Maggot Therapy:

Back to the Future of Wound Care

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949-679-3000

Experience with Maggot Therapy

a) I have done maggot therapy multiple times.

b) I have done it once, or watched it being done.

c) I have never done it, but I plan to do it

d) Is this where we get to learn magnet therapy?

Experience with B*e*TER Lectures

a) Never heard a lecture on maggot therapy.

b) Attended a lecture on maggot therapy; not BTER.

c) Attended a BTER lecture on maggot therapy

- What questions do you still have?
- What more do you want to learn?

Qualifications & Disclosures

Retired, University of California, Irvine, CA

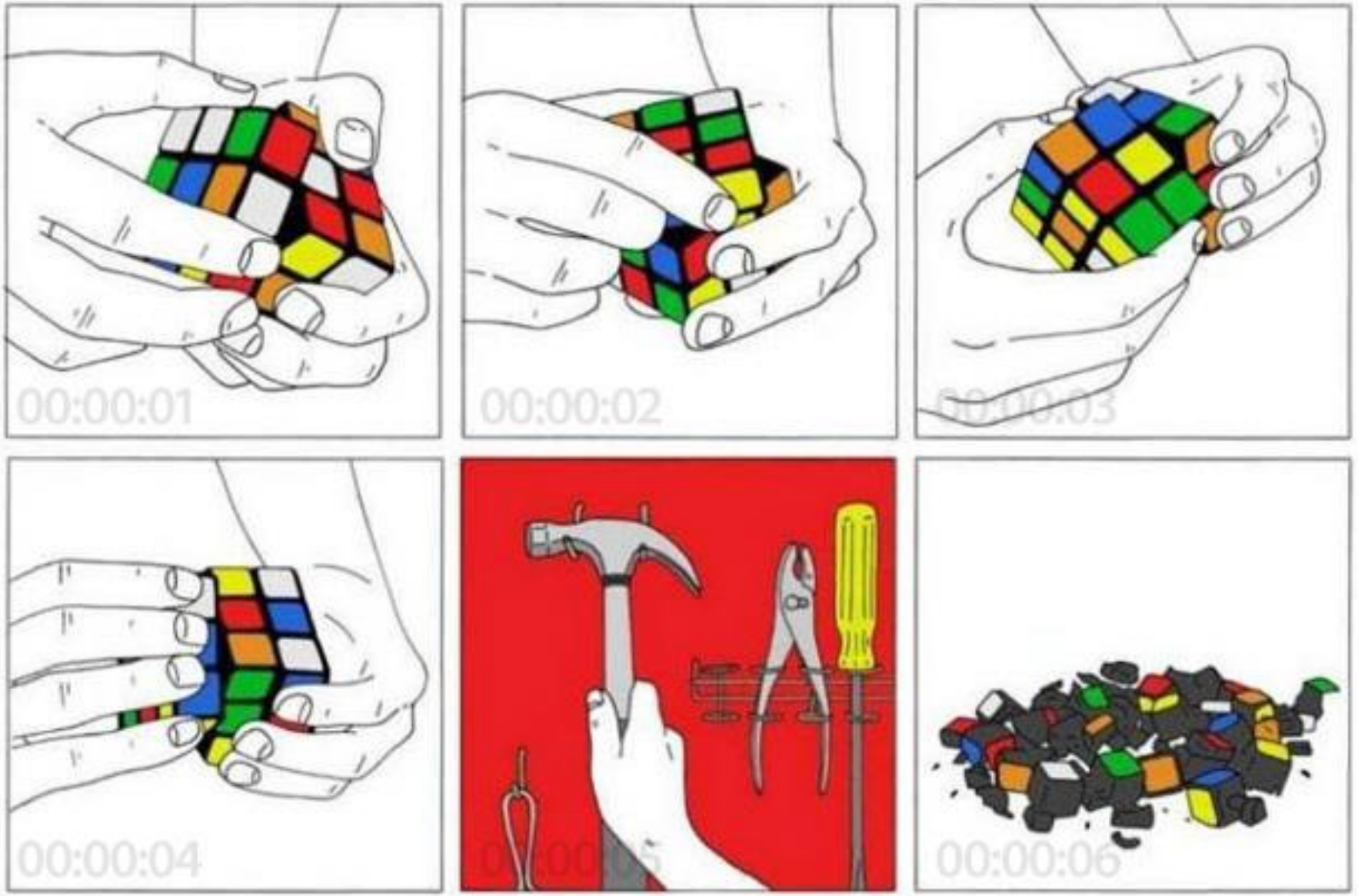
Board of Directors - BioTherapeutics, Education & Research (BTER) Foundation

