering with antiseptic compared to plain soap and to determine if these agents should be recommended for surgical patients to prevent SSI. The use of CHG cloths for antiseptic preoperative bathing is also addressed, but with a separate PICO question.

2. PICO questions

1. Is preoperative bathing using an antiseptic soap more effective in reducing the incidence of SSI in surgical patients when compared to bathing with plain soap?

- **P**opulation: inpatients and outpatients of any age undergoing surgical operations (any type of procedure)
- **I**ntervention: bathing with an antiseptic soap
- **C**omparator: bathing with plain soap
- **O**utcomes: SSI, SSI-attributable mortality

2. Is preoperative bathing with CHG-impregnated cloths more effective in reducing the incidence of SSI in surgical patients when compared to bathing with antiseptic soap?

- **P**opulation: inpatients and outpatients of any age undergoing surgical operations (any type of procedure)
- **I**ntervention: preoperative bathing with no-rinse and use of 2% CHG-impregnated cloths
- **C**omparator: bathing with antiseptic soap
- **O**utcomes: SSI, SSI-attributable mortality

3. **Methods**

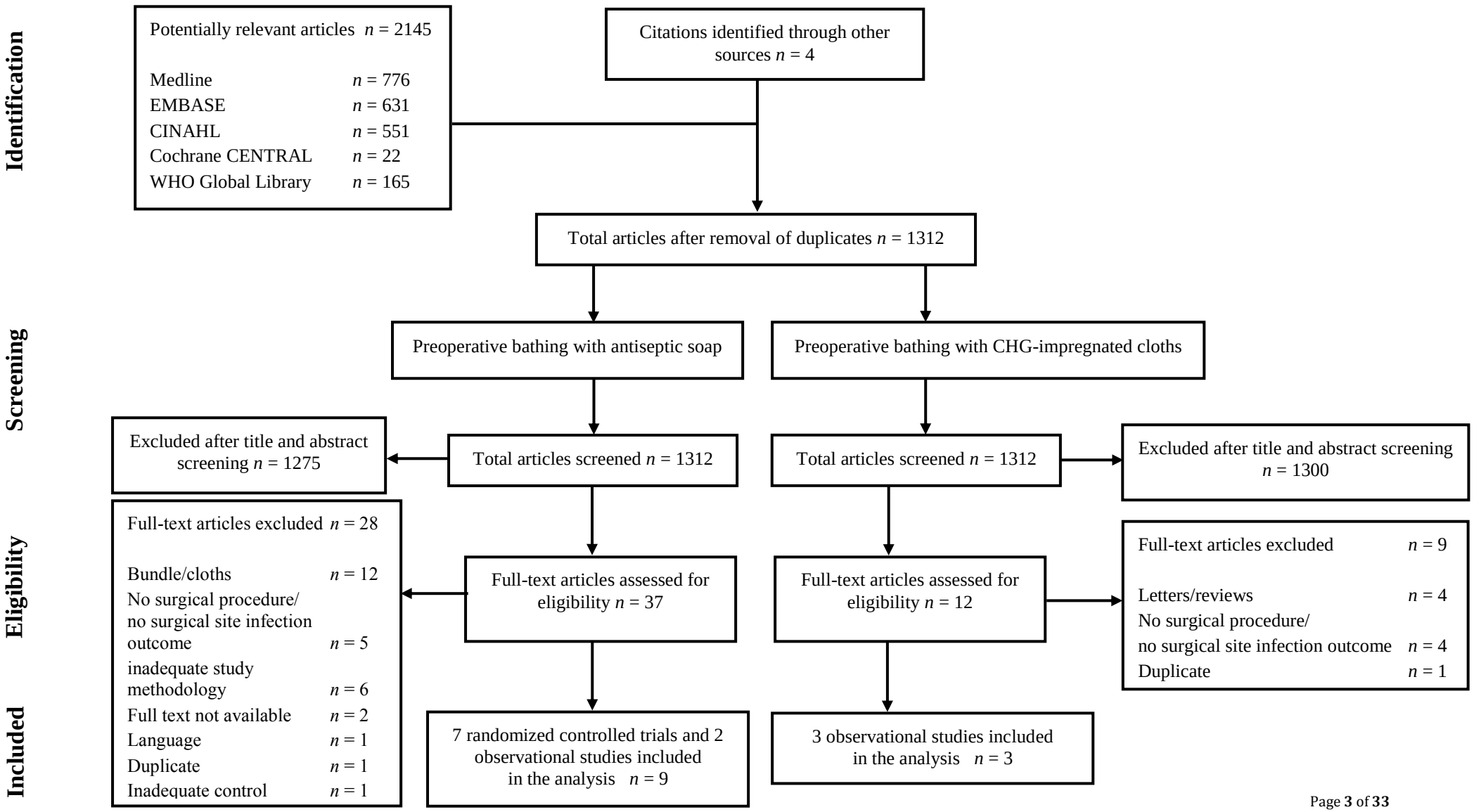
The following databases were searched: Medline (PubMed); Excerpta Medica database (EMBASE); Cumulative Index to Nursing and Allied Health Literature (CINAHL); Cochrane Central Register of Controlled Trials (CENTRAL); and WHO regional medical databases. The time limit for the review was between 1 January 1960 and 15 August 2014. Based on a Cochrane Review on the topic [12], relevant studies published prior to 1990 were included due to the extremely limited number of trials that met the inclusion criteria when using the time limit of 1990, which was usually applied to the systematic reviews performed for the WHO guidelines for the prevention of SSI. Language was restricted to English, French and Spanish. A comprehensive list of search terms was used, including Medical Subject Headings (MeSH) (Appendix 1)

Two independent reviewers screened the titles and abstracts of retrieved references for potentially relevant studies. The full text of all potentially eligible articles was obtained and then reviewed independently by two authors for eligibility based on inclusion criteria. Duplicate studies were excluded.

