Mahendra et al, 2024
https://doi.org/10.70196/jwrt.v1i1.2

Journal of Wound Research And Technology

Received: 14-3-2024; Revised: 14-4-2024, Publish Online: 3-5-2024

ORIGINAL RESEARCH Open Access

An analysis of various wound washing methods and their efficacy in treating chronic wounds: A comprehensive review of existing literature

Rahmat Effan Fahri Mahendra[1], Asmat Burhan[1], Indah Susanti[2]

[1]*Departmen Wound Care Unit, Pontianak Nursing Care, Pontianak, West Kalimantan, Indonesia*
[2]*School of Nursing Anasthesia, Universitas Harapan Bangsa, Banyumas, Indonesia*
[3]*School of Nursing, Universitas Harapan Bangsa, Banyumas, Indonesia*

Abstract
Background: Methods for treating wounds continue to evolve in response to the increasing number of wounds seen each year. Whether patients have chronic or acute wounds, proper wound care can improve their quality of life. One of the most effective ways to speed up the wound healing process is to wash it. As excessive or inappropriate washing procedures can cause trauma to the wound bed, it is important to tailor the washing method to the specific wound condition.
Purpose: Comparing the efficacy of different wound cleansing techniques for chronic wounds.
Methods: A literature review. This research study is a literature review using PI(E)O (patient, intervention/exposure, and outcome) to determine the keywords used in the search in several databases. The databases used were PubMed, Wiley Online Library, Science Direct and ProQuest. The keywords used were (Wound Cleansing Method OR Wound Cleansing Technique) AND (Acute OR Chronic Wound.
Results: A total of 16,500 articles were identified, after screening for the last 5 years (2019-2024), in English, full text, duplication, and according to the title and abstract, 18 articles were obtained, and 9 articles were included in this study. The results of the literature search found nine articles describing the wound washing methods used by patients with acute and chronic wounds, including swabbing in 2 articles, and irrigation in 7 articles.
Conclusion: Irrigation is the most widely used method, due to the reduced number of bacteria, short healing time, minimal pain and high satisfaction rate. In addition, the irrigation method can be used in conjunction with other methods.

Keywords: wound cleansing, wound care, wound chronic

*Correspondence: Rahmat Effan Fahri Mahendra, Email: rahmadefm@gmail.com

Introduction

Wound prevention and care continue to rank high among the most pressing health issues, contributing to morbidity on a global scale (Monika et al., 2022). Research shows that bacterial infections cause the deaths of at least 10,000 people per one million wounded people (Ikuta et al., 2022). There was an increase from 8.2% to 9.2% in the prevalence of wounds in Indonesia, according to the Basic Health Research (Ministry of Heallth RI, 2018). Acute wounds are those that heal quickly, while chronic wounds take longer (Armstrong et al., 2022). While chronic wounds can take months to heal completely, acute wounds usually heal quickly and without problems (Iqbal et al., 2017). Failure to adequately treat acute wounds can lead to the development of chronic wounds, which in turn can cause greater problems, such as impaired daily functioning, increased cost of care, and decreased quality of life (Budirahmadina et al., 2023; Gould et al., 2015).

A healthy wound healing process is highly dependent on optimal wound care (Tottoli et al., 2020). Patients' quality of life can be significantly improved with thorough wound care (Izadi et al., 2018). One of the three steps in wound care, cleaning the wound area is essential for wound management(Vogt et al., 2020). According to research (Atiyeh et al., 2009), cleaning the wound can help remove cell debris and attached bacteria, prepare the wound bed for healing, and reduce the risk of infection. Swabbing, irrigation, and bathing are the three most popular ways to wash wounds (Mak et al., 2015).

