

Advantages of Maggot Debridement Therapy for Chronic Wounds: A Bibliographic Review

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1.5 Contact Hours

GENERAL PURPOSE: To present an overview of the advantages of maggot debridement therapy as a treatment for chronic wounds through the review of several larval properties.

TARGET AUDIENCE: This continuing education activity is intended for physicians, physician assistants, nurse practitioners, and nurses with an interest in skin and wound care.

LEARNING OBJECTIVES/OUTCOMES: After participating in this educational activity, the participant will be able to:

1. Summarize the use, process, and precautions for maggot debridement to treat chronic wounds.
2. Synthesize the results of the bibliographic review of the use of maggot debridement to treat chronic wounds.

ABSTRACT

Maggot debridement therapy (MDT) is effective for ulcer debridement, achieving it in less time than other therapies. It offers a benefit to healing. However, it is unclear whether maggots reduce treatment time and there is considerable controversy around the treatment's potential antimicrobial action and cost-effectiveness. Nevertheless, it can be effective in preventing amputations and reducing the need for systemic antibiotics. This bibliographic review assesses the advantages of MDT as a treatment for chronic wounds through the review of several larval properties. The review was carried out by consulting biomedical databases including CINAHL, MEDLINE (PubMed), and Scopus, and concludes that MDT is an effective debridement and potential technique to facilitate healing. However, more data is needed on the wound type application frequency and the efficacy of treatment.

KEYWORDS: amputation, chronic wound, debridement, larval therapy, maggot debridement therapy, MDT, ulcer, wound healing

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INTRODUCTION

Ulcer treatment consists of the following aspects: control of nonviable tissue, infection management, and moisture maintenance (in the wound bed and wound edge). Debridement is essential to eliminate nonviable or devitalized tissue (necrotic tissue and slough) from the wound bed to stimulate healing.^{1,2} Debridement promotes granulation tissue growth, decreases infection risk, eliminates odor, and controls wound exudate and as such is part of the wound bed preparation paradigm, which is a management strategy for ulcers focused on identifying and eradicating barriers to healing.^{1–5}

Debridement methods include surgical, sharp, autolytic, osmotic, and larval. Larval debridement is also known as maggot debridement therapy (MDT) or biosurgery and is used in the treatment of chronic wounds of diverse etiologies.^{2–4} This therapy uses living blowfly larvae, principally a specimen of green bottle blowfly (*Lucilia sericata*) that are raised in controlled sterile laboratory conditions. This method of debridement is considered selective because blowfly maggots destroy dead tissue, but not healthy tissue, and it is based on three therapeutic actions: debridement, disinfection, and promoting skin growth.^{6–11} The process of MDT begins when tiny spicules on the maggots' bodies scrape necrotic tissue.

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Next, the larvae secrete chemicals rich in proteolytic digestive enzymes that dissolve the necrotic tissue; the resulting product of this extracorporeal digestion is then ingested by the larvae. Several substances inside these secretions may partially explain MDT's antimicrobial and growth promotion actions.^{6,8,12-15}

Maggots can be applied directly to an ulcer, with a dressing to cover them and prevent them from escaping. The dressing must allow air flow and moisture to reach the maggots. This technique does come with some special considerations; for example, maggots should not be applied close to big blood vessels or in patients at high risk of bleeding, and the skin edge must be protected from excoriation.^{6,8,14-16}

Although it fell into disuse following the discovery of antibiotics, MDT has been relied on since antiquity.¹¹ Recent bacterial resistance to many treatments has led to a resurgence in its use. Today, it is considered a last resort for long-term nonhealing ulcers, and this therapy is licensed in more than 30 countries.^{6,8,14-16}

The aim of this review was to evaluate the advantages of MDT as a long-term ulcer treatment for several ulcer etiologies, compare it with other therapies, and analyze the following variables: debridement and healing action of larvae (in terms of effectiveness and treatment time), antimicrobial action, antibiotic use reduction, amputation prevention, cost-effectiveness, pain, and patient acceptability (sensations experienced).