Co-Founder & Laboratory Director - Monarch Labs, producer of medicinal animals

Staff Physician - Orange County Health Care Agency

Big Problems!

Many Solutions!



New Wound-Debriding Device (50 Million years in development)

- Squirts proteolytic enzymes into wound bed
- Microscopic raspers loosen & remove necrotic tissue
- Self-propelled; batteries not required
- Guided by internal optics
- 100% disposable and completely biodegradable

Maggot Therapy:
Back to the Future of Wound Care

Objectives

- List at least 3 indications for using MDT
- List at 3 warnings or problems associated with MDT
- Describe 3 ways that we control therapeutic myiasis (maggot therapy) to ensure safety & efficacy
- Describe 3 mechanisms of action
- Apply MDT dressings with confidence

Maggot Therapy:
Back to the Future of Wound Care

Lecture Outline

History and Current Status of MDT

Clinical Data & Review of the Literature

Maggot Biology 101

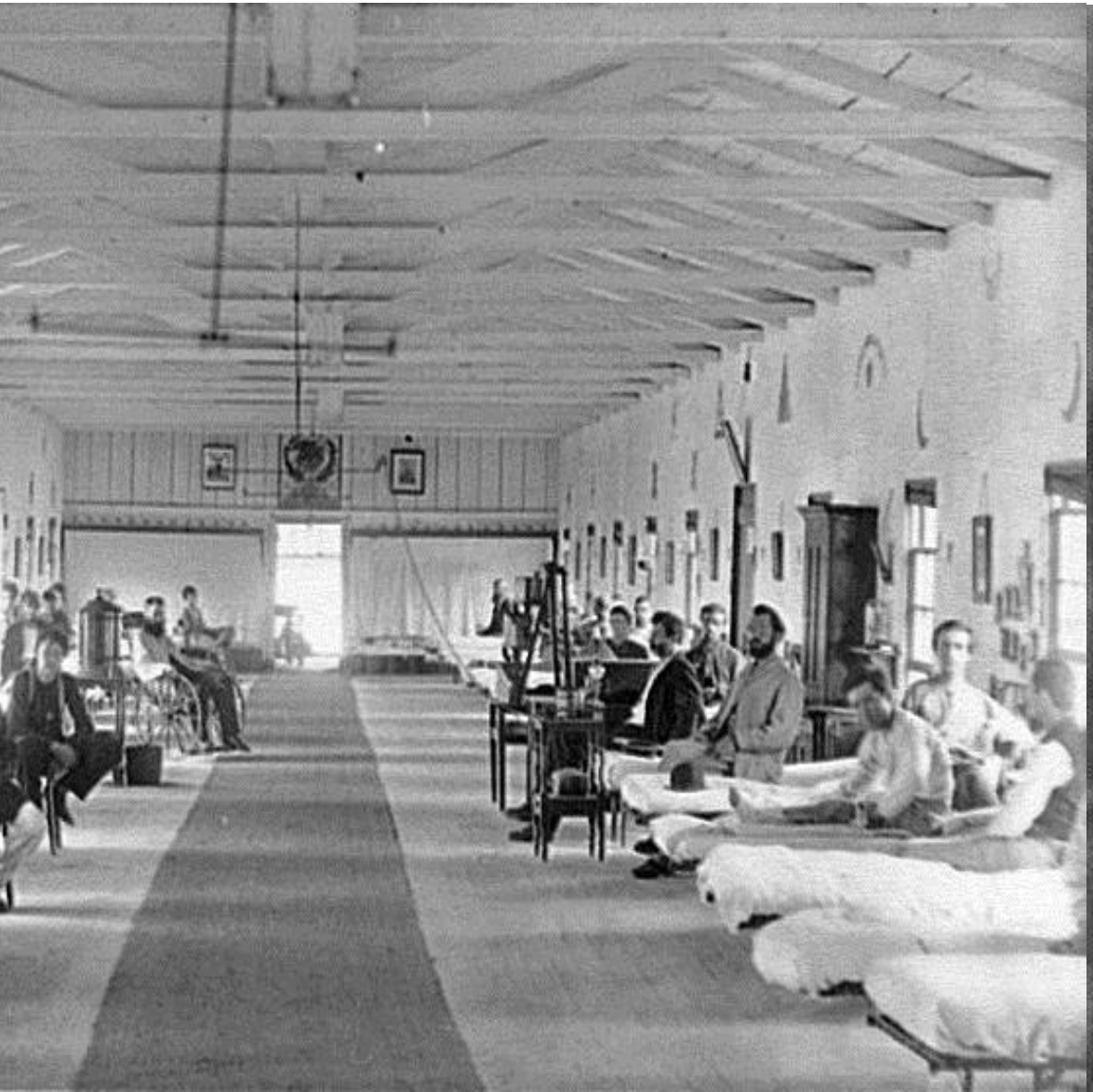
Indications, Contraindications, Warnings

