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Water for wound cleansing

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Water for wound cleansing

Abstract

"Background Although various solutions have been recommended for cleansing wounds, normal saline is favoured as it is an isotonic solution and does not interfere with the normal healing process. Tap water is commonly used in the community for cleansing wounds because it is easily accessible, efficient and cost effective; however, there is an unresolved debate about its use. Objectives The objective of this review was to assess the effects of water compared with other solutions for wound cleansing. Search methods For this fourth update we searched the Cochrane Wounds Group Specialised Register (searched 9 November 2011); The Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library 2011, Issue 4); Ovid MEDLINE (2010 to October Week 4 2011); Ovid MEDLINE (In-Process & Other Non-Indexed Citations, November 8, 2011); Ovid EMBASE (2010 to 2011 Week 44); and EBSCO CINAHL (2010 to 4 November 2011). Selection criteria Randomised and quasi randomised controlled trials that compared the use of water with other solutions for wound cleansing were eligible for inclusion. Additional criteria were outcomes that included objective or subjective measures of wound infection or healing. Data collection and analysis Two review authors independently carried out trial selection, data extraction and quality assessment. We settled differences in opinion by discussion. We pooled some data using a random-effects model. Main results We included 11 trials in this review. We identified seven trials that compared rates of infection and healing in wounds cleansed with water and normal saline; three trials compared cleansing with no cleansing and one trial compared procaine spirit with water. There were no standard criteria for assessing wound infection across the trials, which limited the ability to pool the data. The major comparisons were water with normal saline, and tap water with no cleansing. For chronic wounds, the relative risk of developing an infection when cleansed with tap water compared with normal saline was 0.16, (95% CI 0.01 to 2.96). Tap water was more effective than saline in reducing the infection rate in adults with acute wounds (RR 0.63, 95% CI 0.40 to 0.99). The use of tap water to cleanse acute wounds in children was not associated with a statistically significant difference in infection when compared to saline (RR 1.07, 95% CI 0.43 to 2.64). We identified no statistically significant differences in infection rates when wounds were cleansed with tap water or not cleansed at all (RR 1.06, 95% CI 0.07 to 16.50). Likewise, there was no difference in the infection rate in episiotomy wounds cleansed with water or procaine spirit. The use of isotonic saline, distilled water and boiled water for cleansing open fractures also did not demonstrate a statistically significant difference in the number of fractures that were infected. Authors' conclusions There is no evidence that using tap water to cleanse acute wounds in adults increases infection and some evidence that it reduces it. However there is not strong evidence that cleansing wounds per se increases healing or reduces infection. In the absence of potable tap water, boiled and cooled water as well as distilled water can be used as wound cleansing agents."

Keywords

wound, cleansing, water

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[Intervention Review]

Water for wound cleansing

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ABSTRACT

Background

Although various solutions have been recommended for cleansing wounds, normal saline is favoured as it is an isotonic solution and does not interfere with the normal healing process. Tap water is commonly used in the community for cleansing wounds because it is easily accessible, efficient and cost effective; however, there is an unresolved debate about its use.

Objectives

The objective of this review was to assess the effects of water compared with other solutions for wound cleansing.

Search methods

For this fourth update we searched the Cochrane Wounds Group Specialised Register (searched 9 November 2011); The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2011, Issue 4); Ovid MEDLINE (2010 to October Week 4 2011); Ovid MEDLINE (In-Process & Other Non-Indexed Citations, November 8, 2011); Ovid EMBASE (2010 to 2011 Week 44); and EBSCO CINAHL (2010 to 4 November 2011).

Selection criteria

Randomised and quasi randomised controlled trials that compared the use of water with other solutions for wound cleansing were eligible for inclusion. Additional criteria were outcomes that included objective or subjective measures of wound infection or healing.

Data collection and analysis

Two review authors independently carried out trial selection, data extraction and quality assessment. We settled differences in opinion by discussion. We pooled some data using a random-effects model.

Main results

We included 11 trials in this review. We identified seven trials that compared rates of infection and healing in wounds cleansed with water and normal saline; three trials compared cleansing with no cleansing and one trial compared procaine spirit with water. There were no standard criteria for assessing wound infection across the trials, which limited the ability to pool the data. The major comparisons were water with normal saline, and tap water with no cleansing. For chronic wounds, the relative risk of developing an infection when cleansed with tap water compared with normal saline was 0.16, (95% CI 0.01 to 2.96). Tap water was more effective than saline in

reducing the infection rate in adults with acute wounds (RR 0.63, 95% CI 0.40 to 0.99). The use of tap water to cleanse acute wounds in children was not associated with a statistically significant difference in infection when compared to saline (RR 1.07, 95% CI 0.43 to 2.64). We identified no statistically significant differences in infection rates when wounds were cleansed with tap water or not cleansed at all (RR 1.06, 95% CI 0.07 to 16.50). Likewise, there was no difference in the infection rate in episiotomy wounds cleansed with water or procaine spirit. The use of isotonic saline, distilled water and boiled water for cleansing open fractures also did not demonstrate a statistically significant difference in the number of fractures that were infected.

Authors' conclusions

There is no evidence that using tap water to cleanse acute wounds in adults increases infection and some evidence that it reduces it. However there is not strong evidence that cleansing wounds per se increases healing or reduces infection. In the absence of potable tap water, boiled and cooled water as well as distilled water can be used as wound cleansing agents.

PLAIN LANGUAGE SUMMARY

The effects of water compared with other solutions for wound cleansing

Water is frequently used for cleaning wounds to prevent infection. This can be tap water, distilled water, cooled boiled water or saline (salty water). Using tap water to cleanse acute wounds in adults does not increase the infection rate; however, there is no strong evidence that cleansing per se is better than not cleansing. The reviewers concluded that where tap water is high quality (drinkable), it may be as good as other methods such as sterile water or saline (salty) water (and more cost-effective), but more research is needed.

BACKGROUND

Management of chronic and acute wounds has changed significantly in the last decade; however, minimal attention has been focused on the types of solutions used for wound cleansing.

The process of wound cleansing involves the application of a non-toxic fluid to remove debris, wound exudate and metabolic wastes to create an optimal environment for wound healing (Murphy 1995; Waspe 1996; Rodeheaver 1999). Clinicians and manufacturers have recommended various cleansing agents for their supposed therapeutic value. Preparations with antiseptic properties have been traditionally used, but published research using animal models has suggested that antiseptic solutions may hinder the healing process (Brennan 1985; Thomlinson 1987; Glide 1992; Bergstrom 1994; Hellewell 1997). The controversy surrounding the use of antiseptics prompted the development of guidelines for the use of antiseptics by wound care experts. These guidelines have resulted in changes in hospital practice.

Normal saline (0.9%) is the favoured wound cleansing solution because it is an isotonic solution and does not interfere with the normal healing process, damage tissue, cause sensitisation or allergies or alter the normal bacterial flora of the skin (which would allow the growth of more virulent organisms) (Huxtable 1993; Lawrence 1997; Philips 1997; Joanna Briggs 1998). Tap water is also recommended and has the advantages of being efficient, cost-effective and accessible (Fowler 1985; Angeras 1992; Murphy 1995; Thompson 1999). However, clinicians have been cautioned against using tap water to cleanse wounds that have exposed bone or tendon, in which case normal saline is recommended (Lindholm 1999).

There has been much debate in clinical circles about the potential advantages and disadvantages of cleaning exudate from the wound, as the exudate itself may contain growth factors and chemokines which contribute to wound healing (Thomson 1998). However, the literature also suggests that large amounts of bacteria may inhibit wound healing because of the proteases secreted by the organisms (Robson 1988). Until further research has established its demerits, cleansing will continue to remain an integral part of the wound management process (Hellewell 1997).