The two authors extracted data in a predefined evidence table (Appendix 2) and critically appraised the retrieved studies. Quality was assessed using the Cochrane Collaboration tool to assess the risk of bias of randomized controlled studies (RCTs) [13] (Appendix 3a) and the Newcastle-Ottawa Quality Assessment Scale for cohort studies [14] (Appendix 3b). Any disagreements were resolved through discussion or after consultation with the senior author, when necessary.

Meta-analyses of available comparisons were performed using Review Manager version 5.3 as appropriate [15] (Appendix 4). Adjusted odds ratios (OR) with 95% confidence intervals (CI) were extracted and pooled for each comparison with a random effects model. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology (GRADE Pro software) [16] was used to assess the quality of the body of retrieved evidence (Appendix 5).

4. **Study selection:** Flow chart of the study selection process



5. Summary of the findings and quality of the evidence

Findings related to PICO question 1: preoperative bathing or showering with antiseptic soap vs. plain soap

Nine [17-25] studies, including 7 [17-23] RCTs, were identified with an SSI outcome comparing preoperative bathing or showering with antiseptic soap vs. plain soap. Included patients were adults undergoing several types of surgical procedures (for example, general, gynaecological, orthopaedic, urological, vascular reconstructive, plastic, breast cancer and hepatobiliary surgery). Studies included elective clean, clean-contaminated and implant surgery. Of note, no written instructions were provided to patients in the control group in most studies. This may have potentially resulted in less thorough washing than in the intervention group. All identified studies used CHG as the antiseptic soap.

Among the 7 RCTs, 6 studies [17,18,20-23] showed no statistically significant difference between bathing with soap containing CHG vs. bathing with plain soap. One study [19] reported some effect of bathing with antiseptic soap. A meta-analysis of the 7 RCTs (Appendix 4, comparison 1a) showed no statistically significant difference between the effect of antiseptic soap and plain soap bathing on SSI (OR: 0.92; 95% CI: 0.80 –1.04). In addition, the meta-analysis of the two observational studies [24,25] showed a similar result (OR: 1.10; 95% CI: 0.87–1.38) (Appendix 4, comparison 1b).

The quality of the evidence for this comparison was moderate for the RCTs and very low for the observational studies (Appendix 5).

Findings related to PICO question 2: preoperative bathing with CHG-impregnated cloths

Three observational studies investigating the effectiveness of bathing with CHG-impregnated cloths were identified with SSI as the outcome. No RCTs were found on this topic. The following 2 comparisons were identified.

1. CHG-impregnated cloths vs. CHG soap

One prospective cohort study [26] compared bathing with CHG 2% cloths vs. CHG 4% antiseptic soap in a population of surgical patients undergoing general, vascular and orthopaedic procedures. The results showed that bathing with CHG-impregnated cloths may have some benefit compared to CHG 4% soap (OR: 0.32; 95% CI: 0.13–0.77) (Appendix 4, comparison 2).

2. CHG-impregnated cloths vs. no washing

Two other prospective studies compared bathing twice preoperatively with 2% CHG-impregnated cloths vs. no preoperative bathing in a population of orthopaedic patients. These 2 studies were conducted by the same investigators; one reviewed SSI rates in hip arthroplasties [27] and the other reviewed knee arthroplasties [28]. In both studies, there was no real control group as the comparison was made with a group of patients who did not comply with instructions to bathe with the CHG cloths preoperatively, rather than patients

assigned to a predefined control group. A meta-analysis of the studies showed that there might be a significant benefit in using the CHG cloths vs. no use of cloths (OR: 0.27; 95% CI: 0.09-0.79).

The quality of the evidence for these comparisons was very low (Appendix 5).

In conclusion, the available evidence can be summarized as follows.

- **PICO question 1: Preoperative bathing or showering with CHG antiseptic soap vs. plain soap**
  Overall, a moderate quality of evidence shows that preoperative bathing with CHG soap has neither benefit nor harm in reducing the SSI rate when compared to plain soap.

- **PICO question 2: Preoperative bathing with CHG-impregnated cloths**
  Very low quality evidence shows that preoperative bathing with 2% CHG-impregnated cloths may be beneficial in reducing the SSI rate when compared to either bathing with CHG soap or no preoperative bathing. No RCTs were found on this topic.

6. Other factors considered in the review of studies

The systematic review team identified the following other factors to be considered.

*Potential harm*s

The use of antiseptics for preoperative bathing may reduce the incidence of SSI, which can be an expensive and complicated condition to treat. Possible concerns include potential antibiotic resistance with the continued use of antimicrobial agents and adverse events, such as allergic reactions.

Despite its widespread use, reported side-effects from CHG use have been few. These have included delayed reactions, such as contact dermatitis and photosensitivity, toxicity as a result of inadvertent application to the ear with access to the inner ear through a perforated tympanic membrane and hypersensitivity reactions in very rare cases, such as anaphylactic shock [6]. In the included studies, few adverse events were recorded. Byrne and colleagues [17] found that although 9/1754 and 10/1735 patients from the CHG and plain soap groups, respectively, experienced mild skin irritation, there was no evidence of a true allergic reaction. Veiga and colleagues [23] reported no incidence of adverse events in any of the 150 enrolled patients. Exclusion criteria for individual studies may have eliminated also some of the population that may have experienced allergic reactions in prospective studies by excluding patients with known skin sensitivities and allergies.

Values and preferences

It was acknowledged that most patients with access to water would bathe prior to surgery. Patients would tend to carry out the procedures that they were told to do by the professional health care worker. It was highlighted that it is important for the patient to be informed of best clinical practice.

