The Maggot Manual

Jennifer Byrnes Wound Management Nurse Practitioner

Royal Darwin Hospital January 2015 ©

Maggots

Index:

1. What to do if you find maggots on a patient 3-4

2. What are the best methods for maggot removal 4-5

3. What removal methods are contraindicated 6

4. Maggots general information 7-9
   - 4.1 The Green Bottle fly 7
   - 4.2 How maggots achieve debridement 7
   - 4.3 Maggot anatomy 8
   - 4.4 Therapeutic maggots 8
   - 4.5 Sterile maggots 9
   - 4.6 Clinical use of maggots 9

Maggots

1. What to do if you find maggots on a patient

Feral maggots (maggots that are not born in a sterile clinical environment) can be hazardous to the wound bed. The problem being that they carry disease and bacteria that further cause complications to a wound area. There are over 11 000 species of flies that can cause harm to humans, flies can carry parasites and breed parasites in their own body or mechanically transport viruses and infectious bacteria as they travel from site to site e.g. faecal deposits, garbage bins, waste sites etc[i].

Female flies have a keen sense of smell and can find rotting organic material such as infected tissue in a wound or decaying meat from a long distance and will travel to lay eggs in this suitable environment[ii]. As a result maggots may be found in a wound bed, ears or other cavities, these feral maggots must be removed when the patient presents either to ED or at ward level or outpatient settings.

At present maggot therapy is not utilised in the Northern Territory as there are no facilities to breed sterile maggots for wound care. There is only once place in Australia where maggots are bred in laboratory conditions, that is at Sydney's Westmead Hospital, the transport to the NT for use is still cost prohibitive at this stage. So unless the patient advises or you have written confirmation that the maggots you see in a wound are of a medicinal calibre they must be removed to prevent complications arising from feral maggots.

It is also important to note that only maggots from a specific breed of fly are used in wound management. The type of fly is the Green Bottle fly or Green Blow fly in the genera of *Phaenicia or Lucillia*. These maggots are known to consume dead tissue while leaving live tissue intact, as a result they are the preferred maggot used in wound therapy[iii]. It is important to note that not all maggots differentiate between dead and live tissue as a result leaving maggots in the wound could lead to further tissue damage if it is not the correct breed of maggot.

In some species of flies the maggots feed on live and dead tissue and the maggots become highly invasive. An example is the Screw Worm fly, it is particularly dangerous laying eggs in wound margins or mucous membranes such as the nose or vagina. The maggots then burrow down causing large amounts of tissue damage or even death[iv].

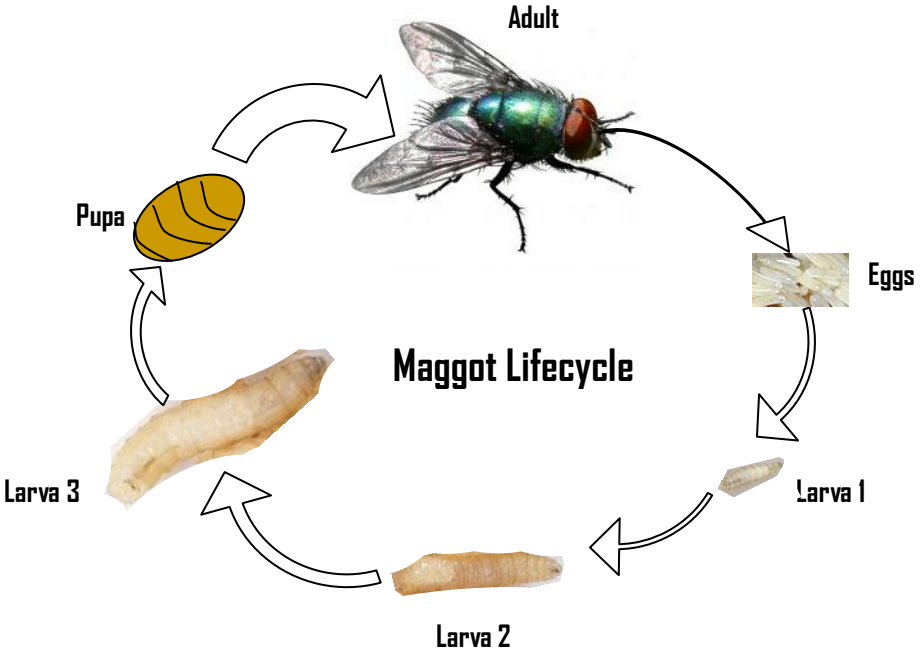
Screw Worm fly has never become established in Australia however it is prominent in Papua New Guinea and is in the coastal swamp lands near Torres Strait so there is potential to see this type of fly in patients who may present to a health region in the NT top end[v].