Wounds cause considerable cost to individuals in terms of morbidity, and to the health services in terms of the personnel and consumables to perform wound care (Johnson 1997). The purpose of this systematic review was to investigate the effectiveness of water for cleansing wounds in clinical practice.

OBJECTIVES

The objective of this review was to compare the effects of water (tap or cool, boiled or distilled) and saline for wound cleansing.

The review will address the following questions.

What are the comparative effects on rates of healing and infection in acute and chronic wounds, of the following cleansing solutions:

- tap water compared with no cleansing;
- tap water compared with sterile normal saline;
- water (distilled and/or cooled boiled water) compared with sterile normal saline;
- tap water compared with cooled boiled tap water;
- tap water compared with any other solution.

METHODS

Criteria for considering studies for this review

Types of studies

We considered all randomised controlled trials (RCTs) and quasi RCTs comparing wound healing outcomes or infection rates in wounds cleaned with water and those cleaned with normal saline or any other solution eligible for inclusion in this review. A quasi RCT uses a method of allocating participants that is not truly random, e.g. according to date of birth (odd or even years) (Jadad 1998). We included trials if they reported an objective measure of infection such as wound culture or biopsy and objective measures of healing such as change in surface area and wound depth. We also included trials that included only subjective measures of infection such as redness, purulent discharge or swelling around the affected area in the review, but we analysed these separately. We included trials undertaken in any country, irrespective of the tap water quality, and there was no restriction on the basis of the language in which the trial reports were written.

Types of participants

Trials involving people of all ages with a wound of any aetiology, in any setting (hospital, community, nursing homes, general practice, wound clinics). For the purpose of the review a wound was defined as a break in the skin.
We excluded trials if they compared solutions for dental procedures or for patients with burns.

Types of interventions

We considered trials eligible for inclusion if the solutions compared were used specifically for wound cleansing. For the purpose of this review, wound cleansing is defined as: "the use of fluids to remove loosely adherent debris and necrotic tissue from the wound surface" (Hellewell 1997).
We considered all trials evaluating the following comparisons eligible for inclusion in the review:

- tap water compared with no cleansing;
- tap water compared with sterile normal saline;
- water (distilled and/or cooled boiled water) compared with sterile normal saline;
- tap water compared with cooled boiled water;
- tap water compared with any other solution.

We excluded trials that:

1. utilised solutions for pre-operative skin cleansing to prevent postoperative infections;
2. assessed the effectiveness of solutions as part of the operative procedure (for example lavage with povidone-iodine or normal saline after fascia closure);
3. compared dressings for patients with ulcers;
4. used a solution, for example povidone-iodine as a prophylactic treatment.

Types of outcome measures

Primary outcomes

The primary outcome of interest was wound infection, as measured objectively by bacterial counts, wound cultures, wound biopsy and/or by subjective indicators of wound infection (e.g. presence of pus, discolouration, friable granulation tissue).

Secondary outcomes

The secondary outcomes of interest were:

- proportion of wounds that healed;
- the rate of wound healing expressed as percentage or absolute change in wound area;
- costs;
- pain and discomfort;
- patient satisfaction;
- staff satisfaction.

Search methods for identification of studies

The search methods section for the third update of this review can be found in Appendix 1.

Electronic searches

For this fourth update we searched the following databases:

- The Cochrane Wounds Group Specialised Register (searched 9 November 2011);
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2011, Issue 4);
- Ovid MEDLINE (2010 to October Week 4 2011);
- Ovid MEDLINE (In-Process & Other Non-Indexed Citations, November 8, 2011);
- Ovid EMBASE (2010 to 2011 Week 44);
- EBSCO CINAHL (2010 to 4 November 2011).

We used the following search strategy to search CENTRAL:
#1 MeSH descriptor Wounds and Injuries explode all trees
#2 MeSH descriptor Skin Ulcer explode all trees
#3 MeSH descriptor Diabetic Foot explode all trees
#4 ("wound" or "wounds" or "ulcer" or "ulcers" or "bite" or "bites" or "abrasion" or "abrasions" or "laceration" or "lacerations" or "diabetic foot" or "diabetic feet"):ti,ab,kw
#5 (#1 OR #2 OR #3 OR #4)
#6 MeSH descriptor Water explode all trees
#7 "water":ti,ab,kw
#8 (#6 OR #7)
#9 (clean* or wash* or irrigat* or shower* or bath* or rins*): ti,ab,kw
#10 (#5 AND #8 AND #9)
We have provided the search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL in; Appendix 2, Appendix 3 and Appendix 4 respectively. We combined the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (2008 revision) (Lefebvre 2011). We combined the Ovid EMBASE and EBSCO CINAHL searches with the trial filters developed by the Scottish Intercollegiate Guidelines Network (SIGN 2011). There were no restrictions on the basis of date or language of publication.

Searching other resources

We scrutinised the reference lists of relevant reviews and trials to identify additional studies.

Data collection and analysis

Selection of studies

Two review authors independently assessed the references and abstracts of the trials identified by the above search against the eligibility criteria, and obtained the full text of potentially relevant trials. We entered references identified from the search of electronic databases and other literature into a bibliographic software package (EndNote). Two review authors jointly made the decision to include or exclude a study against the eligibility criteria.

Data extraction and management

We extracted the following data for each trial:

- characteristics of wounds and patients in the trials;
- description of main interventions, including tap water quality;
- description of concurrent interventions;
- setting;
- duration of follow up;
- rates of wound infection;
- number of wounds healed;
- the number and reasons of withdrawals;
- costs;
- pain score/level of discomfort;
- patient and staff satisfaction.

We included trials published in duplicate only once, but extracted maximum data from each publication. Two review authors independently extracted and summarised data from included trials using a data extraction sheet developed and piloted by the review team. We resolved differences in opinion between the authors by discussion. We excluded trials from the review if they made comparisons that did not include the use of tap water. We have listed these trials with their reasons for exclusion (Characteristics of excluded studies).

Assessment of risk of bias in included studies

The review authors independently evaluated reports of all included trials using the Jadad scale (Jadad 1996) plus the following criteria to assess the methodological quality:

- detailed description of inclusion and exclusion criteria used to derive the sample from the target population;
- appropriate random sequence generation (e.g. random number tables);
- evidence of sample size calculation;
- evidence of allocation concealment at randomisation (e.g. centralised or remote randomisation, sealed opaque envelopes);
- description of baseline comparability of treatment groups;
- description of methods used to assess adverse effects;
- evidence of blinded outcome assessment;
- description of the types of wounds (grades);
- description of withdrawals and dropouts; and
- description of the method of statistical analysis.

We resolved differences in opinion between the review authors by discussion.

Data synthesis

The main comparison of water with other wound cleansing solutions was stratified by whether the wounds were classified as acute or chronic (we pre-specified this subgroup analysis in the protocol). We calculated a weighted treatment effect across trials using the Cochrane statistical package, RevMan version 4.2. We assessed trials for clinical heterogeneity by considering the settings, populations, interventions and outcomes. Where two or more trials compared similar solutions and used the same outcome measures, we tested them for heterogeneity using the I^2 statistic (Higgins 2003). This statistic examines the percentage of total variation across studies due to heterogeneity rather than to chance. Values of I^2 over 75% indicate a high level of heterogeneity and in such cases we would carefully consider the appropriateness of pooling. We have expressed dichotomous outcomes (e.g. number of patients developing a wound infection) as relative risks (RR) with 95% confidence intervals (CI).

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

The searches identified no new trials for this fourth update. We identified 11 trials that were eligible for inclusion in this review. We excluded 18 trials that either compared various types of dressings or used solutions for purposes other than cleansing (e.g. povidone-iodine for infection prophylaxis), or were available in abstract form only with no further data available. We have listed these trials in the Characteristics of excluded studies, with reasons for their exclusion. The included studies were conducted in Australia (Griffiths 2001), Germany (Riederer 1997; Neues 2000), Singapore (Tay 1999), Sweden (Angeras 1992), USA (Goldberg 1981; Bansal 2002; Godinez 2002; Valente 2003; Moscati 2007) and Tanzania (Museru 1989).

