

MAGGOT DEBRIDEMENT THERAPY IN THE TREATMENT OF NONHEALING
CHRONIC WOUNDS

A Research Project by
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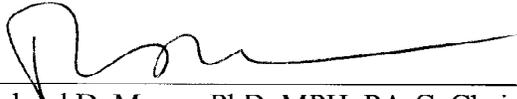
Submitted to the Department of Physician Assistant
and the faculty of the Graduate School of
Wichita State University
in partial fulfillment of
the requirements for the degree of
Master of Physician Assistant

May 2007

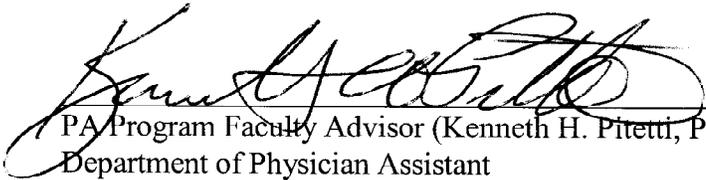
Wichita State University
College of Health Professions
Department of Physician Assistant

We hereby recommend that the research project prepared under our supervision by Dodie L. Martin entitled Maggot Debridement Therapy in the Treatment of Nonhealing Chronic Wounds be accepted as partial fulfillment for the degree of Master of Physician Assistant.

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4-27-07

5-4-07

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ABSTRACT

Background: Maggot therapy utilizes freshly emerged, sterile larvae of the common greenbottle fly, *Phaenicia (Lucilia) sericata*, which secrete digestive enzymes that selectively dissolve necrotic tissue, disinfect the wound, and thus stimulate wound healing. Introduction: The purpose of this paper was to review the literature in an attempt to determine the efficacy of maggot debridement therapy (MDT) of skin ulcers (e.g. diabetic foot ulcers, venous stasis, osteomyelitis), with specific focus on assessing the healing time and amputation rate. Methodology: Efficacy was measured by comparing MDT to traditional treatment (i.e., antibiotics and surgical debridement). Level of evidence included case-control, cohort retrospective, retrospective, prospective control, non-randomized in-vivo, and report studies. Results: Overall results of the thirteen articles that met the inclusion criteria indicate that MDT healing time was equal to or significantly shorter and amputation rate was less compared to traditional treatment. Limitations: Limitations to these studies include minimal amount of subjects involved in each study, the inability to conduct randomized control studies and insufficient number of articles found. Conclusion: Preliminary studies confirm that MDT successfully accelerates debridement of long-standing chronic wounds leading to enhanced healing time and reduced amputation rates, making it a particularly safe and affective method in wound care.

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ACKNOWLEDGMENTS

I would like to give special thanks to my research advisor, Dr. Pitetti, for his guidance and patience throughout writing this paper. I would also like to thank my family and friends for their constant support and endless words of encouragement over the past two years. I am forever thankful.

INTRODUCTION

Insects have been known for centuries to have a healing mechanism that can be used by the medical field.¹ Ambroise Pare was the first to discover that maggots have wound healing capabilities.¹ He documented soldiers who had ‘worm’ infested wounds and their ability to recover successfully from those wounds. Military physicians also discovered maggots’ ability to eat only infected tissue in soldiers during battle.¹ In the 1930's, William Baer started clinical trials with maggots resulting in very successful results in many of these studies.¹ During this time, hundreds of hospitals in the United States were using maggot debridement therapy (MDT) for the treatment of conditions such as osteomyelitis and chronic leg ulcers.¹

Maggots or greenbottle blowflies, *Phaenicia* (*Lucilia*) *sericata*, emit digestive enzymes that dissolve necrotic tissue from wounds and ingest bacteria which both promote wound healing.¹ These two beneficial effects of maggots on wounds are why maggot debridement therapy can help heal wounds, and potentially save limbs from amputation and in some cases, death.

Blowflies are kept in incubators and fed items such as honey, sugar and bananas until they are ready to lay eggs.¹ Once the eggs are laid, they are sterilized with a 5% solution of formaldehyde or Clorox.¹ After 24 hours the eggs are hatched, and within 2 days they are ready for placement on the wound.¹ Anywhere from 200-600 larvae are placed in a wound for 3-5 days.¹ Once the 5 days are up, the larvae are removed from the wound with a saline wash and another round of larvae are placed on the wound as needed.¹

LITERATURE REVIEW

Treating nonhealing chronic wounds is a major challenge for health care professionals and affects the quality of life for millions of people all over the world.² When the wound healing

process is interrupted, a chronic wound will result.² Infection, malnutrition, diabetes mellitus, and necrotic tissue are a few of the many reasons how a wound could become chronic.² Infection is the most common reason for chronic wounds.² Infection and necrotic tissue impede the ability of the wound to start healing, making debridement of the tissue so important.

Many wounds are treated with antibiotics or surgery, which can present two unique problems for the medical community. There can be a resistance to antibiotics used to treat the wound. With surgery, there is the possibility of dissection from the wound due to the inability to differentiate between healthy and infected tissue.

