Annals of Medicine and Surgery 71 (2021) 102876

Contents lists available at ScienceDirect

Annals of Medicine and Surgery

journal homepage: www.elsevier.com/locate/amsu

Systematic Review / Meta-analysis

The role of debridement in wound bed preparation in chronic wound: A narrative review

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ARTICLE INFO

Keywords:
Debridement
Wound bed preparation
Chronic wound
Wound healing
Surgical

ABSTRACT

Objective: To provide an overview of the types of wound debridement and update the available scientific consensus on the effect of wound debridement.
Methods: The articles were searched through CINAHL, PubMed, Cochrane Library, and Medline database for relevant articles on all types of wound debridement. Articles included were all systematic review on the effectiveness of wound debridement-related outcome, published within the year 2017 until Aug 2021, in English.
Results: A total of seven scientific articles had been selected for review out of 318 screened. The authors reviewed a total of 318 titles and abstracts related to wound debridement effectiveness. Seven articles that were selected were narratively reviewed by two authors. The findings of the review were organized into autolytic, enzymatic, sharp, surgical, biological, and mechanical debridement methods and includes the advantages and disadvantages of each. The author further explored on the role of wound debridement according to wound bed preparation model. Articles were synthesized and organized based on the authors, year, total studies included in the systematic review, study range of year, total sample, debridement method, wound types, and findings.
Conclusion: Maggot debridement therapy showed a consistent finding in terms of effectiveness in debriding chronic wounds. The newer debridement method includes hydro-surgery, low-frequency ultrasonic and enzymatic collagenase debridement were getting more attention due to faster wound bed preparation and less painful. However, these newer method of debridements showed inconclusive findings and the patient safety was not clearly defined. A higher level of review is warranted in the future study.

1. Introduction

Chronic wounds affect approximately 1% of people at some point in their lives, and this figure is expected to rise in the future [1]. Chronic wounds are characterized by a complex, inflammatory nature and the production of large volumes of exudate, which obstructs the healing process [2]. To maximize clinical management of chronic wounds, they must be emancipated from the acute wound model, and wound bed preparation (WBP) is one method for accomplishing this goal.

Included in the WBP paradigm [3], wound debridement have an increasingly important role in WBP. Various types of debridement that were available reported in the literature allows the clinician to gauge the potential effect of both conservative and modernized approach to determine if the wound is progressing toward healing.

There are several types of debridement that can be applied, which is essential in getting a chronic wound that was stalled in the inflammatory phase to revert back into wound healing trajectory. Wound debridement can be categorized into autolytic, sharp/surgical, enzymatic, mechanical, and biological debridement. The rapid evidence related to new wound debridement strategies was overwhelming, and it is a challenge for clinicians to keep on track of the updates related to the effectiveness of wound debridement techniques. Therefore, this narrative review aims to provide an overview of the types of wound debridement and update the available scientific consensus on the effect of wound debridement.

2. Methods

2.1. Search strategies and study selection

A systematic search strategy was conducted to identify published

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https://doi.org/10.1016/j.amsu.2021.102876
Received 26 August 2021; Received in revised form 19 September 2021; Accepted 19 September 2021
Available online 4 October 2021
2049-0801/

studies. Specific keywords and the Medical Subject Heading (MESH) term using Boolean operators 'AND' and 'OR' involved in the searching process were: wound debridement, effectiveness, wound bed preparation, de-sloughing, chronic wound debridement, and wound healing. All systematic review articles in English that evaluating the effectiveness of any types of debridement on chronic wound published from 2017 to August 15, 2021 included in this review. Laboratory studies and any animal related studies were excluded.

2.2. Data extraction

The searched exercise identified 318 articles, and 211 duplicates were removed. Articles were screened and assessed for eligibility based on the selection criteria. A total of seven full-text articles for review were included in this narrative review. The search flow diagram was summarized in Figure A. The following information was extracted from all the studies: authors/year, total studies included in the systematic review (SR), study range of year/total sample, debridement method/wound types, and study results. Of the seven systematic reviews included, two SRs focused on hydro-surgery method [4,5]; two SRs on ultrasonic debridement [6,7], two SRs on biological debridement [8,9] and 1 SR on the effect of enzymatic debridement [10].