Resource use

Cloths may provide the benefits of using a preoperative antiseptic without the use of water, which may improve compliance with preoperative bathing protocols. However, it is also important to consider the monetary expense of using agents such as CHG-impregnated cloths vs. traditional bathing and/or bathing with antiseptic solutions. Lynch and colleagues [20] conducted a cost-effectiveness study including 3482 general surgical patients who showered 3 times preoperatively with either CHG detergent (n=1744) or detergent without CHG (n=1738). They found that the average hospital cost of both non-infected and infected patients was higher in the CHG group and concluded that preoperative whole-body washing with a CHG detergent is not a cost-effective treatment for reducing wound infection. However, it is important to note that this study consisted of predominantly clean surgical procedures in which the risk of SSI is lower. Future studies investigating the cost of SSI prevention in contaminated surgery may find that the cost of treating SSI is more of a burden than providing antiseptic preoperative bathing.

Some studies investigating the effectiveness of CHG-impregnated cloths evaluated also the economic impact of their use. Bailey and colleagues found that cloths were the most effective and economical strategy, based on their cost and overall effectiveness for SSI prevention. Therefore, it was concluded that the routine distribution of bathing kits was economically beneficial for the prevention of SSI [29]. Similarly, Kapadia and colleagues calculated a potential annual saving ranging from US$ 0.78-3.18 billion by decreasing health care costs, primarily due to the reduction of the incidence of SSI [30].

7. **Key uncertainties and future research priorities**

The systematic review team identified the following key uncertainties and future research priorities.

The lack of new evidence suggests that practices are already established and accepted in the medical community. In the light of emerging patterns of resistance developing with antiseptic use [31] and the potential for adverse events [6], it may be important for future research to investigate whether the use of antiseptics is pertinent and to re-evaluate the efficacy of non-medicated soap or no bathing vs. preoperative bathing with antiseptics in a variety of settings, particularly in low- and middle-income countries. Safety associated with the use of a non-rinse application of CHG should be evaluated also. Current evidence suggests that CHG may not have a significant benefit or harm compared to plain soap in preventing SSI. Cost and availability may also pose a problem in low-resource hospital settings. Additional studies quantifying SSI as an outcome, rather than bacterial skin colonization, should be considered to further elucidate the effect of preoperative washing with antiseptic solutions, including CHG-impregnated cloths. Future PICO questions should include: (1) does preoperative bathing help reduce the incidence of SSI in clean-contaminated or contaminated surgical procedures? (2) Does preoperative bathing with an antiseptic detergent vs. non-medicated bar soap reduce the incidence of SSI in patients undergoing clean-contaminated or contaminated surgical procedures?

The lack of high-quality RCTs indicates a need for further research on the efficacy of preoperative bathing with CHG-impregnated cloths for the prevention of SSI. In addition,

most procedures in all 3 included studies were orthopaedic operations, many of which did not observe superficial SSI as an outcome. Overall, the available studies had a limited number of events and the quality of evidence was very low.

APPENDICES

Appendix 1: Search terms

Medline (via PubMed)

("surgical wound infection"[Mesh] OR surgical site infection* [TIAB] OR "SSI" OR "SSIs" OR surgical wound infection* [TIAB] OR surgical infection*[TIAB] OR post-operative wound infection* [TIAB] OR postoperative wound infection* [TIAB] OR wound infection*[TIAB]) OR (("preoperative care"[Mesh] OR "preoperative care" OR "pre-operative care" OR "perioperative care"[Mesh] OR "perioperative care" OR "peri-operative care" OR perioperative OR intraoperative OR "perioperative period"[Mesh] OR "intraoperative period"[Mesh]) AND ("infection"[Mesh] OR infection [TIAB])) AND ("skin preparation" [TIAB] OR "skin preparations" [TIAB] OR skin prep [TIAB] OR "baths"[Mesh] OR bath*[TIAB] OR cleaning OR cleansing)

EMBASE

('surgical wound infection' OR 'surgical wound
infection' OR surgical AND site AND infection* OR 'ssi' OR 'ssis' OR surgical AND ('wound') AND infection* OR surgical AND infection* OR 'post operative' AND (wound) AND infection* OR postoperative AND ('wound') AND infection* OR 'wound' OR wound AND infection* OR ('preoperative care' OR 'pre-operative care' OR' perioperative care' OR 'perioperative care' OR 'peri-operative
care' OR perioperative OR intraoperative OR 'perioperative period' OR 'perioperative period' OR 'intraoperative period' AND ('infection')) AND ('skin preparation' OR 'skin preparations' OR skin AND prep OR bath*) AND [1960-2014]/py

CINAHL

(‘surgical wound infection'/exp OR 'surgical wound infection’ OR surgical AND site AND infection* OR 'ssi' OR 'ssis' OR surgical AND ('wound'/exp OR wound) AND infection*) OR (surgical AND infection*) OR ('post operative' AND ('wound'/exp OR wound) AND infection*) OR (postoperative AND ('wound'/exp OR wound) AND infection*) OR ('wound'/exp OR wound AND infection*) OR ('preoperative care'/exp OR 'preoperative care' OR 'pre-operative care' OR'perioperative care'/exp OR 'perioperative care' OR 'peri-operative care' OR perioperative OR intraoperative OR 'perioperative period'/exp OR 'perioperative period' OR 'intraoperative period'/exp OR 'intraoperative period' AND ('infection' OR 'infection'/exp OR infection)) AND ('skin preparation' OR 'skin preparations' OR 'skin'/exp OR (skin AND prep) OR 'baths'/exp OR 'baths' OR bath*)

Cochrane CENTRAL

((ssi) OR (surgical site infection) OR (surgical site infections) OR (wound infection) OR (wound infections) OR (postoperative wound infection)) AND bathing

WHO Global Health Library

((ssi) OR (surgical site infection) OR (surgical site infections) OR (wound infection) OR (wound infections) OR (postoperative wound infection)) AND (bathing OR bath OR shower)

ti: title; ab: abstract.