These two reasons could lead to a reawakening of MDT in the treatment of chronic nonhealing wounds. What was once considered a method of the past may very well be resurfacing as a viable option for treating chronic wounds. At the very least, MDT should be investigated further with more clinical trials to find out more information on this method of wound healing.

Purpose of Study

In medicine, there is a variety of methods to consider when treating patients. Patients with chronic wounds are no exception. Antibiotics and surgery are the two most common methods of chronic wound care. In some cases, neither of these treatments is the most effective choice. MDT is one of the oldest methods of wound healing, yet is relatively new or completely unused by many physicians. Several physicians may not fully understand the healing effects of maggots and their potential as a wound healer.

This paper studies MDT through clinical trials that strongly suggest MDT as an effective and successful method of wound healing. By looking at studies that involved the use of MDT on the treatment of wounds, an additional option for treating chronic, nonhealing wounds was

presented. The research question was stated as: Should MDT be considered as a first line treatment for nonhealing chronic wounds?

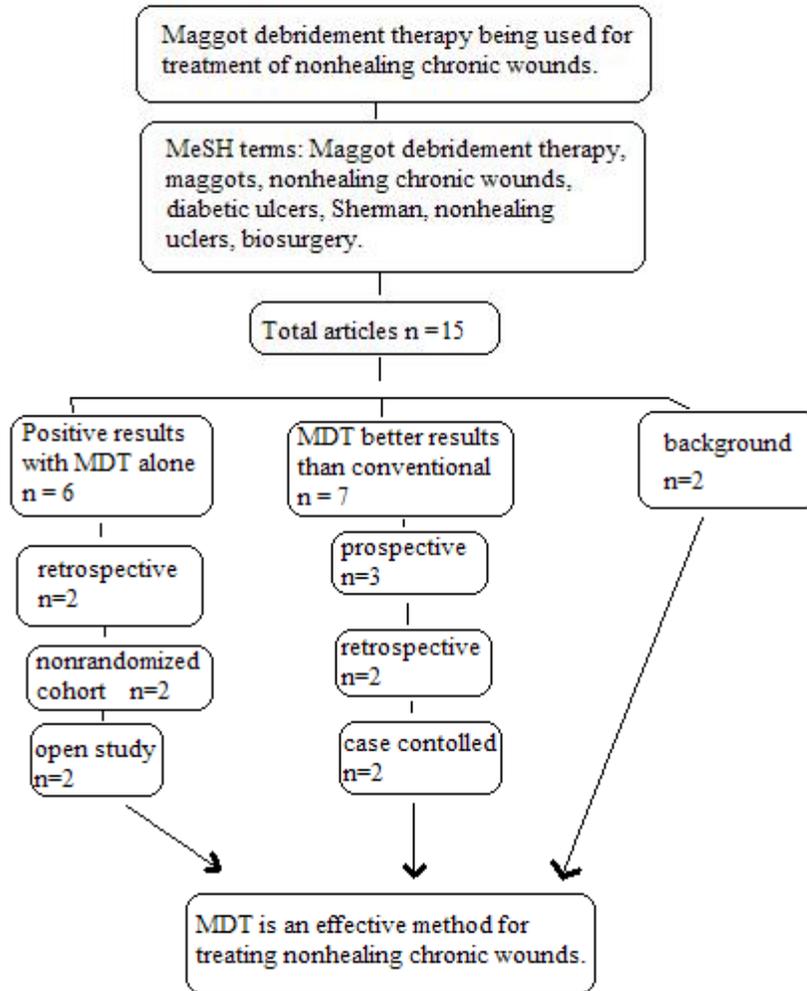
METHODOLOGY

A systematic review of the literature was performed to identify evidence based, controlled trials comparing MDT to conventional treatment of chronic wounds. Subjects ranged from 16-94 years of age and involved a variety of wounds. Infotract, Cochrane, and MedLine were the electronic databases searched to find studies that met the inclusion criteria of studies being performed from 1987 to 2007. The articles used included background of MDT, review of the data, and discussion of the findings. The following terms were searched for: Maggot Debridement Therapy, Maggot Therapy, Nonhealing Chronic Wounds, Sherman, Diabetic Ulcers, Nonhealing Ulcers, and Biosurgery.

RESULTS

Using the search criteria from 1987 to present day, 15 articles were included in this study. (Figure 1) Two of these articles^{1,2} were used solely for background information on MDT and chronic wounds. The other thirteen articles³⁻¹⁵, were used for their clinical studies on MDT. Seven articles^{3-6,12,14,15} compared MDT and conventional methods to see which one had better results. Of these seven, three^{3,5,15} were prospective controlled studies, two^{4,6} were retrospective studies, and the last two^{12,14} were case controlled studies. Six articles^{7,-11,13} focused on MDT being used on patients alone. Two articles^{7,11} were retrospective studies, two^{9,10} were open studies, and the last two were^{8,13} noncomparative cohort studies.

