Wound cleansing: which solution, what technique?

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Abstract
Cleansing is a vital component of wound management. However, there is limited research to inform protocols. Although research has focussed on types of dressings, little attention has been given to the solutions and techniques to be used for cleansing purposes. The available evidence about the effectiveness of solutions and techniques in the prevention of wound infection and the promotion of healing has not been systematically quantified in a manner that would assist clinicians in choosing a solution and the appropriate technique. This study aimed to critically review the literature and present the best available evidence that investigates the effectiveness of solutions and techniques for wound cleansing.

A key word search of wound care journals was completed. At least two types of solutions and techniques had to be compared and the infection rate and/or healing rates analysed. Two independent reviewers extracted data on population, intervention, outcome and methodological quality. In the only study comparing tap water to normal saline, the infection rate in wounds cleansed with tap water was noted to be lower than wounds cleansed with normal saline. Studies that compared normal saline, boiled water, distilled water and povidone-iodine for wound cleansing demonstrated no difference in the infection rate of wounds. However, one study demonstrated a statistical difference in the infection rate in wounds that were not cleaned compared to those that were soaked in normal saline. No randomised controlled trials (RCTs) were identified that compared swabbing or scrubbing as techniques for cleansing wounds. In post-operative patients, showering the wound did not demonstrate a significant difference in the rate of infection and healing; however, it was reported to enhance a feeling of cleanliness and well-being amongst those patients. Insufficient data exists to determine the effect of tap water on chronic wounds. Considering the widespread use of tap water for wound cleansing in the community, more large high quality RCTs of the effectiveness of tap water and the techniques used for wound cleansing are warranted.

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Introduction
Cleansing is a vital component of wound management. However, there is limited research to inform the development of protocols. Although research has focussed on types of dressings, little attention has been given to the solutions to be used for cleansing purposes. Various solutions have been applied for their supposed therapeutic value; however, in practice, the decisions have been based on experience, service policy and personal preference.

Research has established that the use of antiseptic solutions may compromise the healing process and, as a result, the use of normal saline as a cleansing solution is widely recommended. However, there is no agreement amongst wound care authorities on the advantages of using sterile solutions over non-sterile solutions, for example tap water.
Tap water has been recommended as an effective solution for wound cleansing and has the advantages of being cost effective and easily accessible.\(^6,7\)

The most appropriate technique of wound cleansing is also a contentious point. The traditional method of swabbing wounds to remove exudate has been shown to cause tissue trauma and compromise healing.\(^8\) A number of narrative review articles have indicated various techniques for wound cleansing. However, irrigation of wounds is gaining widespread acceptance as clinicians recognise its benefits, namely preservation of newly granulating tissue, effective removal of bacteria and debris and patient comfort and convenience.\(^9\)

Running in parallel with the clinical debate is the emphasis on efficacy and cost effectiveness in health care. Consequently, the current health care environment of best practice reflects fiscal as well as clinical considerations.

This paper reports the findings of a systematic review of randomised control trials (RCT) testing protocols for cleansing of acute and chronic wounds, with particular attention to the solutions and techniques used.

**Methods**

The following databases were searched using the search strategy developed by Carol Lefebvre, Information Specialist at the UK Cochrane Centre, Oxford\(^10\): Medline (1966-2000), CINAHL (1982-2000), Health STAR (1975-2000), EMBASE (1980-current), Cochrane Library (2000 CD ROM issue 2), Nursing Collection (1995-2000). The key words used in the search strategy included wounds and injuries, tears and lacerations, ulcers, contusions and abrasions, iodine, saline, chlorhexidine, eusol, hypochlorites, hydrogen peroxide, water, baths, shower, scrub, swab and irrigation. Experts and wound care representatives were contacted for any unpublished trials and conference proceedings. Hand searches of relevant journals were undertaken and reference lists and bibliographies of retrieved articles were reviewed.

To identify studies for inclusion in this analysis, the type of study included only RCTs; study population included both adults and children; interventions included a comparison of at least two solutions or techniques for wound cleansing; outcomes included infection and healing rates of the wound.

Studies excluded from the review were those that:

- utilised solutions for pre-operative skin cleansing to prevent post-operative infections;
- assessed the effectiveness of solutions as part of the operative procedure, for example lavage with povidone-iodine or normal saline after fascia closure;
- compared solutions for dental procedures;
- compared solutions for patients with burns;
- compared dressings for patients with ulcers; and
- used a solution e.g. povidone-iodine as a prophylactic treatment.

