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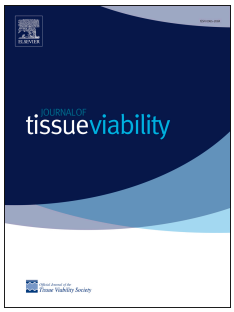

Wound irrigation versus swabbing technique for cleansing noninfected chronic wounds: A systematic review of differences in bleeding, pain, infection, exudate, and necrotic tissue

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Wound irrigation versus swabbing technique for cleansing noninfected chronic wounds: A systematic review of differences in bleeding, pain, infection, exudate, and necrotic tissue

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ABSTRACT

Purpose: To systematically summarize and review the existing literature to determine the difference between wound cleansing techniques, irrigation and swabbing, in relation to bleeding, pain, infection, necrotic tissue and exudate in non-infected chronic wounds including pressure injuries, venous and arterial leg ulcers and diabetic foot ulcers.

Methods: A systematic search of the electronic databases Ovid Medline, Cochrane Database of Systematic Reviews, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and EMBASE was performed to identify all relevant literature in English. The search also included systematic reviews as a method to obtain additional potential citations by manually searching the reference lists. Included studies were assessed for methodological quality using the Cochrane Risk of Bias Tool.

Results: One study met eligibility criteria. Two hundred fifty six patients with wounds healing via secondary intention (n=256) were included. Wound cleansing via swabbing teachnique was associated with increased perception of pain and increased rates of infection when compared to the irrigation group (93.4% versus 84.2% p = 0.02 and 5.2% versus 3.3% p = 0.44, respectively). Only a small proportion of this sample met the inclusion criteria, so the results are not considered externally valid.

Conclusion: Wound cleansing remains a controversial topic. Despite calls for further research, there continues to remain a large gap in evidence to guide practice. Irrigation continues to replace swabbing in the management of chronic wounds, although evidence of improved outcomes is virtually nonexistent. Although the one study identified was of sound methodological quality, chronic wounds accounted for only a small percentage of the sample. Therefore, results are not generalizable to those with chronic wounds. Further research is needed to determine the effectivenss of basic wound cleansing teachniques before considering more costly products.

Keywords: bleeding, chronic wound, cleansing, exudate, infection, necrotic tissue, pain.

1. INTRODUCTION

Wound cleansing is a key component of wound bed preparation, as it serves to remove bacteria, debris (e.g., residual dressing material), and non-viable tissue from the wound bed to promote the body's natural healing process (Wolcott & Fletcher, 2014). Wound cleansing may be a form of mechanical debridement by way of removing nonviable tissue from the wound bed using external force. While there are many studies comparing advanced wound cleansing solutions (Fernandez et al., 2006; Andriessen et al., 2008; Bellingeri et al., 2016) and cleansing methods using advanced technology (Fernandez et al., 2006), there are few studies comparing basic practice such as irrigating or swabbing the wound using normal saline. While swabbing technique remains standard in some parts of the world, many countries have moved to wound irrigation as the new standard of care. Irrigating with normal saline is thought to be superior at removing bacteria, debris, and nonviable tissue while minimizing damage to healthy granulated tissue in comparison to swabbing with saline-soaked gauze (Murphy et al., 2020).

Internationally, wound cleansing is currently being discussed by many key opinion leaders, as it is postulated that inadequate wound cleansing is a driving force for biofilm persistence in a wound bed. It is well established bacterial biofilms are ubiquitous among chronic wounds (Malone et al., 2017) and these established colonies of mixed species of bacteria are adherent to the wound base and not easily dislodged. They have a protective extracellular polymeric substance that protects it from both antibiotic and antimicrobial penetration (Mendoza et al., 2019) rendering our topical antimicrobial dressings equally ineffective.

Biofilm-based wound care is an emerging concept in the science of wound healing and begins with wound cleansing. It is thought that biofilms are a key factor in wounds failing to progress through the stages of healing (Shultz et al, 2017). Therefore, removing biofilm is generally thought to more effectively be managed through physical removal such as the case with mechanical debridement such as cleansing using irrigation or swabbing technique. It is believed lack of education and training in the new wound cleansing practice (irrigation) and the elimination of swabbing the wound led to ineffective wound cleansing, allowing biofilm to become the problem it is today.