Key points if maggots are found in a wound;

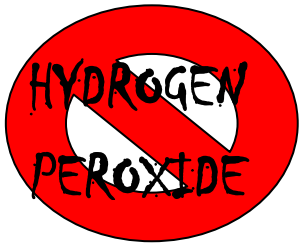
- Identify location of maggot infestation
- Identify the type of wound infested
- Identify if by small chance they are medicinal (i.e. from interstate patient)
- All feral maggots in wounds must be removed or destroyed
- Feral maggots in the wound introduce pathogens and may cause harm to live tissue.
- The type of maggot cannot be identified until it turns into a fly

Note: eggs hatch into maggots within 8-10hours of being laid and will remain in larvae form for up to 6 days in warm climates. Maggots reach full size in approx 40hrs of hatching[vi].

Maggots increase rapidly in size, they moult twice until they are fully grown at day 5 to 6, where they will then leave their food and find a place to turn into pupa[vii].



2. What are the best methods for maggot removal?



Maggot Removal:

The most important thing about maggot removal is firstly identify the location of the wound or area infested with maggots, think about possible problems that could arise using the various techniques suggested for maggot removal then implement the safest technique that will provide the best outcome for the patient.

No matter what technique is used the wound or area should be checked again in 24hrs to ensure all maggots have been removed, small maggots are difficult to see and even though you may think you have them all, on review in 24hrs you may find maggots still residing within the wound area.

Mechanical removal:

The first step is to attempt to wipe maggots out of the wound with damp gauze, once this has been performed go to the next step of irrigation to remove residual maggots.

Irrigation with saline or water:

Irrigation of the area can lift maggots off the surface of the wound if it is a shallow area and the maggots are of medium size, small maggots are more difficult to irrigate off as they tend to stick in the crevices' of the wound tissue.

Irrigation with betadine or chlorhexidine

These antiseptics will kill maggots and will also assist in killing pathogens that may have been introduced by feral maggots. Use saline to irrigate out the antiseptics prior to dressing.

Irrigation with suction:

By irrigating the area and using a soft Y suction catheter you can lift most maggots from the wound base. This is also effective if you have maggots that have collected around a tube or drain site (be aware of where the drain or tube site goes, irrigation may be contraindicated and only suction may be employed in this region).

Suction without irrigation:

This can be utilised if there is a risk of irrigating an area and maggots can be collected by a suction catheter, dry suction can be more time consuming.

Capture:

Catching maggots by forceps is also an option, this can be employed before or after irrigation to catch any maggots that prove difficult to remove. If a maggot is in a cavity you may have to implement the hide and find technique.

Hide and Find:

Hide and find relates to the fact that maggots are photophobic and when exposed to light they will migrate to the darkest part of the wound base, in a cavity it makes them very difficult to catch. By covering the wound with a combine / gauze to make the area dark you lift after 30seconds and you will find they have migrated to the top of the wound where you can catch as many as possible with your forceps or suction catheter before they retreat into the dark region of the wound again. Repeat this action until all are gone. This type of *'peek-a-boo'* maggot collection is also time consuming but is a good way to encourage maggots that are deeply embedded in wound cavities to move to the surface for removal.

Suffocation:

There are some areas where irrigation, suction or capture techniques are not able to be employed e.g. vaginal region, burr holes, ears, or fungating tumours, or where there is a risk of rupturing vessels by using the above techniques. Suffocation can also be used on other areas after initial irrigation to ensure any remaining maggots are killed. Maggots require room to move and oxygen to survive, by creating a wound environment that has limited oxygen, suffocation and death of the maggots can be achieved. Using thick paraffin over the wound base, either in ointment form or triple layer of Paraffin gauze will assist in suffocating the maggots. After 24hrs and maggots will either come off in the dressing or be broken down by macrophages. Smaller maggots are very hard to see and they are very fast making them very difficult to remove, as a result you may remove what you can then suffocate the rest.