Keywords: wound cleansing, wound care, wound chronic

When comparing swabbing to irrigation, it is widely believed that swabbing is more successful in removing germs, debris, and dead tissue with less damage to healthy tissue compared to irrigation (Norman et al., 2022). While wound dressings and other wound therapies have received much attention in the scientific literature, wound washing procedures have received little attention. In addition, there is currently no consensus across healthcare provider levels regarding the best way to wash wounds, leading to variations in the healing process (Monika et al., 2022). Therefore, the aim of this study was to see how different wound washing methods affect chronic and acute wounds

Method

This research study conducted a literature review utilizing the PI(E)O framework to discover databases that were searched using specified keywords pertaining to patients, interventions, and outcomes. The databases utilized were ProQuest, ScienceDirect, Wiley Online Library, PubMed, Google Scholar. The search terms utilized were acute or chronic wounds, as well as wound washing procedures or treatments (Figure 1). We retrieved a total of 18 publications by screening throughout the past 5 years (2015-2024) in English. After eliminating duplicates and assessing the relevance of the titles, abstracts, and full texts, we included 9 articles in this study. The risk of bias was evaluated using Review Manager 5.4.1 (Cochrane, 2020)

Results

The literature search yielded twelve articles detailing various wound washing methods for both acute and chronic wounds. One of these articles,(Mak et al., 2015) focused on the swabbing method, while the other eleven articles, by (Weiss et al., 2013), (Sapra & Bhandari, 2023), (Suyanto & Amal, 2017), (Davis et al., 2020), (Lavery et al., 2020), (Ludolph et al., 2018), (Qin et al., 2019), and (Jeo et al., 2020).

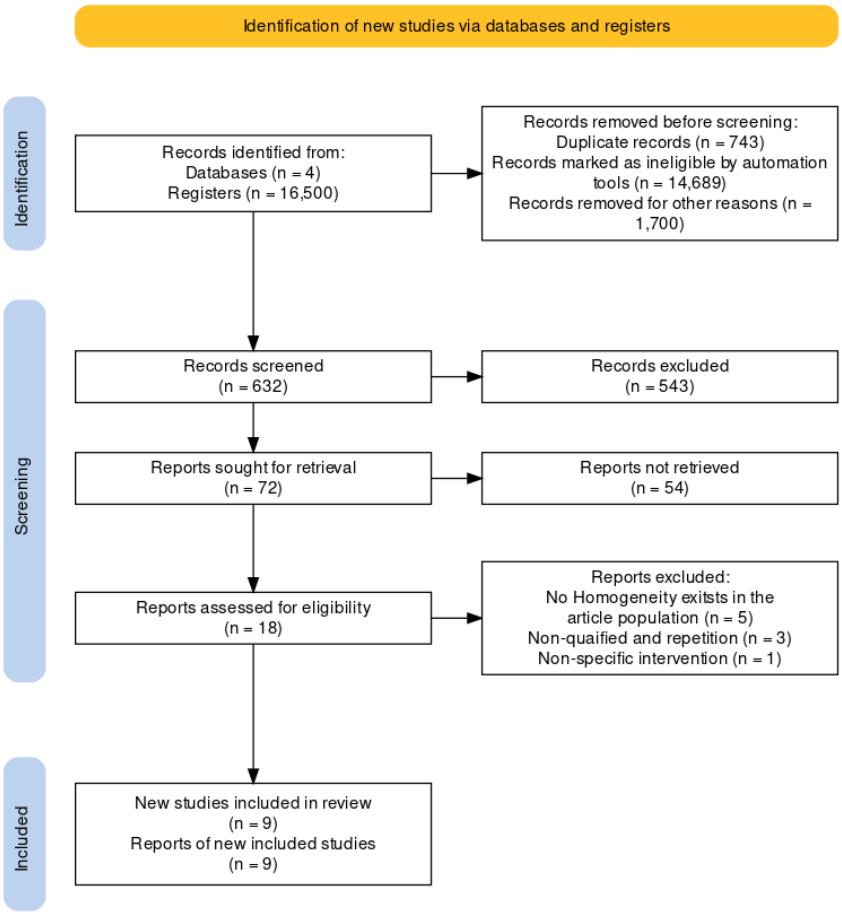

Figure 1. PRISMA Flow Chart (Haddaway et al., 2020).

A previous study conducted with a sample size of 10 participants demonstrated that the utilization of MWID devices during wound irrigation effectively decreases the bacterial count in diabetic ulcers when compared to manual irrigation procedures (Suyanto & Amal, 2017). According to a study conducted by (Mak in 2015),

pressurized irrigation was found to be a more cost-effective method for reducing the healing time of wounds that healed by secondary intention. Additionally, patients who underwent pressurized irrigation reported experiencing less pain during wound cleansing and expressed higher satisfaction with the convenience and effectiveness of this cleansing method.