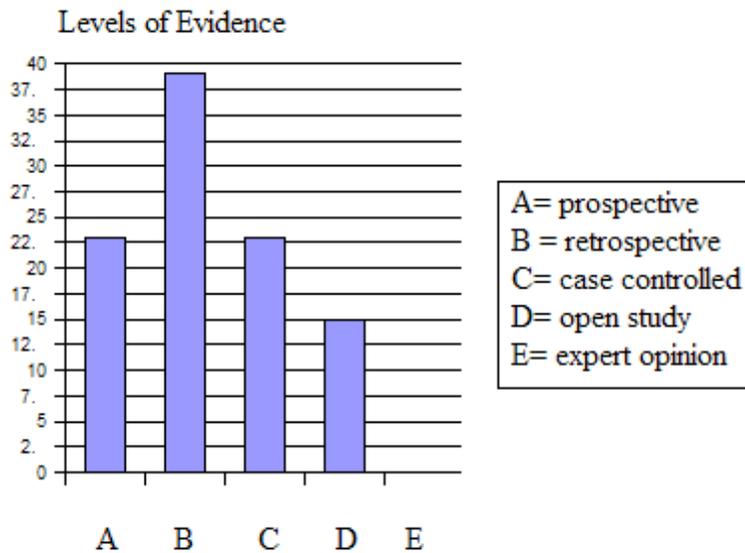
Figure 1: Literature Review Flow Sheet



Levels of evidence for this study were broken down into five categories. The first category consisted of prospective studies of which three articles, or 23 % were graded an “A”. The second category was retrospective studies of which five articles, or 39% were graded “B”. The third category was case controlled of which three articles, or 23% were graded at a “C”

level. The fourth category was open studies of which two articles or 15% of the studies. The last category was expert opinion of which there were no articles.

Figure 2: Levels of Evidence



DISCUSSION

Evidence in the literature

Many in the medical profession have heard of maggot debridement therapy, yet do not fully understand the potential of this treatment method. The purpose of this review is to help bring to the forefront the overwhelming evidence that maggot therapy is useful in wound healing, especially in wounds that are unresponsive to other methods. Further studies are needed to find exactly when MDT should be used and if it should be considered an option as a first line treatment for treating chronic nonhealing wounds.

Perhaps the most important researcher who re-introduced MDT back into the mainstream of treatment of wounds was Dr. R.A. Sherman. Sherman has done several successful studies on

MDT over the past 20 years. In 1999, a study using MDT on pressure ulcers in spinal cord patients started several successful studies by Sherman on MDT. This prospective control study involved 8 patients with MDT and the surface area of wounds.³ Before MDT, wound surface area increased at a rate of 21.8% per week. After MDT treatments, wounds decreased by 22% per week.³ Every worsening ulcer was reversed by maggot therapy with most pressure ulcers being debrided within one week.³ Furthermore, wound healing was faster than all conventional methods.³

Following the promising results from the spinal cord study, Sherman next studied MDT's effects on outpatients. This retrospective study selected 21 patients.⁴ Of these 21 patients, MDT debrided 17 of the 21 wounds with 11 being completely debrided and an additional 7 being completely debrided within 6 months.⁴ Before MDT, eight of these patients were advised to undergo amputation. Only two needed amputation after MDT was applied to their wounds.⁴ Overall, 20 of the 21 cases were satisfied with the overall outcome of MDT.⁴

In 2002, Sherman saw some of the strongest evidence to support MDT. This retrospective study involved 103 patients with 145 pressure ulcers.⁵ For this study, 50 patients with 61 ulcers received MDT while 70 patients with 84 pressure ulcers used conventional methods of wound healing.⁵ Sherman's study⁵ revealed that wounds treated with MDT debrided faster than wounds treated by conventional methods. Eighty percent of wounds treated by MDT were debrided after five weeks, while 52% of wounds treated by conventional methods were still not debrided after 5.5 weeks.⁵ In addition, wound size had a greater decrease with MDT than with conventional methods, 84% to 37% respectively.⁵ Lastly, ulcers treated with MDT were 60% larger in size than those in the conventional group⁵ and necrotic tissue was decreased by an

average of 3.7 cm² after two weeks while conventional methods had no decrease in necrotic tissue.⁵

Another study⁶ completed by Sherman in 2003 was a cohort retrospective study involving patients with diabetic foot ulcers unresponsive to conventional therapy. This study⁶ involved 18 patients with 20 nonhealing wounds. Six of these patients used MDT treatment with another 6 using only conventional methods. The remaining 6 patients used conventional methods followed by MDT.⁶ In only 9 days, wounds treated with MDT had a 50% reduction in necrotic surface area while conventionally treated wounds took 29 days to reach that amount.⁶ Wounds treated with MDT also saw 56% of wounds covered with healthy granulation tissue while only 15% of healthy tissue covered wounds using conventional methods.⁶

After several successful studies, Sherman continued searching for other areas in medicine that could benefit from MDT. In 2004, Sherman researched MDT in postoperative wound infections. Out of the 29 patients in this study, 10 were treated with MDT preclosure.⁷ Of the 10; all 10 were debrided within 1-17 days with none developing postoperative infections.⁷ Of the other 19 wounds not treated by MDT, 6 developed infection after surgery.⁷ This study involved an area of medicine where MDT could be used to treat wounds.