3. What removal methods are contraindicated?

Hydrogen Peroxide is contraindicated in the removal of maggots.

It is thought that hydrogen peroxide kills maggots this is not true.

Peroxide was used to lift hiding maggots out of cavities by using the bubbling effect of the solution.

However the contraindications of using peroxide in a wound outweigh the benefit of a 'quick fix' of lifting the maggots out of the wound.

Peroxide is contraindicated because it is:

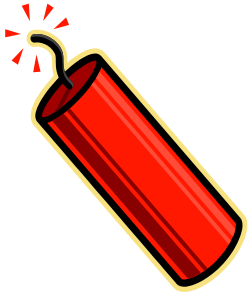
- Cytotoxic to the wound tissue especially fibroblasts
- Can cause subcutaneous emphysema
- Can cause air emboli if irrigated into deep cavities
- Causes contact dermatitis
- Can cause ulceration of newly formed tissue

Peroxide is non selectively cytotoxic, that is it does not differentiate between bacteria, white blood cells and vital wound healing cells such as fibroblasts. This is because their primary mechanism of action is to destroy cell walls regardless of the identity of the cell[viii].

Haller, Faltin-Traud, Faltin and Kern (2002)[ix] state that:

"We emphasize that hydrogen peroxide is a dangerous and unsuitable agent for routine wound irrigation and debridement"

This statement was made after following a case study of a patient who was 33yr old healthy woman that suffered an air emboli in surgery after irrigation of a vulval abscess wound with 3% hydrogen peroxide.



4. Maggot General Information

4.1 The Green Bottle Fly

Eggs laid by the Green Bottle fly are grouped in clusters on organic material. When the maggots hatch they feed with their head down to achieve the best feeding position, the breathing spiracles are located on the bottom of the maggot, this allows unrestricted breathing whilst feeding, the spiracles are also visible when the maggot forms the hardened shell of the pupa prior to hatching into the mature adult fly. Fly larvae undergo a lifecycle of approximately 5-6 days before forming into a pupa then hatching into a newly formed adult fly[x].

The Green Bottle fly larvae are the preferred choice for wound debridement because of the enzymes produced by the maggot larvae. These enzymes only breakdown devitalised tissue as a result healthy tissue remains unaffected[xi].

4.2 How Maggots Achieve Debridement

Maggots achieve debridement through enzymatic breakdown of devitalised tissue, the enzymes produced include collagenase and other powerful enzymes for breaking down devitalised organic matter. When maggots feed they focus in a head down position to achieve best access to the devitalised tissue, once the tissue is softened into a semi liquid form it is then reabsorbed and digested by the maggot[xii].

It has been discovered that using maggots for wound debridement reduces the need for antibiotics, this is a positive factor as less need for antibiotics also aids in the solution to the growing problem of antibiotic resistance. Maggot larvae's secretions have anti-microbial properties, this prevents growth of bacteria in the wound therefore maggot debridement therapy is seen as a natural way to sterilize a wound[xiii].

Biofilms are prominent in chronic wounds they are a matrix of polysaccharide polymer housing numerous and complex array of microbes under its umbrella type appearance. The structure of a biofilm behaves like a miniature city providing nutrients and waste disposal by channels formed between the matrix under the umbrella covering. This is such a sophisticated complex structure that it makes biofilms impenetrable by antibiotics, biofilms can harbour harmful pathogens within its matrix and as such bacteria that grow within a biofilm are 1 ,000 times more resistant to antibiotics than the same bacteria not in a biofilm[xiv]. Studies have demonstrated that the use of maggots has lead to the disruption and breakdown of biofilms in wounds.

Bacteria such as Staphylococcus epidermidis are responsible for biofilm formation in chronic wounds which can lead to tissue infection that cannot be diagnosed by wound swabs, the causative pathogen of the infection may not be identified as it is protected by the biofilm, research has now identified that the secretions and excretions of maggots have demonstrated the capacity to effectively breakdown these biofilms[xv].