METHODS

The authors performed a bibliographic review of the literature in relation to the described aims. An initial search was performed for original scientific articles and bibliographic reviews in the following biomedical databases: CINAHL, MEDLINE (PubMed), and Scopus. The following MeSH terms were used: *larval therapy*, *maggot therapy*, *debridement*, *chronic wound*, *ulcer*. The search query

was: (*maggot debridement therapy* OR *larval therapy*) AND (*chronic wound*); (*maggot therapy* OR *larval therapy*) AND (*chronic wound* OR *ulcer*). The Cochrane Plus library was then examined for systematic reviews from the last 10 years, also in English and Spanish, using the search query: *Maggot debridement therapy*. Finally, authors reviewed the bibliographies of included articles to find any relevant studies that may have been overlooked.

The selected research was limited to English and Spanish articles and reviews from the last 10 years (2009–2019). Included articles were those discussing MDT in chronic wounds of different etiologies (Table 1). They could touch on any of the following topics: debridement and healing action of larvae, antimicrobial action, antibiotic reduction, amputation prevention, cost-effectiveness, pain, and patient acceptability. Exclusion criteria were studies in which wounds were treated with another type of therapy, studies of acute ulcers, in vitro or animal studies, case reports or articles with fewer than 10 participants, clinical practice guidelines, and consensus statements.

Analysis and Study Selection

The authors read each abstract in order to evaluate whether the article was related to the aims of the review. If there was not enough information about the content, the document was read in its entirety to avoid missing useful information.

After applying inclusion and exclusion criteria and removing duplicated, the remaining articles were analyzed. Information on authorship, date of publication, study design, conditions, results, and conclusions were extracted.

RESULTS AND DISCUSSION

The initial search identified 192 articles (sources included CINAHL, MEDLINE, Cochrane reviews, and SCOPUS); 103 were removed because they were not relevant to this

Table 1. SEARCH LIMITERS AND INCLUSION/EXCLUSION CRITERIA

BIBLIOGRAPHIC SEARCH LIMITERS		
Study language	English-Spanish	
Publication date	2009–2019	
SELECTION CRITERIA		
	INCLUSION CRITERIA	EXCLUSION CRITERIA
Study design	Systematic review Bibliographic review Original scientific articles in different modalities	Opinion articles Expert consensus Clinical practice guide Clinical cases In-vitro studies
Study subjects	Humans	Animals
Wound variety	Chronic wounds; any etiology	Acute wounds
Larvae strain	Green bottle fly <i>Lucilia sericata</i> (<i>Calliphoridae</i> family)	Green bottle fly <i>Lucilia cuprina</i> and other myiasis-producing bottle flies



review. Of the remaining articles, 43 were duplicates, and 46 articles were examined in greater detail. In the end, 7 reviews and 11 original articles were included. The review of the selected articles described the following properties and abilities of MDT (Table 2).

Debridement Activity

The first variable analyzed was larval debridement. A clinical trial carried out by Opletalová et al¹⁷ determined that the percentage of slough in wounds on day 8 of treatment was significantly lower in ulcers treated with MDT (54.5%) than in those receiving conventional treatment (66.5%). Mudge et al¹⁸ reported similar results in another clinical trial, noting that the percentage of ulcers completely debrided on day 12 of treatment was 67.4% for the MDT group and 26.2% for the control group, a statistically significant difference. A third clinical trial¹⁹ had similar results, demonstrating that the debridement rate on any day of treatment was doubled with MDT compared with hydrogel. Moreover, there was a statistically significant difference in the time to debridement between groups; essentially, maggots had a shorter median debridement time than hydrogel.

Gilead et al²⁰ conducted a cohort study in which complete debridement with MDT was achieved in 82.1% of participants; a partial debridement was obtained in 16.8%. Only 1.1% of wounds were not debrided, highlighting the effectiveness of MDT. Similar results were seen by Polat et al,²¹ who treated 36 chronic wounds with MDT (1.5 to 5 years' duration). Necrotic tissue was fully debrided in 41.7% of cases within the first week of MDT. In the second week, 27.8% more cases achieved complete debridement, and the remaining ulcers were fully debrided within the third and fourth weeks. However, there was no control group, and the sample was very small.

The same results were noted by Campbell and Campbell,¹⁶ they performed another cohort study where 98.5% of patients completed treatment of their ulcers with MDT. Among these patients, 90% of chronic wounds were debrided within only 1 week. Equally positive results were presented in a systematic review made by Zarchi and Jemec,²² which concluded that maggots debrided more quickly and effectively than hydrogel. Similarly, Shi and Shofler²³ concluded that MDT was more effective and faster at debriding lower-extremity diabetic ulcers and venous ulcers than conventional therapy. A final study by Sherman²⁴ highlighted the advantages of MDT compared with several therapies in terms of effectiveness and debridement time.

