

# Does tap water decrease wound infection rates as compared to sterile saline?

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## Citation

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## Abstract

The purpose of this paper is to determine if there is a decrease in infection rates when wounds are cleansed with tap water instead of traditional sterile saline. Various ideas and techniques are employed when it comes to wound care but what really is the best practice. The available study data has been compiled and is reviewed in this article. As practitioners we need to be aware of the available science in order to bring the best medicine to our patients.

## INTRODUCTION

Hippocrates (460-377 BC), known as the father of medicine, used vinegar to irrigate open wounds and wrapped dressings around wounds to prevent further injury (1).

No matter what area of medicine you practice, at one time or another, all practitioners will come in contact with patients that have wounds that need to be cared for. When it comes to basic wound cleansing, little thought is given as to why we use one solution over another. It has become common practice to cleanse wounds with sterile saline, but is this the best practice? Some practitioners swear by the use of tap water saying that they notice better healing on follow up wound checks. Others say there is no difference in healing or infection rates with either solution, but that tap water should be used more due to the economical benefits. The purpose of this paper is to determine if there is a decrease in infection rates when wounds are cleansed with tap water instead of traditional sterile saline.

## BACKGROUND

Wound care accounts for countless health care dollars and practitioner hours each year. All wounds are contaminated by microbes, but in most cases, infection does not develop because body defenses are capable of handling the contaminants (1).

Microbial factors that influence the establishment of a wound infection are the amount of bacterial pathogen, virulence, and inoculation site. When these factors are favorable to the pathogen, impaired host defenses set the

stage for enacting the chain of events that produce wound infection (1).

Most wounds are contaminated by the patient's own endogenous flora, which are present on the skin, mucous membranes, or hollow viscera. The traditional microbial concentration associated with infection is a count higher than 10,000 organisms per cm<sup>2</sup> of tissue (1).

The most common pathogens on skin and mucosal surfaces are gram-positive cocci (notably staphylococci); however, gram-negative aerobes and anaerobic bacteria contaminate skin in the groin/perineal areas (1).

The most common group of bacteria responsible for wound infections is *Staphylococcus aureus* (1). The emergence of resistant strains has considerably increased the morbidity and mortality associated with wound infections. Methicillin resistant *Staphylococcus aureus* (MRSA) is proving to be a major problem for health care professionals. Like other strains of *S. aureus*, MRSA can colonize the skin and body of an individual without causing infection and can be passed to other individuals. Problems arise in the treatment of infections with MRSA because antibiotic choice is very limited. MRSA infections appear to be on the rise and are displaying resistance to a wider range of antibiotics (1). Of particular concern are the vancomycin intermediate *Staphylococcus aureus* (VISA) strains of MRSA (1). These strains are beginning to develop resistance to vancomycin, which is currently the most effective antibiotic against MRSA (1).

Other risk factors for wound infection are due to systemic factors affecting the patient's healing response and local wound characteristics.

Systemic factors include: age, malnutrition, hypovolemia, poor tissue perfusion, obesity, diabetes, steroids, and other immunosuppressants (1).

Wound characteristics include nonviable tissue in wound, hematoma formation, foreign material including drains and sutures, dead space, poor skin preparation, preexistent sepsis (local or distant), and the location and size of the wound (1).

The use of antibiotics was a milestone in the effort to prevent wound infection. General agreement exists that prophylactic antibiotics are indicated for contaminated wounds. Choice of prophylactic antibiotics should include efficacy against predicted bacterial microorganisms most likely to cause infection, good tissue penetration to reach wound involved, cost effectiveness, and minimal disturbance to intrinsic body flora (1). Other risk variables, like smoking, tissue oxygen tension, glucose control, and shock, should be taken into account when deciding whether or not to prescribe prophylactic antibiotics (1). All these factors are relevant for clinicians and need to be assessed when providing wound care.

While most research time and money is spent on investigating antibiotics and antiseptic cleansers for procedural use – little to no research is done to assess basic wound care techniques like the efficacy of using sterile saline vs. tap water.

Wound cleansing is technically defined as “the use of fluids to remove loosely adherent debris and necrotic tissue from the wound surface” (2) or “the application of fluid to aid removal of exudates, debris, slough and contaminants” (3). Besides the need to cleanse wounds to remove debris and prevent infection, wounds are also cleansed to obtain a better look at the actual wound to determine the best method of treatment.