3. Discussion

3.1. The role of debridement in wound bed preparation

Debridement is a critical step in the WBP that aims to promote the production of healthy granulation tissue and speed the wound healing process [11]. Furthermore, removal of the devitalized tissue through the debridement process helps reduce bacterial burden and biofilm, minimize the risk of infection, and promote healthy tissue granulation, which aids the healing process [12]. Thus, performing debridement reverts a chronic wound environment into an acute milieu, allowing the wound back to a normal healing trajectory.

3.2. Wound bed preparation

The concept of WBP was initially brought to the attention of clinicians by Falanga and colleagues. Henceforth, the concept of WBP had become crucial and signified by most wound care experts in terms of how chronic wound was treated. WBP paradigm described ten approaches of chronic wound management, which include treatment of the causative factors, identify patients' concerns, determine wound heal ability status, monitor wound history and perform clinical examination, debride whenever appropriate with adequate pain control, treat infected/inflamed wound, manage moisture balance, evaluate rate of healing, consideration to active modalities for stalled but healable wound and lastly organizational support [3]. Chronic wounds are likely required a repeated debridement as part of wound management because devitalized tissue tends to resurface due to the underlying cause. As a result, constant application of appropriate debridement procedures with adequate pain control was recommended for effective chronic wound treatment.

3.3. Types of wound debridement

Debridement methods are many and varied, with a few newer alternatives emerging in recent years. It can be divided into two categories: selective and non-selective [13]. Some of the standard debridement methods were autolytic, enzymatic, mechanical, biological, and sharp/surgical debridement. All methods require varying levels of expertise and have their advantages and disadvantages.

3.3.1. Autolytic debridement

It is the process by which the body uses endogenous proteolytic enzyme to shed devitalized tissue [14,15]. In general, this type of debridement method was relatively slower, and the time taken to remove devitalized tissue using this method depends on wound size and amount of dead tissue.

3.3.2. Enzymatic debridement

It is a method of using chemical agents to break down devitalized tissue. The chemical agents contain exogenous proteolytic enzymes that soften the necrotic tissue and removed during wound cleansing. It is relatively faster than autolytic debridement. One study combined this enzymatic debridement to soften eschar using mango cut incision (MCI), resulting faster result compared to enzymatic application alone [16]. Enzymatic debridement reported as the one most cost effective debridement method, shorter duration and fewer clinical visit compared other debridement types [17]. However, precaution is needed as evidence reported some adverse events [10].

3.3.3. Sharp debridement

It is referred to as a conventional debridement using a scalpel blade or scissors to remove necrotic tissue with limited pain or bleeding. Sharp debridement can be done at patients' bedside or in a clinic by a skilled clinician with wound specialist training. Clinicians must be able to distinguish tissue types and understand anatomy as the procedure carries the risk of damage to blood vessels, nerves, and tendons.

3.3.4. Surgical debridement

It is the gold standard of wound debridement, conducted in a strict sterility environment in operation theatre by a surgeon [18–20]. The outcome was rapid, and the patient underwent this type of debridement requiring adequate pain management, similar to post-operative nursing care.

3.3.5. Biological debridement

It is usually known as maggot debridement therapy (MDT) of larval therapy. It involves using sterile larvae of green bottle fly, *Lucilia sericata* to shed all the dead tissue [20–22]. This therapy's effectiveness lies in the secretion by the maggot, which contains antibacterial and chemical secretion that can break down dead tissue.

3.3.6. Mechanical debridement

The earlier method of mechanical debridement involves using dry or wet-to-dry gauze or impregnated gauze to ripped off dead tissue. Moistened gauze was applied on a sloughy wound bed. As it dried out, the gauze was ripped off to remove dead tissue. However, due to painful experiences from the patient, new advanced debridement methods emerged, such as monofilament pads, hydro-surgery, and low-frequency ultrasonic debridement. Table A1 summarizes the type of wound debridement, mechanism of action, and advantages and disadvantages of each method.