Maggot debridement could be seen as a symbiotic relationship, Leong 2009[xvi] sums it up nicely stating that:

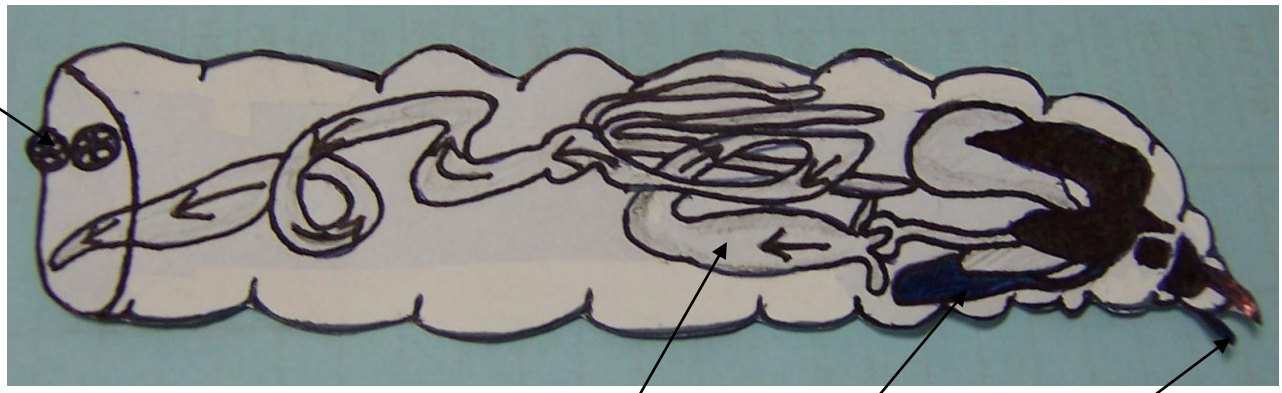
> "using maggots for wound care and debridement is a win-win situation for patients and maggots. The patient gets his or her wound cleaned quickly and efficiently and the maggot gets a good meal".

Ultimately maggots come out on top as the champions in wound management as they effectively debride / clean the wound, disrupt biofilm, and reduce the need / frequency of antibiotic therapy which results in improved wound healing and better patient outcomes.

4.3 Maggot Anatomy

A maggot has hooks called 'mandibles' located at the mouth, these allow the maggot to attach to its food source and also assist in movement around the tissue surface. The thought is that maggots use their hooks to scrape the surface of their food source, the action is thought to disrupt the tissue membranes making it easier to break down the tissue as it travels, although this has not been confirmed as the true reason for this action[xvii].

The Maggot Digestive System



4.4 Therapeutic Maggots

In the first half of the 20th century when world wars were at their peak of devastation and destruction, major injuries were a common sight and with potentially life threatening injuries that lead to fatal infections, amputations and festering wounds. It was in this time that it was noted that those soldiers who had maggot infested wounds were more likely to survive and did not develop systemic infections or die from infected wound with rotting tissue.

It was recognised that maggots were becoming the saviour of limbs and lives, as a result maggot therapy became a path for ongoing wound management techniques, even so it took until the late 20th century before true medicinal maggots were developed specifically for wound management purposes[xviii].The FDA of America did not approve of maggot therapy until 2004 where it is now a recognised therapeutic treatment for wound debridement[xix].

As maggot therapy becomes more popular and acceptable form of debridement of wounds, research continues to fully understand the behaviours and benefits of maggot therapy. Recently it has been discovered that maggot secretions also inhibit the pro inflammatory response of monocytes in the human cellular system[xx].

Chronic wounds are known to stagnate and fail to progress along the normal wound healing cascade due to a pro-inflammatory status of the wound. This is when the wound remains in the inflammatory stage of wound healing for a prolonged period of time leading to chronic wound. By suppressing the pro-inflammatory status of the wound, maggot therapy has the ability to tip the wound back into the normal wound healing cascade.

There is research now currently underway looking at the enzymes, secretions and excretions produced by maggots with the thought process that in the future these can be produced and applied to the wound base without the need of the physical maggot being applied to the wound base. The research has lead to the development of a prototype hydrogel containing insect derived active products[xxi] is still in early phases but in the future we may see maggot therapy without the maggot, which might make this type of treatment more widely acceptable to staff and patients alike.