Healing Ability of MDT

Maggots can stimulate granulation tissue and close wounds. The clinical trial carried out by Opletalová

et al¹⁷ observed healing rates on different days of treatment and detected a slightly higher probability of healing in the larval group than in the hydrogel group, although this was not very significant. A meta-analysis by Tian et al²⁵ found a significant difference in favor of the larval group as opposed to hydrogel treatment. This was further supported by the study of Polat et al,²¹ where, in a sample of 36 long-term ulcers, 80.6% were fully healed within 1 to 2 months of maggot applications, and 19.4% of ulcers were fully healed in 3 to 4 months of MDT. That said, it should be noted that Sherman²⁴ reported variability in their results, concluding that maggots did not demonstrate any improvement in healing rates. The same problem was encountered in healing time reduction.

A systematic review⁹ studied healing rates for diabetic foot ulcers versus venous or pressure ulcers and determined that there existed an equivalent positive effect with MDT and conventional therapy. This study concluded that healing time was significantly shorter when MDT was used.⁹ Finally, a study by Wilasrusmee et al²⁶ suggested that ulcer healing rates are seven times higher with MDT than with conventional therapy.

Another clinical trial observed a small reduction in healing time with maggots in comparison with hydrogel, although the result was not significant.²⁰ More favorable results were reported by Shi and Shofler,²³ who concluded that MDT achieved significantly better granulation rates and shorter healing times than traditional dressings in pressure ulcers and diabetic foot ulcers.

Antimicrobial Effect of MDT

Some articles discuss the reduction in infection seen with MDT. One clinical trial reported that the number of infected wounds decreased between days 1 and 15 with MDT but not in the control group (conventional treatment).¹⁸ However, a meta-analysis by Tian et al²⁵ reviewed infection incidence and concluded that there was no statistically significant difference between infection rates in the larval group (80%) and the control group (patient treatment with hydrogel; 60%). However, another study showed that infections were cured faster, and patients were infection-free for a longer period with MDT.²³

With regard to bacterial burden, a recent clinical trial¹⁹ did not find any difference between treatment groups.¹⁹ A bibliographic review performed by Sherman²⁴ studied the antimicrobial and disinfectant abilities of MDT, but found no positive results after statistical analysis. However, in the study performed by Malekian et al,²⁷ 50 patients with diabetic foot ulcers were randomly allocated to MDT or conventional treatment group; 18 ulcers were infected with *Staphylococcus aureus* and 16 with *Pseudomonas aeruginosa*. After 48 hours of treatment, the MDT group had a significant reduction in the bacterial burden compared with the control group. Moreover, after