Concluding Remarks

MDT Dressings Workshop

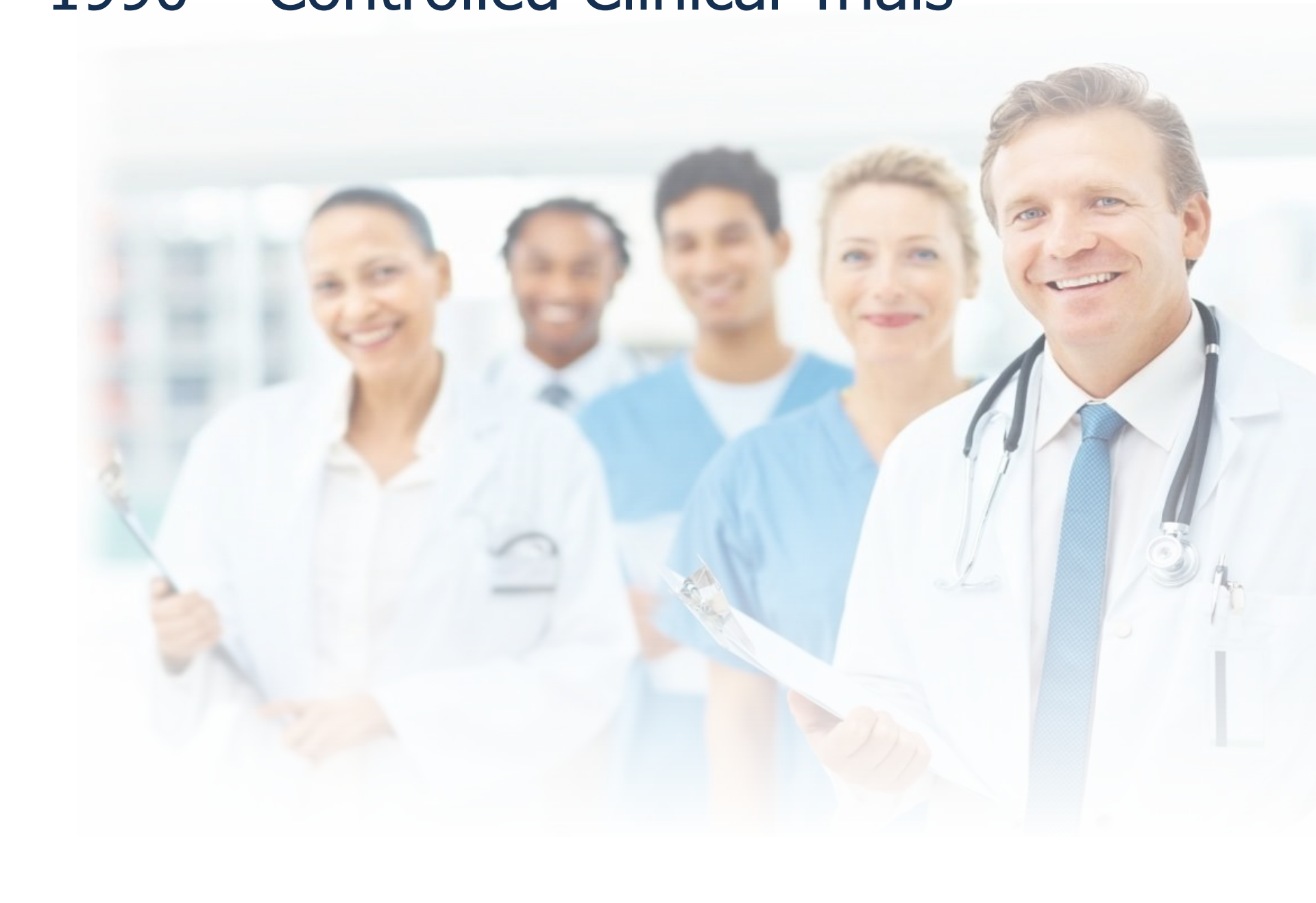
History of Maggot Therapy

William S. Baer, MD (1872 - 1931)



Maggot Therapy – 1940's

1990 – Controlled Clinical Trials



1990 – Controlled Clinical Trials

2003 – FDA regulates medicinal maggots

2004 – FDA permits marketing of first live medicinal animal (Medical Maggots™) for:

" . . . debriding non-healing necrotic skin and soft-tissue wounds, including pressure ulcers, venous stasis ulcers, neuropathic foot ulcers, and non-healing traumatic or post surgical wounds."