Trial design

Nine of the eleven trials were conducted in single centres (Goldberg 1981; Museru 1989; Angeras 1992; Riederer 1997; Tay 1999; Neues 2000; Bansal 2002; Godinez 2002; Valente 2003). All trials utilised a parallel group design and the studies by Museru 1989 and Neues 2000 had three comparison arms.

Participants

The age of the patients ranged from two to 95 years. Two trials were undertaken in children (Bansal 2002; Valente 2003). In five of the 11 trials (Angeras 1992; Tay 1999; Griffiths 2001; Bansal 2002; Valente 2003), the treatment groups in each individual trial were comparable at baseline. In the trial by Angeras 1992, there were significantly more males than females in both groups and half the patients were between 18 and 35 years. In eight trials the baseline data were not available. Of the included trials, five trials involved people with lacerations (Angeras 1992; Bansal 2002; Godinez 2002; Valente 2003; Moscati 2007); one trial each involved people with open fractures, (Museru 1989) and chronic wounds (Griffiths 2001); and four trials examined people with surgical wounds (Goldberg 1981; Riederer 1997; Tay 1999; Neues 2000).

Interventions

Ten of the 11 trials evaluated patients in the hospital emergency departments and ward settings (Goldberg 1981; Museru 1989; Angeras 1992; Riederer 1997; Tay 1999; Neues 2000; Bansal 2002; Godinez 2002; Valente 2003; Moscati 2007) and only one trial (Griffiths 2001) was undertaken in the community. The cleansing process was undertaken by the medical or nursing staff (Museru 1989; Angeras 1992; Griffiths 2001; Bansal 2002; Godinez 2002; Valente 2003; Moscati 2007) or by the person themselves (Goldberg 1981; Riederer 1997; Tay 1999; Neues 2000; Moscati 2007). It was unclear if standard instructions were given to the patients or the health professionals about the cleansing process. Only one trial (Godinez 2002) specified the duration of the cleansing process and only four trials reported on the volume of the cleansing fluid used (Museru 1989; Griffiths 2001; Valente 2003; Moscati 2007). The solutions used for wound cleansing included tap water (Goldberg 1981; Angeras 1992; Riederer 1997; Tay 1999; Neues 2000; Griffiths 2001; Bansal 2002; Godinez 2002; Valente 2003; Moscati 2007), cooled boiled water (Museru 1989), distilled water (Museru 1989) and normal saline (Museru 1989; Angeras 1992; Griffiths 2001; Godinez 2002; Moscati 2007). The duration of follow up ranged from one to six weeks. The method used to contain the solution was reported in four trials and included bowls (Angeras 1992; Godinez 2002), clean washed bottles (Griffiths 2001), and sterile bottles or basins (Museru 1989; Bansal 2002). The method for cleansing included irrigation (Museru 1989; Angeras 1992; Griffiths 2001; Godinez 2002; Bansal 2002; Valente 2003; Moscati 2007) and showering (Goldberg 1981; Riederer 1997; Neues 2000).

Risk of bias in included studies

We used the eight-point Quality Scale Assessment tool developed by the Cochrane Collaboration (Mulrow 1996) to measure the quality of the RCTs; based on these criteria essential information was absent from five of the 11 trials (Goldberg 1981; Museru 1989; Tay 1999; Neues 2000; Godinez 2002). All trials stated that allocation to treatment was random; random number tables were used in three trials (Griffiths 2001; Bansal 2002; Moscati 2007);

alternate allocation (in fact quasi-random) in six trials (Goldberg 1981; Angeras 1992; Riederer 1997; Tay 1999; Neues 2000; Valente 2003) and the allocation method used was not described in two trials (Museru 1989; Godinez 2002). Two trials (Griffiths 2001; Moscati 2007) clearly described concealed allocation, which was achieved by a computer generated randomisation process with the code held at a remote site.

Eight trials (Goldberg 1981; Museru 1989; Angeras 1992; Riederer 1997; Griffiths 2001; Bansal 2002; Valente 2003; Moscati 2007) provided a clear description of the inclusion/exclusion criteria; three trials (Angeras 1992; Griffiths 2001; Moscati 2007) provided information on whether the patients and the outcome assessors were blinded to the intervention.

A description of the baseline characteristics of the patients is essential to assess comparability between the groups (indicates if randomisation was successful). It also assists the reader in deciding if the results are applicable to their situation. The baseline characteristics for each treatment group were given in six of the nine trials (Angeras 1992; Tay 1999; Neues 2000; Griffiths 2001; Bansal 2002; Valente 2003). The sex of the patients in each group was stated in five trials (Angeras 1992; Tay 1999; Griffiths 2001; Bansal 2002; Valente 2003). The distribution of males and females was even in three trials (Angeras 1992; Griffiths 2001; Bansal 2002) and the Tay 1999 trial had recruited only females. There was no difference in the age of the patients in each treatment group in the six trials (Angeras 1992; Tay 1999; Neues 2000; Griffiths 2001; Bansal 2002; Valente 2003) in which age was reported. Comparability between types of wounds was reported in all but one trial (Godinez 2002).

A wide range of outcome measures was used in the included trials. With the exception of trials that compared tap water with no cleansing, other comparisons were represented within single studies. The patients were followed up for a maximum of six weeks after therapy (Griffiths 2001), thus it is difficult to determine the long-term effects of tap water on the wounds that had not healed. Six of the included trials commented on the attrition rates and described the number and reason for withdrawals (Angeras 1992; Riederer 1997; Griffiths 2001; Bansal 2002; Valente 2003; Moscati 2007). Sample sizes ranged between 35 and 770 patients (median 111). Two trials described a priori sample size calculation (Valente 2003; Moscati 2007). Cost analysis was reported in only two trials (Griffiths 2001; Moscati 2007).

Effects of interventions

We identified 11 trials that met the inclusion criteria. Three trials (Goldberg 1981; Riederer 1997; Neues 2000) compared wounds cleansed using tap water with those not cleansed and eight trials (Museru 1989; Angeras 1992; Tay 1999; Griffiths 2001; Bansal 2002; Godinez 2002; Valente 2003; Moscati 2007) compared wound cleansing with water and other solutions. There was significant heterogeneity in the types of the wounds, the cleansing solution used and the outcomes measures used in the trials. All trials used subjective measures to assess wound infection and two trials used blinded outcome assessment (Griffiths 2001; Moscati 2007).

1. Comparison of tap water with no cleansing (Analysis 1)

We identified three RCTs (Goldberg 1981; Riederer 1997; Neues 2000) that compared infection and healing rates in patients with surgical wounds who were allowed to bathe or shower their wounds and those who were not. The studies allowed patients assigned to the showering group to use cleansing agents.

Primary outcome (infection)

We pooled data for infection in a meta-analysis. Neues 2000 assigned participants to one of three groups: those assigned to the control group were required to keep the wounds dry for eight days following surgery; one intervention group used tap water only and the third group used tap water and shower gel for body cleansing. No wound infection was reported in any of the three groups. As the characteristics of the two groups that showered were comparable, we considered it appropriate to combine the data from those groups for comparison with data from the no cleansing group. Although this approach maintains the randomisation and avoids double counting, it results in unequally sized comparison groups. Overall pooling the results of these three trials (Goldberg 1981; Riederer 1997; Neues 2000) demonstrated no difference in infection rate between wounds that were cleansed using tap water compared with wounds not cleansed (RR 1.06, 95% CI 0.07 to 16.50)(Analysis 1.1).