3.4. Selecting appropriate debridement method

Selecting the appropriate method of debridement with adequate pain control, particularly for patients with chronic wounds, was challenging, as many factors were needed to consider, such as patients' underlying condition, comorbidity, patient/family-centered concern, and wound heal ability classification [3]. The selection of wound debridement types basically depends on the wound heal ability classifications: 1) healable, 2) maintenance and 3) non-healable. A healable wound has an adequate blood supply for wound healing, and the underlying cause has been corrected. Therefore, the clinician may consider active surgical debridement method, promote granulation, and provide a moist environment for the wound. Next, a maintenance wound happens either due to patient issues or other health factors that inhibit healing. Conservative debridement may be applied, preventing further deterioration of the wound and reduce moisture. Lastly, for non-healable wounds, often due to inadequate blood supply that cannot be treated or corrected, such as advanced chronic disease or the dying process. The aim of wound management fall under this classification includes enhance comfort, debridement only focusing on comfort removal of the slough, prevent infection, and moisture reduction.

3.5. Scientific evidence updates on the effect of wound debridement

The second aim of this review was to focus on the selected SRs published recently (2017–August 2021). Literature search that had been conducted aims to provide scientific evidence updates on the effect of wound debridement. Search strategy focused mainly on systematic review to report scientific evidence related to the effectiveness of the wound debridement method. For the past half-decade, the trend of wound debridement-related research was hydro-surgery, low-frequency ultrasonic debridement (LFUD), and maggot debridement therapy (MDT). Table A.2 showed an overview of the selected article in this review.

3.5.1. Hydro-surgery debridement

Hydro-surgery work based on the principle of the Venturi effect. Sterile saline is forced to flows through a tiny jet nozzle, create a localized vacuum. This concurrently grasps cuts and removes dead tissue and debris from the wound. Based on this finding, it was identified that hydro-surgery, ultrasound, and biological debridement had been studied extensively on their effectiveness to accelerate wound healing progress. Both researchers who evaluate and critically appraise the effect of hydro-surgery stated that this system was 8.87 min faster compared to conventional sharp debridement and fewer debridement follow-up needed [5] in another SR evaluating the effectiveness of hydro-surgery among burn wounds reported otherwise. Twenty studies evaluating the effectiveness of hydro-surgery among patients with burn wounds shows inconsistent result in the two SRs due to limited of high quality trials, therefore more prospective RCT is to be conducted [4].

3.5.2. Ultrasonic debridement

The removal of dead tissue was performed using low-frequency ultrasonic waves ranging between 20 and 40 kHz to the destruction of devitalized soft tissue by the cavitation effect. Two SRs evaluated the effectiveness of lower-frequency ultrasonic debridement (LFUD) on a patient with diabetic foot ulcer [6] and chronic ulcer [7]. The ultrasonic debridement, which was compared to non-surgical sharp debridement, concluded in the SRs no significant difference in wound healing. However, Chang et al. (2017) reported that LFUD showed good outcomes under a low-frequency spectrum between 20 and 34 kHz, with a treatment frequency of 3 times per week [7].

3.5.3. Biological debridement – maggot debridement therapy

3.5.3.1. Evidence on MDT effectiveness. Biological debridement, mainly known as maggot debridement therapy (MDT), continues to attract interest among researchers and clinicians in the treatment of chronic wounds. As a choice of debridement method, MDT boasts many positive outcomes. For instance, a previous review reported that five SRs conducted between January 1960 until June 2010 consistently showed that chronic wounds treated with MDT remove all devitalized tissue faster than hydrogel [23]. Two SRs included in this review further adding to the existing evidence on the effectiveness of MDT in accelerating the process of devitalized tissue removal. In addition, venous leg ulcers [8] and other chronic wounds [9] treated with MDT demonstrate faster wound surface reduction and attained more granulation tissue.