Table 2. FEATURES SUMMARY OF INCLUDED ARTICLES IN THE BIBLIOGRAPHIC REVIEW

Author	Title	Study design	Methodology	Results
¹⁸ Campbell N et al. (2014) Ostomy Wound Manage 60(7):16–25	A retrospective, quality improvement review of maggot debridement therapy outcomes in a foot and leg ulcer clinic	Bibliographic review/retrospective cohort study	The study was carried out in Canada. There were 68 patients who had started MDT. They had diabetic and lower limb ulcers. The study gathered information about individual characteristics, wound outcomes, nursing visits and personal experiences of the patients. A literature review was also performed regarding the study variables.	40% of ulcers in the study required three sessions of larval debridement. 67 patients achieved debridement in more than 90% of wound surface in a period between 2 and 10 days. The majority of wounds (56) healed during the monitoring time.
¹⁹ Opletalova et al. (2012) Arch Dermatol 148(4):432–438	Maggot debridement therapy: a randomized multicenter trial	Randomized clinical trial	The sample consisted of 119 patients with venous ulcers of lower and higher limbs that did not heal (stagnated), and showed presence of sloughs. The ulcers were treated with MDT or conventional treatment in French hospitals in order to study the main larval properties on days 1, 8, 15 and 30 of treatment.	Debridement was achieved significantly faster with MDT in the first week. After two to three sessions of maggots, treatment was changed.
²⁰ Mudge et al. (2014) Wound Rep Reg 22(1):43–51	A randomized controlled trial of larval therapy for the debridement of leg ulcers...	Randomized clinical trial	The sample consisted of 88 patients with venous or mixed ulcers of lower limbs and, at least, 25% of sloughy tissue. Patients were treated with maggots (n=46) or hydrogel (n=42) in hospitals in the United Kingdom (UK), analyzing the utility of MDT and the personal implications of their use.	48% of the ulcers were completely debrided within 21 days, with a much higher full-debridement incidence in the MDT group. More pain was experienced with larvae but there were good adherence levels.
²¹ Dumville JC et al. (2009) BMJ 338:b773	Larval therapy for leg ulcers (VenUS II): randomised controlled trial	Randomized clinical trial	267 patients with at least one venous, arterial, or mixed ulcer of lower limb, with as far as 25% of sloughy tissue. Study performed in the UK. Ulcers were treated with MDT or hydrogel to study the advantages and characteristics of maggot use.	Healing time was not significant in comparison with hydrogel, but the time of attainment was. More pain was registered with maggots.
²² Gilead L et al. (2012) J Wound Care 21(2):78–85	The use of maggot debridement therapy in the treatment of chronic...	Cohort study	Study included 435 patients, 261 hospitalized and 174 outpatients in Israel. They were treated with MDT. 90% of the wounds were lower limb ulcers, 8% were sacrum ulcers and 1.5% were located in hands. Many variables related to the use of maggots were studied.	A full debridement was achieved in 357 patients (82,1%). A partial debridement was achieved in 73 of them (16,8%). Only 5 patients did not achieve debridement (1.1%).
²³ Polat E et al. (2017) Turk J Phys Med Rehab 63(4):307–312	Treatment of pressure ulcers with larvae of <i>Lucilia sericata</i>	Retrospective study	36 patients with long-term pressure ulcers in several locations were treated with MDT in order to achieve debridement and healing. Each session of larvae lasted between 48 and 72 hours. There was no control group.	Debridement was achieved in 41.7% of patients within the first week, 27.8% in 2 weeks, and 19.4% in 3 weeks. The remaining patients achieved debridement in 4 weeks. Healing: 80.6% of ulcers were healed within 1–2 months and the remaining 19.4% fully healed in 3–4 months.

(continues)

**Table 2. FEATURES SUMMARY OF INCLUDED ARTICLES IN THE BIBLIOGRAPHIC REVIEW, CONTINUED**

Author	Title	Study design	Methodology	Results
²⁴ Zarchi K et al. (2012) Int Wound J 9(5):469–477	The efficacy of maggot debridement therapy - review...	Systematic review.	The authors compared 3 random clinical trials and 5 non-random clinical trials in order to study the efficacy of MDT when it was applied to several aetiology ulcers.	MDT was significantly more effective than hydrogel as a debriding agent. However, the quality of studies was defined as poor.
²⁵ Shi E, et al. (2014) Br J Community Nurs 19 (Suppl 12):S6–13	Maggot debridement therapy: A systematic review	Systematic review	The authors evaluated some abilities and properties of maggots: debriding action, antimicrobial and healing effect, cost-effectiveness, pain or patient anxiety.	MDT was an efficient debriding method. Benefits are promising but, for the moment, more clear evidence is required.
²⁶ Sherman RA (2014) Evid Based Compl Altern Med 1–13	Mechanisms of maggot-induced wound healing: what do we know, and where do we go from here?	Bibliographic review	The author summarized the outcomes from 93 in-vitro and in-vivo studies from the biomedical literature. The aim was to evaluate current knowledge about MDT in the following aspects: debriding action, healing effect, wound disinfection and miscellaneous actions.	MDT is a safe and effective treatment for chronic wounds. Debriding, antimicrobial, and healing action were demonstrated in the review, although the authors advise that more research is needed.
²⁷ Tian X et al. (2013) J Wound Care 22(9):462–469	Maggot debridement therapy for the treatment of diabetic foot ulcers: a meta-analysis	Meta-analysis	The review included four studies. The principal question was the review of the efficacy of maggots in comparison with standard care in diabetic lower limb ulcers.	The experimental group (larval group) obtained significantly better results regarding the percentage of completely debrided ulcers, number of days without antibiotics, and amputation and healing rates. However, literature evidence was defined as weak.
³⁵ Sun X et al. (2014) Int J Infect Dis. 25:32–37	A systematic review of maggot debridement therapy for chronically...	Systematic review	12 articles were included in order to compare MDT and several conventional therapies. The review was focused on infected chronic wounds. It was performed in China.	The most relevant outcome was the improvement in the healing time as well as the healing rate of chronic wounds. MDT was confirmed as a good treatment for ulcers.
²⁹ Wilasrusmee C et al. (2014) Asian J Surg 37(3):138–147	Maggot therapy for chronic ulcer: A retrospective cohort and a meta-analysis	Retrospective cohort study / meta-analysis	This review included 111 patients (59 treated with MDT and 52 with conventional treatment) who had diabetic lower limb ulcers. They were treated in Thailand with the purpose of evaluating the probability of healing. The results were crossed with other cohort studies.	The evidence suggested that MDT was significantly better wound care than conventional therapy in the study, providing better cost-effectiveness. However, more literature was required in order to confirm the outcomes.
³⁰ Malekian et al. (2019) J Wound Ostomy Continence Nurs 46(1):25–29	Efficacy of Maggot Therapy on Staphylococcus aureus and Pseudomonas aeruginosa in Diabetic Foot Ulcers: A Randomized Controlled Trial	Randomized Controlled Trial	50 diabetic foot ulcers were randomly allocated to either a maggot or a control group. Moreover, 18 wounds were infected with S. aureus and 16 with P. aeruginosa. The bacterial burden and the number of infections was examined after 48 and 96 hours of treatments.	In infection cases treated with maggots, the rate was lowered from 9 to 1 in 96 hours in the case of P. aeruginosa infections and from 9 to 0 in the case of S. aureus infections. However, the control group did not achieve a significant reduction in the bacterial burden of the wounds (9 S. aureus and 7 P. aeruginosa infection cases).