The swabbing technique was studied (Sen, 2021), on 22 people suffering from chronic and acute wounds. No differences were seen in infection management or wound healing between patients who received sterile saline or tap water when swabbed. Regarding infection control, it was seen that the wounds were inflamed in both groups using different solutions; however, there was no significant increase; in addition, there were no infected wounds, pain, or excessive exudate volume. At the same time, no changes were seen in the healing process of the wounds included in the study. In a separate study, researchers compared two methods for treating acute wounds: swabbing and irrigation. The patients were separated into two groups, with one group given irrigation and the other group given swabbing. In the study conducted by(Mak et al., 2015), it was found that the group that underwent irrigation experienced decreased wound size, decreased pain levels, increased satisfaction and comfort, and cost savings. Furthermore, (Sapra & Bhandari, 2023) divided 2,215 fracture patients into three groups and found that low pressure irrigation was the most appropriate and safe option. The patients also reported no adverse effects from the other two pressure groups.

Figure 2. Risk of bias of the included studies using Rev-Man 5.4.1

Research by (Qin et al., 2019), compared irrigation procedures with administration of calcium sulfate-containing antibiotics in 74 people with persistent osteomyelitis of the lower limbs. The researchers found that calcium sulfate-containing antibiotics were more effective than irrigation in preventing recurrence of wound infection (Jeo et al., 2020), compared irrigation procedures with povidone iodine and antibiotic administration in a trial involving 80 patients who had undergone postoperative laparatomy. When looking at treatment costs, the irrigation approach proved to be cheaper than the comparator. In a study conducted (Borges et al., 2018), 44 patients suffering from venous leg ulcers were irrigated with PHMB solution or saline solution. The results showed a decrease in bacterial load in both cases. Wound improvement was demonstrated using BWAT scores, which include wound progression, inflammation, and pain ratings, in another study (Bellingeri et al., 2016). The patients, who suffered from leg ulcers and pressure sores, were administered Polyhexanide and saline solutions using an irrigation approach. Additionally, (Weiss et al., 2013), found that comparing irrigation methods using saline and tap water reduced wound infection and treatment costs in a study of 631 patients with acute wounds. A different study was conducted on pigs (De Francesco et al., 2022). They used an irrigation approach to cleanse wounds with six different solutions, and they found that MRSA biofilm decreased. The results of the risk of bias assessment of the article are presented in figure 2There was no significant difference between the two groups in terms of wound proportion, infection rate, or duration of wound healing in another study that used irrigation in conjunction with NPWT methodology (Malviya et al., 2022), (Lavery et al., 2020), found that 150 patients with diabetic foot infections used the NPWT + irrigation method, and on average, wounds healed quickly. (Ludolph et al., 2018) found that 267 patients had fewer bacteria colonizing their wounds.

Discussion

Worldwide, the prevalence of wounds, both acute and chronic, continues to increase; in fact, 2% of all hospitalized patients suffer from chronic wounds (Sen, 2021). Chronic wounds affect nearly one billion people

worldwide, according to a recent report (Yang et al., 2023). According to Nussbaum et al. (2018), this enormous number represents a large financial outlay. In addition, pain, exudates, body image and healing anxiety all impact the patient's quality of life, which is a major concern for those with chronic wounds (Frescos, 2018). Patients are expected to experience the shortest possible duration of painless wound healing with the least possible degree of scarring (Kolimi et al., 2022). Therefore, wound care is key to a speedy recovery. As part of wound care, cleaning the area is necessary (Burhan & Sebayang, 2022). In this study, the irrigation method-consisting of eleven articles-was the most used approach to wound care (Burhan & Arofiati, 2021).

One strategy that has been used for centuries to reduce bacterial load, prevent infection and accelerate wound healing is wound irrigation (Papadakis, 2021). Several different solutions were used to clean wounds in the study. Wounds must be washed with specific solutions, and biofilms are notoriously difficult to remove using isotonic irrigation (Gardezi et al., 2021). Additionally, there is debate about the relative benefits of different irrigation pressures; while high pressure can kill more germs and particles than low pressure, it also has the potential to damage bone and slow down the healing process(Burhan et al., 2023). Bone injury and slow healing may be prevented with low pressure, although foreign substances and microorganisms may be less effectively removed (Zhao et al., 2016). Studies have shown that open wound contamination cannot be adequately removed by irrigation at pressures below 10 psi (Luck et al., 2016).

