بسم الله الرحمن الرحيم
MAGGOT THERAPY

By

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Also known as:

- Maggot Debridement Therapy (MDT)
- Larval Therapy (LT)
- Biodebridement
- Biosurgery
It is a type of **biotherapy** involving the intentional introduction by a health care personnel of live, disinfected maggots (fly larvae) raised in special facilities into the non-healing skin and soft tissue wound(s) of a human or animal **for the purposes of** selectively cleaning out only the necrotic tissue within a wound (**debridement**), disinfection, and promotion of wound healing.
History of maggot therapy
Having observed the benefits of maggot-infested wounds firsthand during the first World War.

It have been recognized that wounds infested by certain species of fly larvae debride, enhance healing, and decrease the mortality associated with the underlying injury.

Then, maggot therapy was in widespread use during the following 10 years.

But soon, it was supplanted by the new antibiotics and surgical techniques that came out of the second World War.
Rebirth of maggot therapy
The recent resurgence and reintroduction of maggot therapy stems from the steep rise in the emergence of antibiotic resistant strains of bacteria, and the need for an effective non-surgical method of wound debridement.

In 1995, a handful of doctors in 4 countries were using MDT. In February, 2004, the British National Health Service (NHS) permitted its doctors to prescribe maggot therapy.
Any physician in the U.S. can prescribe maggot therapy. Over 4,000 therapists are using maggot therapy in 20 countries. Approximately 50,000 treatments were applied to wounds in the year 2006.

And now, several specialist laboratories produce maggots for clinical and research purposes.
Usually the green blow fly (*Lucilia sericata*) is used in clinical settings for MDT.

The larvae *hatch* from eggs of adult flies after 12–24h.
These 1–2 mm long larvae grow up rapidly. It has been calculated, that 200 maggots consume up to 15 g of necrotic tissue per day. Maturity is reached after 4–5 days when they are about 10 mm long. After this time, they stop feeding and develop the puparium to undergo metamorphosis into an adult fly.
This picture shows the size of larvae used in the treatment of diabetic foot ulcer.

Day 1, maggots 1 to 2 mm

Day 3, maggots 3 to 4 mm

Day 3

Day 7, maggots removed
Indications of maggot therapy

- Maggot debridement therapy is mainly used for the cleaning and disinfection of chronic wounds that are sloughy, necrotic, and infected.

- MDT has been demonstrated to be useful in surgical wounds infected with methicillin resistant Staphylococcus aureus infection (MRSA).

- It is also used in veterinary medicine,

It is particularly helpful with chronic osteomyelitis, chronic ulcers, and other pus-producing infections that are frequently caused by chafing due to work equipment.
This is a case of osteomyelitis in an adult horse which was treated by larval therapy (Sherman et al., 2007)
And this picture shows the a gunshot wound of a dog foreleg which was successfully treated by larval therapy after the failure of surgery and antibiotics (Sherman et al., 2007)
Each vial contains approximately **2,000 Lucilia sericata eggs**, from which **1,000 maggots** will normally hatch within **12 hours** of preparation.

Each vial also contains **2" x 2" gauze** and **sterile food** (containing soyprotein and yeast).

**Medical Maggots** can be removed easily by wiping them off the sides of the vial with a gauze pad moistened with sterile saline or water.
Maggots are contained in a cage-like dressing over the wound for two days. The maggots may be allowed to move freely within that cage, with the wound floor acting as the bottom of the cage; or the maggots may be contained within a sealed pouch, placed on top of the wound.

When maggots are satiated, they become substantially larger and seek to leave the site of a wound.
The maggots have three principal actions:

- **debride** wounds by dissolving only necrotic, infected tissue;
- **disinfect** the wound by killing bacteria; and
- **stimulate** wound healing.
Debridement

The **debridement** of necrotic tissue is a prerequisite for successful wound care. If debridement does not take place, wound repair is significantly impaired.
How maggots remove devitalized necrotic tissues from wound?

Maggots derive nutrients through a process known as "extracorporeal digestion" by secreting a broad spectrum of proteolytic enzymes that liquefy necrotic tissue, and absorb the semi-liquid result within a few days.

This rich soup of digestive enzymes while feeding, including carboxypeptidases A and B, leucine aminopeptidase, collagenase and serine proteases (trypsin-like and chymotrypsin-like enzymes).
**Lucillia sericata** larvae secrete four proteolytic enzymes, comprising two serine proteases, a metalloproteinase and an aspartyl proteinase with molecular weights ranging from 20 to 40 kDa, with activity across a wide pH range.