Appendix 2: Evidence table

Appendix 2a: Studies related to bathing with an antiseptic soap vs. plain soap

Author, year, reference	Design, scope, setting, popu-lation	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results	Limitations
Ayliffe, 1983 [24]	Cross-over study (60 weeks) 2 large district hospitals and 1 orthopaedic hospital United Kingdom 5536 patients Exclusion: trauma surgery	To compare wound infection rates in patients bathing pre-operatively with either CHG detergent or non-medicated soap.	Mild: a wound with a small or superficial area of inflammation and with minimal discharge. Moderate: superficial inflammation of the whole wound with a serous or small amount of purulent discharge or a deeper wound infection involving a small area usually with purulent discharge.	General, gynaeco-logical, orthopaedic and urological procedures	Surgical wards were divided into groups to either use CHG 4% detergent (Hibiscrub®, Mölnlyke Health Care, Gothenburg, Sweden) or non-medicated bar soap for all preoperative bathing. Wards using CHG scrub were supplied with instruction cards and patients either bathed themselves or were bathed by nursing staff. After a 30-week period, wards	Group 1: CHG 4% Group 2: non-medicated bar soap	Group 1: wound infections 147/2703 Group 2: wound infections 140/2833 *P*=0.440	No instructions given to patients using non-medicated bar soap; unblended due to nature of cleansers; impossible to confirm appropriate use of CHG detergent.

			Severe: deep purulent infection with or without sinuses or fistulae, widespread cellulitis or wound breakdown with an obvious inflammatory reaction and pus.		switched to the opposite cleansing agent. No other skin preparation procedure was changed during the trial.			

Byrne, 1992 [17]	Prospective, randomized, controlled, double-blind trial (regular soap) 3733 patients United Kingdom	To study the importance of definition and post-discharge wound surveillance on reported wound infection rates.	Primary outcome: wound infection (defined as discharge of pus from a wound for inpatients or outpatients or an ASEPSIS score of >9). Secondary outcomes: death, allergic reactions, cost Follow-up: 6 weeks	Elective or potentially contaminated surgery.	Randomization was performed in blocks of 6 using computer-generated random numbers and allocated in a sealed envelope. All personnel and patients were blinded. All patients showered 3 times preoperatively using 50 mL of the allocated agent at admission, the night before surgery, and the morning of surgery. Written instructions were provided to each patient.	Group 1: CHG 4% Group 2: detergent without CHG	Group 1 SSI: 256/1754 (14.6%); Group 2 SSI: 272/1735 (15.7%) *P*=NS	

Earnshaw, 1989 [18]	Prospective RCT 66 patients United Kingdom	To determine whether two CHG baths could reduce the incidence of post-operative sepsis.	Primary outcome: wound infection was defined as discharge of pus from a wound; one patient with severe cellulitis was also included. Secondary outcome: death	Vascular re-construction	Randomization methods not specified. All patients had two baths: Group 1: entire body painted with undiluted CHG 4% followed by rinsing in the bath. Precise instructions given. Group 2: non-medicated soap used. No specific instructions provided.	Group 1: CHG 4% Group 2: non-medicated soap	Group 1 SSI: 8/31 Group 2 SSI: 4/35 *P*=1.20	No written instruction were given to the control group, potentially resulting in less thorough washing than the intervention group, which received precise instructions.

Hayek, 1988 [19]	Cluster RCT 1 hospital (4 wards) and 1 hospital (2 wards) over 2 years United Kingdom 2015 patients Exclusion: patients receiving antibiotics or with existing infection.	To study the reduction of postoperative wound infection after 2 pre-operative baths or showers with CHG scrub, regular soap or non-medicated soap.	Primary outcome: wound infection was defined as either discharge of pus from a wound, or erythema, or swelling considered to be greater than expected.	Routine general surgery	Randomization not specified. All patients had either a shower or bath on the day before and morning of their operation. Primary outcome was wound infection.	Group 1: CHG 4%. Instruction card for washing provided. Group 2: detergent without CHG. Instruction card for washing provided (5 months into the study, the regular soap was found to have antimicrobial properties and was changed). Group 3: bar soap. No washing instructions provided.	Group 1 SSI: 62/689 (9.0%); Group 2 SSI: 83/700 (11.7%); Group 3 SSI: 80/626 (12.8%) *P*<0.05	Liquid agents were given with instructions. No written instruction were given to the control group, potentially resulting in less thorough washing than the intervention group, which received precise instructions.

Leigh, 1983 [25]	Prospective cohort study 1 hospital; over 4 months The Netherlands 224 patients (127 male) undergoing a procedure involving a skin incision. Exclusion: not stated.	To investigate if the use of preoperative whole-body bathing with CHG-detergent solution was more effective than non-medicated soap in reducing the bacterial flora of certain specified areas of the body and to determine the influence of this procedure in the development of postoperative wound infection.	Wound infection was "assessed by the infection control nursing officer by frequent visits to the wards and a final examination of inpatient notes".	Mixed surgical procedures, consisting of 72% clean procedures.	Patients were usually admitted the day before or morning of surgery; bathing was carried out a few hours before operations. The 2 treatments were alternated between the male and female wards for 4 months, beginning with the male ward using non-medicated soap first. Primary outcomes included bacterial flora and post-operative wound infection.	Group 1: CHG 4%. Group 2: non-medicated soap Instructions were posted in each bathroom and the procedure of total body bathing explained to each patient. Hair washing was not compulsory.	Wound infection (clinical) Group 1:12/109 Group 2: 13/115	Hair washing was not compulsory; depending on the procedure, deferringhair washing may contribute to an increased number of microorganisms.