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Table 2. FEATURES SUMMARY OF INCLUDED ARTICLES IN THE BIBLIOGRAPHIC REVIEW, CONTINUED

Author	Title	Study design	Methodology	Results
³¹ Soares MO et al. (2009) BMJ. 338:b773	Cost effectiveness analysis of larval therapy for leg ulcers.	Randomized clinical trial	This was a secondary study, from a clinical trial in which 267 patients were randomly assigned to a MDT or to a hydrogel group. In this clinical trial, the cost-effectiveness of treatments was assessed by means of an analysis of costs during a year of monitoring. The study was carried out in the UK	The increase in cost-effectiveness of MDT was of £8826 per year due to the improvement in the quality of life of patients and of £40 per day free of ulcers. The outcomes are not statistically significant.
³² Jones J et al. (2011) Br J Card Nurs 16 (Suppl 3):S24–33	Maggots and their role in wound care.	Bibliographic review	7 reviews were used to evaluate the larvae role in ulcer care, by means of the review of the following variables: infection control, healing promotion, cost-effectiveness, and reject factors of therapy in patients. The study was carried out in the UK.	It was concluded that MDT reduced healing time and total costs of wound management. The authors concluded that professionals needed more knowledge about the issue in order to overcome personal barriers in the use of this treatment.
³³ Mumcuoglu KY et al. (2012) J Wound Care. 21(8):400–405.	Pain related to maggot debridement therapy	Cohort study	435 patients were treated with free-range maggots or bio-foams in Israeli hospitals, making an analysis of experienced pain in patients and examining solutions for it.	From among the sample, 165 patients (38%) experienced increased pain during the application of maggots. They were treated with analgesics and, in some cases, nerve blocks or systemic analgesia.
³⁴ Morozov et al. (2018) Int Wound J. 1–5	Survey of patients in the Tver region of Russia regarding maggots and maggot therapy	Original article: survey.	345 subjects responded to a survey performed in a Russian hospital between 2014 and 2016. It consisted of 6 images. Some of them were chronic wounds and other were MDT photographs or isolated larvae. The patients had to sort the images from less repulsive to most repulsive.	The most disgusting photographs among both men and women were the MDT images, followed by the isolated larvae. In third place were the images of gangrenous ulcers. Patients considered MDT more repulsive than chronic wounds and they were less ready to experience the therapy than those who did not consider maggots so repulsive.
³⁵ McCaughan D et al. (2015) Health Expect 18(4):527–541	Patients' perceptions and experiences of venous leg ulceration and...	Qualitative study	This Qualitative study included 18 patients (12 men and 6 women) from the UK, with at least one venous ulcer. They were interviewed to know their experience with the use of maggots and the repercussion in their ulcers, normally long-term ones.	The majority of patients in the study were ready to start the therapy, showing a great desire to cure their ulcers. Some personal characteristics helped in the case of people who wanted to experience the therapy, such as good family support.