In addition, NPWT is a treatment that changes the course of care and outcomes for complicated wounds (Burhan et al., 2022). Incorporating irrigation into NPWT can improve healing rates, reduce the need for amputation, and increase the proportion of wounds that heal (Armstrong et al., 2022; Burhan et al., 2022; Malviya et al., 2022). Another option is swabbing, which can damage tissue and slow down the healing process (Mak et al., 2015). Therefore, when using this method, it is important to apply as much force as the patient can handle (Burhan & Sebayang, 2022; Yu et al., 2022).

Strengths And Limitations of The Study

This study examined the efficacy of deep wound washing methods in enhancing infection control and promoting the healing of chronic wounds. While this review provides strong evidence and a focused study strategy, there are a few possible drawbacks. These factors encompassed the incorporation of small-scale research, keyword-based searches, a restricted number of articles in English, and diverse measurements of outcomes. Additionally, heterogeneity was also detected in certain studies. Furthermore, a prevalent critique of this literature evaluation is that it amalgamated various types of investigations in a comparable inquiry, perhaps leading to an overall assessment that fails to acknowledge noteworthy disparities across the studies. The study's bias was evaluated using metrics from the review manager.

implications on patient care and the profession.

Implications for the profession and/or patient care: The results of this study contribute very important information for wound nurses, especially in the selection of chronic wound washing techniques. The findings will benefit all wound nurses, healthcare providers, researchers and academics who provide chronic wound care.

Conclusion

The objectives of wound cleansing methods for both chronic and acute wounds encompass the eradication of microbes, expediting the healing process of the wound, and enhancing the overall well-being of the patient. Irrigation is the most preferred treatment because to its ability to decrease bacterial count, promote rapid healing, minimize discomfort, and achieve a high level of patient satisfaction. Furthermore, irrigation can be employed independently or in conjunction with other methodologies.

Author contribution

Made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data: Indah Susanti; Involved in drafting the manuscript or revising it critically for important intellectual content: Asmat Burhan; Gave final approval of the version to be published. Each author must participate sufficiently in the work to take public responsibility for the appropriate portion of the content: Indah Susanti, Asmat Burhan; Agree to take responsibility for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work can be appropriately investigated and resolved: Indah Susanti and Asmat Burhan.

Acknowledgment

The authors would like to thank the Faculty of Nursing Science, Faculty of Health, Universitas Harapan Bangsa, Indonesia

Funding Information

None

Conflict of Interest Statement
The authors declare that they have no competing interests.

Data Availability
On a proper request, the owner of the dataset that has either developed or analysed it in the current study can be contacted directly.

Reference

Armstrong, D. G., Orgill, D. P., Galiano, R. D., Glat, P. M., Kaufman, J. P., Carter, M. J., DiDomenico, L. A., & Zelen, C. M. (2022). Use of a purified reconstituted bilayer matrix in the management of chronic diabetic foot ulcers improves patient outcomes vs standard of care: Results of a prospective randomised controlled MULTI-CENTRE clinical trial. *International Wound Journal*, *19*(5), 1197–1209. https://doi.org/10.1111/iwj.13715

Atiyeh, B. S., Dibo, S. A., & Hayek, S. N. (2009). Wound cleansing, topical antiseptics and wound healing. *International Wound Journal*, *6*(6), 420–430. https://doi.org/10.1111/j.1742-481X.2009.00639.x

Bellingeri, A., Falciani, F., Traspedini, P., Moscatelli, A., Russo, A., Tino, G., Chiari, P., & Peghetti, A. (2016). Effect of a wound cleansing solution on wound bed preparation and inflammation in chronic wounds: A single-blind RCT. *Journal of Wound Care*, *25*(3), 160–168. https://doi.org/10.12968/jowc.2016.25.3.160