Lynch, 1992 [20]	Double-blind RCT April 1987 – December 1989 United Kingdom 3482 general surgery patients. Exclusion: not stated.	To measure the efficacy of whole-body disinfection with a CHG 4% detergent solution in reducing the postoperative wound infection rate in patients undergoing clean or potentially contaminated surgery.	Wound infection was defined as: 1. discharge of pus from the wound in hospital = inpatient clinical; 2. no discharge of pus, but ASEPSIS >10 = inpatient ASEPSIS; 3. discharge of pus from the wound after leaving hospital = outpatient clinical. Secondary outcomes: colony-forming units, cost.	Elective clean or potentially contaminated surgery	Follow-up period All patients had 3 showers with liquid soap provided (either CHG or regular soap). First shower upon admission before putting on clean clothes, second before going to bed, and the third on the morning of the operation before changing into clean cloths. After third shower, agar skin contact plates were taken from the axillae and groin areas and incubated for 24 hours (colony-forming units measured). Wounds were assessed postoperatively	Group 1: CHG 4% solution Group 2: detergent without CHG	SSI Group 1 SSI: 250/1744 Group 2 SSI: 263/1738 *P*=NS	

					using the ASEPSIS scoring system, as well as by clinical observation of the wound.			
Randall, 1985 [21]	RCT; 3-arm United Kingdom 94 patients	To assess the true wound infection rate for vasectomy at the hospital and its subsequent morbidity and to elucidate any factors that may be responsible for infection.	Primary outcome Wound infection was defined as discharging either purulent or serous fluid.	Vasectomy	Follow-up period: one week after discharge	Group 1: 1 preoperative shower with CHG 4%, Group 2: 1 shower with normal soap. Group 3: no shower.	Group 1 SSI: 12/32 (37.5%); Group 2 SSI: 10/30 (33.3%); Group 3 SSI: 9/32 (28.1%). *P*<0.05	Unclear if group 3 was specifically instructed not to shower or if other hygienic cleansing may have occurred.

Rotter, 1988 [22]	Cluster RCT Austria 2953 patients Exclusion criteria: temperature >37.5°C, antibiotics given within 7 days of surgery, incarcerated inguinal hernia, radical mastectomy.	To compare the effect of pre-operative whole-body bathing on 2 occasions with a detergent containing CHG on the incidence of wound infection in elective clean surgery with two bathings with a detergent without CHG.	Wound infection was defined in the report as "inflammation of the surgical wound with discharge of pus, spontaneous and/or after surgical intervention that occurs during hospitalization or during routine follow-up".	Elective clean surgery	All patients had 2 showers; one on the day before surgery and one on the day of surgery. Group 1: used 50 mL of CHG 4% for each shower. Group 2: regular soap. Special application instructions were provided to all participants.	Group 1: CHG 4% Group 2 detergent without CHG	SSI: Group 1: 37/1413 (2.6%); Group 2: 33/1400 (2.4%). *P*=NS	

Veiga, 2008 [23]	RCT university-affiliated hospital Brazil 150 adult patients Exclusion: hypersensitivity to CHG, skin lesions, diabetes heavy smoking, immune-suppression.	To assess the effect of pre-operative CHG showers on skin colonization and post-operative infection rates associated with plastic surgery procedures involving the trunk.	SSI (CDC criteria) Secondary outcome: adverse reactions	Plastic surgery	Group 1: shower with liquid-based detergent containing CHG 4%. Group 2: shower with the same liquid-based detergent, without CHG. Group 3: no preoperative showering instructions were given. Follow-up: 30 days	Group 1: liquid based CHG 4%. Group 2: detergent without CHG. Group 3: no wash. All patients were prepped with an alcohol-based solution of CHG 0.5% paint following sample collection.	Group 1 SSI: 1/50 (2%) Group 2 SSI: 1/50 (2%) Group 3 SSI: 0/50 (0%) No adverse reactions reported. *P*=0.6	Group 3 (control) was not given instructions and therefore preoperative bathing may have occurred with normal soap or other personal hygiene practices.

SSI: surgical site infection; RCT: randomized controlled trial; CHG: chlorhexidine gluconate; ASEPSIS (scoring system): **A**dditional treatment, **S**erous discharge, **E**rythema, **P**urulent exudate, **S**eparation of deep tissues, **I**solation of bacteria and **S**tay as inpatient prolonged over 14 days CDC: Centers for Disease Control and Prevention; NS: not significant.

Appendix 2b: Studies on chlorhexidine-impregnated cloths

Author, year, reference	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results
Graling, 2013 [26]	Prospective cohort study USA 619 adult patients Exclusion criteria: patients with missing records or who did not receive a CHG bath.	To determine the effectiveness of a CHG 2% no-rinse cloth bath for patients within 3 hours of scheduled surgery for the reduction of SSI.	CDC criteria	General, vascular and orthopaedic surgical procedures	Inclusion criteria included patients older than 18 years who were scheduled for surgery in the main operating room suite, including inpatient, urgent, and same-day admission status. Patients meeting inclusion criteria were sent a follow-up letter regarding their status to their physician's office for completion at 30 days after surgery. Control data was extracted from the institution's national surgical quality improvement programme database as a baseline comparison. The	CHG 4% solution group: patients instructed to shower 2 times with a CHG 4% antiseptic solution before admission to hospital. CHG 2% cloths group: patients were given warmed packages of CHG 2% cloths and instructions on how to apply the "bath" before changing into clean hospital gowns prior to surgery.	CHG 4% solution group SSI: 18/284 CHG 2% cloths group SSI: 7/335 *P*=0.01