3.5.3.2. The process of MDT. MDT begins when it was applied on to the wound surface area, either free-range or bagged. In free-range, maggots were applied directly on the wound bed and containment dressing to keep the maggots in place. Bagged maggots were sealed in a porous mesh bag. Porous beg allows the secretion from the maggots to reach the necrotic wound. Then the maggots' scrape the necrotic tissue and secrete proteolytic digestive enzymes, which dissolve and liquefy the necrotic tissue. MDT needs a prescription from the physician, with an ideal dosage of maggots were depends on the wound size. MDT was contraindicated when blood vessel exposure; acute life-threatening infections, ulcers requiring frequent inspection, necrotic bone or tendon tissues exposure; or circulatory impairment.

3.5.3.3. Healing ability. Four studies in the SR reported that the duration to complete wound closure using MDT and hydrogel group showed similar findings, indicating that types of debridement do not affect healing ability. However, the clearance of non-viable tissue can be seen as early as 1–5 weeks in a patient treated with MDT. The healing time was significantly shorter in MDT and seven times higher than conventional therapy [24].

3.5.3.4. Pain. Pain-related to MDT has been studied extensively in multiple studies. In comparison to autolytic debridement (hydrogel), the quality of pain was stronger among MDT group. The two SRs reported a higher level of pain and discomfort among patients treated with MDT. Nevertheless, the pain level decreasing upon completion of the treatment and does not affect their quality of life [24].

3.5.3.5. Cost-effectiveness. Cost-effectiveness was estimated using the cost and effectiveness of treatment over time. One study on cost-effectiveness reported that MDT was costly [17]. However, considering the debridement time was shorter than hydrogel and improved patients' quality of life, it was concluded that MDT was cost-effective [24].

3.5.3.6. Patient acceptability to MDT. Patient acceptability to MDT was an interesting issue and clinically relevant aspect to consider. Regardless of the positive effect of MDT, the patient physiological impact should always be bear in mind. Patients complain of pain during MDT may be augmented due to being psychologically unprepared, overthinking the possibility of maggots escaping and penetrating the body cavity. Due to this reason, wound clinicians must be prepared the patients' mentally, physically and psychologically prior to MDT.

3.5.4. Enzymatic debridement

One SRs on enzymatic debridement was identified, including 19 RCTs focusing on the effectiveness of enzymatic debridement with collagenase among wounds and ulcers. The SR reported that collagenase dressing promotes the removal of devitalized tissue in pressure injury wounds, diabetic foot ulcers, and burns; however, the meta-analysis showed an increased risk of an adverse event. More high-quality studies were needed to evaluate the effect of the enzymatic debridement method.

3.6. Recommendation and clinical implication

The rapid changes related to new wound debridement strategies challenge clinicians to keep on track with the latest evidence. Therefore, crucial information in this review is necessary that should be delivered to assist wound clinicians in determining the best types of debridement for the patient. In addition, this review shall benefit all clinicians and wound care nurses as it provides an insight into the types of wound debridement, the advantages and disadvantages of each and the latest evidence on new wound debridement methods. Furthermore, the updates on the WBP paradigm requires that all clinicians assess the wound based on wound heal ability classifications prior to select suitable types of wound debridement.

Given newer debridement method which includes hydro-surgery, low-frequency ultrasonic debridement (LFUD), and enzymatic collagenase debridement, all clinicians must be well equipped with the relevant and latest knowledge and skills related to wound debridement. Updating knowledge on new debriding techniques and skills can be carried out frequently under continuous education or wound management in the medical curriculum. Patients also will benefit from this updated evidence because clinicians will be able to disseminate wound debridement information to patients.

4. Conclusion

Maggot debridement therapy demonstrates a consistent finding on the effectiveness of the debridement method in treating chronic wounds. Meanwhile, a newer method of debridement such as hydro-surgery, LFUD, and collagenase enzymatic debridement in this review gained more attention on its effectiveness in promoting faster wound bed preparation and less pain. However, more studies were required in future, focusing on patient safety.