Secondary outcomes

(i) Wound healing

Two trials reported on wound healing (Goldberg 1981; Neues 2000). Neues 2000 reported wound dehiscence as a measure of wound healing. Pooled data demonstrated no statistically significant difference in the number of wounds that did not heal between the groups (RR 1.26, 95% CI 0.18 to 8.66) (Analysis 1.2).

(ii) Patient satisfaction

The only secondary outcome for which there were data from both trials was patient satisfaction. Although an objective measurement scale was not used in either trial, a feeling of well being was reported

in both studies among the patients who were allowed to shower their wounds.

2. Comparison of tap water with normal saline (Analysis 2)

Six trials (Angeras 1992; Griffiths 2001; Bansal 2002; Godinez 2002; Valente 2003; Moscati 2007) compared infection and healing rates in acute and chronic wounds irrigated with either tap water or normal saline.

Primary outcome (infection)

(a) Acute wounds

Three trials (Angeras 1992; Godinez 2002; Moscati 2007) compared infection rates in acute soft tissue wounds and lacerations that were sutured and pooled results demonstrated a significant reduction in infection rates in wounds cleaned with tap water compared with normal saline (RR 0.63, 95% CI 0.40 to 0.99; P = 0.05) (Analysis 02, Outcome 01). This result is interpreted as a relative risk reduction in the incidence of wound infection of 37% associated with the use of tap water for wound cleansing. A significantly higher infection rate in the saline group was reported in one trial (Angeras 1992) which could be attributed to the difference in the temperature of the irrigant used (tap water was at 37ºC whilst normal saline was at room temperature). Two trials (Bansal 2002; Valente 2003) measured infection rates in children and the pooled results demonstrated no statistically significant difference in the infection rates in children whose wounds were cleansed with saline or tap water (RR 1.07, 95% CI 0.43 to 2.64; P = 0.88) (Analysis 2.1).

(b) Chronic wounds

Griffiths 2001 reported no statistically significant difference in infection rates in non sutured chronic wounds that were cleansed with either tap water or normal saline (RR 0.16, 95% CI 0.01 to 2.96; P = 0.22). The low power of this trial to detect a clinically important difference as statistically significant must be emphasised (49 wounds and only three infections) (Analysis 2.2).

Secondary outcomes

(i) Wound healing

Only one trial reported on wound healing (Griffiths 2001). There was no statistically significant difference in the number of wounds that healed after cleansing with either tap water or normal saline (RR 0.57, 95% CI 0.30 to 1.07) (Analysis 2.3).

(ii) Cost analysis

Two trials (Griffiths 2001; Moscati 2007) reported a cost analysis and demonstrated that the use of tap water was inexpensive compared with the use of normal saline. In the trial by Griffiths 2001, the estimated cost per dressing using normal saline was AUD$1.43 plus the cost of the dressing, compared with AUD$1.16 using tap water. If the wound was cleansed during showering, the only cost would be the dressing. Costs for the saline group included staff time, materials and equipment used for the dressings. In the second trial (Moscati 2007), costs were calculated to include supplies, saline and antibiotics if required. The costs were extrapolated to the eight million lacerations that occur in the USA each year. The results demonstrated an adjusted annual saving of US$65,600,000 if wounds were irrigated using tap water.

(iii) Patient satisfaction

Griffiths 2001 cleansed wounds using tap water and normal saline, both administered from a bottle. The authors reported that patients who had showered their wounds prior to participating in the trial preferred that method to irrigation with normal saline. This finding demonstrates that method of cleansing remains as important as the solution used for cleansing wounds.

3. Comparison of water (distilled water and/or cooled boiled water) with normal saline (Analysis 3)

Museru 1989 designed a three-arm study to compare the infection and healing rates as a consequence of cleansing by irrigation open fractures using distilled water; cooled boiled water; or isotonic saline. The study made the following comparisons.
(a) Distilled water compared with cooled boiled water.
(b) Distilled water compared with isotonic saline.
(c) Cooled boiled water compared with isotonic saline.
(d) Water (distilled water and/or cooled boiled water) compared with normal saline.

(a) Distilled water compared with cooled boiled water

Primary outcome (Infection)

Six out of 35 patients (17%) in the distilled water group and nine out of 31 (29%) in the cooled boiled water group developed a wound infection; this difference was not statistically significant. (RR 1.69, 95% CI 0.68 to 4.22). The small number of wounds cleansed using distilled water (n = 35) and cooled boiled water (n = 31) means that the study lacked power to detect clinically important differences (Museru 1989)Analysis 3.1.

(b) Distilled water with isotonic saline

Primary outcome (infection)

Outcomes from the distilled water group were also compared with the isotonic saline group. In this comparison 7/20 (35%) patients whose fractures were cleansed with isotonic saline developed an infection compared with 6/35 (17%) in the distilled water group (RR 0.49, 95% CI 0.19 to 1.26) (Analysis 3.1) (Museru 1989).

(c) Cooled boiled water with isotonic saline

Primary outcome (infection)

Outcomes from the isotonic saline group were also compared with the cooled boiled water group. In this comparison 9/31 (29%) patients whose fractures were cleansed with cooled boiled water developed an infection compared with 7/20 (35%) cleansed with isotonic saline (RR 0.83, 95% CI 0.37 to 1.87) (Analysis 3.1) (Museru 1989).

(d) Water (distilled water and/or cooled boiled water) with normal saline

Primary outcome (infection)

When the results for the distilled and cooled boiled water were pooled and compared with isotonic saline, there was no statistically significant difference in the number of infections (RR 0.65, 95% CI 0.31 to 1.37) (Analysis 3.1). However this comparison was severely under-powered (86 participants, 22 infections) (Museru 1989).

Secondary outcomes

No secondary outcomes were reported for any of the comparisons.

4. Comparison of tap water with cooled boiled tap water

No trials were identified that made these comparisons.

5. Comparison of tap water with procaine spirit

Procaine spirit is a preparation of procaine HCL 2% with spirit 70%, that is commonly prescribed as a wound cleansing agent following surgery. One trial compared the use of procaine spirit with tap water for washing postoperative wounds (Tay 1999). Women who had undergone a normal vaginal delivery with an episiotomy were randomised to have the incision site cleaned with either tap water or procaine spirit.

Primary outcomes

The authors reported that there were no statistically significant differences in the number of infections. As actual data were unavailable the analysis could not be replicated.

Secondary outcomes

No statistically significant difference in wound complications was reported and by the 14th day all the wounds had healed well. Another outcome reported was pain, and the findings indicated that there were no statistically significant differences in pain scores between women cleansing with procaine and tap water.

Quality of the tap water

Two trials reported on the quality of the water used. Griffiths 2001 reported that the quality of the tap water met the requirements of the Australian National Health and Medical Research Council and Angeras 1992 undertook microbiological cultures of samples of the water used and reported that the bacterial counts were fewer than 5 bacteria/ml except in two instances, when gram negative rods 103/ml and antheroid rods 106/ml were isolated. However none of the bacteria isolated from the tap water were identified in the cultures taken from the wound.

DISCUSSION

This systematic review of the effectiveness of water for wound cleansing has summarised the best available evidence at the time of the report. Following an extensive literature search, we identified 11 trials that met the inclusion criteria and we have presented them in this review. With the exception of one trial (Angeras 1992), there was no evidence of a benefit of cleansing, nor of any particular type of cleansing solution. However the trial by Angeras 1992 has some methodological flaws; for example the solutions were administered at different temperatures, therefore the evidence needs to be interpreted with caution and more rigorous research is needed. Furthermore the Angeras trial was conducted in Sweden, where high-quality drinking water is readily available. The use of tap water as a cleanser would not be recommended in a country where a constant supply of potable drinking water is not available.