Borges, E. L., Frison, S. S., Honorato-Sampaio, K., Guedes, A. C. M., Lima, V. L. D. A. N., Oliveira, O. M. M. D., Ferraz, A. F., & Tyrone, A. C. (2018). Effect of Polyhexamethylene Biguanide Solution on Bacterial Load and Biofilm in Venous Leg Ulcers: A Randomized Controlled Trial. *Journal of Wound, Ostomy & Continence Nursing*, *45*(5), 425–431. https://doi.org/10.1097/WON.0000000000000455

Budirahmadina, N. A., Perdanakusuma, D. S., Ervianti, E., & Saputra, I. D. (2023). The Clinical Profile of Patients with Chronic Wounds at Dr. Soetomo General Hospital 2015-2020. *Berkala Ilmu Kesehatan Kulit Dan Kelamin*, *35*(1), 57–66. https://doi.org/10.20473/bikk.V35.1.2023.57-66

Burhan, A., Ali Khusein, N. bin, & Sebayang, S. M. (2022). Effectiveness of negative pressure wound therapy on chronic wound healing: A systematic review and meta-analysis. *Belitung Nursing Journal*, *8*(6), 470–480. https://doi.org/10.33546/bnj.2220

Burhan, A., & Arofiati, F. (2021). *Effect of Compression Bandage on the Healing of Diabetic Foot Ulcers: A Scooping Review:* 4th International Conference on Sustainable Innovation 2020–Health Science and Nursing (ICoSIHSN 2020), Yogyakarta, Indonesia. https://doi.org/10.2991/ahsr.k.210115.110

Burhan, A., Arofiati, F., Abreu Da Silva, V., & Mixrova Sebayang, S. (2023). Effect of ankle brachial index (abi) and compression therapy on diabetic foot ulcer healing. *Current Diabetes Reviews*, *19*. https://doi.org/10.2174/1573399819666230331083420

Burhan, A., & Sebayang, S. M. (2022). The Combination of Polyhexamethylene Biguanide and Cadexomer Iodine in Healing Chronic Venous Leg Ulcers: A Case Report. *Viva Medika: Jurnal Kesehatan, Kebidanan Dan Keperawatan*, *16*(1), 12–21. https://doi.org/10.35960/vm.v16i1.832

Cochrane. (2020). *Welcome to RevMan 5.4*. Cochrane Review. https://training.cochrane.org/system/files/uploads/protected_file/RevMan5.4_user_guide.pdf

Davis, K. E., La Fontaine, J., Farrar, D., Oz, O. K., Crisologo, P. A., Berriman, S., & Lavery, L. A. (2020). Randomized clinical study to compare negative pressure wound therapy with simultaneous saline irrigation and traditional negative pressure wound therapy for complex foot infections. *Wound Repair and Regeneration*, *28*(1), 97–104. https://doi.org/10.1111/wrr.12741

De Francesco, F., Riccio, M., & Jimi, S. (2022). Contribution of Topical Agents such as Hyaluronic Acid and Silver Sulfadiazine to Wound Healing and Management of Bacterial Biofilm. *Medicina*, *58*(6), 835. https://doi.org/10.3390/medicina58060835

Frescos, N. (2018). Assessment of pain in chronic wounds: A survey of Australian health care practitioners. *International Wound Journal*, *15*(6), 943–949. https://doi.org/10.1111/iwj.12951

Gardezi, M., Roque, D., Barber, D., Spake, C. S. L., Glasser, J., Berns, E., Antoci, V., Born, C., & Garcia, D. R. (2021). Wound Irrigation in Orthopedic Open Fractures: A Review. *Surgical Infections*, *22*(3), 245–252. https://doi.org/10.1089/sur.2020.075

Gould, L., Abadir, P., Brem, H., Carter, M., Conner-Kerr, T., Davidson, J., DiPietro, L., Falanga, V., Fife, C., Gardner, S., Grice, E., Harmon, J., Hazzard, W. R., High, K. P., Houghton, P., Jacobson, N., Kirsner, R. S., Kovacs, E. J., Margolis, D., … Schmader, K. (2015). Chronic Wound Repair and Healing in Older Adults: Current Status and Future Research. *Journal of the American Geriatrics Society*, *63*(3), 427–438. https://doi.org/10.1111/jgs.13332