Several other researchers have studied MDT and its usefulness on successfully treating wounds. Jukema and colleagues did a study using MDT on 11 patients having wounds unresponsive to conventional methods and antibiotics.⁸ All of the wounds were treated in 11-34 days without any of the 11 patients requiring amputation.⁸ Nine patients fully recovered while two died due to causes unrelated to the maggot debridement study.⁸ Jukema added that maggot therapy may prevent the need to amputate and adequately heal wounds.⁸

In 1999, another successful study on MDT was done by K.Y. Mumcuoglu. This study involved the treatment of intractable wounds involving 25 patients.⁹ Complete debridement was achieved in 18 patients or 88.4%. In three other patients, debridement was significant, with one being partial and one unchanged.⁹ Only 8 days were needed to debride 13 out of the 25 patients with 10 days being the average. However, all five patients were referred to amputation before MDT was applied.⁹ All five patients were spared from amputation due to MDT.⁹

As recent as two years ago, researchers were studying¹⁰ the effects of MDT on chronic wounds in patients at a hospital in Turkey. Complete debridement was seen in 10 of the 11 patients within 1 to 9 treatments while one patient saw only partial debridement.¹⁰ In the 10 patients with complete debridement, a remarkable granulation of healthy tissue was noticed.¹⁰ Tanyuksel added that MDT was able to fight infections in a variety of wounds and contribute to a drastic improvement over conventional treatment healing times.¹⁰

Another study¹¹ was done in 2004 using MDT on two different types of wounds. This retrospective non-comparative cohort study consisted of in-vivo results on the use of MDT for Gram-positive and Gram-negative infected wounds.¹¹ This study was composed of 16 patients with Gram positive and Gram negative wounds. Steenvoorde found that Gram-positive bacteria are killed and digested by maggots more easily than Gram-negative bacteria, thus a greater amount of maggots are needed for Gram-negative infected wounds.¹¹ All 16 patients were healed with the use of maggot therapy within six months with 3 dying from events unrelated to the study.¹¹

Armstrong and colleagues did a case-controlled retrospective study¹² with MDT using 60 ambulatory patients in which 30 used MDT and 30 used a control group. Armstrong found that patients with MDT had significantly more antibiotic free days than those that used conventional

methods.¹² In the patients who healed with treatment, healing time was significantly shorter in the MDT group (18.5 +/- 4.8 weeks) than in the control group (22.4 +/-4.4 weeks).¹²

Armstrong also noted that MDT may reduce short-term morbidity in nonambulatory patients with diabetic foot ulcers.¹²

A study¹³ was done involving MDT and ulcer debridement involving 74 patients. Wolff and colleagues found that MDT effectively debrided 86% of the ulcers with one application being effective in two-thirds of the patients.¹³ A large number of patients, (86%), saw ulcer debridement between 66 to 100%. Wolff and colleagues noted that using MDT resulted in fast debridement as well as generation of granulation tissue.¹³

In a study¹⁴ on necrotic ulcers in 2000, larval debridement therapy (LDT) was compared to hydrogel treatment on 12 randomized patients. In the LDT group, debridement was achieved faster than the Hydrogel group with all patients who received LDT treatments needing only one LDT application.¹⁴ One patient in the hydrogel study switched to LDT after 13 visits and debridement began rapidly.¹⁴

Biosurgery (MDT) was used in a study¹⁵ to determine its usefulness to clean and disinfect wounds prior to surgery. In this study, 30 patients reported that Biosurgery was very selective in removing necrotic tissue.¹⁵ Average wound scores before treatments were 13.5 +/- 1.8 to 6.3 +/- 2.7 after treatment.¹⁵ Wollina and colleagues noted that one of the main reasons for the effectiveness of Biosurgery was due to the selective removal of necrotic tissue while leaving healthy tissue unharmed.¹⁵

Weaknesses in the literature

The cost of MDT versus conventional methods was not discussed thoroughly in the literature. One article published by Wayman and colleagues, found¹⁴ that MDT was cheaper

overall than the conventional methods. The main reason due to decreased nursing time (375 hours vs. 75 hours) and cheaper material costs. [\$105 vs. \$21]¹⁴ However, further studies should be performed that focus on the cost efficiency of MDT as compared to traditional treatment.

Another shortcoming in the literature was the lack of research done on the availability of maggots for use in hospitals and clinics. No studies were found on how long it took to obtain maggots and what steps need to be taken to get maggots for medical use. This may be a factor in helping medical professionals make a decision on therapy for patients needing treatment quickly. Patients may not be able to wait for maggots to become available.