The physical friction of cleansing a wound with saline-soaked gauze may provide more effective biofilm management than irrigation due to biofilm’s adherent nature. Improper irrigation can result in a fluid current too weak to displace bacteria in the wound bed allowing

biofilm to form, or alternatively, too much pressure pushing bacteria into deeper tissues and causing deep tissue or systemic infection (Sibbald et al., 2021). This change in practice may be contributing to biofilm becoming a more significant problem. If biofilms have been associated with chronic wounds for many years (James et al., 2008) and this change in practice, that is vastly understudied, is less effective at removing biofilm, the emerging problem of biofilm in chronic wounds may in fact simply be due to deteriorating wound hygiene practices. The practice of wound cleansing continues to be influenced only by expert opinion, which hinders the ability of wound care providers to make truly evidence-based decisions (Sibbald et al., 2021) and allows industry to control public health markets by introducing more expensive, advanced solutions.

This article endeavours to systematically summarize and evaluate the existing evidence on the two most common wound cleansing techniques using normal saline as the standard cleansing solution. The specific aim of this work is to determine if the change in practice from wound cleansing by swabbing the wound with saline soaked gauze to irrigation with pressurized saline is supported by the evidence. To mitigate any confounding factors and to ensure that only directly measurable wound outcomes of each cleansing procedure are considered, bleeding, pain, infection, exudate, and necrotic tissue are used as search outcomes.

2. METHODS

2.1 Design

A systematic review was conducted to answer the question of what differences there are between irrigation and swabbing techniques, when caring for noninfected chronic wounds, in terms of bleeding, pain, infection, exudate, and necrotic tissue. ~~in uninfected chronic wounds~~. Chronic wounds are defined as partial or full thickness wounds complicated by underlying conditions such as pressure, diabetes and arterial or venous insufficiency (Frykberg & Banks, 2015). This systematic review was guided using the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines (Paige et al., 2020). The protocol for this systematic review was submitted to PROSPERO on March 20, 2021, and accepted for publication (CRD42021237961).

2.2 Search Strategy

A medical information specialist conducted a systematic search of four electronic databases Ovid Medline, Cochrane Database of Systematic Reviews, Cumulative Index to Nursing and

Allied Health Literature (CINAHL), and EMBASE to identify all relevant literature in the English language published between 1946 and February 14, 2022. An updated search was then conducted in April 2022 to capture any addional current publications. The main search terms related to type of chronic wound, technique of wound irrigation or swabbing, and outcomes of interest including bleeding, pain, infection, exudate, and necrotic tissue. The term chronic wound is not consistently defined in the literature, so in addition to the key term 'chronic wound', common chronic wound types were used as keywords, including diabetic foot ulcer, pressure ulcer, venous ulcer, and arterial ulcer or leg ulcer. Study types included randomized controlled trials, prospective and retrospective comparative cohort studies, case-control studies, case series, and case reports. Search results were reviewed by a second information specialist using the Peer Review of Electronic Search Strategies Guidelines (McGowan et al, 2016) an independent search using the same search filter produced identical results. Systematic reviews were included only to search for additional studies in the reference list. Hand searches were performed to identify additional studies, and when additional studies were found, additional electronic database searches were conducted using key terms found in the hand-searched studies (see Appendix A for final search string).

2.3 Study Selection

All study designs including randomized controlled trials, prospective and retrospective comparative cohort studies, case-control series, case series, and case reports were considered provided they met inclusion criteria outlined in Table 1. Studies focusing on nonhuman tissue, alternate cleansing agents, or wounds considered acute in nature were excluded. Advanced irrigation methods such as negative pressure wound therapy using instillation and ultrasound guided irrigation were also excluded.

Table 1. Eligibility criteria for included studies

Population	• Adult patients over the age of 18 • Noninfected chronic wounds (i.e., diabetic foot ulcers, venous or arterial ulcers, pressure injuries)
Intervention	• Irrigation using normal saline as the cleansing agent
Control	• Swabbing technique using normal saline as the cleansing agent
Outcomes	• Bleeding • Pain • Exudate

- Necrotic tissue
- Infection

Search results were imported into Covidence Systematic Review software (Veritas Health Innovation, Melbourne, Australia), an internet-based software program that allows collaboration across multiple reviewers during the review and study selection process. Two independent reviewers were used for each step in the screening process and data extraction. During the initial title and abstract review, all study records were reviewed for relevance to the research question. Irrelevant study citations were removed from the search according to predetermined criteria. For the remaining records, full texts were reviewed and data extracted and appraised where applicable. Abstracts were first reviewed for relevance to the research question, and full text was reviewed for articles that met the eligibility criteria. For articles where there was disagreement, a third reviewer made the final decision. The general inclusion criteria were for noninfected chronic wounds cleansed with normal saline by either irrigating or swabbing techniques and measured any of the following outcomes: Bleeding, Pain, Infection, Amount of Necrotic Tissue, and Exudate. Articles were excluded if they focused on a cleansing solution other than normal saline, a cleansing method other than irrigating or swabbing, participants with acute wounds, animal studies, and another debridement method including dressings and instillation therapy