Articles that used povidone-iodine as a cleansing solution rather than for its antiseptic properties were included in the review.

Two investigators, using a data extraction form developed and piloted by the review team, conducted data abstraction independently. The selected publications were critically appraised by two reviewers using the quality scale developed by the Cochrane Collaboration.\(^11\) This tool examines the reported quality of the:

- description of inclusion and exclusion criteria used to derive the sample from the target population;
- evidence of allocation concealment at randomisation;
- description of methods used to assess adverse effects;
- evidence of blinding;
- description of withdrawals and dropouts; and
- description of the method of statistical analysis.

**Results of kappa statistics**

Measure of agreement between the two independent assessors was calculated using the kappa statistics. If the measurements agree more often than expected by chance, kappa is positive; if concordance is complete, kappa=1; if there is no more nor less than chance concordance, kappa=0; if the measurements disagree more than expected by chance, kappa is negative.\(^12\) Differences of opinion were settled by consensus after consultation with third investigator.

<table>
<thead>
<tr>
<th>Question</th>
<th>Result</th>
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<tbody>
<tr>
<td>Description of methods to assess adverse effects</td>
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<tr>
<td>Study described as double blind</td>
<td>1</td>
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<tr>
<td>Description of withdrawals and dropouts</td>
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</tr>
<tr>
<td>Description of statistical analysis</td>
<td>0.42</td>
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</tbody>
</table>

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Kappa could not be calculated for the questions relating to inclusion/exclusion criteria and study randomisation as both assessors rated these identically. The kappa results for the remaining questions are presented in Table 1.

The results were analysed separately for the different types of solutions and techniques used. Where possible odds ratios (OR) and a fixed effects model was used to combine outcome across trials using the statistical package Review Manager 4.0 (RevMan)\(^1\). Thirty four published studies comparing solutions or techniques were retrieved. However, 22 were excluded as they did not meet the inclusion criteria. One study was excluded because the data was not available and two other studies were not included in the review as the articles were not obtainable at the time of the completion of this report (Table 2).

<table>
<thead>
<tr>
<th>Table 2. Reasons for references to studies to be excluded from the review.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compares dressings</strong></td>
</tr>
</tbody>
</table>

**Non-randomised controlled trial comparing dressings**


**Povidone-iodine used as prophylaxis**


**Lavage was used as part of surgical procedure**


**Case study**


**Examines reduction in bacteria on skin not in wounds**


**Description of irrigation devices**


**Comparative study without randomisation**


**Comparative study with historical controls**


**Comparative study with concurrent controls**


**Cohort study**


**Data of outcomes not available**


**Article not available at the time of completion of the report**


Table 3 summarises the methodological qualities of the remaining nine studies. Four of the trials compared not only the solution but also the technique for wound cleansing.

**Solutions for wound cleansing**

The solutions used for wound cleansing in the included studies were tap water, boiled water, distilled water, normal saline, povidone-iodine and Pluronic F68 (Shur Clens®).

Of the studies that met the inclusion criteria, only one compared infection rates between wounds cleansed with normal saline and those cleansed with tap water. The trial showed significant treatment effect in wounds that were cleansed with tap water (p<0.05; OR=0.53; 95%CI=0.30-0.96) 14.

Four trials 15-18 comparing infection and healing rates in postoperative patients that were allowed to bathe or shower their wounds and those that received standard treatment were included in the review. Pooled data demonstrated no significant difference in the infection and healing rates between the two groups (OR=0.80; 95%CI=0.29-2.21). Two of the four studies also reported that patients who showered expressed a feeling of well-being and cleanliness. 17, 18.

One trial comparing distilled water, boiled water and normal saline for cleansing open fractures reported infection rates of 35, 29 and 17 per cent respectively 19. The authors concluded that in the absence of normal saline, boiled or distilled water could be an effective alternative.

**Table 3. Methodological quality of included studies.**

<table>
<thead>
<tr>
<th>Author &amp; country</th>
<th>Description of inclusion and exclusion criteria</th>
<th>Study described as RCT</th>
<th>Method to assess adverse event described</th>
<th>Study described as double blind</th>
<th>Description of withdrawal and dropouts</th>
<th>Method of statistical analysis described</th>
<th>Method of allocation</th>
<th>Sample size calculation</th>
<th>Blinded outcome assessment</th>
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<td>yes</td>
<td>yes <strong>†</strong></td>
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<tr>
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<td>yes <strong>†</strong></td>
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<td>no</td>
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<td>not stated</td>
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<td>yes <strong>†</strong></td>
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<td>no</td>
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<td>no</td>
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<td>not stated</td>
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**† described and appropriate**
Three studies reported that the infection rate in wounds cleansed with 1 per cent povidone-iodine was lower than those cleansed with normal saline\(^\text{20-22}\). However, data from only two studies could be pooled due to the clinical difference between samples under investigation. The results of the pooled data favour the use of 1 per cent povidone-iodine for cleansing contaminated wounds (OR=0.18; 95%CI=0.07-0.45).