Old experiments from 1959 state that using water to cleanse wounds may be detrimental because adding water to human cells involved in wound healing results in diffusion that removes dissolved substances from the intracellular fluid (4). Based on this idea, scientists hypothesize that pain experienced when cleaning a wound with water is caused by tissue destruction possibly due to introducing a hypotonic solution which under osmosis causes cells to swell and rupture within the tissue (4). For this reason sterile saline has

been promoted as the best solution for wound cleansing because it is an isotonic solution that has similar osmotic pressures to interstitial fluid (4), but is this really the case?

Another factor to consider when choosing the proper solution for wound cleansing is the idea of using sterile technique for wound care.

In general, the sterile technique involves practices that promote maximum reduction in microbial counts by means of microorganism-free objects, such as: washing hands, using sterile fields, sterile gloves, sterile tools, sterile saline and sterile bandages. In this technique, it is possible to touch what is sterile with another sterile object or tool. Breaking the “barrier” or touching any other non-sterile surface or product is avoided (5).

The use of tap water for wound cleansing is described as using the clean technique. Clean technique involves the use of procedure gloves while cleansing with tap water at a sink or the use of sterile gloves if the tap water is already at the pre set sterile field. Sterile tools are used for wound care, in addition to asepsis principles, which includes sterile environment and sterile bandages (5).

Considering the importance of an evidence-based practice, the objective of this paper is to determine if the use of tap water can decrease wound infection rates as compared to sterile saline.

## **METHODS**

A computerized literature search for relevant evidence based reviews, meta-analysis, and randomized control trials using the keywords tap water vs. saline and wound infection was performed in the MEDLINE and PubMed databases with the following limitations: studies had to be published in the last 5 years (2003-2008), only could be free full text articles, performed on humans, be peer reviewed studies, and had to be written in English. These limiters were chosen to allow for studies that were current and easily accessible.

## **DISCUSSION**

### **ARTICLE 1**

### **SOLUTIONS, TECHNIQUES AND PRESSURE FOR WOUND CLEANSING (2).**

This article is an evidence based medicine review of randomized controlled trials (RCTs) involving several wound cleansing topics.

Electronic searches were performed on multiple databases.

The actual databases used were not listed.

The following were inclusion criteria for this article: randomized controlled trials, comparative, cohort, and case controlled studies that assessed the effectiveness of various solutions, techniques, and pressures for wound cleansing were considered. Studies involving adults or children and those describing objective or subjective measures of wound infection were included.

The following exclusions criteria were used:

- Any studies involving solutions for pre-operative management to prevent post-operative infection, or solutions used as part of an operative procedure.
- Studies comparing solutions for dental procedures use with burn patients, and solutions used as prophylactic treatment (example: Povidone-iodine).
- Studies that also compared dressings for patients with ulcers.

For the purposes of this paper, I will focus on the section that covers tap water vs. saline. This section evaluates two RCTs that compared infection rates in wounds cleansed with tap water or normal saline.

The first study by Angerus et al. was performed on 705 patients with acute wounds found higher infection rates in wounds cleansed with sterile normal saline ( $p < 0.05$ ). This study does mention that the tap water was administered at a warmer temperature (approx 98.5 °F) as compared to the saline that was administered at room temp (approx 70 °F).

The second study conducted by Griffiths involving 49 chronic wounds found no difference in infection rates for tap water vs. saline.

This is all the detail that is given in the article regarding the study results. The article then goes on to make the following conclusions:

- Tap water is an effective cleansing solution for acute wounds
- Tap water is effective to cleanse clean sutured surgical wounds in healthy adults
- Tap water can be used on chronic wounds
- Showering of post-operative wounds does not

increase infection rates or slow healing, and promotes a sense of well-being and health associated with cleanliness

- Showering of chronic wounds and ulcers should be done with caution

### CRITIQUE

The article is very effective at organizing studies about several different wound care topics in a concise and clear manner. In doing so, the article skimps on the important information about the actual studies. There is adequate detail in explaining how the information was collected, and where the studies came from, but then falls short with the actual statistical detail, leaving you to trust that they interpreted the information correctly to draw their conclusions.

The first study discussing the topic of tap water vs. saline mentions that there was a difference in the temperatures of the fluids when they were used to clean wounds. This difference in temperature may be responsible for the tap water having less of an infection rate. Warmer solutions may cause vascular vasodilatation at the wound site therefore decreasing the infection rate, whereas using a solution at a temperature significantly less than body temperature (70 °F vs. 98.5 °F respectively) may cause the vasculature at the wound site to vasoconstrict resulting in a decrease in blood flow to the affected area predisposing it to an increase in the chance for infection.

The study also does not say where the wounds were located and if they were in similar areas or were similar in size. This may also affect the infection rate where wounds that are on the distal extremities or are located in the groin region have a higher infection rate than those located on the trunk or face.