2.4 Quality Assessment

Data extraction of studies that met inclusion criteria for demographic information, study design and methodology, intervention characteristics, and outcome measures was conducted independently by two researchers. The included studies were then assessed for methodological quality by two authors independently using the revised Cochrane Risk of Bias Tool for Randomized Trials (RoB 2.0) (Sterne et al., 2019). Methodological quality was graded as high risk of bias, low risk of bias, or unclear risk of bias.

2.5 Data Synthesis

For studies reporting dichotomous outcomes, it was planned to use odds ratios and relative risk determined by using a 95% confidence interval. For continuous outcomes, it was planned to use weighted mean differences or standardized mean difference, and skewed or nonquantitative data reported using descriptive statistics. In the event the data was heterogenous, synthesis

would be reported using a narrative approach to discuss identified trends. Because the search revealed an included study, a summary presentation of the article was provided.

3. RESULTS

3.1 Review Process

The final systematic search yielded 10,391 articles: Ovid Medline 5062; Cochrane Database of Systematic Reviews 1037; CINAHL 787; EMBASE 3505, of which 2,884 were removed as duplicates (Appendix A). Two independent reviewers screened the remaining 7507 articles. A further 7500 articles were eliminated in the title/abstract screen, and 7 were selected for full-text search. After full-text review, one study met the inclusion criteria (Figure 1). No further studies were found through manual search of reference lists. Studies were included if there was comparison of swabbing and irrigation techniques of noninfected wounds with any one of the desired outcomes, pain, amount of necrotic tissue, infection, bleeding, or level of exudate.