The bacterial count of treatment groups determined in one study established that there was an increase in the bacterial count in wounds treated with normal saline (p=0.0001)\(^\text{21}\). Healing rate as an outcome was assessed in only one study which demonstrated that primary healing was increased in the group cleansed with povidone-iodine. However, there was no difference in the healing rate at less than 3 months or at 3-6 months in wounds cleansed with normal saline and those cleansed with povidone-iodine\(^\text{22}\).

The trial comparing infection rates in traumatic lacerations treated with povidone-iodine, Pluronic F68 (Shur Clens\(^\text{6}\)) and normal saline reported that although the infection rates between the groups was 4.3, 5.6 and 6.9 per cent respectively, these results were not statistically significant\(^\text{20}\).

When infection rates in wounds that were soaked in 1 per cent povidone-iodine were compared to those that were not cleansed with any solution, no difference was reported\(^\text{21}\). The study also indicated that soaking in 1 per cent povidone-iodine solution was not effective in reducing bacterial count. Lammers also assessed the infection rates in contaminated wounds soaked in normal saline and those that received no treatment and reported a higher infection rate in the normal saline group (Table 4).

Cost effectiveness was not reported in any of the above studies.

**Techniques for wound cleansing**

There were no RCTs identified that compared the common techniques of wound cleansing such as swabbing and scrubbing.

Five studies compared the effect of showering to non-showering patients in the post-operative period. The pooled results of four studies\(^\text{15-18}\) indicated that there was no statistical difference in the infection rate (OR=0.80; 95 per cent CI=0.29-2.21) and the healing rate between the groups. However, two studies reported that patients who were in the showering group felt a sense of health and well-being derived from the hygiene and motivation of showering\(^\text{17,18}\).

**Discussion**

RCTs offer the best possibility to detect differences between two types of solutions or techniques. The most striking finding of this review was that none of the studies included for wound cleansing were performed on chronic wounds. It is clearly evident that various definitions for infection have been adopted. A standard definition of infection would enable pooling of smaller trials that are of value but do not reach significance. Considering the large volume of information that is available regarding infection in acute and chronic wounds, it is unfortunate that there is no consensus amongst wound care experts as to an agreed definition of infection.

There was a wide variation in the methodological rigour of the studies. The heterogeneity of the studies also precluded comparison of outcomes or pooling of data. The methodological limitations of the studies such as small sample size or failure to control for baseline measures make it difficult to draw definitive conclusions. For example, in the study by Angeras, although the sample size was large, the finding of decreased infection rate in wounds cleansed with tap water is difficult to interpret due to the fact that the temperature between the two solutions used in the study was not controlled.

Of the nine studies included in this review, blinded outcome assessment was used in only one trial\(^\text{14}\). However, due to inadequate resources, blinded outcome assessment is not always feasible. This bias in outcome assessment can be minimised by having a second assessor and presenting interrater reliability data or by presenting photographic evidence of wound infection and/or wound healing. However, these were not reported in any of the studies.

Although cost is becoming an increasingly important factor in clinical decisions, none of the studies that compared solutions reported cost evaluations.