Table A.1
The types of wound debridement

Debridement type	Mechanism of action	Advantages	Disadvantages	Precaution
Autolytic [14,15]	• Encourage own body endogenous proteolytic enzymes to selectively liquefy and separate non-viable tissue from healthy tissue	• Pain: relatively low • Debridement method: highly selective • Infection: lower risk • Less invasive • Available in-home therapy • Easy application	• Debridement rate: Poor • Longer duration and frequent clinical visit	• To monitor exudate level, avoid maceration
Enzymatic [15,16]	• Application of exogenous proteolytic enzymes onto wound surface to act similar to body's own endogenous enzymes • Combined with mango cut incision (MCI) to facilitate softening eschar	• Pain: relatively low • Cost effective • Debridement method: highly selective • Less invasive • Easy application	• Debridement rate: Adequate • Exudate: excessive, risk of macerated wound • Frequent clinical visit	• To monitor excessive exudate • Requires good exudate control
Sharp [15]	• Removal of non-viable tissue using forceps, scalpel blade or sterile scissors • It is considered as standard of care • Done repeatedly and commonly combined with autolytic debridement.	• Debridement method: very selective • Debridement rate: fast • Cost effective • Frequent but shorter duration of clinical visit • Recovery time: relatively shorter compared to surgical • Can be done by-bedside or in procedure room	• Pain: Moderate, may require local analgesic • Invasive procedure • Infection: high • Not available for in-home therapy • Require skilled wound specialty clinician/nurse	• Risk of damaging tendons, blood vessels and nerve • To monitor any bleeding and exudate
Surgical [15,18–20]	• Similar to sharp debridement but carried out in operation theatre to reduce risk of infection. • Referred as gold standard for debridement	• Debridement method: very selective • Debridement rate: immediately • Cost effective	• Pain: Very painful, anaesthetic is required • Invasive procedure • Infection: very high • Recovery time: longer • Only done by surgeon • Longer recovery time • Healthy tissue may be sacrifices along with necrotic tissue	• To monitor any bleeding and exudate • Patient may refuse procedure due to pain
Biological [20–22]	• Known as larval therapy or maggot debridement therapy (MDT) • Done by application of sterile fly larval onto the non-viable tissue • Requires physician's prescription	• Debridement rate: Rapid • Pain: Moderate • Debridement method: very selective • Larval secretion has anti-microbial properties • Shortened time to heal ulcers	• Costly but resource effective • Special training requires to apply MDT	• Escaping maggots may spread infection • To monitor for sign of skin irritation due to larval secretion
Mechanical [5,6,15]				
Conservative mechanical debridement	• Traditional method involves of using wet-to-dry dressing • Wet gauze placed on wound surface to dry, and 'pulled' away when dressing is removed	• Debridement rate: fast, but ripped off dead and health tissue • Cost: Low • Easy application • Did not require advanced skill training	• Pain: very painful • Debridement method: non-selective • Longer duration and frequent clinical visit	• Pain on removal, may traumatized patient
Hydro-surgery	• Debrides non-viable tissue using a high-pressure saline cutting technology	• Debridement rate: fast • Pain: Less pain • Debridement method: highly selective • Duration to complete procedure: quick	• Costly • Require advanced skill training • High risk of aerosol contamination	• Ensure to wear full PPE and follow infection control policy on the prevention of aerosol contamination
		• Painless	• Very costly	

(*continued on next page*)

Table A.1 (*continued*)

Debridement type	Mechanism of action	Advantages	Disadvantages	Precaution
Low-frequency ultrasonic debridement	• Debrides using low-frequency (20–40 kHz) ultrasonic-waves • Promote elimination and destruction of non-viable tissue by the cavitation effect	• Debridement method: selective • Reduce microbial bioburden	• Require maintenance debridement • Require long setup time • Require advanced skill training • Ultrasonic exposure duration: time and frequency have not been stated and clarified • Safety: unclear	• Ensure to wear full PPE and follow infection control policy on the prevention of aerosol contamination