Gaps in the literature

As the maggots eat necrotic tissue they become larger, thus causing an increase in pain while feeding on the wound. A small complaint with MDT was a few patients that experienced a slight discomfort in their treatment.^{2-4,5-11,13-15} The majority of those patients that experienced discomfort said that it was not enough to stop treatment. Any pain from MDT could be treated with oral analgesics. For some patients, the use of a biobag, or a Polyvinyl Alcohol (PVA) contained bag may stop the pain of MDT without disrupting the effectiveness of the treatment.

A further problem with MDT was the psychological effects of “having bugs crawling on one’s limb”. For some patients, this may be enough to make them forgo MDT no matter how effective the treatment. This may decrease if MDT became more popular and more patients began using it. More studies and media reports on MDT are just a few ways to start changing people’s perceptions of the treatment. With the biobag, MDT can be completed without maggots ever crawling freely over the wound thus diminishing patients’ fear of maggots crawling elsewhere on their body.

Validity of the review

This study was done systematically using the aforementioned keywords and electronic databases. The included articles were examined closely and the raw data of each article was put into matrices to further dissect. Each article was broken down by study year, research addresses, level of evidence, demographics, diagnosis/underlying condition, results and limitations. Each article was also reviewed to verify that all search criteria had been met.

Weakness in the review

As with many research papers, this review was not complete without some weaknesses. The authors and journals names were not blinded from the author and advisor. This could lead to bias in choosing articles for the paper. Another weakness was the lack of articles on this subject. With MDT being a fairly unknown treatment method, not a lot of research has been completed on it. Sample sizes were another weakness in this review. Many studies have too small of a sample size to obtain a strong sample of the population.

CONCLUSION

Conventional methods can work, but it is often difficult for a surgeon to differentiate between healthy and infected tissue. This makes surgery risky for the patient. Antibiotics can work for some patients, but many wounds do not respond to antibiotics. Maggot therapy has not only been shown to remove necrotic tissue, but has also been proven to work on disinfecting wounds unresponsive to antibiotics. In the past, maggot debridement therapy was used as a last resort method of wound healing. These studies indicate that maggot therapy could be considered as a first line treatment for non-healing, chronic wounds.

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Appendix A Raw Data

Study year	Research Addresses	Level of Evidence	Demographics		Diagnosis/ Underlying Condition	Results	Limitations
Armstrong 2005	The potential efficacy of MDT in 60 ambulatory patients with neuroischemic diabetic foot wounds and peripheral vascular disease which met the following criteria: 1) a diagnosis of diabetes by their primary-care physician 2) presence of a single wound of the foot 3) the inability to walk w/o the use of an assistive device 4) diagnosis of peripheral vascular disease w/o surgical intervention by the attending vascular surgery service 5) at least 6 months of reliable follow-up info. All wounds were classified as wounds with ischemia or infection and ischemia.	Case-control Retrospective	MDT	Control	Neuroischemic diabetic foot wounds and Peripheral vascular disease	<p>There were no significant differences in age (P = .6), gender prevalence (P = .99), duration of DM (P = .4), or wound size (P = .4) between the MDT and control group. 27 (45%) healed during 6 months of review</p> <p>No significance difference in the proportion of pt's healing in the MDT vs. the control group: 57% vs. 33%.</p> <p>In the pt's who healed, time to healing was significantly shorter in the MDT than in the control group (18.5 +/- 4.8 vs. 22.4 +/-4.4 weeks).</p> <p>No significant difference in infection prevalence in pt's undergoing MDT vs. controls (80% vs. 60%).</p> <p>There were significantly more antibiotic-free days during follow-up in pt's who received MDT (126.8 +/- 303.3 vs. 81.9 +/- 42.1 days).</p> <p>~1 in 5 pt's (22%) underwent a high-level (above foot) amputation. Pt's were ~ three times as likely to undergo amputation in the control group (33% vs. 10%).</p> <p>MDT reduces short-term morbidity in nonambulatory pt's with diabetic foot wounds.</p>	<p>Because this study was a case-control retrospective study, outcomes were subject to selection & tx. The clinic where pt's were evaluated uses a method of assessment, operational definitions, & tx. that are standardized b/w the 2 attending clinicians, who based their dx. On clinical & noninvasive vascular assessments. Not all pt's received a noninvasive or invasive exam.</p>
Maggot Therapy in "Lower-extremity Hospice" Wound Care			30 pt's	30 pt's			
			71.7 +/- 6.8 y/o	72.7 +/- 6.8 y/o			
			86.7 % male	86.7 % male			
			Duration of DM: 14.7 +/- 8.4 years	Duration of DM: 16.3 +/- 7.6 years			
	Tx: 6 mo	Tx: 6 mo					

