Systematic Review / Meta-analysis

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

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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
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. 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 flow through a tiny jet nozzle, create a localized vacuum. This concurrently grasps cuts and removes 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 bag 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, overlooking 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.
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 rate: Poor | • To monitor exudate level, avoid maceration |
| | | • Debridement method: highly selective | • Longer duration and frequent clinical visit | |
| | | • Infection: lower risk | | |
| | | • Less invasive | | |
| | | • Available in-home therapy | | |
| Enzymatic [15,16] | Application of exogenous proteolytic enzymes onto wound surface to act similar to body’s own endogenous enzymes | • Pain: relatively low | • Debridement rate: Adequate | • To monitor excessive exudate |
| | Combined with mango cut incision (MCI) to facilitate softening eschar | • Cost effective | • Exudate: excessive, risk of macerated wound | • Requires good exudate control |
| | | • Debridement method: highly selective | • Frequent clinical visit | |
| | | • Less invasive | | |
| | | • Easy application | | |
| Surgical [15, 16-20] | Removal of non-viable tissue using forceps, scalpel blade or sterile scissors | • Debridement method: very selective | • Pain: Moderate, may require local analgesic | • Risk of damaging tendons, blood vessels and nerve |
| | Done repeatedly and commonly combined with autolytic debridement. | • Debridement rate: fast | | |
| | | • Cost effective | • Invasive procedure | | |
| | | • Frequent but shorter duration of clinical visit | • Infection: high | | |
| | | • Recovery time: relatively shorter compared to surgical | • Not available for in-home therapy | | |
| | | • Can be done by-bedside or in procedure room | • Require skilled wound specialty clinician/nurse | | |
| Biological [20-22] | Known as larval therapy or maggot debridement therapy (MDT) | • Debridement rate: Rapid | • Pain: Very painful, anaesthetic is required | • To monitor any bleeding and exudate |
| | Done by application of sterile fly larval onto the non-viable tissue | • Pain: Moderate | • Invasive procedure | | |
| | Requires physician’s prescription | • Debridement method: very selective | • Infection: very high | | |
| | | • Larval secretion has anti-microbial properties | • Recovery time: longer | | |
| | | • Shortened time to heal ulcers | • Only done by surgeon | | |
| Mechanical [5, 15] | Conservative mechanical debridement | • Debridement rate: moderate | • Infection: very high | • To monitor for sign of skin irritation due to larval secretion |
| | Traditional method involves of using wet-to-dry dressing | • Pain on removal, may traumatized patient | • Debridement method: non-selective | |
| | • Wet gauze placed on wound surface to dry, and ‘pulled’ away when dressing is removed | • Debridement rate: fast | • Longer duration and frequent clinical visit | | |
| | | • Cost: Low | | | |
| | | • Easy application | | |
| | | • Did not require advanced skill training | | |
| Hydro-surgery | Debrides non-viable tissue using a high-pressure saline cutting technology | • Pain: Less pain | • Pain: very painful | • Pain on removal, may traumatized patient |
| | | • Debridement method: highly selective | • Debridement method: non-selective | | |
| | | • Duration to complete procedure: quick | • Longer duration and frequent clinical visit | | |
| | | | | | |

(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 |

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**Fig. A.** Article search flow diagram.

Records identified through database searching \(n = 318\)  
PubMed \((n = 103)\); CINAHL \((n = 118)\); ProQuest \((n = 97)\)

Records after duplicates removed \((n = 211)\)

Abstract screened \((n = 107)\)

Records excluded, with reasons \((n = 57)\)  
- Lab/animal studies \((n = 32)\)  
- Other languages \((n = 6)\)  
- Report/guideline \((n = 19)\)

Records assessed for eligibility \((n = 50)\)

Records excluded, with reasons \((n = 42)\)  
- Not relevant/area of interest \((n = 20)\)  
- Review paper \((n = 18)\)  
- Qualitative study \((n = 2)\)  
- Discussion paper \((n = 1)\)  
- Scientific meeting \((n = 1)\)

Full text included for review \((n = 8)\)

- Full-text unavailable \((n = 1)\)

Studies included for narrative review \((n = 7)\)
Table A.2
Overview of the included studies

| Author, Year | Total studies included (n) | Study range of year | Total and study design | Debridement method wound types | Results |
|--------------|---------------------------|---------------------|------------------------|-------------------------------|---------|
| Shimada et al. (2021) [5] | • n = 7 | Jan 1, 2000–Aug 10, 2020 | Prospective RCT = 2 Retrospective RCT = 2 Case series = 3 | • Hydro-surgery | A total of 8.87 min faster compared with the conventional methods. |
| | • Adult = 645 | | | • Chronic wound | 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 | Prospective RCT = 3 | Hydro-surgery | Limited evidence regarding the efficacy and safety of the method |
| | | | Prospective = 1 | Burn wound | No significant differences compared to the surgical debridement |
| | | | Non-controlled prospective = 3 | | Fair and limited evidence on cost-effectiveness |
| | | | Case series = 7 | | 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 | RCT = 3 | Non-surgical sharp debridement (NSSD) versus LFUD | Results are inconclusive |
| | | | | Diabetes-related foot ulceration | Difference was not significant in healing time |
| Chang et al. (2017) [7] | • n = 25 | • 2000 to 2017 | RCT = 1 | LFUD | Well-designed, controlled clinical studies are needed |
| | | | | Chronic Wound (mainly pressure injury, venous/atrial leg ulcer) | |
| Biological debridement | Greene et al. (2021) [8] | • n = 6 | • Jan 2020-May 2021 | RCT = 6 | Low frequencies sound ranging between 20 and 34 kHz reported better results |
| | | | • Adults = 531 | | 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. |
| | Mohd Zubir et al. (2020) [9] | • n = 5 | • Inception-Oct 2020 | RCT = 3 | Maggot debridement therapy (MDT) compared to hydrogel dressings | Effective method of debridement for venous leg ulcer |
| | | | • Adults = 580 | | 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 |
| | | | | | 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) | RCT = 19 | Enzymatic debridement with collagenase | Ability to remove necrotic or devitalized tissues in pressure injury, diabetic foot ulcer, and burn with topical antibiotics |
| | | | • Adults = 927 | Cost-effectiveness RCT related studies = 2 Erratum reference = 1 | Wounds and ulcers | 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

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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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