Haddaway, N. R., Page, M., Pritchard, C. C., & McGuinness, L., A. (2020). *PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis Campbell Systematic Reviews*. https://doi.org/10.1002/cl2.1230

Ikuta, K. S., Swetschinski, L. R., Robles Aguilar, G., Sharara, F., Mestrovic, T., Gray, A. P., Davis Weaver, N., Wool, E. E., Han, C., Gershberg Hayoon, A., Aali, A., Abate, S. M., Abbasi-Kangevari, M., Abbasi-Kangevari, Z., Abd-Elsalam, S., Abebe, G., Abedi, A., Abhari, A. P., Abidi, H., … Naghavi, M. (2022). Global mortality associated with 33 bacterial pathogens in 2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, *400*(10369), 2221–2248. https://doi.org/10.1016/S0140-6736(22)02185-7

Iqbal, A., Jan, A., Wajid, M., & Tariq, S. (2017). *Management of Chronic Non-healing Wounds by Hirudotherapy*.

Izadi, M., Bozorgi, M., Hosseine, M. S., Khalili, N., & Jonaidi-Jafari, N. (2018). Health-related quality of life in patients with chronic wounds before and after treatment with medical ozone. *Medicine*, *97*(48), e12505. https://doi.org/10.1097/MD.0000000000012505

Jeo, W., Pratama, D., Training Program in Surgery, Department of Surgery, Faculty of Medicine Universitas Indonesia, dr. Cipto Mangunkusumo General Hospital, Jakarta., Vanto, Y., Training Program in Surgery, Department of Surgery, Faculty of Medicine Universitas Indonesia, dr. Cipto Mangunkusumo General Hospital, Jakarta., Kekalih, A., Department of Community Medicine, Faculty of Medicine Universitas Indonesia, Moenadjat, Y., & Department of Surgery, Faculty of Medicine Universitas Indonesia, dr. Cipto Mangunkusumo General Hospital, Jakarta. (2020). Postoperative Wound Irrigation Using Distilled Water in Preventing Surgical Site Infection in a Tertiary Hospital: A Retrospective Cohort and Cost-effective Study. *The New Ropanasuri : Journal of Surgery*, *5*(1), 5–8. https://doi.org/10.7454/nrjs.v5i1.1074

Kolimi, P., Narala, S., Nyavanandi, D., Youssef, A. A. A., & Dudhipala, N. (2022). Innovative Treatment Strategies to Accelerate Wound Healing: Trajectory and Recent Advancements. *Cells*, *11*(15), 2439. https://doi.org/10.3390/cells11152439

Lavery, L. A., Davis, K. E., La Fontaine, J., Farrar, J. D., Bhavan, K., Oz, O. K., & Crisologo, P. A. (2020). Does negative pressure wound therapy with irrigation improve clinical outcomes? A randomized clinical trial in patients with diabetic foot infections. *The American Journal of Surgery*, *220*(4), 1076–1082. https://doi.org/10.1016/j.amjsurg.2020.02.044

Luck, J. B., Campagne, D., Falcón Banchs, R., Montoya, J., & Spano, S. J. (2016). Pressures of Wilderness Improvised Wound Irrigation Techniques: How Do They Compare? *Wilderness & Environmental Medicine*, *27*(4), 476–481. https://doi.org/10.1016/j.wem.2016.09.002

Ludolph, I., Fried, F. W., Kneppe, K., Arkudas, A., Schmitz, M., & Horch, R. E. (2018). Negative pressure wound treatment with computer-controlled irrigation/instillation decreases bacterial load in contaminated wounds and facilitates wound closure. *International Wound Journal*, *15*(6), 978–984. https://doi.org/10.1111/iwj.12958

Mak, S. S.-S., Lee, M.-Y., Cheung, J. S.-S., Choi, K.-C., Chung, T.-K., Wong, T.-W., Lam, K.-Y., & Lee, D. T. (2015). Pressurised irrigation versus swabbing method in cleansing wounds healed by secondary intention: A randomised controlled trial with cost-effectiveness analysis. *International Journal of Nursing Studies*, *52*(1), 88–101. https://doi.org/10.1016/j.ijnurstu.2014.08.005