Study year	Research Addresses	Level of Evidence	Demographics	Diagnosis	Underlying Condition	Results	Limitations
Jukema 2002 Amputation Sparing treatment by Nature. “Surgical Maggots Revisited”	MDT used in as adjunct to wounds unresponsive to classical approach and of wound debridement and antibiotic therapy.		11 patients 16-81 y/o 9 males 2 Female	Osteomyelitis: 5 pt’s Gangrene : 2 pt’s Soft tissue inf.: 3 pt’s Ulcus cruix: 1pt’s	Osteomyelitis: vascular insufficiency, DM, trauma, steroid treatment Gangrene: vascular insufficiency, DM, meningococcal sepsis Soft-tissue infection: vascular insufficiency, DM, trauma, fasciitis Ulcus cruix: DM, chronic ulcers, steroid treatment, rheumatoid arthritis	Maggot Therapy prevented amputation and preserved extremities.	Empirical treatment was used: fluclozccillin
Mumcuoglu 1999 Maggot Therapy for the treatment of intractable wounds.	To assess the efficacy of maggot therapy for the treatment of intractable, chronic wounds and ulcers in long-term hospitalized patient’s in Israel		43 wounds 25 patients 35-88 y/o 12 male 13 female	Diagnosis Underlying Condition	Results		The article stated that MT proved to be a cost-effective tool; however, there is no research or evidence suggesting this statement.
				Venous Stasis: 12 pt’s Paraplegic: 5 pt’s Hemiplegia: 2 pt’s Birger’s Disease: 1 pt Lymphostasis: 1 pt Thalassemia: 1 pt Polycythemia: 1 pt Dementia: 1 pt Basal Cell Carcinoma: 1	In 13 patients with superficial wounds, the lesions were debrided after only 1-4 treatments within 1-8 days Complete debridement was achieved in 38 (88.4 %); in 3 (7%) wounds the debridement was significant, in one (2.3%) partial, and one wound (2.3%) remained unchanged. Five patients who were referred for amputation of the leg prior to MT, the extremity was salvaged as a result of MT. Three pt’s with deep wounds, where septicemia had been a serious threat, it was prevented as a result of MT.		

Sherman 1995 Maggot Therapy for Treating Pressure Ulcers in Spinal Cord Injury Patients	The effectiveness of MT in the treatment of necrotic pressure ulcers in patients with spinal cord injuries	Prospective Control Study	8 patients 44-68 y/o 8 males 0 females 1 Quadriplegic 7 paraplegic All pressure ulcers existed for at least one month before patients were enrolled in the study	Diagnosis Underlying Condition	Results		Small study
				Spinal Cord injury patients with pressure ulcers	MT reversed the progression of each worsening ulcer, and increased the average rate of healing for those wounds which were slowly improving. Ulcers with a 20% or larger necrotic base, none were more than ½ debrided by the time MT was initiated; however, all such ulcers were completely debrided within one-two weeks afterwards. The average surface area prior to MT was an increase of 21.8 % per week. The average change during MT was a decrease in size by 22% per week.		
Sherman 2001 Maggot Debridement Therapy in Outpatients	To identify the benefits, risks, and problems associated with outpatient maggot therapy.	Prospective Study Descriptive case series, with survey.	21 Patient's 35-95 y/o 15 male 6 female	Venous stasis ulcer = 14 Neurovascular ulcer = 4 Pressure ulcer = 1 Traumatic wound = 1 Abscess = 1	Diabetes = 14 Peripheral venous or arterial disease = 5 Spinal cord injury/paraplegia = 1 Allergies to multiple prior wound tx. = 2 Thalassemia = 1	Maggot therapy completely or significantly debrided 18 (86%) of the wounds; 11 healed w/o any additional surgical procedures. Despite successful debridement, 2 pt's required amputation as originally planned.	The study should include a control group and a detailed cost analysis.
Sherman 2002 Maggot versus conservative debridement therapy for the treatment of pressure ulcers.	To define the efficacy and safety of maggot therapy	Retrospective Study	103 patient's 145 pressure ulcers -- 61 ulcers in 50 pt's received MT --84 ulcers in 70 pt's did not	Diagnosis Underlying Condition	Results		A weakness of any retrospective study is the possibility that the bias accompanies a nonrandomized selection may influence the outcome.
				Pressure Ulcers	80% of maggot-treated wounds were completely debrided in less than 5 weeks, while most (52%) non-maggot-treated wounds were still not completely debrided after 5.5 weeks of therapy (p =0.021). Twice as many maggot-treated wounds decreased in size during therapy (p = 0.001). Maggot treated wounds were associated with a significant decrease in necrotic tissue (p = 0.001), with an average decrease of 3.7 cm ² necrotic tissue w/n the first 2 weeks		