96 hours of treatment, none of the *S aureus* patients in the larvae group had infected ulcers, and all but one of the *P aeruginosa* infections were eliminated.²⁷

Reductions in Amputations and Antibacterial Use

A bibliographic review from Campbell and Campbell¹⁶ studied limb salvage after MDT (used as a last-resort treatment). It was estimated that about 60% of patients experienced successful treatment and avoided amputation.¹⁶ The same hypothesis was investigated by Tian et al,²⁵ after comparing the results of the reviewed studies, they concluded that MDT achieved a significant reduction in amputation rates.²⁵ In the same vein, Sun

et al⁹ concluded that at-risk patients in the control group (with conventional treatment) were twice as likely to experience amputation compared with those receiving MDT.⁹ Finally, Gilead et al²⁰ found that an imminent amputation was successfully avoided in 12.6% in patients in their cohort study.²⁰ The authors concluded that MDT delivered fairly effective results considering its use as a last-resort treatment. Although their study was conducted before 2009, Steenvoorde et al²⁸ also showed that 73% of patients at risk of amputation treated with MDT (either free-range or contained) saw beneficial results, avoiding amputation and achieving complete ulcer closure.

Regarding the prescription of systemic antibiotics for local ulcer treatment, some studies compared the number of days without antibiotics between treatments. Many systematic reviews found that there were more antibiotic-free days in patients treated with maggots than among those in control groups (generally conventional treatments or hydrogel).^{9,22,23,25} Only Shi and Shofler²³ found that results were not statistically significant.

The use of maggot therapy has been documented in a survey by Sherman et al²⁹ to include many other clinical indications that require clinical studies before these indications are incorporated into clinical practice.

Cost-Effectiveness of MDT

The economic efficiency of MDT can be estimated using costs and treatment effectiveness over time. However, some authors report considerable heterogeneity in results because of the diversity of elements that are considered costs. Half of the studies in one review reported that the MDT was as cheap as hydrogel, whereas the other half estimated that the cost of maggots was double.⁹ Wilasrusmee et al²⁶ examined several outlays generated by the therapies, including nursing costs and wound dressings. The final median cost of MDT (\$293) was around half the cost of hydrogel (\$490). Moreover, considering that the median healing times were 9 and 28 weeks with MDT and hydrogel, respectively, it appears that MDT is more cost-effective.

Another recent study³⁰ asserted that larvae were in general more expensive than hydrogel per participant and year. However, this therapy cured ulcers faster and consequently achieved a slight increase in patient quality of life; the author concluded that cost-effectiveness increased with MDT, and the total amount of money saved was £8,826 per year. The improvement in quality of life saved £40 per wound-free day. However, the author admitted that there was a large level of uncertainty in the results.³⁰ Finally, a review focused on patients with venous ulcers reported that the cost of maggots was significantly lower than that of hydrogel, given that maggots achieved faster debridement than hydrogel.³¹

Pain and MDT

Pain related to MDT has been extensively discussed in multiple studies. Opletalová et al¹⁷ established that pain was similar and fairly low in both the experimental and control groups, without significant differences. However, most articles found higher pain levels with MDT. A clinical trial¹⁸ demonstrated higher levels of pain in patients treated with MDT than in those who were treated with hydrogel (control group). Nevertheless, the final evaluation showed a statistically significant general reduction of pain in both groups over time.¹⁸

Dumville et al¹⁹ affirmed that pain scores self-reported by patients in the MDT group were statistically significantly higher than in the hydrogel group; Zarchi and Jemec²² also noted that pain was stronger in the larvae group, but that pain levels described by patients did not reduce their quality of life. The overall percentage of patients with complaints about the therapy was quite low.²²

Another systematic review²³ compared pain in patients with and without diabetes, concluding that among patients with diabetes pain levels were similar before and after the application of MDT, whereas in the second group more pain was reported during MDT than before. The authors suggested that the majority of patients who experienced pain could be adequately treated with analgesics.²³ Finally, a cohort study by Mumcuoglu et al³² showed that 38% of patients experienced an increase in pain during the application of maggots, but that in the majority of cases, it was possible to reduce it with analgesia before or during the therapy.