Malviya, V., Goyal, S., Bansal, V., & Jaiswal, K. (2022). Clinical uses of NPWT with irrigation of normal saline in diabetic foot ulcer: Outcome assessed by DEPA score. *Journal of Cutaneous and Aesthetic Surgery*, *15*(1), 58. https://doi.org/10.4103/JCAS.JCAS_227_20

Ministry of Heallth RI. (2018). *Hasil Utama Riskesdas 2018*. Kementrian Kesehatan RI. https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf

Monika, P., Chandraprabha, M. N., Rangarajan, A., Waiker, P. V., & Chidambara Murthy, K. N. (2022). Challenges in Healing Wound: Role of Complementary and Alternative Medicine. *Frontiers in Nutrition*, *8*, 791899. https://doi.org/10.3389/fnut.2021.791899

Norman, G., Shi, C., Goh, E. L., Murphy, E. M., Reid, A., Chiverton, L., Stankiewicz, M., & Dumville, J. C. (2022). Negative pressure wound therapy for surgical wounds healing by primary closure. *Cochrane Database of Systematic Reviews*, *2022*(4). https://doi.org/10.1002/14651858.CD009261.pub7

Papadakis, M. (2021). Wound irrigation for preventing surgical site infections. *World Journal of Methodology*, *11*(4), 222–227. https://doi.org/10.5662/wjm.v11.i4.222

Qin, C.-H., Zhang, H.-A., Chee, Y.-H., Pitarini, A., & Adem Ali, A. (2019). Comparison of the use of antibiotic-loaded calcium sulphate and wound irrigation-suction in the treatment of lower limb chronic osteomyelitis. *Injury*, *50*(2), 508–514. https://doi.org/10.1016/j.injury.2018.10.036

Sapra, A., & Bhandari, P. (2023). *Diabetes*. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK551501/

Sen, C. K. (2021). Human Wound and Its Burden: Updated 2020 Compendium of Estimates. *Advances in Wound Care*, *10*(5), 281–292. https://doi.org/10.1089/wound.2021.0026

Suyanto, S., & Amal, A. I. (2017). MODERN WOUND IRRIGATION DEVICE (MWID) REDUCE THE NUMBER OF BACTERIA IN DIABETIC ULCER PATIENTS. *INDONESIAN NURSING JOURNAL OF EDUCATION AND CLINIC (INJEC)*, *2*(1), 105. https://doi.org/10.24990/injec.v2i1.125

Tottoli, E. M., Dorati, R., Genta, I., Chiesa, E., Pisani, S., & Conti, B. (2020). Skin Wound Healing Process and New Emerging Technologies for Skin Wound Care and Regeneration. *Pharmaceutics*, *12*(8), 735. https://doi.org/10.3390/pharmaceutics12080735

Vogt, T. N., Koller, F. J., Dias Santos, P. N., Lenhani, B. E., Guimarães, P. R. B., & Kalinke, L. P. (2020). Quality of life assessment in chronic wound patients using the Wound-QoL and FLQA-Wk instruments. *Investigación y Educación En Enfermería*, *38*(3). https://doi.org/10.17533/udea.iee.v38n3e11

Weiss, E. A., Oldham, G., Lin, M., Foster, T., & Quinn, J. V. (2013). Water is a safe and effective alternative to sterile normal saline for wound irrigation prior to suturing: A prospective, double-blind, randomised, controlled clinical trial. *BMJ Open*, *3*(1), e001504. https://doi.org/10.1136/bmjopen-2012-001504

Yang, C., Yang, C., Chen, Y., Liu, J., Liu, Z., & Chen, H.-J. (2023). The trends in wound management: Sensing, therapeutic treatment, and "theranostics." *Journal of Science: Advanced Materials and Devices*, *8*(4), 100619. https://doi.org/10.1016/j.jsamd.2023.100619

Yu, R., Zhang, H., & Guo, B. (2022). Conductive Biomaterials as Bioactive Wound Dressing for Wound Healing and Skin Tissue Engineering. *Nano-Micro Letters*, *14*(1), 1. https://doi.org/10.1007/s40820-021-00751-y

Zhao, R., Liang, H., Clarke, E., Jackson, C., & Xue, M. (2016). Inflammation in Chronic Wounds. *International Journal of Molecular Sciences*, *17*(12), 2085. https://doi.org/10.3390/ijms17122085