					comparison group was chosen from the corresponding time frame one year before the project began.		
Johnson, 2010 [27]	Prospective cohort record review USA 1054 adult patients Exclusion criteria: patients of surgeons who did not perform at least 20 hip arthroplasties each year.	To evaluate the effectiveness of an advance, at-home CHG-impregnated skin preparation cloth in decreasing the incidence of deep periprosthetic hip arthroplasty infections.	Not stated	Orthopaedic (hip arthroplasty)	Prospectively collected infection-tracking database of all patients undergoing hip arthroplasty was reviewed. All surgeons at the institution were asked to have patients perform an at-home application of a CHG cloth (instructions given), while "non-compliant" patients received only standard perioperative site preparation with DuraPrep™ (0.7% povidone iodine + 74% isopropyl alcohol; 3M, St Paul, MN, USA) paint.	Patients were instructed to use a pack of CHG 2% cloths in 2 applications (6 wipes each). One on the night before surgery and one on the morning of surgery. One cloth applied to head and trunk, one to each arm, one to each leg and one to the surgical site.	Not compliant with CHG cloth bathing protocol: 714/897 CHG cloth group: 0/157 *P*=0.231

Johnson, 2013 [28]	Prospective cohort record review USA 2213 adult patients Exclusion criteria: none specified	To evaluate the incidence of SSI in total knee arthroplasty patients with a preadmission cutaneous skin preparation protocol compared with a cohort of patients undergoing standard in-hospital perioperative preparation only.	CDC criteria	Orthopaedic (knee arthroplasty)	Infection-tracking database of all patients undergoing knee arthroplasty was reviewed. All surgeons at the institution were asked to have patients perform an at-home application of CHG cloths (instructions given), while "non-compliant" patients received only standard perioperative site preparation with DuraPrep™ paint.	Patients were instructed to use a pack of CHG 2% cloths in 2 applications (6 wipes each; each cloth contained 500 mg CHG) on the night before surgery and one in the morning of surgery. One cloth applied to head and trunk, one to each arm, one to each leg and one to the surgical site.	Not compliant with CHG cloth bathing protocol: 38/1735 CHG cloths group: 3/478 *P*=0.021

SSI: surgical site infection; CHG: chlorhexidine gluconate; ASEPSIS (score): A=additional treatment; S=serous discharge; E=erythema; P=purulent system score; exudate; S=separations of deep tissue; I=isolation of bacteria; S=stay in hospital prolonged >14 days; NS: not significant; RCT: randomized controlled trial; CFU: colony-forming units.

Appendix 3. Risk of bias assessment of the included studies

Appendix 3a: Studies related to preoperative bathing with an antiseptic soap vs. plain soap

Risk of bias in the included randomized controlled studies (Cochrane Collaboration tool)

RCT Author, year, reference	**Study design**	**Sequence generation**	**Allocation concealment**	**Participants and personnel blinded**	**Outcome assessors blinded**	**Incomplete outcome data**	**Selective outcome reporting**	**Other sources of bias**
Byrne, 1992 [17]	RCT	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Earnshaw,1989 [18]	RCT	UNCLEAR	UNCLEAR	HIGH	LOW	LOW	LOW	HIGH
Hayek, 1988 [19]	RCT	UNCLEAR	UNCLEAR	HIGH	UNCLEAR	UNCLEAR	LOW	HIGH
Lynch, 1992 [20]	RCT	UNCLEAR	UNCLEAR	LOW	LOW	LOW	LOW	UNCLEAR
Randall, 1983 [21]	RCT	LOW	UNCLEAR	HIGH	UNCLEAR	LOW	LOW	LOW
Rotter, 1988 [22]	RCT	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Veiga, 2008 [23]	RCT	LOW	UNCLEAR	LOW	LOW	LOW	LOW	LOW

Risk of bias in the included cohort studies (Newcastle-Ottawa Quality Assessment Scale)

Other controlled studies Author, year, reference	**Representativeness of cohort**	**Selection of non-exposed cohort**	**Ascertainment of exposure**	**Demonstration that outcome of interest was not present at start**	**Comparability of cohorts**	**Assessment of outcome**	**Follow-up long enough**	**Adequacy of follow-up of cohorts**
Ayliffe, 1983 [24]	B (*)	B	B (*)	B	A (*)	B (*)	B	D
Leigh, 1983 [25]	B (*)	A (*)	A (*)	B	-	B (*)	A (*)	C

Appendix 3b: Risk of bias assessment of studies related to preoperative bathing with CHG–impregnated cloths (Newcastle-Ottawa Quality Assessment Scale)

Author, year, reference	Representativeness of cohort	Selection of non-exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start	Comparability of cohorts	Assessment of outcome	Follow-up long enough	Adequacy of follow-up of cohorts
Graling, 2013 [26]	B*	B	A*	A*	-	B*	A*	B*
Johnson, 2010 [27]	B*	A*	C	A*	Age(*)	B*	A*	D
Johnson, 2013 [28]	B*	A*	C	A*	Age(*) Other(*)	B*	A*	D

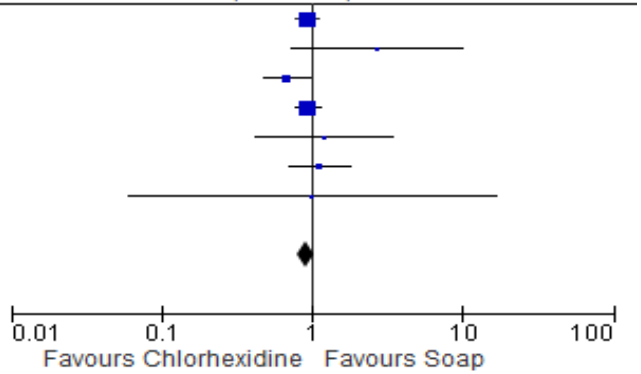
CHG: chlorhexidine gluconate

Appendix 4: Comparisons

Comparison 1a: Preoperative bathing with CHG vs. plain soap (randomized controlled trials only)

