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Efficacy of Maggot Debridement Therapy on Burn Wounds as an Alternative Treatment Modality

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Abstract

Background: Burns cause devastating injuries and a high incidence of severe physical and psychological impairment. Severe burns require specialized medical professionals and facilities for optimal recovery that require multiple surgeries, long hospital stays and rehabilitation. Surgical debridement and skin grafting is the standard of care for most burn patients. Maggot Debridement Therapy (MDT) is a modality that might be useful as an alternative to surgical debridement for wound bed preparation. This could be an excellent alternative to wound debridement for patients that are not surgical candidates. This review looks at the efficacy of MDT for debridement of acute burn patients.

Methods: An exhaustive systematic literature review was performed using MEDLINE-Ovid, Web of Science, CINAHL and Google Scholar utilizing the keywords maggot therapy, larvae therapy and burns.

Results: A total of 143 articles were screened with 7 case studies meeting designated criterion reviewed. Maggot debridement therapy was found to be effective in removal of necrotic tissue from these burn wounds in 6 out of 7 cases. The case report where debridement was not successful was due to burn destruction into the knee joint capsule and MDT was terminated secondary to the need for bilateral knee amputation. The number of MDT treatments required to obtain full debridement ranged from 2-5 applications. The overall quality of these studies via the GRADE criteria is very low due to there being no RCTs performed at the time of this review and further studies need to be performed on a larger population of patients with acute burns.

Conclusion: Based on these case reports, MDT should be considered for the burn patient population as a rapid, effective, safe and economical alternative modality for wound management.

Keywords: *Maggot therapy, larvae therapy, burns.*

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List of Abbreviations

MDT……Maggot Debridement Therapy
FDA.....Federal Drug Administration
RCTs……...…Random Control Trials
MRSA…….Methicillin Resistant *Staphylococcus auereus*
TBSA……...Total Body Surface Area
GRADE……. Grading of Recommendations, Assessment, Development and Evaluation
BTER….. ……..The BioTherapeutics, Education and Research

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BACKGROUND

Burns cause devastating injuries and a high incidence of severe physical and psychological impairment. Disabilities ranging from disfiguring scars, contractures, amputations, anxiety and depression are common. Mortality rates vary depending on the extent of the burn and if inhalation injuries are involved.[1] Survival is largely dependent on early intervention with fluid resuscitation and early wound excision. Wound infection and skin graft rejection is a major concern adding to post injury complications. Classically, debridement of necrotic tissue from burn injuries is done surgically often requiring multiple operations as skin grafting and reconstruction are common. Management of burn patients is multi-disciplinary including a specialized surgical team, nursing, social services, behavioral health, physical therapy, occupational therapy, respiratory therapy and speech therapy. Often advance wound dressings, splints, compression garments and prostheses are necessary to optimize function and mobility with the goal to improve the overall quality of life. Many patients experience severe pain complicated by dressing changes and multiple surgical interventions that can take weeks to months to heal which result in long costly hospital stays for these patients.[2]

Although maggot debridement therapy (MDT) has hundreds of years of documented success for wound debridement, their use for acute burn patients is a new area of research. Exploring alternative methods to surgery to reduce pain and recovery time for burn patients is an important step in advancing burn wound care. Maggots have been documented to be adventitious for debridement of battle wounds since antiquity. The first intentional MDT application into a

wound was during the American Civil War by a Confederate army surgeon named J.F. Zacharias who found that the soldiers infested with maggots had a much higher survival rate and faster healing times.[3] In 1917, during World War I, an orthopedic surgeon named William S. Baer recognized the benefit of maggots in soldiers with open femur fractures. Baer noted no purulence or infection of the wounds after maggot removal and the wounds were covered with healthy pink granulation tissue often extending over the exposed bone. This occurred in a time where open femur fractures resulted in an 80% mortality rate. Baer popularized maggot therapy in the United States during the 1930's for use in osteomyelitis infections and formulated a method to raise and sterilize the eggs of the green blow fly.[4] Thousands of physicians utilized maggots until the 1940's when the invention of antibiotics became widely available which greatly reduced the popularity of the use of maggots.[5] Although MDT has hundreds of years of documented success for wound debridement, their use for the burn patients is a new area of research.

Medicinal maggots are larvae from the green blow fly of the species *Phaenicia sericata.* The use of these maggots is due to their specificity of consuming only necrotic tissue leaving viable tissue untouched.[6] The eggs are disinfected with 3% Lysol solution for 5-6 minutes[7] or 0.525% sodium hypochlorite[8] then rinsed with sterile saline and placed in sterile containers with a sterile food source for incubation. Each sterile container holds 250-500 maggots.[5] Generally 5-10 maggots/cm2 are placed into the wound and covered with a fine mesh to ensure adequate oxygenation and then lightly covered with an absorbent pad and left in place for 2-3 days.[7] Maggots are known to promote wound healing by multiple actions:

- Wound debridement by utilizing necrotic tissue as their food source. The maggots have proteolytic enzymes that liquefy dead tissue within 48-72 hours. This process produces copious exudate that irrigates the wound during the digestion process.[3,6]

