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 [1]. Although research has focussed on types of dressings, little attention has been give 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 [2, 3] and, as a result, the use of normal saline as a cleansing solution is widely recommended [2, 4, 5]. 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 1. Result of kappa statistics.

Question	Result
Description of methods to assess adverse effects	1
Study described as double blind	1
Description of withdrawals and dropouts	1
Description of statistical analysis	0.42

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) [13].

Data synthesis

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 2. Reasons for references to studies to be excluded from the review.

Compares dressings

- Bulstrode CJ, Goode AW & Scott PJ. A prospective controlled trial of topical irrigation in the treatment of delayed cutaneous healing in human leg ulcers. Clin Sci 1988; **75**:637-640.
- Kucan JO, Robson MC, Heggers JP & Ko F. Comparison of silver sulfadiazine, povidone-iodine and physiologic saline in the treatment of chronic pressure ulcers. J Am Geriatr Soc 1981; **29**(5):232-235.
- Ljungberg S. Comparison of dextranomer paste and saline dressings for management of decubital ulcers. Clin Ther 1998; **20**(4):737-743.
- Moberg S, Hoffman L, Grennert M & Holst A. A randomized trial of cadexomer iodine in decubitus ulcers. J Am Geriatr Soc 1983; **31**(8):462-465.
- Sollitto RJ & Napoli RC. An alternative technique in the care of the postoperative wound. J Foot Surg 1989; **28**(6)(Nov-Dec):549-50.
- Svedman P. Irrigation treatment of leg ulcers. Lancet 1983; (September 3): 532-34.

Non-randomised controlled trial comparing dressings

- Daltrey DC & Cunliffe WJ. A double-blind study of the effects of benzoyl peroxide 20% and eusol and liquid paraffin on the microbial flora of leg ulcers. Acta Derm Venereol 1981; **61**(6):575-7.

Povidone-iodine used as prophylaxis

- Morgan WJ. The effect of povidone-iodine (Betadine) aerosol spray on superficial wounds. Br J Clin Pract 1979; **33**(4):109-110.
- Rogers DM, Blouin GS, O'Leary JP. Povidone-iodine wound irrigation and wound sepsis. Surg, Gynecol & Obstet 1983; **157**(November): 426-430.

Lavage was used as part of surgical procedure

- Lopez V, Yague Perez S, Llamas Zuniga P & Perez Trallero E. Evaluation of Pulsating Jet lavage in prevention of surgical wound infection. J Abdom Surg 1984; **26**(3-4):34-38.

Case study

- Bohannon RW. Whirlpool versus whirlpool rinse for removal of bacteria from a venous stasis ulcer. Phys Ther 1982; **62**(3):304-8.

Examines reduction in bacteria on skin not in wounds

- Neiderheber S, Stribley R & Koepe G. Reduction of skin bacteria load with use of therapeutic whirlpool. Phys Ther 1975; **55**(5):482-86.

Description of irrigation devices

- Sobel JW & Goldberg VM. Pulsatile irrigation in orthopedics. Orthopedics. 1985; **8**(8):1019-22.
- Westaby S & Everett WG. A wound irrigation device. Lancet. 1978; **2**(8088):503-4.

Examines bacterial growth at different sites in the tank

- Stanwood W, Pinzur MS. Risk of contamination of the wound in a hydrotherapeutic tank. Foot & Ankle Int 1998; **19**(3):173-176.

Comparative study without randomisation

- Bryant RA, Rodeheaver GT, Reem EM, Nichter LS, Kenney JG & Edlich RF. Search for a non-toxic surgical scrub solution for periorbital lacerations. Ann Emerg Med 1984; **13**(5):317-321.
- Hollander J, Richman PB, Werblud M, Miller T, Huggler J & Singer A. Irrigation in facial and scalp lacerations: Does it alter outcomes? Ann of Emerg Med 1998; **31**(1):73-77.
- Weller K. In search of efficacy and efficiency: An alternative to conventional wound cleansing modalities. Ostomy Wound Manage 1991; **37**:23-8.

Comparative study with historical controls

- Carragee EJ & Vittum DW. Wound care after posterior spinal surgery. Does early bathing affect the rate of wound complications? Spine 1996; **21**(18):2160-2162.

Comparative study with concurrent controls

- Meeker J. Whirlpool therapy on postoperative pain and surgical wound healing: an exploration. Patient Educ Couns 1998; **33**(1):39-48.

Cohort study

- Noe JM & Keller M. Can stitches get wet? Plast Reconstr Surg 1988 Jan:82-83.
- Lee BY, Trainor FS & Thoden WR. Topical application of povidone-iodine in the management of decubitus and stasis ulcers. J Am Geriatr Soc 1979; **27**(7):302-306.

Data of outcomes not available

- Tay SK. Is routine procaine spirit application necessary in the care of episiotomy wound? Singapore Med J 1999; **40**:581-583.

Article not available at the time of completion of the report

- Neues C & Haas E. Modification of postoperative wound healing by showering. Chirurg 2000; **71**:234-236.
- Koninger J, Russ M, Schmidt R, Feilhauer K & Butters M. Post operative wound healing in wound-water contact. Zentralbl Chir 2000; **125**:157-160.

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 post-operative 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.

Author & country	Description of inclusion and exclusion criteria	Study described as RCT	Method to assess adverse event described	Study described as double blind	Description of withdrawal and dropouts	Method of statistical analysis described	Method of allocation	Sample size calculation	Blinded outcome assessment
Angeras [14] (Sweden)	yes	yes	yes	yes †	yes	yes	odds and even week	not stated	yes
Dire & Welsh [20] (USA)	yes	yes	yes	no	no	no	by the month	not stated	not stated
Lammers [21] (USA)	yes	yes †	yes	no	no	yes	random numbers table	not stated	not stated
Fraser **et al.** [15] (UK)	yes	yes †	yes	no	no	no	random card selection	not stated	not stated
Goldberg **et al.** [16] (USA)	yes	yes	no	no	no	no	consecutive patients	not stated	not stated
Johnson **et al.** [22] (UK)	yes	yes	yes	no	no	no	not stated	not stated	not stated
Museru **et al.** [19] (Tanzania)	yes	yes	no	no	no	no	not stated	not stated	not stated
Voorhees & Rosenthal [17] (USA)	yes	yes †	yes	no	no	no	social security number	not stated	not stated
Reiderer & Inderbitzi [18] (Germany)	yes	yes	yes	no	yes	no	alternate	not stated	not stated

† 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 [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) [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 [22].

The trial comparing infection rates in traumatic lacerations treated with povidone-iodine, Pluronic F68 (Shur Clens ®) 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 [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 [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 [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 [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 [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 4. Results.

Author & country	Study	Participants	Results
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 $3.39X10^7$ SD $1.05X10^8$ • 1% povidone-iodine decreased $9.19X10^6$ SD $1.72X10^7$ • No treatment decreased $6.4X10^5$ SD $1.68X10^6$ **Infection rate:** • Normal saline 71% • 1% povidone-iodine 12.5% • No treatment 12.5%
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 **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-iodine19 days
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%
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.

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