Sherman 2003 Maggot Therapy for treating Diabetic Foot Ulcers Unresponsive to Conventional Therapy	Evaluation of wounds that were not responding to conventional care and the demonstration that MDT was far more effective in treating chronic wounds than was a trial of another standard therapy; suggesting that we should not consider MDT as a last resort; rather consider it earlier.	Cohort Retrospective	18 patients 20 nonhealing wounds 6 pt's treated w/ conventional therapy 6 pt's treated w/ MDT 8 pt's received conventional therapy followed by MDT	Diagnosis Underlying Condition			Results			Small number of subjects.		
				Foot and leg ulcers in Diabetic Patients			Maggot therapy was associated with faster debridement and wound healing than conventional therapy. MDT-treated wounds saw a 50% reduction in necrotic surface area in 9 days, whereas conventionally treated wounds did not reach that stage until day 29. Within 2 weeks, maggot-treated wounds were covered by only 7% necrotic therapy compared with 39% necrotic tissue for conventional. Within 4 weeks, MDT treated wounds were completely debrided, whereas wounds treated with conventional therapy for an average of 5 weeks were still covered with necrotic tissue over 33% of their surface. Maggot Therapy was associated w. hastened growth of granulation tissue and greater wound healing rates. Within 4 weeks, maggot-treated wounds were not only debrided, but were covered with healthy granulation tissue over about 56% of their wound base. However granulation tissue covered only 15% of the base of those wounds treated conventionally.					
Sherman 2004 Presurgical Maggot Debridement of Soft Tissue Wounds Is Associated with decreased rates of postoperative infection.	Postoperative complications were assessed for all pt's who received presurgical maggot debridement therapy and for a matched group of pt's who did not.		25 patients 29 wounds			<u>MDT</u>	<u>Non-MDT</u>		<u>MDT</u>	<u>Non-MDT</u>	10 wounds were debrided by maggots w/n 1-17 days prior to surgical closure. Debridement was effective in all cases, and there were no postoperative wound infections. 6 of 19 wounds not treated presurgically with MDT developed post-op infection. Presurgical closure, w/o increased risk of postsurgical wound infection	
				MDT	Non-MDT	Pressure Ulcers	7	15	Spinal Cord injury	7		16
			54 (42-76) y/o	57 (27-81) y/o	Arterial and/or ischemic ulcer	2	1	DM	6	8		
					Trauma &/or burn	0	2	V/A disease	5	8		
					Nonhealing postsurgical wound	1	1	HTN/ Cardiac disease	4	4		
					Incontinence	7	16					

<p>Steenvoorde 2004</p> <p>Antimicrobial Activity of maggots</p>	<p>In-vivo results of the use of maggots to treat gram positive and gram-negative infected wounds.</p>	<p>Retrospective noncomparative cohort study</p>	<p>16 patients 16-88 y/o 14 males 2 females Average treatment =27 days with an average of 7 dressings.</p>	<p>Osteomyelitis: 9 pt's Gangrene : 2 pt's Soft tissue inf.: 2 pt's Ulcus cruix: 1pt's Fasciitis necroticans: 2 pt's</p>	<p>Osteomyelitis: vascular insufficiency, DM, trauma, steroid treatment Gangrene: vascular insufficiency, DM, meningococcal sepsis Soft-tissue infection: vascular insufficiency, trauma Ulcus cruix: Vascular insufficiency, DM, steroid treatment, rheumatoid arthritis</p>	<p>Gram positive bacteria are digested & killed more easily than Gram-negative bacteria. A greater # of maggots are needed for larger wounds & also for gram-neg wounds</p>	<p>All patients who were septic or had a severe wound infection were treated with antibiotics directed at the causative agent which would have probably influenced the cultures.</p>
<p>Tanyuksel 2005</p> <p>Maggot Therapy in the Treatment of Chronic Wounds in a Military Hospital setup in Turkey.</p>	<p>To examine the efficacy of maggot debridement therapy in the debridement of chronic wounds in a military hospital.</p>		<p>11 patient's 21-72 y/o 7 male 4 female</p>	<p>Diagnosis Underlying Condition</p> <ol style="list-style-type: none"> 1. Diabetes Mellitus = 6 (<i>Staph. Aureus, pseudomonas aeruginosa</i>) 2. Berger's Disease = 2 (<i>Pseudomonas aeruginosa, Staph Aureus</i>) 3. Gunshot wound = 1 (<i>Stah. Aureas, proteus mirabilis</i>) 4. Chronic Ostoemyelitis = 1 (<i>Pseudomonas aeruginosa</i>) 5. Venous stasis ulcer = 1 (<i>E. coli, Serratia marcescens</i>) 	<p>Complete debridement was achieved in 10 our of 11 pt's, while in 1 patient the wound could be cleaned only partially. A remarkable reduction in odor was emanating from the wound & notable granulations were observed in all debrided wounds. Increased pain was noted in 1 pt. with a venous stasis ulcer.</p> <p>This study supports the claims that MDT is a valuable method for complete debridement of diabetic foot ulcers, chronic leg ulcers and pressure sores.</p> <p>Marked antimicrobial activity of larval secretions was detected against <i>Streptococcus</i> A, B, <i>Pseudomonas</i> sp. & methicillin-resistant strains of <i>S. aureus</i>. <i>E. coli</i> were destroyed in the midgut during the passage through the maggot's digestive tract.</p>		