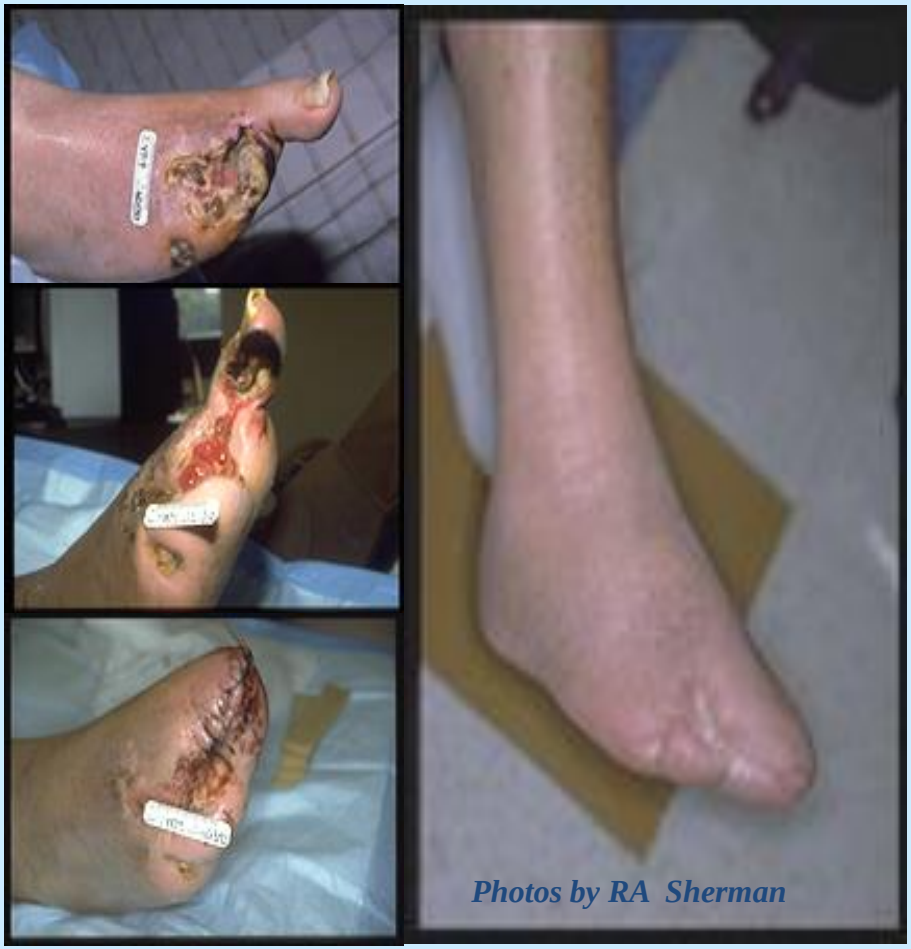
Maggot Therapy - Current Status

- ✓ 23 laboratories
- ✓ Patients treated in 30 countries
- ✓ 50,000+ treatments

Why such a rapid adoption of this "new" technology?

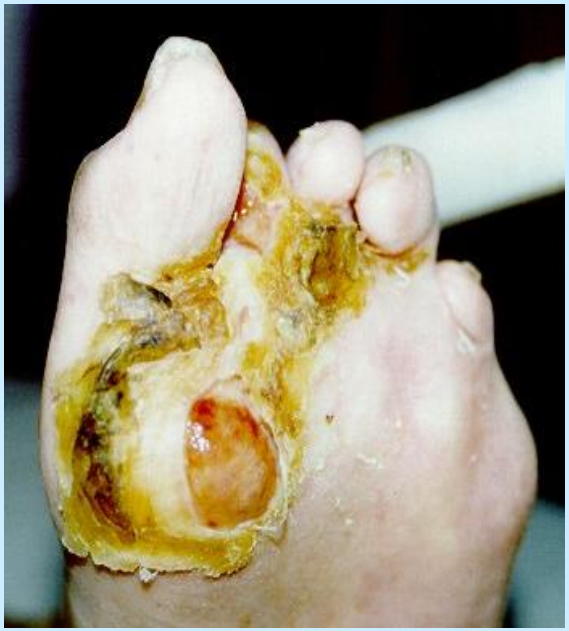
1. Chronic Wounds:
   a growing problem
2. Antimicrobial Resistance
3. Clinical studies now available
4. Personal successes.