Study or Subgroup	Chlorhexidine Events	Total	Soap Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Byrne	256	1754	272	1735	38.9%	0.92 [0.76, 1.11]
Earnshaw	8	31	4	35	1.0%	2.70 [0.72, 10.05]
Hayek	62	689	80	626	12.9%	0.67 [0.48, 0.96]
Lynch	250	1744	263	1738	38.1%	0.94 [0.78, 1.13]
Randall	12	32	10	30	1.6%	1.20 [0.42, 3.41]
Rotter	37	1413	33	1400	7.3%	1.11 [0.69, 1.79]
Veiga	1	50	1	50	0.2%	1.00 [0.06, 16.44]
Total (95% CI)		**5713**		**5614**	**100.0%**	**0.92 [0.80, 1.04]**
Total events	626		663			

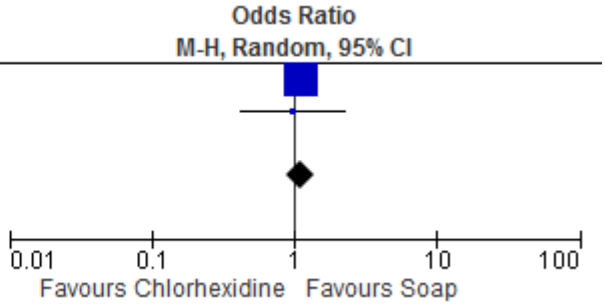
Heterogeneity: Tau² = 0.00; Chi² = 6.47, df = 6 (P = 0.37); I² = 7%
Test for overall effect: Z = 1.30 (P = 0.19)



Comparison 1b: Preoperative bathing with CHG vs. plain soap (observational studies only)

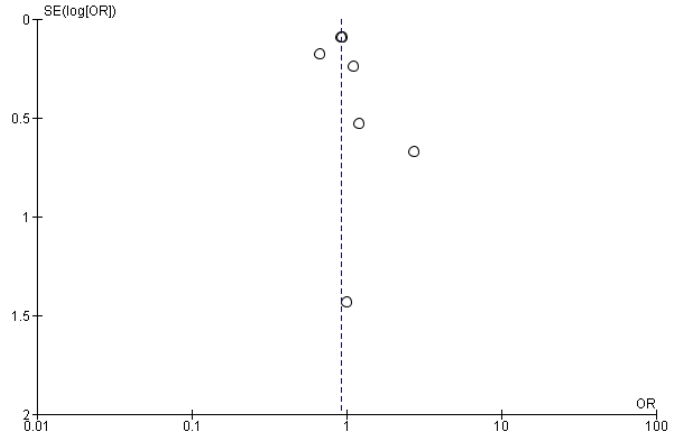
Study or Subgroup	Chlorhexidine Events	Total	Soap Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Ayliffe	147	2703	140	2833	92.5%	1.11 [0.87, 1.40]
Leigh	12	109	13	115	7.5%	0.97 [0.42, 2.23]
Total (95% CI)		**2812**		**2948**	**100.0%**	**1.10 [0.87, 1.38]**
Total events	159		153			

Heterogeneity: Tau² = 0.00; Chi² = 0.09, df = 1 (P = 0.77); I² = 0%
Test for overall effect: Z = 0.78 (P = 0.43)

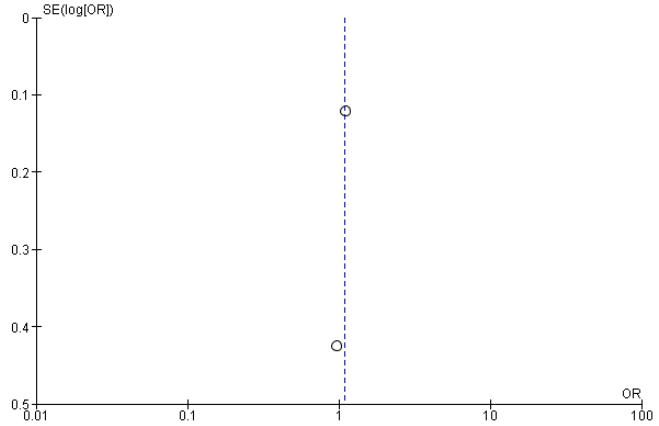


M-H: Mantel-Haenszel (test); CI: confidence interval

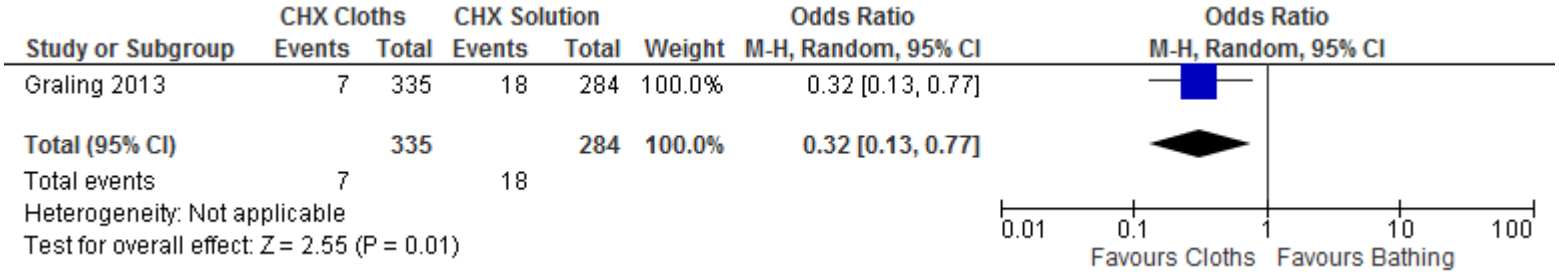
Funnel plot 1a: Preoperative bathing with CHG vs. plain soap (randomized controlled trials only)