Acceptability and Experienced Sensations with MDT

The psychological impact of MDT on a patient is a relevant aspect to keep in mind. A significant proportion of participants in one study¹⁸ treated with maggots described the therapy as uncomfortable compared with those patients treated with hydrogel and other therapies. However, the majority of patients in each group admitted that they were very satisfied with their therapy.¹⁸

Campbell and Campbell¹⁶ described patient anxiety when faced with the idea of using maggots in their wounds. The reasons that patients gave were fear of pain, overthinking about maggots escaping from the wound, or disgusting sensations inside the ulcer. However, once patients had started the therapy, most of their worries disappeared.

Aversion seems to be a problem, according to several authors. Initially, patients describe repulsion, doubts, and negative prejudices; however, once the therapy is started, patients state that it was not so unpleasant, even recommending the therapy.^{23,31,33} Morozov and Sherman³³ conducted a survey among patients with ulcers in a Russian hospital, showing them several photographs of maggots and chronic wounds. The images of MDT appeared more repulsive to patients than photographs of ulcers without larvae. In addition, 50% of patients experienced a feeling of repulsion toward MDT, probably induced by the association between maggots and death or decomposition. However, the authors stated that a bigger sample was needed to support the results.³³

Campbell and Campbell¹⁶ estimated that about 25% of patients rejected MDT when it was offered to them. In contrast, a qualitative study³⁴ estimated there was 83% therapy acceptance among patients with chronic ulcers; patients were ready to use maggots because they

had a deep desire to try anything that could heal their ulcers. A high level of willingness to use maggots was attributed to several personal characteristics: previous knowledge, an open-minded attitude, a large drive to overcome problems, absence of aversion to bugs, contact with nurses who knew how to cope with the therapy, and strong family support.³⁴

Limitations

This review includes a small number of articles with strong evidence related to MDT use in chronic wounds. Because of language restrictions and article availability, it is possible that some articles of interest were left out of the review. Further, many studies did not meet the inclusion criteria, so it was necessary to loosen the initial criteria, making the review less specific than originally intended. Many articles differed in their definitions of chronic wounds and complete healing, making the comparison difficult. Finally, many studies applied MDT to chronic wounds without specifying their etiology, making it difficult to generalize and extrapolate results.

CASE REPORT

A 61-year-old quadriplegic man was admitted to a VA Medical Center for worsening pressure injuries and because the patient wanted his tracheostomy removed. He had sustained a cervical injury 2 years prior and required assisted ventilation at that time. After being weaned from the ventilator, he still had problems with secretions, so the tracheostomy was left in place. His spinal cord injury was complicated by bowel dysfunction and a neurogenic bladder with frequent urinary tract infections. His spasticity led to severe contractures of his lower extremities. In addition, he had heterotopic ossification of both hips. No longer a smoker, he eventually could clear his own airway secretions and sit in a wheelchair long enough that he developed ischial and posterior heel pressure injuries (stage 3) 2 months prior to admission. These wounds grew larger despite outpatient care, so he was admitted for wound treatment as well as take-down of the tracheostomy. His medical history was otherwise notable only for the successful treatment of *Clostridium difficile* colitis during a prior hospitalization.

On examination, the patient's BP was 60/40 mm Hg, with a pulse of 88 beats/min. There was a 6-cm² triangular area of eschar on the posterior surface of his left heel, surrounded by erythema and fluctuance. There was also a 3-cm² ulcer on his left ischium with a dry yellow base. His hips were frozen at near 90 degrees of flexion, and his legs were crossed. His legs were spastically contracted, with his heels rubbing into the bed's air-filled mattress when not supported by pillows. His tracheostomy was in place, and the stoma was clean. As was the case at this facility for all patients with spinal cord injury and

pressure injuries, the patient's wound care was prescribed by the surgery service. He received intermittent sharp debridement at the bedside with povidone-iodine gauze dressings in between. The wound beds were never free of necrotic tissue, which dried over the base as eschar. The patient did not consent to intraoperative surgical resection but did consent to a prospective controlled study of MDT (reported elsewhere in aggregate: Sherman, 2002).