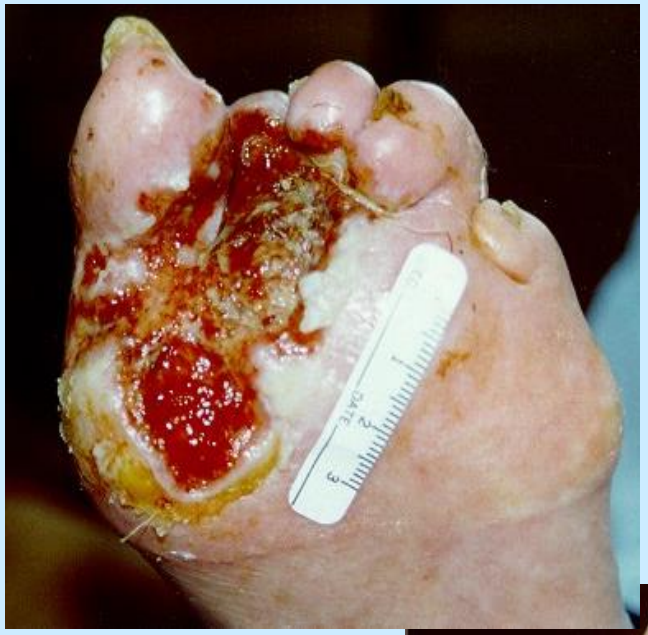
Maggot Debridement Therapy

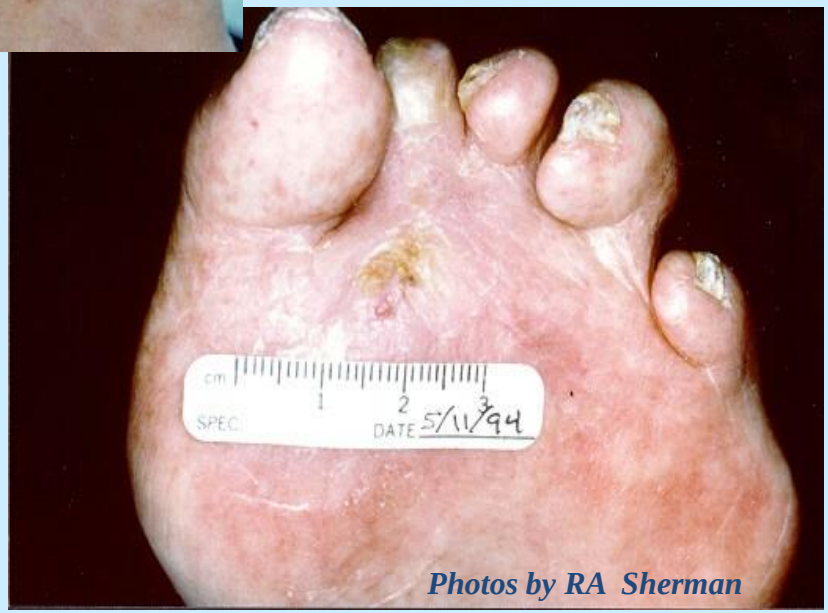


59 year old man with DFU & osteomyelitis, refused amputation. Maggot therapy debrided his