- The mechanical action of the maggots crawling in the wound bed stimulates rapid granulation tissue formation.[3,8]
- Maggot secretions possess broad spectrum antimicrobial activity with further bactericidal action within the stomach of the maggot.[6]
- Reduction of biofilm formation of MRSA and *Pseudomonas aeurginosa.*[9]

In 2004, the U.S. Food and Drug Administration (FDA) authorized a licensed practitioner to prescribe medical maggot use in humans and animals for treatment of pressure ulcers, diabetic foot ulcers, venous stasis ulcers, post-surgical wound and non-healing traumatic wounds. To date, it is not FDA approved for the treatment of acute burns. While MDT is well documented to be a successful modality for wound debridement in many types of wounds, the question of the benefit in acute burn wounds still remains to be answered.

METHODS

An exhaustive systematic literature review was performed using MEDLINE-Ovid, Web of Science, CINAHL and Google Scholar utilizing the keywords maggot therapy, larvae therapy and burns. Articles were screened and references were reviewed for relevance using inclusion criteria of human studies and studies published in the English language. Animal studies were excluded. There are no controlled clinical studies using MDT on burn wounds published at the time of this review, therefore case reports were selected and cross referenced. The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) criterion was used to evaluate the level of evidence quality.[10]

RESULTS

A total of 143 articles were screened with 7 case studies meeting designated criterion reviewed. The information provided by these case reports was incredibly limited and inconsistent with available details summarized. (See Table I.)

- Case 1: A 72 year old male with diabetes, heart disease and vascular disease sustained an upper arm burn and was deemed medically unfit for surgery. This patient achieved complete debridement with 4 maggot applications and underwent a split thickness skin graft with complete healing after 3 weeks from initiation of MDT. It was predicted that wound healing would have taken 6-8 weeks with standard dressings.[2]
- Case 2: A 32 year old male with spina bifida sustained a full thickness friction burn of his right foot. This patient was unwilling to have surgery due to not wanting another scar. With 5 MDT applications he achieved complete debridement and wound closure in 51 days. Maggot therapy allowed this patient to stay out of the hospital and play an active decision making role in his care.[2] (Figure I.)
- Case 3: A 64 year old male with myasthenia gravis had bilateral knee burns from a campfire. After 2 failed grafts, MDT was initiated and larvae were found to be burrowing into the joint capsule. Due to the extensive invasion of soft tissue structures this patient underwent bilateral amputations. Edwards speculates that if MDT was initiated earlier, then the painful failed prior skin graft surgeries could have been avoided.[2]
- Case 4: A 41 year old male suffered from 9% total body surface area (TBSA) burns on his legs from sleeping by a campfire and underwent 2 failed surgical debridement with autografting, 13 hyperbaric oxygen therapy treatments, and burr holes were drilled into his tibia to promote granulation tissue along with sharp debridement. Grafting failure was due to residual failure to remove non-viable tissue during surgical debridement. Maggots

were placed in the wound for a total of 4 applications for complete debridement and granulation tissue migrated over his exposed bone.[11]

- Case 5: An 80 year old female with a full thickness flame burn covering 7% TBSA burns was not a surgical candidate due to acute kidney injury and "a prohibitively high risk for surgical intervention" from heart complications. This patient was fully bio-debrided after 2 MDT applications.[12]
- Case 6: A 59 year old male involved in a traffic crush incident that was rescued from a hot furnace cinder, sustained burns to bilateral legs, buttock and perineal area encompassing 60% TBSA. After extensive escharotomy revealed 30% TBSA muscle necrosis the left leg was amputated. When skin allografting failed and infection was present, MDT was initiated to the existing wound sites for a total of 2 applications. The patient's fever dropped within 24 hours of the first maggot application and he regained consciousness. After maggot removal of the second application, the necrotic tissue was debrided and "a bulk of fresh granulation tissue was seen on the wound" and this patient recovered without complications.[13]
- Case 7: A 61 year old male type 1 diabetic with diabetic neuropathy and Charcot foot deformity sustained a right foot burn with 1% TBSA affected. This patient received a total of 3 MDT applications with successful debridement of the anterior wound surface with wound healing. The patient was noncompliant with his non-weight bearing status during MDT with subsequent difficulty maintaining the maggots within the dressing of the posterior aspect of the wound near the heel and underwent surgical debridement and grafting to this area.[14]

DISCUSSION

Use of MDT fell out of favor for many years because of the utilization of antibiotics, but this old method is making a comeback in chronic non-healing wounds and this modality for the burn patient is a new area of research that warrants further investigation. Although MDT is not FDA approved for use in the burn population, these case reports clearly represent an efficient method for rapid and complete debridement of necrotic tissue in acute burn wounds. MDT takes 2-3 days per application and provides a low cost alternative for wound bed preparation and should be an early consideration by clinicians for patients unable or unwilling to undergo surgical debridement.[9] The additional benefit of infection control and degradation of biofilm is paramount as these complications are extremely difficult to treat and contribute to prolonged healing time and hospital stays or even failed grafts.[9]

Use of MDT can greatly reduce cost by avoiding exorbitant operating room and surgeon fees for wound debridement. According to Monarch Labs LLC, in Irvine, California, the cost of one vial of Medical Maggots is $190 and contains 250-500 larvae.[15] See Figure II. The majority of the cost of this vial stems from the labor involved in the blowfly rearing process and the quality control of the laboratory.[5] Besides the inexpensive cost of the vial, MDT can be performed on an outpatient basis with relative ease using overnight courier services which would further reduce length of hospital stays and improve the quality of life for these patients during their long recovery. MDT can give patients a viable treatment option alternative to surgical debridement that even improves their chance of recovery.