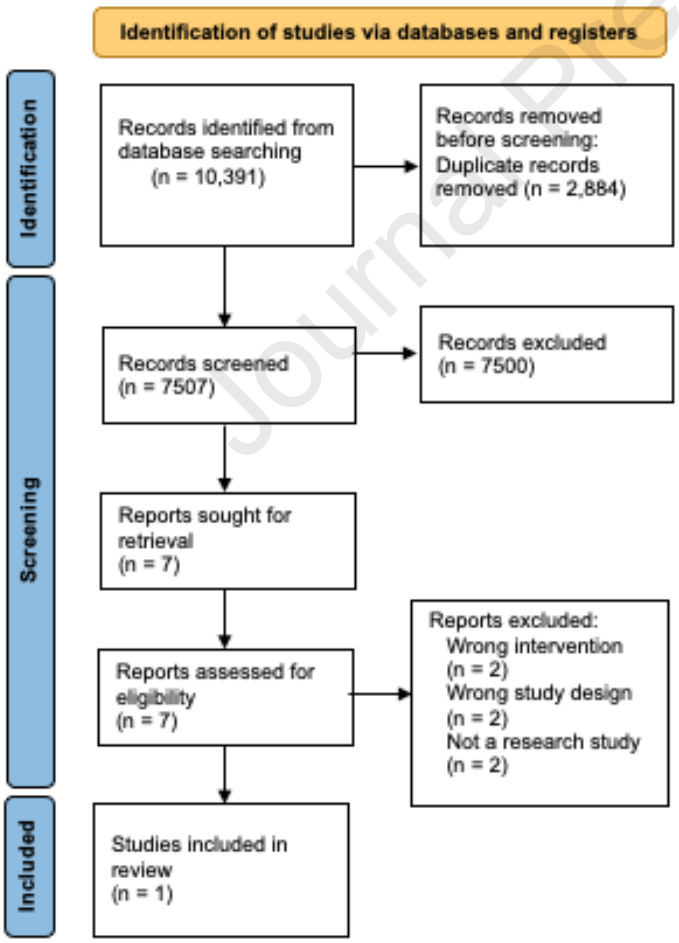

Figure 1. PRIMSA flow chart

3.2 Description of Included Study

One study (RCT) met the inclusion criteria because it compared pressure irrigation with swabbing with normal saline. The population included adult participants with burns or scalds, lacerations or abrasions, dehisced surgical wounds, leg ulcers, dog bites, and other partial-thickness wounds that heal by secondary intention. Outcomes measured included infection and pain, but did not include other outcomes of interest such as bleeding, exudate, or amount of necrotic tissue. Mak et al (2015) recruited a total of 256 participants as 122 participants were required for each arm due to the sample size calculation. Apart from patient satisfaction and health-related quality of life, the primary and secondary endpoints were analyzed based on intention to treat. Of the 256 patients, 12 met the inclusion criteria for the presence of a leg ulcer. The characteristics of the included studies are summarized in Table 1. To achieve a consistent pressure range of irrigation flow (4 to 13 psi), a DeVilbiss syringe was connected to the Gomco® Model 309 vacuum/pressure pump. Demographic data showed a higher proportion of patients with chronic underlying disease and a larger initial wound size in the swabbed group. Signs of infection were detected by the patient using a self-assessment took and confirmed supported by a physician masked to treatment allocation.

Table 2. Characteristics of Included Study

Authors (Year)	Country	Study Design	Setting/ Sample	Sample		Outcomes			
				Swabbing	Irrigation	Median Time to Heal	Lower Pain Rating	Infection Rate	Wound Closure
Mak et al., 2015	China	RCT	Outpatient clinics Traumatic wounds (30.1%) Burns/ scalds (17.6%) Dehisced surgical wounds (17.2%)	(n=134) Cleansed using swabbing technique that used forceps and cotton wool from a sterile dressing pack	(n=122) In addition to procedure for swabbing, used DeVilbiss syringe attached to the Gomco Vacuum/ Pressure Model 309 to deliver 4 to 13 psi	Swabbing 12 days (95% CI: 10.2-13.8 days) Irrigation 9 days (95% CI: 7.4-10.6 days) p = 0.007	Swabbing 84.2% Irrigation 93.4% p = 0.02	Swabbing 5.2% Irrigation 3.3% p = 0.443	Swabbing 78.4% Irrigation 82.0% p = 0.470

Abbreviations: RCT, randomized controlled trial; psi, pounds per square inch; CI, confidence interval)

3.3 Risk of Bias Assessment

The methodological quality of the study was assessed independently by two reviewers using the Cochrane risk of bias 2.0 tool (Figure 2). Rationale for each domain grade is provided in Table 3.

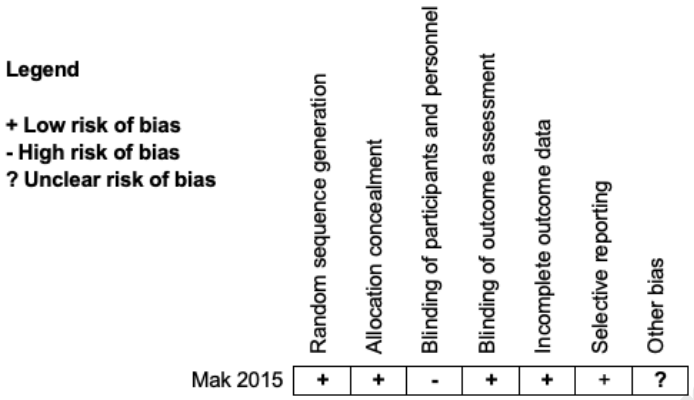

Figure 2. Risk of Bias Summary

Table 4. Risk of Bias Assessment

Source of Bias	Support for Rating	Overall Rating
Random sequence generation	Blinded statistician created computer generated random codes prior to recruitment.	Low risk of bias
Allocation concealment	Sealed opaque envelopes with serial numbers prepared by the statistician who was blinded.	Low risk of bias
Blinding of participants and personnel	Potential performance bias as both participants and personnel were unable to be blinded due to the difference in technique.	High risk of bias
Blinding or outcome assessment	Participants were blinded for data collection and wound assessment.	Low risk of bias
Incomplete outcome data	Description was provided for patients lost to follow-up and intention to treat was used to compute results.	Low risk of bias
Selective reporting	All outcomes were reported.	Low risk of bias
Anything else, ideally prespecified	Wide variance of dressing types were included and varying amounts of normal saline were used to cleanse each wound. There was no description on education and training or the type of health care professional performing the cleansing. There was no indication of an assessment tool used to clinically diagnose infection.	Unclear risk of bias

4. DISCUSSION

Overal, the study by Mak et al (2015) was found to have a low risk of bias. An electronic pump was used to create a standardized pressure range of 4 to 13 psi for the irrigation group, and it was found that wounds cleansed with irrigation had fewer infections and less pain than wounds in the swab group (Mak et al., 2015). The authors report there was no significant difference between the groups in adverse events such as wound pain, fluid leaking from the dressing, itching, bleeding, and odour; however, they unequivocally report that pain was significantly less in the irrigation group.