The MDT was performed once or twice weekly by applying maggot-impregnated gauze containing approximately 10 larvae/cm² of wound base. The larvae were confined to the wound by a hydrocolloid pad around the periphery of the wound and a polyester net over the top of the wound affixed to the pad. This "cage dressing" was topped by a light absorptive gauze dressing that was changed whenever soiled by wound drainage. The cage dressing itself was removed within 2 to 3 days and discarded as wet wound dressing waste (ie, in a biohazard bag). When the patient was not receiving MDT, his wound care comprised saline-moistened gauze changed every 8 hours. Wound photographs and measurements were taken weekly; the patient consented to publication of these case details and the associated images. The ischial wound was treated with MDT for a total of 3 weeks and completely healed a week later (Figure 1); the heel wound was treated with MDT for a total of 6 weeks and healed 3 weeks later (Figure 2). In retrospect, fewer maggot treatments would have been required had the eschar first been softened or removed, but that was not the way the study protocol was designed.

CONCLUSIONS

In view of the literature review results, although there are discrepancies among studies, MDT appears to be effective in debriding chronic wounds. In addition, larvae may reduce the recovery time in comparison with other therapies, such as hydrogel. These studies also demonstrated that maggots have a similar ability in healing ulcers compared with other debridement methods, although there are inconsistencies in relation to the time required to achieve this. Although there was no consensus about the antimicrobial effect of larvae, many studies reported a reduction in the number of days with antibiotics, as well as a reduced likelihood of amputation. No other treatment examined could achieve this. Further, MDT is generally considered a relatively cheap treatment despite controversy about its cost-effectiveness.

Critically, the literature suggests that many patient fears concerning the use of maggots disappear when the therapy is implemented. Patients with ulcers, especially

Figure 1. ISCHIAL PRESSURE INJURY

A, Immediately before maggot debridement therapy. B, Ten days later. C, One month later, after complete healing.

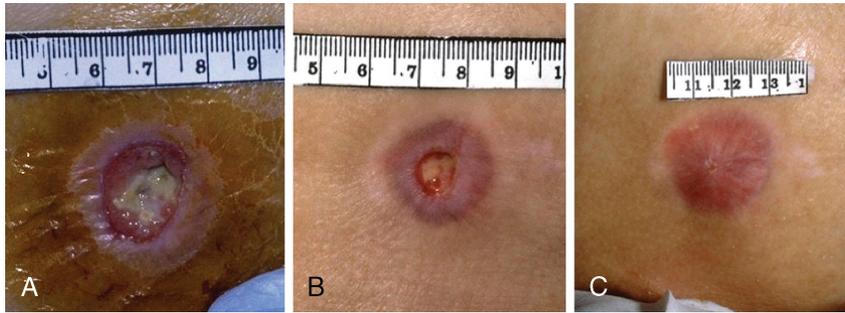


Figure 2. POSTERIOR HEEL PRESSURE INJURY

A, Immediately prior to maggot debridement therapy. B, Ten days later. C, At the end of 5 weeks. D, Just prior to complete healing 3 weeks later.



those with long-term ulcers, had positive feelings toward the therapy. Unpleasant sensations were not frequent or intense, and in many cases, they were only psychological. Pain usually increases with MDT, but it can be easily treated with analgesics.

Although some of these conclusions were consistent in reported literature, it is necessary to continue researching MDT to generate a clearer picture of the evidence. There is a general lack of knowledge about the abilities and properties of maggots, and more information is needed. Further, the best evidence compares MDT with hydrogel (autolytic debridement). Recommendations for future study involve evaluating whether this technique is more efficient when combined with other therapies, given that other treatments have demonstrated better results in certain stages of the healing process.

PRACTICE PEARLS

- Maggot debridement therapy is effective in chronic wounds that have necrotic tissue or slough as long as they meet certain requirements such as distance from large blood vessels.
- Maggot debridement therapy is useful for ulcers that do not have necrotic tissue or slough but do not heal completely because they have an active infection resistant to conventional therapies.
- In complicated ulcers, MDT may be used as a last resort where no other therapy has been effective and for which amputation is being considered.
- The etiology of chronic wounds for which MDT can be used is diverse, including diabetic foot ulcers, pressure injuries, and venous ulcers. ●

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