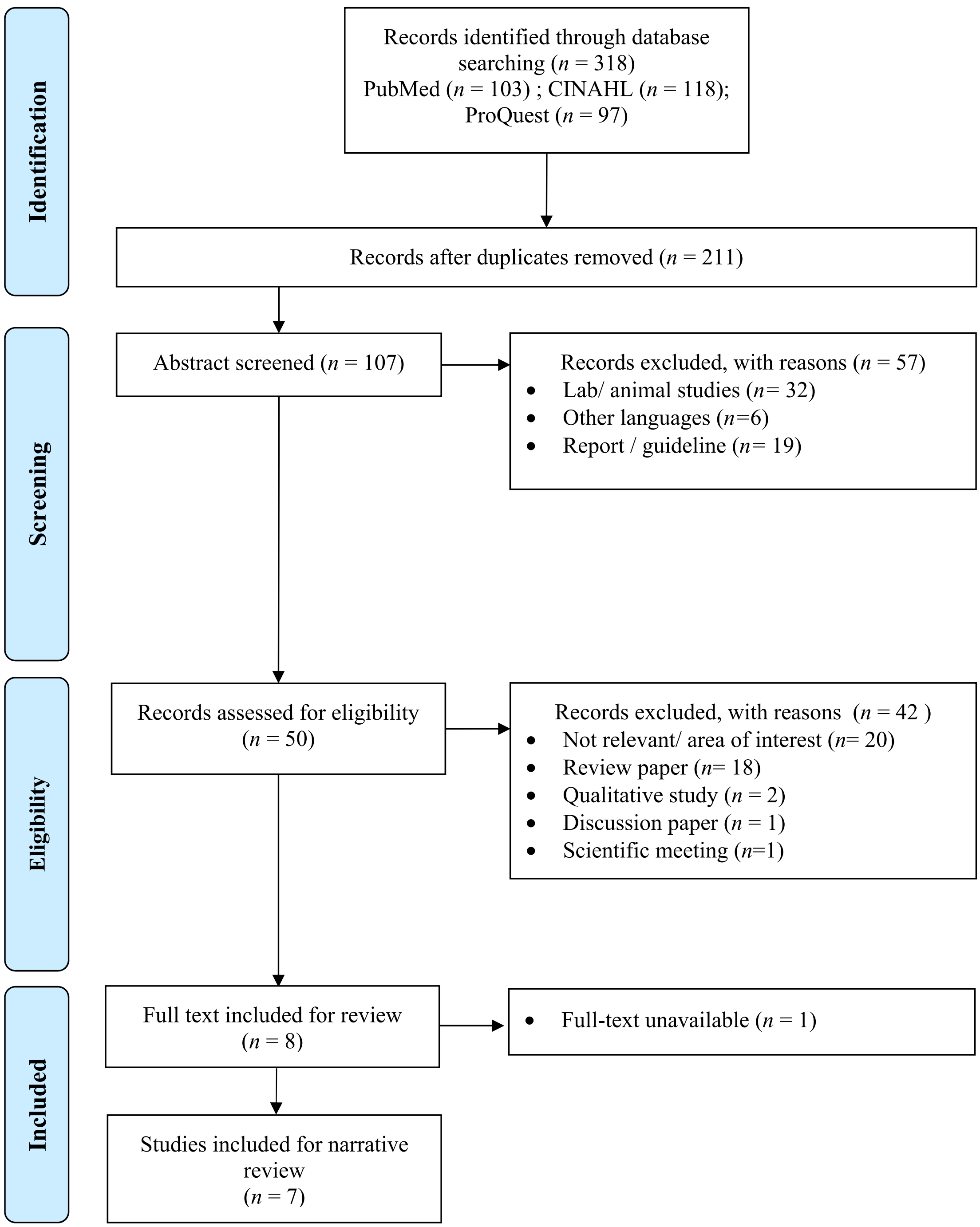

Fig. A. Article search flow diagram.