Without knowing all the details of the studies that were reviewed in this article, I cannot investigate whether there were flaws in the study design or statistical evaluation. Therefore, I cannot make a determination based on the evidence that this article presents.

### ARTICLE 2

Is tap water a safe alternative to normal saline for wound cleansing (4)?

This article is a systematic review that discusses several different studies looking at the topic tap water vs. saline.

An electronic search was performed for randomized and quasi-randomized controlled trials using the following databases: CINAHL, MEDLINE, BNI, and the RCN website.

The following key words were used in the electronic search: wound care, irrigation, wound cleansing, cleaning, tap water, hypertonic, normal saline, saline solution, and isotonic.

The first study is the same study that was mentioned in the previous article by Angerus et al. The study compared infection rates of acute soft tissue wounds irrigated with tap water vs. sterile saline. The study is listed as a RCT that was conducted on 705 patients which is an adequate size. Patients were randomized into the tap water or saline group depending on if they presented for treatment on an even or odd trial week. This way of dividing patients into groups does not meet the criteria for a RCT and is more “quasi-random.”

The study was flawed because there was no standardized way that the solutions were used for cleansing making it impossible to accurately determine if the solutions or the techniques were responsible for the outcome. It was also noted that practitioners were more generous with the amount of tap water used for irrigation which most likely had an effect on the results.

Outcomes were measured by wound infection rate which was defined as having “pus and prolonged healing” at follow up intervals. The follow up intervals were not defined.

Another study was conducted in 2003 by Bansal et al. comparing infection rates of wounds irrigated with normal saline vs. tap water.

The wounds studied were extremity lacerations less than 8 hours old at presentation. Exclusion criteria included: dog bites, hand wounds, immune compromised patients, and those patients already on antibiotic therapy.

The study was conducted on 46 patients that were randomized into tap water and sterile saline groups. Tap water and sterile saline were provided in bottles to allow for the study to be conducted in double blind format. The wounds were cleansed by irrigation.

Outcomes were measured with pre and post-irrigation wound cultures, and on 48 hour follow up examination. Infection was defined as cellulites, erythema, tenderness, purulent discharge, or wound dehiscence.

This study demonstrated similar infection rates with normal saline at 2.8% and tap water at 2.9. The study did say that both solutions have different physical fluid properties, causing there to be a difference in solution pressures and flow rates when irrigated through a syringe. The article goes on to say the antimicrobial effects of the tap water are most likely due to the fact that the tap water can be irrigated at a higher pressure due to its physical properties, therefore having more irrigation power. They concluded that this increased irrigation power makes tap water an effective alternative to saline.

The conclusion of the article is that the literature does not provide an adequate level of evidence to make a definitive decision.

### **CRITIQUE**

This article provides more information about the actual studies, but as in the first article reviewed falls short with the actual statistical details. These authors do an effective job at pointing out the flaws that they found in reviewing the studies, but this is what is discussed in the majority of their evidence based medicine review. They discuss the problems with the evidence but fail to actually show the evidence that they are critiquing.

Again, without knowing all the details of the studies that were reviewed in this article, I cannot investigate whether there were flaws in the study design or statistical evaluation. Therefore, I cannot make a determination based on the evidence that this article presents.

### **ARTICLE 3**

#### **WATER FOR WOUND CLEANSING (6).**

This article is a meta-analysis for 7 RCT and quasi-RCT that compared rates of infection and healing in wounds that were cleansed with either tap water or sterile saline.

Randomized and quasi-randomized controlled trials were selected from electronic searches of the following databases: Cochrane Wounds Group Specialized Register, MEDLINE, EMBASE, CINAHL, and the Cochrane Controlled Trials Register. Primary authors and content experts were contacted to further identify eligible studies.

Studies were included as long as they compared the use of tap water verses normal sterile saline for wound cleansing. Additional criteria were outcomes that included objective or subjective measures of wound infection or healing.

Trial selection, data extraction, and quality assessment were carried out independently by two authors and checked by a third author. Differences in opinion were settled by discussion. Some data were pooled using a random effects model.

Seven trials were identified that compared rates of infection and healing in wounds cleansed with water and normal saline. There were no standard criteria for assessing wound infection across the trials which limited the ability to pool the data.

The following paragraph is an excerpt from their article listing the flaws that they found in evaluating the 7 studies that they compiled their data from:

“Methodologic limitations of the included trials are absence of details concerning the method of randomization of patients to treatment groups, selection bias, overall poor quality, lack of replication of most comparisons, poorly defined eligibility criteria in some cases, lack of consistency in the criteria used to assess wound infection, variance data for the healing outcomes not reported in the study that compared tap water with procaine spirit, failure to measure other outcomes such as patient comfort and satisfaction, and meta-analysis restricted to trials of the same intervention that evaluated the same outcome.”