Some disadvantages are the negative public perspective that maggots are dirty and a misguided perception that larvae carry disease or cause further tissue damage. Medical personnel can be reluctant because of the aesthetics of maggots and find it distressing to remove the larvae from the wound which can be a difficult objection to overcome. Education on the therapeutic and

economic benefits of this treatment can reduce the apprehension from the point of view of clinicians and patients alike. The BioTherapeutics, Education and Research (BTER) Foundation offers education, sample policies and procedures for use and disposal of the maggot dressings.[5] Furthermore, the patient needs to be cognizant enough to give consent to this therapy. Another limitation is that the wound cannot have copious drainage as this fluid will flush out the maggots and there is always the possibility that the maggots will escape the dressing. The BTER Foundation has easy to use specialized dressings to assist in maggot containment and reduces dressing application times for staff managing the wound care.[8] While there seems to be great benefits and promising results associated with MDT from these case reports, it is not FDA approved for the use in acute burns further limiting the use in this population of patients.

These case reports were assessed for quality using the GRADE with a score of very low.[10] These reports lack consistent detailed accounts of the burn stage, size, extent of injury and outcomes. They had limited details without consistent maggot application frequency or dressing specifications. The number of MDT applications was reported but the time between applications was not indicated. It is evident that all patients within these case reports reviewed had successful debridement with maggots and could potentially replace surgical debridement prior to skin grafting. Having further studies that standardize this treatment procedure with detailed measureable parameters will result in more evidence-based outcomes that can be utilized in future research.

Elements to consider in future studies would be detailing the wound size before and after each MDT application with percentages of necrotic vs. granulation tissue present in the wound bed recorded with a control group using standard dressing and surgical debridement. Perhaps performing a study with specific burn criteria limited to Stage IV with designation of a minimum

% TBSA involved and a post procedure dressing protocol with daily wound measurements along with patient response via a 0-10 pain scale would enlist a great deal of useful information regarding the efficacy of maggot therapy. Random control trials (RTCs) could be performed in large burn centers with existing dressing protocols, using surgical debrided patients in the control group and MDT as the test group. Long term follow up after MDT is also necessary to assess outcome reliability. It is evident that all patients within these case reports reviewed had successful debridement with maggots and could potentially replace surgical debridement prior to skin grafting. Clearly, it requires further studies to investigate this modality in an evidence-based forum in order to enable the use of medicinal maggots in acute burn management as a standard treatment option.

CONCLUSION

Based on these case reports, MDT should be considered in the burn patient population as a rapid, effective, safe and economical alternative modality for wound management. Maggot therapy for acute burn patients has received little attention in the research arena and is underutilized to date. There is a clear need for further studies in the acute burn population as MDT is effective at eliminating biofilm, promoting proliferation of granulation tissue and has excellent antimicrobial activity reducing wound infections. MDT can greatly reduce hospital cost and the treatment is easily accessible in the United States with the use of 24 hour overnight couriers. Patients who use this method also seem to have an increased chance of a successful recovery with less pain. Although more studies are needed to look at the benefits of MDT specific to the acute burn patient, the known benefits of MDT should warrant consideration of the patient and clinician alike who are open to a non-surgical alternative for effective wound debridement. Further evidence-based investigation to support medicinal maggot use in the acute

burn patient is necessary before it can be integrated into the current standard of care with FDA approval for this population. Maggot therapy is an antiquated modality but this new area of research could greatly improve successful outcomes for burn victims and warrants immediate attention from the research arena.

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Table I. Case Report Summary

Case Report Summary					
Case Report	**Age in years/Gender**	**Burn location/TBSA**	**# of MDT applications**	**Healing Time**	**Complete Debridement**
1	72/Male	Upper Arm	4	3 weeks	Yes
2	32/Male	Right Foot	5	51 days	Yes
3	64/Male	Bilateral Knees	1	-	No
4	41/Male	Bilateral Legs/ 9%	4	-	Yes
5	80/Female	7%	2	-	Yes
6	59/Male	Bilateral Legs, Buttock, Perineum/ 60%	2	-	Yes
7	61/Male	Right Foot/1%	3	-	Yes, in area where MDT remained

Figure I. Photo of Wound Pre and Post MDT[2]

Case 2 pre MDT[2] Case 2 post MDT[2]

Figure II. Monarch Labs Medial Maggot vial[15]

Photo by RA Sherman, courtesy of Monarch Labs, Irvine, CA