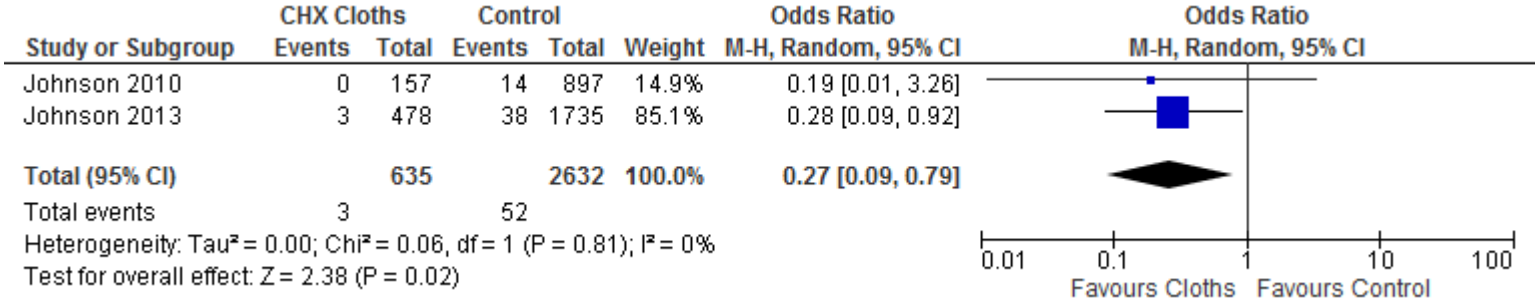
Funnel plot 1b: Preoperative bathing with CHG vs. plain soap (observational studies only)



Comparison 2: Preoperative bathing with 2% CHG-impregnated cloths vs. standard CHG 4% preoperative bathing

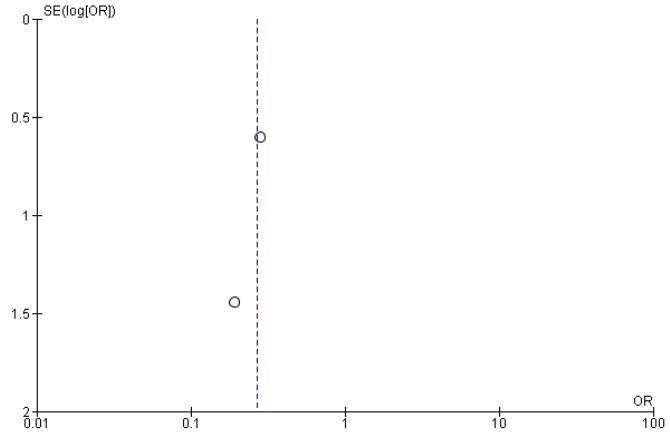


Comparison 3: Preoperative bathing with 2% CHG-impregnated cloths vs. no washing



M-H: Mantel-Haenszel (test); CI: confidence interval

Funnel plot 3: Preoperative bathing with 2% CHG-impregnated cloths vs. no washing



Appendix 5: Grade tables

Comparison 1: Preoperative bathing with CHG vs. plain soap

Quality assessment							№ of patients		Effect		Quality
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	With CHG	With soap	Relative (95% CI)	Absolute (95% CI)	
Surgical site infection											
7	RCTs	serious [1]	not serious	not serious	not serious	none	626/5713 (11.0%)	663/5614 (11.8%)	OR: 0.92 (0.80-1.04)	8 fewer per 1000 (from 4 more to 21 fewer)	⊕⊕⊕◯ MODERATE
Surgical site infection											
2	Observational studies	serious [1]	not serious	not serious	serious [2]	none	159/2812 (5.7%)	153/2948 (5.2%)	OR: 1.10 (0.87-1.38)	5 more per 1000 (from 6 fewer to 18 more)	⊕◯◯◯ VERY LOW

1. Risk of performance bias
2. Optimal information size is met but CI overlaps no effect and fails to exclude important benefit or important harm (RR or RRR of 25%)

CHG: chlorhexidine gluconate; CI: confidence interval; OR: odds ratio; RCT: randomized controlled trial; RR: relative risk; RRR: relative risk reduction

Comparison 2: Preoperative bathing with 2% CHG-impregnated cloths vs. standard CHG 4% preoperative bathing

Quality assessment							№ of patients		Effect		Quality
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Bathing with CHG-impregnated cloths	CHG detergent	Relative (95% CI)	Absolute (95% CI)	
Surgical site infection											
1	Observational studies	not serious	not serious	not serious	serious [1]	none	18/284 (6.3%)	7/335 (2.1%)	OR: 0.32 (0.13- 0.77)	14 fewer per 1000 (from 5 fewer to 18 fewer)	⨁◯◯◯ VERY LOW

1. Optimal information size not met

CHG: chlorhexidine gluconate; CI: confidence interval; OR: odds ratio

Comparison 3: Preoperative bathing with CHG-impregnated cloths vs. no bathing for the prevention of SSI

Quality assessment							№ of patients		Effect		Quality
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Bathing with CHG-impregnated cloths	No bathing	Relative (95% CI)	Absolute (95% CI)	
Surgical site infection											
2	Observational studies	not serious	not serious	not serious	serious [1]	none	3/635 (0.5%)	52/2632 (2.0%)	OR: 0.27 (0.09-0.79)	14 fewer per 1000 (from 4 fewer to 18 fewer)	⨁◯◯◯ VERY LOW

1. Optimal information size not met

CHG: chlorhexidine gluconate; CI: confidence interval; OR: odds ratio.

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