4.5 Sterile Maggots?

This does not mean they do not have the ability to breed, the sterilisation process is to remove any pathogens that may be on the surface of the larvae eggs prior to hatching so that when the maggots emerge they are sterile i.e. will not be carry any pathogens that could be introduced into the wound. Prior to hatching and after sterilisation the eggs are placed on a medium in sterile container that will keep the hatchlings alive but will not provide enough nutrients for the maggots to grow rapidly, otherwise they would be of little use when they reach the desired wound site[xxii].

4.6 Clinical use of Maggots

Protection of surrounding skin is essential when using maggot therapy. The standard form of protection is a hydrocolloid sheet cut to the size of the skin surrounding wound usually a 3 -5cm margin. Once the maggot larvae are introduced in to the wound a fine mesh is applied over the maggots, it is to be cut approx 1-2cm larger than the wound so it can be taped to the hydrocolloid boarder with fixomul or similar tape. An absorbent pad such as a Zetuvit™ or Mesorb™ pad is applied over the mesh to absorb any liquid exudate that comes from the wound surface. It is important that the pad is not strapped tightly as the maggots require room to move and also ensure that when the pad is applied it does not form an occlusive environment ad maggots require oxygen to survive. The pad can be changed regularly but the net stays insitu to prevent escapees.

The recommended amount of maggots required for a wound varies, a finger wound may only require 5 or 6 maggots whilst a deep wound on the thigh may require 500-600 maggots. The general rule is to have no more than 10 maggots per square centimetre of tissue and less if there is only limited necrotic tissue at the wound base.

A therapeutic cycle of maggot therapy is generally 3 days after that time the maggots become full and tend to fall of the wound bed as they no longer require nutritional intake. Any remaining maggots can be removed by methods discussed earlier in this manual. Generally one application of maggots is sufficient to provide adequate debridement of devitalised tissue, however maggots can be reapplied if there is particularly stubborn necrotic tissue that requires further maggot therapy[xxiii].

Summary:

Maggot therapy is an effective method of debridement and for stimulation of chronic wounds, and has the ability to breakdown biofilms in chronic wounds. Overall this therapy is under estimated and possibly under utilised in many wound management techniques. The barriers to maggot therapy include patient and staff acceptability of maggot application to the wound and the actual availability of maggots in the Australian Health Care setting. There is potential in the future to have the benefits of maggot therapy without the maggots and as further testing advances it is potential this will be seen as part of future wound management strategies.

The most important factor of this manual is identifying if feral or a therapeutic maggot is in the wound bed and knowing the appropriate measures to remove them if they are feral and/ or how to care for them if they are therapeutic. Understanding the differences in these two types of maggots is essential to ensure that the patients' safety is not compromised through introduction of potential hazardous pathogens due to feral maggots living in a compromised wound. The manual also discusses unsafe practices in removal of maggots from the wound bed, focusing on evidence based practice to ensure optimal outcomes are achieved for the patient with maggots in the wound.

References:

[i] Fleischmann.W., Grassberger.M., & Sherman.R.,(2004) Maggot Therapy: A Handbook of Maggot-assisted Wound healing. Georg Thieme Verlag, Rudigerstrasse 14, 70469 Stuttgart Germany.

[ii] Fleischmann.W., Grassberger.M., & Sherman.R.,(2004) Maggot Therapy: A Handbook of Maggot-assisted Wound healing. Georg Thieme Verlag, Rudigerstrasse 14, 70469 Stuttgart Germany.

[iii] Dente.K.M., (2007) Alternative Treatments for Wounds: Leeches, Maggots, and Bees. [Onl;ine]. Available: http://www.medscape.com/viewarticle/563656. Accessed February 2012

[iv] Thomas.S., Jones.M., Shutler.S., and Jones.S.,(1999) Maggots in Wound Debridement - an Introduction. [Online]. Available: http://www.smtl.co.uk/WMPRC/Maggots/maggots.html. Accessed 14th January 2010.

[v] Primary Industries and Fisheries within the Department of Employment, Economic Development and Innovation (2010) Queensland Primary industries and Fisheries [Online]. Available: http://www2.dpi.qld.gov.au/health/3958.html Accessed: 14th January 2010.

[vi] Monarch labs (2011) History of maggot therapy. [Online]. Available: http://www.monarchlabs.com /veterinarians_mdt.htm#Biology%20of%20flies%20and%20maggots. Accessed 15th February 2012.