The strengths of this review include the systematic approach to searching the literature, selecting the relevant studies and independent assessment of trial quality. However, readers should refer to original publications for further detail.
<table>
<thead>
<tr>
<th>Author &amp; country</th>
<th>Study</th>
<th>Participants</th>
<th>Results</th>
</tr>
</thead>
</table>
| Angeras 14 (Sweden) | RCT | n=705 Soft tissue wounds | **Infection rate:** p<0.05  
- Normal saline 10.3%  
- Tap water 5.4% |
| Museru 19 (Tanzania) | RCT | n=86 Open fractures | **Infection rate:**  
- Isotonic saline 35%  
- Distilled water 17%  
- Boiled water 29% |
| Lammers 21 (USA) | RCT | n=37 Tissues from contaminated traumatic wounds  
 n=23 Contaminated traumatic wounds | **Mean bacterial count/gm of tissue:**  
- Normal saline increased 3.39x10⁷ SD 1.05x10⁸  
- 1% povidone-iodine decreased 9.19x10⁶ SD 1.72x10⁷  
- No treatment decreased 6.4x10⁶ SD 1.68x10⁷  
**Infection rate:**  
- Normal saline 71%  
- 1% povidone-iodine 12.5%  
- No treatment 12.5%  
**Healing at 3-6 months:**  
- Normal saline 6/28  
- 1% povidone-iodine 2/28  
**Sinus at 6 months:** (p=0.0514)  
- Normal saline 5/28  
- 1% povidone-iodine 0/28  
**Mean no. of days in hospital:**  
- Normal saline 28 days  
- 1% povidone-iodine 19 days |
| Johnson 22 (UK) | RCT | n=56 Abdomino perineal excision for carcinoma | **Infection rate:**  
- Normal saline 21/28  
- 1% povidone-iodine 10/28  
**Primary healing:** (p<0.02)  
- Normal saline 9/28  
- 1% povidone-iodine 19/28  
**Healing at <3 months:**  
- Normal saline 8/28  
- 1% povidone-iodine 7/28  
| Dire and Welsh 20 (USA) | RCT | n=531 Soft tissue lacerations | **Infection rate:**  
- Normal saline 6.9%  
- 1% povidone-iodine 4.3%  
- Pluronic F68 Shur Clens® 5.6%  
**Healing:**  
- Showered group 100%  
- Non-showered group 100% |
| Fraser et al. 15 (UK) | RCT | n=100 After surgery with or without drains | **Infection:**  
- Showered group 8%  
- Non-showered group 8%  
OR 1; 95% CI 0.24, 4.21  
**Healing:**  
- Showered group 100%  
- Non-showered group 100% |
| Voorhees et al. 17 (USA) | RCT | n=82 After surgery with or without drains | **Infection:**  
- Showered group 5%  
- Non-showered group 9%  
OR 0.54; 95% CI 0.10, 2.85  
**Healing:**  
- Showered group 95%  
- Non-showered group 91%  
OR 1.84; 95% CI 0.35, 9.60 |
| Riederer et al. 18 (Germany) | RCT | n=121 After surgery for inguinal hernia | **Infection:**  
- Showered group no infection  
- Non-showered group no infection  
OR 1.06; 95% CI 0.07, 17.24  
**Healing:**  
- No difference in healing between the groups  
- 1 stitch abscess in each group |
| Goldberg et al. 16 (USA) | RCT | n=200 Lacerations that needed surgery | **Infection:**  
- Showered group 1 patient developed inclusion cyst  
- Non-showered group no infection  
**Healing:**  
- No difference in wound healing between the groups |
Implications for further research

As identified earlier, the studies have several methodological limitations which should be considered in future studies. Properly designed multi-centre trials are needed to compare the clinical benefits and cost effectiveness of different solutions, pressures and techniques for wound cleansing in different groups of patients (particularly in children), different types of wounds and in a wide range of settings.

True randomisation should be ensured and the sample size should be adequate to detect clinically important differences. A standardised and validated tool should be utilised for the measurement of wound infection and healing, with the assessor blinded to the intervention. Other outcomes such as patient comfort and accessibility of the solution should be measured. Future studies should have a well-defined follow up period.

Conclusion

This systematic review has highlighted the paucity of research that examines the use of tap water as a wound cleansing agent, although it is widely used for this purpose. Only one study showed a significant difference in infection rates between wounds cleansed with normal saline and those cleansed with tap water. All other studies indicated no difference in the infection and healing rates between the different solutions and techniques used for wound cleansing.

However, it is not possible to predict whether those results were influenced by the methodological limitations of the study. Additional studies that address the methodological issues are warranted to support the findings of the literature and shed further light on the various techniques to be used for wound cleansing.

The results of the studies described above have prompted the investigators to undertake a RCT on the effectiveness of tap water and normal saline on the infection and healing rates of wounds. The study currently in the pilot phase will add to the existing body of knowledge relating to wound management.

Acknowledgements

The investigators are grateful to the members of the South Western Sydney Area Health Service Clinical Practice Review Network for their assistance with the data abstraction and would also like to acknowledge Ms Heidi Otten and Dr Hashi Devi for their assistance in translation of papers from German. In addition, we would like to thank Rachel Langdon and Soufianne Boufous for their statistical support and Venita Devi for the secretarial support.

References