When the authors compiled the research data they came up with the following statistics:

- The relative risk (RR) of developing an infection in chronic wounds cleansed with tap water vs. saline was 0.16 (95% confidence interval [CI] of 0.01-2.96).
- Tap water is more effective in reducing infection rates in adults with acute wounds with a RR of 0.63 (95% CI of 0.40-0.99).
- There was no statistically significant difference in infection rates in children with a RR OF 1.07 (95% CI of 0.43-2.64).

The authors concluded that there is no evidence that tap water increases infection rates as compared to sterile saline. The statistics give some evidence that tap water actually prevents infection.

### CRITIQUE

This article did not give any information about the 7 studies

that they chose to compile for their data. They do list the databases that they searched in the methods section of the article, but that is as far as they go. They then list the flaws of the studies after they give their own findings. They fail to admit that their data may not be reliable since it is based on values from other unreliable studies.

### ARTICLE 4

#### WOUND CLEANSING: WATER OR SALINE (7)?

This article is a meta-analysis for 9 RCT that subjectively measured infection rates (redness, purulent discharge, pain, or smell) in wounds that were cleansed with either tap water or sterile saline.

Studies were selected from electronic searches of the following databases: Cochrane Wounds Group Specialized Register, MEDLINE, CINAHL, Nursing Collection, Health STAR, EMBASE, and the Cochrane Controlled Trials Register. The following terms were used to search for studies: water, saline, solution or solutions, tap and water, cleansing, irrigation, wound or wounds, and healing.

Studies in any language were included as long as they were randomized controlled trials of human subjects that compared the use of tap water verses normal sterile saline for wound cleansing in subjects of all ages. The author defined wound cleansing as “the use of fluids to remove loosely adherent debris and necrotic tissue from the wound surface.”

The following is listed in the articles data extraction section:

“The characteristics of the subjects, interventions, follow-up, outcomes, and findings were extracted from each study by 2 authors and verified by the third. The primary outcome measure was objective and/or subjective wound infection. Secondary measures were proportion of healed wounds, rate of healing, pain and discomfort, and patient and staff satisfaction. All studies were graded independently by 2 authors and verified by a third author to determine methodologic quality. Where appropriate, the data were pooled and analyzed with a fixed-effects model. RevMan software (version 4.2; Cochrane Centre, Oxford, UK) was used for statistical analysis.”

The research data was compiled resulting in the following statistics:

- Tap water reduced the relative risk (RR) of infection by 45% compared with sterile saline in acute soft tissue wounds that were sutured (RR of

0.55; 95% confidence interval [CI] of 0.31-0.97).

- There was no statistically significant difference in infection rates of non-sutured wounds cleansed with tap water vs. sterile saline (RR of 0.16; 95% CI of 0.01-2.96).
- Analysis of secondary outcomes revealed no significant differences in wound healing rates of non-sutured chronic wounds cleansed with tap water or sterile saline (RR of 0.57; 95% CI of 0.30-1.07).

It was also noted that patients felt better and were more compliant with cleansing routines when allowed to cleanse their wounds by showering as opposed to using sterile saline from a bottle.

Tap water was also listed as being more cost-effective compared with sterile saline at \$1.16 vs. \$1.43.

## **CRITIQUE**

This article listed the data sources, inclusion criteria, and data extraction methods that were used to compile data. The article mentions that 24 studies were originally selected based on the sources used and the inclusion criteria listed, but only 9 studies were used for data extraction because the other studies were found to have design or data collection flaws that made research calculations unreliable. In the conclusion the article notes that the statistical evidence is only as reliable as the original study data that it was compiled from, and that additional RCTs are needed to adequately determine the answer to this question.

This is the only article found that met the search criteria used in this evidence based medicine paper that adequately listed where and how the author obtained the articles that were reviewed.

## **CONCLUSION**

After reviewing the available articles on the topic of tap water vs. sterile to determine if there is a difference in the infection rate of wounds, there is some evidence to support the use of tap water over sterile saline. The evidence is not strong enough to change to tap water only, but there are no proven adverse effects of using tap water.

The determination to use tap water should be made on an individual basis, as it is not appropriate for every type of wound. The tap water quality in your practice area should be assessed to see if the water supply is adequate for wound care or if it has known contaminants. Practitioners should also take into account the patients co-morbidities, as it remains preferential to use a sterile solution for a patient who is immune-compromised, or a diabetic patient with a foot wound.

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