The fundamental feature of RCTs is the ability to eliminate selection bias through the method of allocation. In three of the included trials, details of the method of randomisation of patients to treatment groups were absent (Museru 1989; Neues 2000; Godinez 2002) and in six the methods were susceptible to selection bias (Goldberg 1981; Angeras 1992; Tay 1999; Riederer 1997; Neues 2000; Valente 2003), which reduces the strength of the evidence. The ability to extract definitive conclusions from the trials detailed in this review is reduced by the overall poor quality of the trials

and the lack of replication of most comparisons. Although three trials (Goldberg 1981; Museru 1989; Angeras 1992) were completed before the CONSORT guidelines were published (Begg 1996) when recommendations for trial reporting were formalised, the trial by Angeras 1992 was well reported.

It is essential that the eligibility criteria are well defined in order to understand the type of population treated. The eligibility criteria should also define the severity of the patients eligible to participate. For example the description of the type of wound should accord with a standard criteria. This would allow the findings and recommendations to be generalised to other clinical settings.

Data analysis regarding wound infection was complicated by a lack of consistency in the criteria used to assess wound infection. In addition, variance data for the healing outcomes were not reported in the study that compared tap water with procaine spirit (Tay 1999). The use of a standardised and validated tool for the measurement of wound infection and healing and an assessor blinded to the intervention would have enhanced the rigour of the trials and strengthened the evidence. Other outcomes such as patient comfort and satisfaction should be measured.

Meta-analysis was restricted to trials of the same intervention that assessed the same outcome and was consequently limited by the lack of replication studies. As a result, this report is mainly in the narrative form with figures utilised to highlight particular findings.

The lack of an apparent effect of cleansing on the infection and healing rates in wounds that were not cleansed and those that were cleansed with either tap water or other solutions is important for the clinicians and the health services. The current practice in wound management is to cleanse the wound while showering the patient and in many instances these patients include those who are bedfast (AWMA Inc 2002). In this review although all trials used some type of water, only three trials (Goldberg 1981; Riederer 1997; Neues 2000) used showering as a method to cleanse wounds. While the findings of this review do not indicate adverse effects from the use of tap water, practitioners and health service managers should interpret the findings with caution as most of the comparisons were based on single trials, some of which do not report the methodology in sufficient detail to enable assessment of quality.

The availability and cost of resources may also determine which solution is used for cleansing wounds in different settings. One trial reported that in countries with limited resources, distilled or boiled water is used for wound cleansing without complications.

Prospective trials in this subject need to be more robust in order to assist clinicians and policy makers in making informed decisions about the appropriate use of solutions for cleansing wounds.

Limitations of the review

Inadequate reporting of the trials made it difficult for the authors to critically appraise the validity of the trials. Although we attempted made to contact the authors to obtain additional data, we received no response and this lack of information is reflected in the report.

AUTHORS' CONCLUSIONS

Implications for practice

Tap water is a wound cleansing agent commonly used in the community and hospitals; however published data on patient outcomes from tap water cleansing have not previously been reviewed. Based on the randomised trials undertaken to date, evidence suggests that tap water is unlikely to be harmful if used for wound cleansing. The decision to use tap water to cleanse wounds should take into account the quality of water, nature of wounds and the patient's general condition, including the presence of comorbid conditions.

This update includes two trials undertaken in patients with acute lacerations which, together with the trial included in the previous review, demonstrate a significant reduction in the infection rates in wounds that were cleansed using tap water compared with those cleansed with normal saline. There is evidence that the use of tap water is cost-effective when it is undertaken as part of the patient's personal hygiene, as it limits the use of other equipment. The meta-analysis indicated no significant difference in the infection and healing rates in postoperative wounds that were cleansed with tap water (showered) and those that were not cleansed. Clinicians should consider the relative benefits of cleansing clean surgical wounds.

Implications for research

Properly designed multicentre trials are needed to compare the clinical benefits and cost effectiveness of different solutions for wound cleansing in different groups of patients, different types of wounds and in a wide range of settings.

Trials comparing cleansing with no cleansing are required to determine the extent to which cleansing contributes to the healing and infection of acute and chronic wounds.

The strongest evidence for whether tap water is an effective wound cleansing solution is likely to be provided by trials in which the volume and the temperature of the comparison solution are the same as the tap water.

Future research should have well defined inclusion and exclusion criteria, adequate sample size, methods to ensure baseline comparability of the groups, use of true randomisation with allocation concealment, use of an objective outcome measurement of wound infection and healing (e.g. percentage and absolute change

in wound area), blinded outcome assessment, adequate follow-up period and appropriate statistical analysis.

The trials should be reported according to the guidelines set out in the CONSORT statement (Begg 1996) to enable readers to determine the validity and reliability of the results.

Given the purchasing costs of equipment, economic evaluations should be undertaken in future trials.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

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

Angeras 1992

Methods	Quasi-randomised controlled trial (allocation by alternation). Baseline characteristics comparable.
Participants	705 patients with soft tissue wounds less than 6 hours old, requiring sutures. Exclusion criteria: wounds that had connection with the thoracic cavity, abdominal cavity or the joints
Interventions	1) Wounds irrigated with tap water (n = 295). 2) Wounds irrigated with sterile normal saline (n = 332).
Outcomes	1) Wound infection (defined as pus visible in the wound and prolonged healing time as judged by the nurse)
Notes	88 patients evenly distributed between the two groups were lost to follow up. Follow up was undertaken 1 to 2 weeks after wound closure. Bacterial cultures taken every week from the tap water. Temperature of the tap water was 37 degrees C while the saline was delivered at room temperature

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	High risk	Inadequate

Bansal 2002

Methods	Randomised controlled trial. Allocation using randomisation schedule. Baseline characteristics comparable.
Participants	46 children with simple lacerations.
Interventions	1) Cleansing with tap water (n = 21). 2) Cleansing with saline (n = 24).
Outcomes	Wound infection - criteria for wound complications (one or more of the following). 1. Cellulitis or erythema of the wound margin of more than 4 mm with tenderness. 2. Purulent discharge from the wound. 3. Ascending lymphangitis. 4. Dehiscence of the wound with wound separation of > 2mm.

Bansal 2002 (*Continued*)

Notes	Person performing the wound irrigation was blinded to the solution used. Wound irrigated with 35 ml syringe attached to an irrigation shield (25-40 psi)	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	Low risk	Adequate, allocation using randomisation schedule.

Godinez 2002

Methods	Randomised controlled trial. Method of allocation not stated. Baseline comparability not stated.	
Participants	94 participants with minor extremity lacerations.	
Interventions	1) Irrigation with tap water (n = 36). 2) Irrigation with saline (n = 41).	
Outcomes	1) Wound infection.	
Notes	Wounds were irrigated with tap water at a flow rate of 7 litres/minute. Saline was poured in a basin and aspirated using a syringe and irrigation was done using a pulsatile motion	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	Unclear risk	Unclear

Goldberg 1981

Methods	Quasi randomised controlled trial. Method of allocation by alternation. Consecutive patients allocated to each group. Does not state if the assessor was blinded.	
Participants	200 patients with lacerations or incisions who were operated	
Interventions	1) Patients allowed to rinse all over with soap and water after 24 hours (n = 100). 2) Patients kept their wounds dry (n = 100).	
Outcomes	1) Wound infection.	
Notes		

Goldberg 1981 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	High risk	Method of allocation by alternation. Consecutive patients allocated to each group