[vii] Thomas.S., Jones.M., Shutler.S., and Jones.S.,(1999) Maggots in Wound Debridement - an Introduction. [Online]. Available: http://www.smtl.co.uk/WMPRC/Maggots/maggots.html. Accessed 14th January 2010.

[viii] Burmark.M., (2004) Hydrogen peroxide in wound care. [Online] Home Care Association Washington. Available: http://www.hcaw.org/displaycommon.cfm?an=13. Accessed 13th January 2010.

[ix] Haller.G., Faltin-Traud.E., Faltin.D., and Kern.C., (2002) Oxygen embolism after hydrogen peroxide irrigation of a vulvar abscess. *British journal of Anaesthesia December 5, 2002; 88: 597-9.*

[x] Thomas.S., Jones.M., Shutler.S., and Jones.S.,(1999) Maggots in Wound Debridement - an Introduction. [Online]. Available: http://www.smtl.co.uk/WMPRC/Maggots/maggots.html. Accessed 14th January 2010.

[xi] Wikipedia (2010) Green bottle fly. [Online]. Available: http://en.wikipedia.org/wiki/Green_bottle _fly. Accessed 14th January 2010.

[xii] Thomas.S., Jones.M., Shutler.S., and Jones.S.,(1999) Maggots in Wound Debridement - an Introduction. [Online]. Available: http://www.smtl.co.uk/WMPRC/Maggots/maggots.html. Accessed 14th January 2010.

[xiii] Leong.K., (2009) The benefits of using maggots for wound care and debridement. [Online] Available:http://www.associatedcontent.com/article/1639427/the_benefits_of_using_maggots_for_wound. html. Accessed 13th January 2010.

[xiv] MedicineNet (2010) Definition of a Biofilm [Online]. Available:http://www.medterms.com/ script/main/art.asp?articlekey=16932. Accessed 18th February 2010.

[xv] Harris LG, Bexfield A, Nigam Y, Rohde H, Ratcliffe NA, Mack D 2009. Disruption of Staphylococcus epidermidis biofilms by medicinal maggot Lucilia sericata excretions/secretions.
The International Journal of Artificial Organs. Vol. 32, no. 9, 2009; 555-564

[xvi] Leong.K., (2009) The benefits of using maggots for wound care and debridement. [Online] Available:http://www.associatedcontent.com/article/1639427/the_benefits_of_using_maggots_for_wound. html. Accessed 13th January 2010.

[xvii] Thomas.S., Jones.M., Shutler.S., and Jones.S.,(1999) Maggots in Wound Debridement - an Introduction. [Online]. Available: http://www.smtl.co.uk/WMPRC/Maggots/maggots.html. Accessed 14th January 2010.

[xviii] Fleischmann.W., Grassberger.M., & Sherman.R.,(2004) Maggot Therapy: A Handbook of Maggot-assisted Wound healing. Georg Thieme Verlag, Rudigerstrasse 14, 70469 Stuttgart Germany.

[xix] Leong.K., (2009) The benefits of using maggots for wound care and debridement. [Online] Available:http://www.associatedcontent.com/article/1639427/the_benefits_of_using_maggots_for_wound.html. Accessed 13th January 2010.

[xx] Van der Plas.M.J.A., Baldry,M.,Van Dissel.J.T., Jukema.G.N.,and Nibbering.P.H.,(2009) Maggot secretions suppress pro-inflammatory responses of human monocytes through elevation of cyclic AMP [Online]. Available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2723663/. Diabetologia. 2009 September; 52(9): 1962–1970. Accessed 16th February 2010.

[xxi] Science Daily (2006) Science news: New wound dressing May Lead To maggot Therapy Without The Maggots. [Online]. Available: http://www.sciencedaily.com/releases/2006/10/ 061009031912. htm. Accessed 18th February 2010.

[xxii] Thomas.S., Jones.M., Shutler.S., and Jones.S.,(1999) Maggots in Wound Debridement - an Introduction. [Online]. Available: http://www.smtl.co.uk/WMPRC/Maggots/maggots.html. Accessed 14th January 2010.

[xxiii] Thomas.S., Jones.M., Shutler.S., and Jones.S.,(1999) Maggots in Wound Debridement - an Introduction. [Online]. Available: http://www.smtl.co.uk/WMPRC/Maggots/maggots.html. Accessed 14th January 2010.