Limitations of this study include the large proportion of traumatic wounds compared to chronic wounds, the variability of dressings used, and the lack of description of training for the medical staff who performed the cleansing. In addition, full-thickness wounds were excluded from the study and of the 256 participants only 12 had leg ulcers limiting the generalizability of the results, as many chronic wounds encountered today penetrate the dermis and are complicated by chronic disease processes. There was no description of what education or training was provided for irrigation prior to data collection. Nevertheless, this method of cleansing was new to healthcare professionals and would have required education and training to ensure appropriate irrigation technique was used.

There continues to be much debate as to whether wound cleansing is a necessary part of wound care or merely a ritualistic behavior. Regardless, many wound care experts and best practice guidelines from around the world continue to view cleansing as part of the foundation of wound healing and wound bed preparation (Sibbald et al, 2021; LeBlanc et al, 2021; NPIAP/EPUAP/PPPIA, 2019). High-quality evidence supporting one cleansing method over another is scarce, and existing studies do not address high-prevalence types of chronic wounds such as leg ulcers and diabetic foot ulcers.

A systematic review by Fernandez et al in 2004 sought to identify and evaluate evidence comparing the efficacy of cleansing solutions, techniques and pressure. The authors were able to identify a comparative cross-sectional study with concurrent controls comparing irrigation with swabbing technique using saline-soaked gauze. This showed the incidence of wound infection between the irrigation and non-irrigation groups was not statistically significant (0.9% versus 1.4; $p = 0.28$) (Hollander et al., 1998); however, the population included in this study was limited to patients with lacerations of the face or scalp who were receiving

prophylactic antibiotic therapy. It is difficult to say beyond doubt that one solution is superior to another without first determining the effectiveness of cleansing techniques using standard solutions such as normal saline or potable water. Although the debate over the use of potable water versus normal saline in chronic wounds remains contentious, it is still recommended that sterile products be used in patients with compromised immune systems and deep wounds (Sibbald et a., 2021).

Many guidelines and best practice recommendation documents referenced today suggest that a pressure range of 4 to 15 psi is required to achieve desired outcomes in wound irrigation (Perry et al., 2012; RNAO, 2016; Wounds Canada, 2017); however, primary sources are not referenced, so these recommendations are expert opinion only (Perry et al., 2012; NPIAP/EPUAP, 2009). Fernandez et al. (2005) caution against using pressure at the extreme ends of the range when irrigating, as the lower end is unable to remove bacteria and debris, and the higher range may actually cause tissue damage. The authors conclude that a pressure of 13 psi is required during irrigation to dislodge bacteria from the wound bed (Fernandez et al., 2005). Ho et al (2012) reported that pulsatile irrigation with a pressure of 11 psi is optimal to achieve a reduction in wound volume. However, the study had a small sample size, there was a high risk of selection bias as the healthcare professionals performing the intervention were not blinded, and there were no controls for the types of dressing protocols used thereby increasing the risk of performance bias (Ho et al., 2012). Another systematic review from Ireland looked at wound cleansing solutions and techniques specifically for pressure injuries. Only one study was found that compared cleansing techniques with and without whirlpool. Wounds cleaned with or without a whirlpool showed no statistically significant difference (RR 2.10, 95% CI 0.93-4.76) (Moore et al., 2008). Standard care in both groups was wound cleansing using irrigation technique with normal saline and the same wound dressing with saline soaked gauze changed twice daily.

One recent trend in wound care is the development and increasing availability of commercially manufactured surfactant-based wound cleansers. As biofilm continues to play an important role in the management of chronic wounds, many opinion leaders are advocating the use of surfactant-based cleansers as the new standard of care (Murphy et al., 2020; Chamanga et al., 2015). While these cleansers may serve to reduce signs of inflammation and overall healing rates (Bellingeri et al., 2016), the use of these products adds significant costs associated with wound care. Therefore, it is imperative to further research be conducted to explore the use of

more traditional solutions and techniques to first determine the impact of each method on the wound bed and identify the factors that contribute to nurses choosing one technique or solution over another.