Griffiths 2001

Methods	Randomised controlled trial. Allocation was by a list of random numbers nominated by person not entering patients into the trial (closed list). Both patients and outcome assessors were blinded to the treatment. Baseline characteristics comparable.
Participants	35 patients with 49 chronic wounds. Exclusion criteria: Grade 1 & 4 wounds, patients receiving antibiotics or who were immuno suppressed due to therapy, and wounds with a sinus where the base was not visible
Interventions	1) Wounds irrigated with tap water (n = 23). 2) Wounds irrigated with normal saline (n = 26).
Outcomes	1) Wound infection (defined as presence of pus, discolouration, friable granulation tissue, pain tenderness, pocketing or bridging at base of the wound, abnormal smell and wound breakdown). 2) Number of wounds that healed. 3) Cost effectiveness. 4) Patient satisfaction. 5) Variance in wound size.
Notes	4 patients in each group withdrew from the study. Wounds were assessed at the end of 6 weeks. Quality of tap water reported to meet Australian National Health and Medical Research Council requirements

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	Low risk	Adequate - allocation was by a list of random numbers nominated by person not entering patients into the trial (closed list)

Moscati 2007

Methods	Randomised controlled trial. Allocation using computer based random numbers generator. Baseline comparability between groups not stated. Person performing the assessment was blinded to the solution used
Participants	715 subjects with uncomplicated skin lacerations requiring staple or suture repair
Interventions	1) Irrigation with tap water (n = 334). 2) Irrigation with minimum 200 mls of sterile saline (n = 300). Irrigation with tap water undertaken by patient while irrigation with sterile saline was undertaken by the provider. Wounds were irrigated with a 35 ml syringe using a splash guard
Outcomes	1) Wound infection (defined as wounds that required a significant change in their course of treatment such as surgical debridement, antibiotics or early removal of sutures). 2) Costs.
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	Low risk	Adequate - allocation using computer based random numbers generator

Museru 1989

Methods	Randomised controlled trial. No information on the method of randomisation. Blinding not mentioned. No loss to follow up. Baseline characteristics of patient not stated however baseline description of wounds comparable
Participants	86 patients with open fractures. No exclusion criteria stated
Interventions	1) Wounds irrigated with distilled water (n = 35). 2) Wounds irrigated with boiled water (n = 31). 3) Wounds irrigated with isotonic saline (n = 20).
Outcomes	1) Wound infections (no definition for wound infection). 2) Chronic osteomyelitis. 3) Tetanus. 4) Gangrene.
Notes	Length of follow up not stated.

Museru 1989 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	Unclear risk	Unclear

Neues 2000

Methods	Quasi-randomised controlled trial (allocation by the month). Blinding not mentioned. Both groups comparable for age however comparability for gender not stated
Participants	817 patients having surgery for varicose veins. Exclusion criteria not specified
Interventions	1) Wounds showered on day two (water only) (n = 274). 2) Wounds showered on day two (water + shower gel) (n = 268). 3) Wounds kept dry for 8 to 10 days (not cleansed) (n = 302)
Outcomes	1) Wound infections (not defined).
Notes	94 patients in the non showered group, 130 in the group that used only water and 40 patients in the group that used water and shower gel were lost to follow up

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	High risk	Inadequate - allocation by the month

Riederer 1997

Methods	Quasi-randomised controlled trial (allocation by alternation). Blinding not mentioned. Patient demographics not stated.
Participants	121 patients having surgery for inguinal hernia. Exclusion criteria not stated.
Interventions	1) Wounds showered on day one (n = 49). 2) Wounds kept dry for 14 days (not cleansed) (n = 52).
Outcomes	1) Wound infection (defined as irritation, slight redness of skin and stitch abscess). 2) Patient satisfaction.
Notes	Wounds assessed after 14 days.

Riederer 1997 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	High risk	Inadequate - allocation by alternation

Tay 1999

Methods	Quasi-randomised controlled trial (allocation by the month). Blinding of outcome assessors not mentioned. Participants in both groups comparable for age, parity, educational level and duration of first and second stage of labour
Participants	100 women having an episiotomy for a normal vaginal delivery. No loss to follow up. No exclusion criteria specified.
Interventions	1) Perineal toilet using water and procaine spirit (n = 50). 2) Perineal toilet using water only (n = 50).
Outcomes	1) Wound infection (not defined). 2) Wound healing (assessed for the degree of edema, bruising, erythema, wound union and wound discharge with a score of 0-2 for each parameter). 3) Pain score assessed using a verbal analogue scale between 0-10
Notes	Wounds assessed on day 14.

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	High risk	Inadequate - allocation by the month

Valente 2003

Methods	Quasi randomised controlled trial. Method of allocation was by alternation.
Participants	530 children with simple lacerations.
Interventions	1) Cleansing with tap water (n = 259). 2) Cleansing with saline (n = 271). Wounds assigned to the normal saline group were irrigated using a 30-60 ml syringe and a 18G angiocatheter or splash guard. Wounds assigned to the tap water group were irrigated under running tap water for 10 seconds

Valente 2003 (*Continued*)

Outcomes	Wound infection. Criteria for wound infection not stated.	
Notes	Tap water pressure and flow rates were measured prior to the study	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	High risk	Inadequate - method of allocation was by alternation

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

Study	Reason for exclusion
Bansal 1993	This study compared the effects of topical phenytoin powder and normal saline on the healing of trophic leprosy ulcers
Bulstrode 1988	This study compared the addition of dilute and concentrated amino acids to saline on the rate of healing of chronic leg ulcers
Burke 1998	Study was excluded because the intervention was combined with saline dressings and whirlpool therapy (water). It is therefore not possible to attribute any effect to whirlpool therapy (water)
Chisholm 1992	This study compared two devices used for irrigation of wounds. Irrigating solution used with both devices was normal saline
Fraser 1976	The purpose of the trial was not to assess the cleansing of the wound
Greenway 1999	Study excluded because it evaluates the effect of insulin and normal saline on the healing rate of wounds
Johnson 1985	Study excluded because it compares irrigation of perineal wounds with either 1% povidone-iodine or normal saline
King 1984	Wound cleansing in this study was part of the operative procedure
Manhold 1976	The study compared normal saline and glycoside for irrigation during dental procedures
Medves 1997	The study evaluates solution used to cleanse umbilical cord. A systematic review focusing on umbilical cord care has been undertaken
Patterson 2005	This study used antibacterial soap along with water for cleansing which could influence the findings
Scondotto 1999	This study evaluates the efficacy of sulodexide compared to cleansing with physiological solution and the application of elastic compression on the healing of venous ulcers

(*Continued*)

Selim 2000	Review.
Selim 2001	No data reported.
Svedman 1983	Compares two different methods of wound irrigation. Isotonic saline was the irrigant used in both groups
Sweet 1976	Not relevant to the review. This study compares two different devices for the irrigation of third molar surgical sites with high volumes of normal saline
Voorhees 1982	The purpose of the trial was not to assess the cleansing of the wound
Weiss 2007	Abstract only. The authors were contacted but did not respond, therefore there was insufficient information to include the trial in the update

DATA AND ANALYSES

Comparison 1. Tap water versus no cleansing

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Infection	3	873	Risk Ratio (M-H, Fixed, 95% CI)	1.06 [0.07, 16.50]
2 2. Wounds not healed	2	772	Risk Ratio (M-H, Fixed, 95% CI)	1.26 [0.18, 8.66]

Comparison 2. Tap water versus normal saline

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Infection (acute wounds only)	5		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
1.1 Adults	3	1338	Risk Ratio (M-H, Fixed, 95% CI)	0.63 [0.40, 0.99]
1.2 Children	2	535	Risk Ratio (M-H, Fixed, 95% CI)	1.07 [0.43, 2.64]
2 Infection (chronic wounds only)	1	49	Risk Ratio (M-H, Fixed, 95% CI)	0.16 [0.01, 2.96]
3 Healing	1		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only

Comparison 3. Water (distilled water and/or cool boiled water) versus normal saline

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 1. Infection	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.1 Distilled water versus cool boiled water	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Distilled water versus isotonic saline	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.3 Cool boiled water versus isotonic saline	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.4 Water (distilled and boiled) vs isotonic saline	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 1.1. Comparison 1 Tap water versus no cleansing, Outcome 1 Infection.