Table A.2
Overview of the included studies

Author, Year	Total studies included (n) / Study range of year / Total sample	Total and study design	Debridement method wound types	Results
Mechanical debridement				
Shimada et al. (2021) [5]	• n = 7 • Jan 1, 2000–Aug 10, 2020 • Adult = 645	Prospective RCT = 2 Retrospective RCT = 2 Case series = 3	• Hydro-surgery • Chronic wound	• A total of 8.87 min faster compared with the conventional methods. • Fewer debridement numbers needed • Considering its speed and quality, this method may benefit patients with chronic wounds
Kakagia & Karadimas (2018) [4]	• n = 20 • 2005–Oct 10, 2016 • Adults = 339; Paediatric = 91	Prospective RCT = 3 Prospective = 1 Non-controlled prospective = 3 Retrospective = 7 Case series = 6	• Hydro-surgery • Burn wound	• Limited evidence regarding the efficacy and safety of the method • No significant differences compared to the surgical debridement • Fair and limited evidence on cost-effectiveness • More prospective RCT with long-term follow-up is required establish the superiority of the method over conventional surgical debridement
Michailidis et al. (2018) [6]	• Systematic Review n = 4, Meta analysis, n = 2 • Earliest data – April 2017 • Adults = 173	RCT = 3	• Non-surgical sharp debridement (NSSD) versus LFUD • Diabetes-related foot ulceration	• Results are inconclusive • Difference was not significant in healing time • Well-designed, controlled clinical studies are needed
Chang et al. (2017) [7]	• n = 25 • 2000 to 2017 • Adults = 850	RCT = 1 Non-RCT = 3 Case report/case series, = 21	• LFUD • Chronic Wound (mainly pressure injury, venous/atrial leg ulcer)	• Low frequencies sound ranging between 20 and 34 kHz reported better results • The treatment frequency (3 times per week) • LFUD can be performed at least three weeks in a row • Potential in decreasing exudate and slough • Less pain, disperse biofilms • Increase healing in wounds of various etiology.
Biological debridement				
Greene et al. (2021) [8]	• n = 6 • Jan 2020–May 2021 • Adults = 531	RCT = 6	• Larval therapy • Venous leg ulcers	• Effective method of debridement for venous leg ulcer • Debride faster than hydrogel • Have similar effect with sharp debridement • Greater effect of debridement when combined with compression • Did not improve overall healing • Pain increase during larval therapy
Mohd Zubir et al. (2020) [9]	• n = 5 • Inception -Oct 2020 • Adults = 580	RCT = 3 Comparative studies = 2 (580 participants)	• Maggot debridement therapy (MDT) compared to hydrogel dressings • Chronic wounds.	• *Lucilia sericata* used in the majority of studies • Faster, more effective debridement of non-viable tissue compared to hydrogel • No effect on disinfection and complete healing rate
Enzymatic debridement				
Patry & Blanchette (2017) [10]	• n = 22 • Study Range (no restriction) • Adults = 927	RCT = 19 Cost-effectiveness RCT related studies = 2 Erratum reference = 1	• Enzymatic debridement with collagenase • Wounds and ulcers	• Ability to remove necrotic or devitalized tissues in pressure injury, diabetic foot ulcer, and burn with topical antibiotics • Meta-analysis reported that patients treated with collagenase have an increased risk of adverse events compared to an alternative treatment • Lack of RCTs with sound methodological quality; included studies had a high risk of bias

Please state any conflicts of interest

The authors declare no conflict of interest.

Please state any sources of funding for your research

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical approval

No ethical approval is required.

Consent

No consent is required.

Author contribution

Deena initiated the concept of paper and writing the manuscript. Deena and Nik Amin Sahid critically review the selected paper. Nik Amin Sahid supervised, reviewed and edited the manuscript.

Registration of research studies

1. Name of the registry: n/a.
2. Unique Identifying number or registration ID: n/a.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): n/a.

Guarantor

Nik Amin Sahid.

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