5. CONCLUSION

This work highlights the continuing need for further research in this important area of wound management. Other systematic reviews over the years have concluded there is a tremendous need for research; yet, 15 years later, there is only one study legitemitely comparing basic wound cleansing techniques (Mak et al., 2015). As more advanced and costly products come to market, and key opinion leaders advocate for their adoption as the new standard of care (Murphy et al, 2021; Bellingeri et al, 2016; Chamanga et al, 2015; Percival et al, 2019), public health funders should first ensure the problem of persistent chronicity is not due to another factor.

Recent reviews confirm there is insufficient evidence to support the use of surfactants and emphasize the importance of effective wound cleansing (Percival et al., 2019); however, surfactant-based cleansers are still recommended by experts over more traditional methods. One paper reviewing multiple studies using a common surfactant-based cleanser reported significantly high positive results in terms of improved wound closure and lower infection rates. Nevertheless, there are many confounding factors, such as small sample size, administration of systemic antibiotics during the study, and a lack of description of dressing protocols and treatment of the underlying etiology (Cutting, 2010). Rather than investigating the impact of each technique on important components of wound care or the level of training of the healthcare professional performing the cleansing, there seems to be a driving need to ignore this important factor rather than address it. Percival et al (2019) highlight the fact that inadequate cleaning is likely to compromise the efficacy of surfactant-based cleaning products, rendering these expensive products useless (Percival et al (2019)). Therefore, it is imperative that studies are conducted to highlight the varying outcomes associated with key wound cleansing techniques using simple, cost-effective solutions.

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8. CONFLICT OF INTEREST

All authors declare no conflict of interest regarding this work.

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Appendix A
Search Terms

All Ovid Medline <1946 – 02/14/2022>

1 exp Therapeutic Irrigation/ 53300
2 (irrigat* or lavag* or spray* or soak* or rins* or douch*).ti,ab,kf. 164590
3 (wound* adj3 (care or clean: or cleansing)).ti,ab,kf. 11288
4 (wound* adj3 (irrigation or irrigat:)).ti,ab,kf. 896
5 (wound* adj3 (wash: or washing)).ti,ab,kf. 268
6 1 or 2 or 3 or 4 or 5 192582
7 Debridement/ 17254
8 (swab* or tamponade or scrub* or debride or debridement).ti,ab,kf. 91074
9 7 or 8 98709
10 6 or 9 [debridement or irrigation] 284091
11 exp Skin Ulcer/ 48322
12 Diabetic Foot/ 10203
13 "Abscess"/ 28509
14 ((ulcer or ulcers or ulceration or breakdown) adj3 (skin or leg or venous or varicose or foot or feet or stasis or pressure)).ti,ab,kf. 31221
15 Diabetic Foot.ti,ab,kf. 9999
16 "pressure injur*".ti,ab,kf. 1566
17 (decubitus ulcer* or bedsore* or bed sore* or pressure sore* or skin tear* or abscess*).ti,ab,kf. 89234
18 (chronic adj2 wound*).ti,ab,kf. 8105
19 secondary intention.mp. 1144
20 *Wound Healing/ 46035
21 or/11-20 198860
22 Hemorrhage/ 77726
23 (bleeding or hemorrhage or haemorrhage or hemorrhagic or hemorrhages or friabil$ or friable tissue*).ti,ab,kf. 456426
24 (hard-to-heal or unhealed or nonheal* or non-heal* or chronic).ab,kf,ti. 1298893
25 Pain/ 141360
26 Pain Management/ 38699
27 Pain Measurement/ 92351
28 pain.ti,ab,kf. 702609
29 "exudates and transudates"/ or cyst fluid/ or gingival crevicular fluid/ 14841
30 (transudate* or exudate* or exudative).ti,ab,kf. 31538
31 ((cyst* or wound*) adj2 (fluid* or discharge*)).ti,ab,kf. 6208
32 Necrosis/ 59843
33 ((necrotic or necroti?ation or necroti?ing or non?vital or non vital) adj2 (tissue* or wound*)).mp. 6198
34 exp Bacteria/gd [Growth & Development] 124408
35 (Bacterial adj3 (count or growth)).ti,ab,kf. 22682
36 bioburden.mp. 847
37 exp Biofilms/ 39594
38 biofilm*.ti,ab,kf. 60158
39 coloni?ation.ti,ab,kf. 74884
40 *infections/ or exp skin diseases, infectious/ or exp soft tissue infections/ 148069
41 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 2834218
42 10 and 21 and 41 6617
43 animals/ not humans.sh. 4925081