Review: Water for wound cleansing

Comparison: 1 Tap water versus no cleansing

Outcome: 1 Infection

Study or subgroup	Water n/N	No cleansing n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Goldberg 1981	0/100	0/100		0.0 [0.0, 0.0]
Neues 2000	0/364	0/208		0.0 [0.0, 0.0]
Riederer 1997	1/49	1/52		1.06 [0.07, 16.50]
Total (95% CI)	**513**	**360**		**1.06 [0.07, 16.50]**

Total events: 1 (Water), 1 (No cleansing)

Heterogeneity: Chi^2 = 0.0, df = 0 (P = 1.00); I^2 =0.0%

Test for overall effect: Z = 0.04 (P = 0.97)

Test for subgroup differences: Not applicable

Analysis 1.2. Comparison 1 Tap water versus no cleansing, Outcome 2 2. Wounds not healed.

Review: Water for wound cleansing

Comparison: 1 Tap water versus no cleansing

Outcome: 2 2. Wounds not healed

Study or subgroup	Water n/N	No Cleansing n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Goldberg 1981	1/100	0/100		28.2 %	3.00 [0.12, 72.77]
Neues 2000	1/364	1/208		71.8 %	0.57 [0.04, 9.09]
Total (95% CI)	**464**	**308**		**100.0 %**	**1.26 [0.18, 8.66]**

Total events: 2 (Water), 1 (No Cleansing)

Heterogeneity: Chi^2 = 0.60, df = 1 (P = 0.44); I^2 =0.0%

Test for overall effect: Z = 0.23 (P = 0.82)

Test for subgroup differences: Not applicable

Analysis 2.1. Comparison 2 Tap water versus normal saline, Outcome 1 Infection (acute wounds only).

Review: Water for wound cleansing

Comparison: 2 Tap water versus normal saline

Outcome: 1 Infection (acute wounds only)

Study or subgroup	Tap Water n/N	Normal Saline n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Adults					
Angeras 1992	16/295	33/332		67.6 %	0.55 [0.31, 0.97]
Godinez 2002	0/36	3/41		7.1 %	0.16 [0.01, 3.04]
Moscati 2007	12/334	11/300		25.2 %	0.98 [0.44, 2.19]
Subtotal (95% CI)	**665**	**673**		**100.0 %**	**0.63 [0.40, 0.99]**
Total events: 28 (Tap Water), 47 (Normal Saline)					
Heterogeneity: Chi^2 = 2.23, df = 2 (P = 0.33); I^2 =10%					
Test for overall effect: Z = 2.00 (P = 0.045)					
2 Children					
Bansal 2002	2/21	2/24		21.5 %	1.14 [0.18, 7.42]
Valente 2003	7/239	7/251		78.5 %	1.05 [0.37, 2.95]
Subtotal (95% CI)	**260**	**275**		**100.0 %**	**1.07 [0.43, 2.64]**
Total events: 9 (Tap Water), 9 (Normal Saline)					
Heterogeneity: Chi^2 = 0.01, df = 1 (P = 0.94); I^2 =0.0%					
Test for overall effect: Z = 0.15 (P = 0.88)					

Analysis 2.2. Comparison 2 Tap water versus normal saline, Outcome 2 Infection (chronic wounds only).

Review: Water for wound cleansing

Comparison: 2 Tap water versus normal saline

Outcome: 2 Infection (chronic wounds only)

Study or subgroup	Tap Water n/N	Normal Saline n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Griffiths 2001	0/23	3/26		100.0 %	0.16 [0.01, 2.96]
Total (95% CI)	**23**	**26**		**100.0 %**	**0.16 [0.01, 2.96]**

Total events: 0 (Tap Water), 3 (Normal Saline)
Heterogeneity: not applicable
Test for overall effect: Z = 1.23 (P = 0.22)
Test for subgroup differences: Not applicable

Analysis 2.3. Comparison 2 Tap water versus normal saline, Outcome 3 Healing.

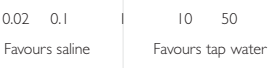
Review: Water for wound cleansing

Comparison: 2 Tap water versus normal saline

Outcome: 3 Healing

Study or subgroup	Tap Water n/N	Normal Saline n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Griffiths 2001	8/23	16/26		0.57 [0.30, 1.07]
Subtotal (95% CI)	**0**	**0**		**0.0 [0.0, 0.0]**

Total events: 8 (Tap Water), 16 (Normal Saline)
Heterogeneity: not applicable
Test for overall effect: Z = 0.0 (P < 0.00001)

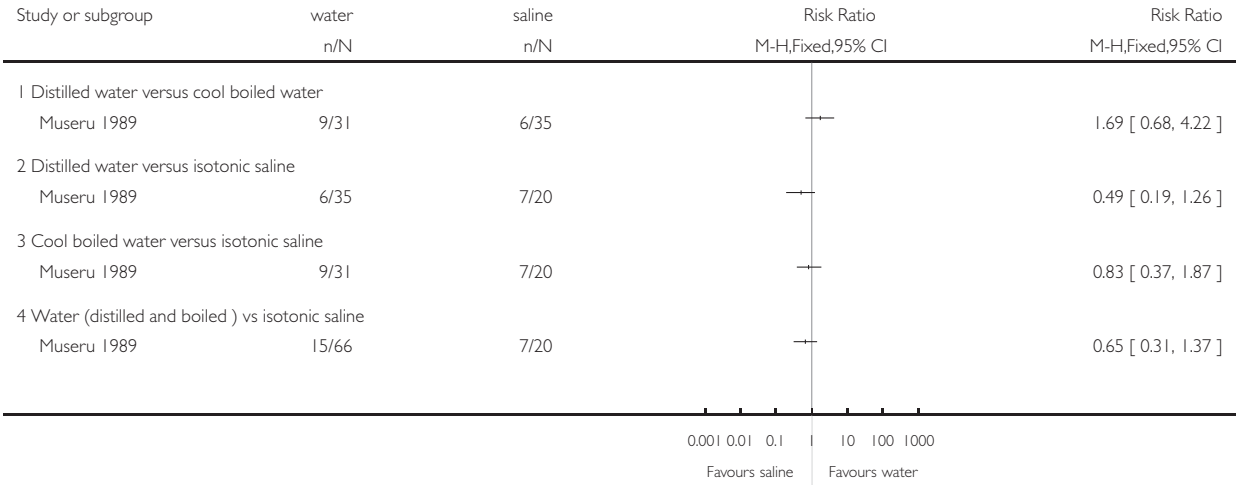


Analysis 3.1. Comparison 3 Water (distilled water and/or cool boiled water) versus normal saline, Outcome 1 1. Infection.

Review: Water for wound cleansing

Comparison: 3 Water (distilled water and/or cool boiled water) versus normal saline

Outcome: 1 1. Infection



APPENDICES

Appendix 1. Search methods for the third update - 2010

For this third update we searched the following databases:

- Cochrane Wounds Group Specialised Register (Searched 22/2/10)
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library,* 2010 Issue 1);
- Ovid MEDLINE - 2007 to February Week 2 2010;
- Ovid MEDLINE - In-Process & Other Non-Indexed Citations (Searched 19/2/10);
- Ovid EMBASE - 2007 to 2010 Week 06;
- EBSCO CINAHL - 2007 to February 22 2010.