Wolina 2002 Biosurgery Supports granulation & debridement in chronic wounds	The investigation of the clinical effects, side-effects, and mechanisms of action of biosurgery with the use of remittance spectroscopy as an objective approach in monitoring.	Report	30 patients					Biosurgery is very selective with removal of necrotic tissue while preserving living tissue, including bone & tendons. Being most effective in pt's with neuropathic ulcers-DM foot ulcers and limited in gangrene or infections	Remittance spectroscopy in human skin depends on absorption and scattering. This causes systematic errors b/c the microcirculation of tissue will be influenced by pressures.
			18-89 y/o						
			12 males						
			18 females						
		Days of treatment = 1-4 days							
Wayman 1999 Cost effectiveness of larval therapy in venous ulcers.	The comparison of LDT with hydrogel dressings in the treatment of necrotic venous ulcers. Also to compare the efficacy and cost of sterile fly larvae with conventional pharmaceutical agent for the debridement of necrotic venous ulcers.	Randomized control study 1. Control Group 2. Larval Therapy	Control Group	Larval Therapy	Diagnosis & Underlying Condition Necrotic, Sloughy Venous Ulcers	RESULTS <ul style="list-style-type: none"> The two groups were comparable in terms of age, sex, ulcer size, and duration. Debridement occurred more rapidly in the LDT where patients only required one application of larvae. In the hydrogel group only 2 patient's were de-sloughed w/n the month. Furthermore, one pt. changed to LDT after the study The findings suggest that larval debridement is more cost-effective than standard hydrogel for the debridement of venous ulcers. 			The debridement and exudates were not blinded making the results vulnerable to elements of bias. The study didn't use healing rates as the main outcome of measure. -Assessment of quality of life wasn't used.
			6 pt's 40-75 y/o 3 M 3 F Months of Tx: 2-6	6 pt's 48-72 y/o 2 M 4 F Months of Tx: 2-8					

<p>Wolff 2003</p> <p>Larval Therapy – an effective method of ulcer debridement.</p>	<p>The investigation of whether or not larvae of the blowfly, <i>L. sericata</i>, can effectively debride chronic ulcers.</p>		<p>74 patients 25-94 y/o 39% w/ diabetes Treatment = 6 wks Study = 3 years</p>	<p>Arterial leg and foot ulcers = 38 (51%)</p> <p>Venous Leg Ulcers = 10 (14%)</p> <p>Combined arterial & venous leg ulcers-5 (7%)</p> <p>Decubital ulcers = 5 (7%)</p> <p>Neuropathic diabetic foot ulcers = 4 (5%)</p> <p>Ulcers due to myeloproliferative or myelodysplastic dz. = 2 (3%)</p> <p>Inoperable malignant ulcerative skin tumors =2 (3%)</p> <p>Ulcers after radiotherapy = 2 (3%)</p> <p>Hypertensive ulcers = 2 (3%)</p> <p>Vasculitic ulcer = 1 (1%)</p> <p>Calciphylaxis ulcer = 1 (1%)</p> <p>Puoderma gangrenosum ulcer) = 1 (1%)</p> <p>Necrotic ulcer after an infection = 1 (1%)</p> <p style="text-align: center;"><u>LIMITATIONS</u></p> <p>The article addresses that it is necessary to determine more precisely the types of ulcers in which larval therapy is most beneficial; furthermore, larval therapy presents special problems and cannot; for example, be performed as a double-blinded study or be compared with any other treatment. In this study, there were no noticeable assoc. b/w debridement and wound origin. The study addressed that one potential problem, although not seen in this study, is injury to blood vessels causing bleeding. All patients had been previously treated with other wound tx. Therapy was less efficient in the vasculitic ulcer & ulcer & pyoderma gangrenosum ulcer.</p>	<p style="text-align: center;"><u>RESULTS</u></p> <p>Larval therapy was not only found to be effective in debriding necrotic ulcers, but also very fast & precise, as the larvae avoided healthy tissue. They also confirmed the statement of Sherman et al. that most necrotic ulcers were debrided within 1 week. 93 % = necrotic ulcers and in 86% of these pt's the ulcer was debrided to b/w 66-100%. The remaining were considered failures. 1 application was performed in 53 (72%), 2 consecutive in 14 (19%), and 3-4 in 7 (9 %). 29 (39%) of the pt's had DM and were all successfully debrided. Malodor was experienced in 31 (42%) and was reduced in 18/31 (58%). One wound was more malodorous after tx. 61 (82%) were able to describe the pain during the larval tx. 21/61 (34%) felt inc. pain during tx. leading to interruption. Less pain was felt in 15/61 (25%) and no difference in pain in 25/61 (41%). 3 of the patients found the therapy psychologically repellent. The larvae seemed to thrive especially well in the wounds of diabetic patients which were all completely debrided.</p>
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Vita

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