44 limit 41 to ("newborn infant (birth to 1 month)" or "infant (1 to 23 months)" or "preschool child (2 to 5 years)" or "child (6 to 12 years)" or "adolescent (13 to 18 years)") 391701
45 43 or 44 5316758
46 42 not 45 5691
47 limit 46 to english language 5062

ALL EBM Reviews

1 exp Therapeutic Irrigation/ 2350
2 (irrigat* or lavag* or spray* or soak* or rins* or douch*).ti,ab,kf. 21733
3 (wound* adj3 (care or clean: or cleansing)).ti,ab,kf. 1920
4 (wound* adj3 (irrigation or irrigat:)).ti,ab,kf. 294
5 (wound* adj3 (wash: or washing)).ti,ab,kf. 113
6 1 or 2 or 3 or 4 or 5 24048
7 Debridement/ 690
8 (swab* or tamponade or scrub* or debride or debridement).ti,ab,kf. 9339
9 7 or 8 9541
10 6 or 9 [debridement or irrigation] 32364
11 exp Skin Ulcer/ 3261
12 Diabetic Foot/ 1148
13 "Abscess"/ 358
14 ((ulcer or ulcers or ulceration or breakdown) adj3 (skin or leg or venous or varicose or foot or feet or stasis or pressure)).ti,ab,kf. 6643
15 Diabetic Foot.ti,ab,kf. 2679
16 "pressure injur*".ti,ab,kf. 219
17 (decubitus ulcer* or bedsore* or bed sore* or pressure sore* or skin tear* or abscess*).ti,ab,kf. 4022
18 (chronic adj2 wound*).ti,ab,kf. 974
19 secondary intention.mp. 218
20 *Wound Healing/ 0
21 or/11-20 12705
22 Hemorrhage/ 4405
23 (bleeding or hemorrhage or haemorrhage or hemorrhagic or hemorrhages or friabil$ or friable tissue*).ti,ab,kf. 62548
24 (hard-to-heal or unhealed or nonheal* or non-heal* or chronic).ab,kf,ti. 158249
25 Pain/ 12400
26 Pain Management/ 4199
27 Pain Measurement/ 22760
28 pain.ti,ab,kf. 188001
29 "exudates and transudates"/ or cyst fluid/ or gingival crevicular fluid/ 650
30 (transudate* or exudate* or exudative).ti,ab,kf. 1528
31 ((cyst* or wound*) adj2 (fluid* or discharge*)).ti,ab,kf. 576
32 Necrosis/ 520
33 ((necrotic or necroti?ation or necroti?ing or non?vital or non vital) adj2 (tissue* or wound*)).mp. 416
34 exp Bacteria/gd [Growth & Development] 58
35 (Bacterial adj3 (count or growth)).ti,ab,kf. 965
36 bioburden.mp. 76
37 exp Biofilms/ 349
38 biofilm*.ti,ab,kf. 1393
39 coloni?ation.ti,ab,kf. 4171

40 *infections/ or exp skin diseases, infectious/ or exp soft tissue infections/ 3883
41 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 382629
42 10 and 21 and 41 1053
43 animals/ not humans.sh. 21
44 limit 42 to ("adult (19 to 44 years)" or "middle age (45 to 64 years)" or "middle aged (45 plus years)" or "all aged (65 and over)" or "aged (80 and over)") 1047
45 44 not 43 1047

CINAHL (787)