We used the following search strategy to search CENTRAL:
#1 MeSH descriptor Wounds and Injuries explode all trees
#2 MeSH descriptor Skin Ulcer explode all trees
#3 MeSH descriptor Diabetic Foot explode all trees
#4 ("wound" or "wounds" or "ulcer" or "ulcers" or "bite" or "bites" or "abrasion" or "abrasions" or "laceration" or "lacerations" or "diabetic foot" or "diabetic feet"):ti,ab,kw
#5 (#1 OR #2 OR #3 OR #4)
#6 MeSH descriptor Water explode all trees
#7 "water":ti,ab,kw
#8 (#6 OR #7)
#9 (clean* or wash* or irrigat* or shower* or bath* or rins*):ti,ab,kw

#10 (#5 AND #8 AND #9)

We have provided the search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL in; Appendix 2, Appendix 3 and Appendix 4 respectively. We combined the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (2008 revision). We combined the Ovid EMBASE and EBSCO CINAHL searches with the trial filters developed by the Scottish Intercollegiate Guidelines Network. There were no restrictions on the basis of date or language of publication.

Appendix 2. Search strategy Ovid MEDLINE

1 exp "Wounds and Injuries"/
2 exp Skin Ulcer/
3 (wound*1 or ulcer*1 or laceration*1 or bite*1 or abrasion* or tear*1 or diabetic foot or diabetic feet).ti,ab,hw.
4 or/1-3
5 exp Water/
6 water.ti,ab,hw.
7 or/5-6 (458407)
8 (clean* or wash* or irrigat* or shower* or bath* or rins*).ti,ab,hw.
9 and/4,7-8

Appendix 3. Search strategy Ovid EMBASE

1 exp Wound/
2 exp Skin Ulcer/
3 (wound*1 or ulcer*1 or laceration*1 or bite*1 or abrasion* or tear*1 or diabetic foot or diabetic feet).ti,ab,hw.
4 or/1-3
5 exp Water/
6 water.ti,ab,hw.
7 or/5-6
8 (clean* or wash* or irrigat* or shower* or bath* or rins*).ti,ab,hw.
9 and/4,7-8

Appendix 4. Search strategy EBSCO CINAHL

S9 S4 and S7 and S8
S8 TI (clean* or wash* or irrigat* or shower* or bath* or rins*) or AB (clean* or wash* or irrigat* or shower* or bath* or rins*)
S7 S5 or S6
S6 TI water or AB water
S5 (MH "Water+")
S4 S1 or S2 or S3
S3 TI (wound* or ulcer* or laceration* or bite* or abrasion* or tear* or diabetic foot or diabetic feet) or AB (wound* or ulcer* or laceration* or bite* or abrasion* or tear* or diabetic foot or diabetic feet)
S2 (MH "Skin Ulcer+")
S1 (MH "Wounds and Injuries+")

FEEDBACK

Data and Conclusions

Summary

The abstract data needs correcting. The first OR given is not the OR it is the RR. The second estimate is also confused as the RevMan graph on this occasion is set to RR and the figures are different. The last estimate in the abstract doesn't seem to connect to anything, or maybe the first comparison in the relevant graph.
The conclusions about the quality of tap water are not conclusions from the data provided.

Reply

We have replied to each of the points raised as follows:
1. The first OR given is not the OR it is the RR.
Author's reply: This was amended when the review was updated and RR is now used.
2. The second estimate is also confused as the RevMan graph on this occasion is set to RR and the figures are different.
Author's reply: This was amended when the review was updated. RR is now used and the figures are now consistent between abstract and graph.
3. The last estimate in the abstract doesn't seem to connect to anything, or maybe the first comparison in the relevant graph.
Author's reply: This estimate was quoted in error. The correct estimate has now been inserted.
4. The conclusions about the quality of tap water are not conclusions from the data provided.
Author's reply: The conclusions of the review have been amended in the light of this comment.

Contributors

Feedback received: Professor Paul Garner, International Health Research Group, Liverpool School of Tropical Medicine.
Responses: Author, Ritin Fernandez.

Data queries, 26 May 2008

Summary

I have two comprehension questions concerning the review Water for wound cleansing 2008, Issue 1.

1. Under description of studies/intervention: Doesn't it mean Ten of the eleven studies instead of eight of the nine?
2. Under results/3. Comparison of water (...) with normal saline/ (A): Are it nine out of 31 patients (29%) in the distilled water group and 6/35 (17%) in the cooled boiled water group who developed a wound infection or vice versa like described in paragraph (B) and (C) respectively?

Reply

Thanks for bringing the correction to my attention. Please note the following changes which have been made to the text of the review:

1. Ten of the eleven studies is correct
2. Comparison 3: (A) Distilled water compared with cooled boiled water (Analysis 03, Outcome 01)

Primary outcome (Infection)
Six out of 35 patients (17%) in the distilled water group and 9/31(29%) in the cooled boiled water group developed a wound infection; this difference was not statistically significant. (RR 1.69, 95% CI 0.68 to 4.22). The small number of wounds cleansed using distilled water (n = 35) and cooled boiled water (n = 31) means that the study lacked power to detect clinically important differences (Museru 1989).

Contributors

Feedback received: Sibylle Wenzler, Occupation medical scientist. Freiburgh.
Responses: Author, Ritin Fernandez.

WHAT'S NEW

Last assessed as up-to-date: 14 December 2011.

Date	Event	Description
5 January 2012	New search has been performed	We carried out new searches in November 2011. We identified no new studies for inclusion
5 January 2012	New citation required but conclusions have not changed	Fourth update.

HISTORY

Protocol first published: Issue 4, 2000

Review first published: Issue 4, 2002

Date	Event	Description
18 March 2010	New search has been performed	For this third update we carried out new searches in February 2010. We identified no new studies for inclusion. We assigned four studies in awaiting assessment as either duplicate publications of an included trial or as excluded from the review
13 May 2009	Amended	Contact details updated.
18 June 2008	Amended	Converted to new review format.
18 June 2008	Feedback has been incorporated	Feedback queries received and answered
2 November 2007	New citation required and conclusions have changed	Substantive amendment. For this second update, new searches were carried out in November 2007. Four studies were identified, of which 2 (Godinez 2002; Moscati 2007) were included and two studies were excluded.
18 June 2004	New search has been performed	For the first update new searches were carried out in June 2004. Five studies were identified, of which 3 (Bansal 2002; Goldberg 1981; Valente 2003) were included and 2 were excluded.

CONTRIBUTIONS OF AUTHORS

Both authors designed the review.

Ritin Fernandez co-ordinated the review. In addition she was responsible for writing to study authors for additional information, data management and data entry into RevMan.

Ritin Fernandez and Rhonda Griffiths undertook data collection, developed the search strategy, searched the literature, screened search results, retrieved papers, appraised trial quality, analysed and interpreted data and wrote the review.

Funding for the review was obtained by Rhonda Griffiths from the South Western Sydney Area Health Service.

Contributions of editorial base:

Nicky Cullum: edited the review, advised on methodology, interpretation and review content. Approved the final review and review update prior to submission.
Sally Bell-Syer: coordinated the editorial process. Advised on methodology, interpretation and content. Edited the review and the updated review.
Ruth Foxlee: designed the search strategy, ran the searches and edited the search methods section for the update.

DECLARATIONS OF INTEREST

The authors of the review conducted one of the trials included in the review, however the authors did not receive from any commercial entity any payments or pecuniary, in-kind or other professional or personal benefits that were related in any way to the subject of the work. This trial was also subject to the same rigorous quality assessment as other trials included in the review.

SOURCES OF SUPPORT

Internal sources

- University of Western Sydney Macarthur, Australia.
- South Western Sydney Area Health Service, Australia.

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The published protocol was titled: 'Normal saline vs tap water for wound cleansing'. This has been changed at the review stage to: 'Water for wound cleansing' to reflect the different types of water used in the studies.

INDEX TERMS

Medical Subject Headings (MeSH)

Drinking Water; Hydrotherapy [*methods]; Randomized Controlled Trials as Topic; Skin Ulcer [therapy]; Sodium Chloride [*therapeutic use]; Therapeutic Irrigation [methods]; Wound Infection [*prevention & control]; Wounds and Injuries [*therapy]

MeSH check words

Humans