A chymotrypsin-like serine proteinase exhibited excellent degradation of ECM components *laminin, fibronectin, and collagen types I and III* and may therefore play a significant role in the digestion of wound matrix and effective debridement.
The mechanical action of numerous wriggling maggots in a necrotic debris-filled wound has also been suggested in aiding wound debridement. Maggots possess a pair of mandibles (hooks) which assist locomotion and attachment to tissue. This probing and maceration of wound tissue with maggot mouthhooks may enhance debridement, but these hooks are used during feeding to disrupt membranes and thus facilitate the penetration of proteolytic enzymes.
Disinfection

Any wound infection is always a serious medical complication. Infected living tissue cannot heal. If the wound is infected with an antibiotic-resistant bacterial strain, it becomes difficult or impossible to treat the underlying infection and for any healing to occur.
Maggot secretions believed to have broad-spectrum antimicrobial activity include: allantoin, urea, phenylacetic acid, phenylacetaldehyde, calcium carbonate, and proteolytic enzymes.

Bacteria not killed by these secretions are subsequently ingested and lysed within the maggots.

Lucilia excrete their nitrogenous waste as 10% allantoin and 90% ammonia. The quantity of ammonia produced by aseptically raised maggots is sufficient to account for an increase in wound pH from acid to neutral or slightly alkaline at pH 7 or 8.
In addition, larvae of *L. sericata* carry in their midgut a commensal, *Proteus mirabilis*. These commensals produce agents such as **phenylacetic acid** (PAA) and **phenylacetaldehyde** (PAL), with known antibacterial properties.

*In vitro* studies have shown that maggots inhibit and destroy a wide range of pathogenic bacteria including methicillin-resistant *Staphylococcus aureus* (MRSA), group A and B *streptococci*, and **Gram-positive** aerobic and anaerobic strains.
Maggot secretions appear to amplify the wound healing effects of host epidermal growth factor and IL-6. Maggot secretions are able to stimulate the growth of human fibroblasts and slow-growing chondrocytes. Chondrocyte proliferation, as well as the synthesis of cartilage-specific type II collagen, increases in the maggot secretion environment. Maggot excretory/secretory (ES) products cause changes in fibroblast adhesion and spreading upon extracellular matrix protein surfaces. Also, affected the integrity of the protein surface especially that of fibronectin, whilst maintaining cell viability.
Maggots secrete cytokines in vitro. High levels of gamma-interferon, IL-8, IL-10 and growth factor in maggot secretions were found which contribute to the increase in granulation tissue.

Maggot secretions also contain a substance called allantoin (2,5-Dioxo-4-imadazolidinyl urea) and ammonia bicarbonate which are responsible for the abundant growth of granulation tissue.

Micromassage of the wound by maggot movement is further thought to stimulate the formation of granulation tissue and wound exudates by the host.
Advantages of maggot therapy

• Takes about **15-30 minutes** to be applied.

• **Excellent** safety record.

• **Simple** enough that non-surgeons can use it. This means that it is also possible to provide surgical quality debridement as an outpatient or in the home.

• **Low cost** treatment.

• Maggot debridement therapy has **not been associated with major adverse effects or complications**.
Limitations of maggot therapy

• A major obstacle to the utilization of MDT appears to be its poor acceptance by both patients and health care professionals.

• Not all wound-types are suitable: wounds which are dry, or open wounds of body cavities do not provide a good environment for maggots to feed.

• Maggots have a short shelf life which prevents long term storage before use.

• Dressings must be designed to prevent any maggots from escaping, while allowing air to get to the maggots.

• Maggots should not be used in patients who are allergic to eggs, soybeans, or fly larvae.
Conclusion
It is questionable as to whether maggot therapy, a unique inexpensive, natural way of attempting to combat wound infections, will ever obtain the recognition it deserves.

The main problem remains, not patient compliance, but willingness by physicians and surgeons to implement it.

Many doctors see maggot therapy as an antiquated treatment. Others describe maggot-therapy as a step backwards, which owing to social disappointment, will never regain the popularity of the 1930s.
It is now a universally acknowledged fact that maggot therapy can be used successfully to treat chronic, long-standing, infected wounds, which have previously failed to respond to conventional treatment.

Even though research into the science behind the success of maggot therapy is proliferating, much more laboratory evidence into the exact mechanisms of healing and of the nature of the antibacterial molecules are needed.
Only with this evidence will the cynics and doubters be convinced that maggots are natural remarkable answer to festering, infected, non-healing wounds.

Until, we know more and can harness their secrets, maggots will continue in the face of their critics, to wander, debride, cleanse and heal our wounds.