S1	MH "therapeutic irrigation" OR (AB "irregate" or "lavage" or "spray" or "soak" or "rinse" or "douche") OR (AB "wound" AND AB ("care" or "cleanse" or "wash" or "rinse" or "douche"))	25,705
S2	(MH "Debridement+") OR (AB "swab" or tamponade" or "scrub")	11,310
S3	S1 OR S2	35,667
S4	((MH "Skin Ulcer+") OR "skin ulcer") OR ((MM "Diabetic Foot") OR "diabetic foot") OR MH "abscess"	40,345
S5	(AB (ulcer or ulcers or ulceration or breakdown or unviable) AND AB (skin or leg or venous or varicose or foot or feet or stasis or pressure)) OR AB (diabetic foot) OR (AB (pressure injuries or pressure injury or bed sore))	19,549
S6	(AB (decubitus ulcer or ulceration or breakdown)) OR ((MM "Wounds, Chronic") OR "Chronic wound") OR secondary intention	15,677
S7	S4 OR S5 OR S6	55,113
S8	(MH "Hemorrhage+") OR (AB bleeding or hemorrhage or haemorrhage or hemorrhagic or hemorrhages or friability or friable tissue)) OR (mh ("pain") or (MM "Pain Management") or (MM "Pain Measurement") OR "pain measurement" or TI pain OR AB pain OR "pain")	456,546
S9	(MM "Exudates and Transudates") OR "(exudates and transudates) OR (cyst fluid or gingival)" OR TI (transudate* or exudate* or exudative) OR AB (transudate* or exudate* or exudative) OR ("transudate*" or "exudate*" or "exudative")	5,216
S10	TI ((Cyst or wound) and (fluid or discharge)) OR AB ((Cyst or wound) and (fluid or discharge)) OR ((Cyst or wound) and (fluid or discharge)(Cyst or wound) and (fluid or discharge))	7,346
S11	(MH "Necrosis+") OR "necrosis" TI (necrotic or necroti?ation or necroti?ing) OR AB (necrotic or necroti?ation or necroti?ing) OR (necrotic or necroti?ation or necroti?ing)	30,301

S12	"Bacterial growth"	1,512
S13	(MM "Bacterial Colonization") OR (MM "Bacterial Translocation") OR (MM "Bacterial Contamination")	2,975
S14	(MM "Biofilms") OR "biofilm"	4,940
S15	"bacterial"	66,891
S16	S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15	555,896
S17	S3 AND S7 AND S16	1,822
S18	S3 AND S7 AND S17	787
S19	S3 AND S7 AND S17	787

Embase Classic+Embase <1947 to 2021 July 21>

1 exp therapeutic irrigation/ or exp lavage/ or therapeutic irregation.mp. 94077
2 ("irregate" or "lavage" or "spray" or "soak" or "rinse").mp. or "douche".ti,ab,kw. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word] 169430
3 (wound adj (care or cleans* or wash: or rins: or douch:)).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word] 22120
4 debridement.mp. or exp debridement/ 60898
5 (swab* or tamponade* or scrub*).ti,ab,kw. 90782
6 or/1-5 336308
7 skin ulcer/ 20914
8 diabetic foot/ or diabetic foot.ti,ab,kw. 20533
9 abscess/ 56974
10 ((ulcer* or ulceration or breakdown) adj3 (skin or leg or venous or varicose or foot or feet or stasis or pressure)).ti,ab,kw. 45060
11 diabetic foot.ti,ab,kw. 14659
12 pressure injur*.ti,ab,kw. 1901
13 decubitus ulcer.mp. or exp decubitus/ 25219
14 wounds chronic.mp. or exp chronic wound/ 5468
15 or/7-14 148202
16 exp bleeding/ 1108532
17 hemorrhage/ or (haemorrhage or hemorrhagic or hemorrhages or friability or friable tissue).ti,ab,kw. 277222
18 exp pain/ 1548251
19 pain management/ 106792
20 pain measurement.mp. or exp pain measurement/ 24839
21 pain.ti,ab,kw. 1075932
22 exudates.mp. or exp exudate/ 25475
23 exp pleura effusion/ or transudate.mp. 73070
24 ((cyst* or wound*) adj2 (fluid or discharge or effus:)).ti,ab,kw. 8187
25 exp necrosis/ or necrosis.mp. 1362667
26 (necrotic or necroti?ation or necroti?ing).ti,ab,kw. 113656

27	bacterial infection.mp. or exp bacterial infection/	1117231
28	(bacteria* adj3 (count$ or growth or load or measur$)).ti,ab,kw.	57538
29	exp bacterial count/	33081
30	exp biofilm/ or biofilm.mp.	75442
31	16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30	5168925
32	6 and 15 and 31	6717
33	limit 32 to (human and english language)	5771
34	limit 33 to (adult <18 to 64 years> or aged <65+ years>)	3505

Highlights for Wound irrigation versus swabbing technique for cleansing noninfected chronic wounds: A systematic review of differences in bleeding, pain, infection, exudate, and necrotic tissue

- Wound cleansing practice continues to be influenced by expert opinion alone.
- Inadequate wound cleansing can lead to biofilm and wound chronicity.
- Studies continue to be lacking in the comparison of cleansing techniques.
- Lack of research has allowed industry to introduce more costly, advanced products.

Conflict of Interest Statement

Prof. Dimitri Beeckman and Dr. Kevin Woo speak on behalf of various industry in the field of wound care; however, there are no conflicts of interest regarding the development of this work.