wounds, including the non-viable big toe; the remains of that toe were removed surgically. He left the facility with his foot fully healed.

Maggot Debridement Therapy



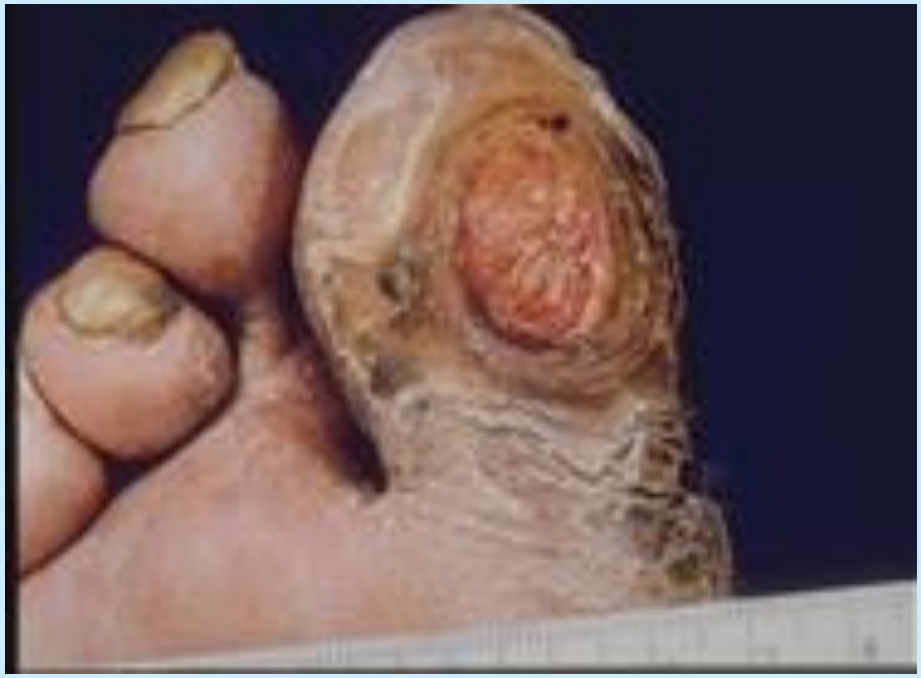


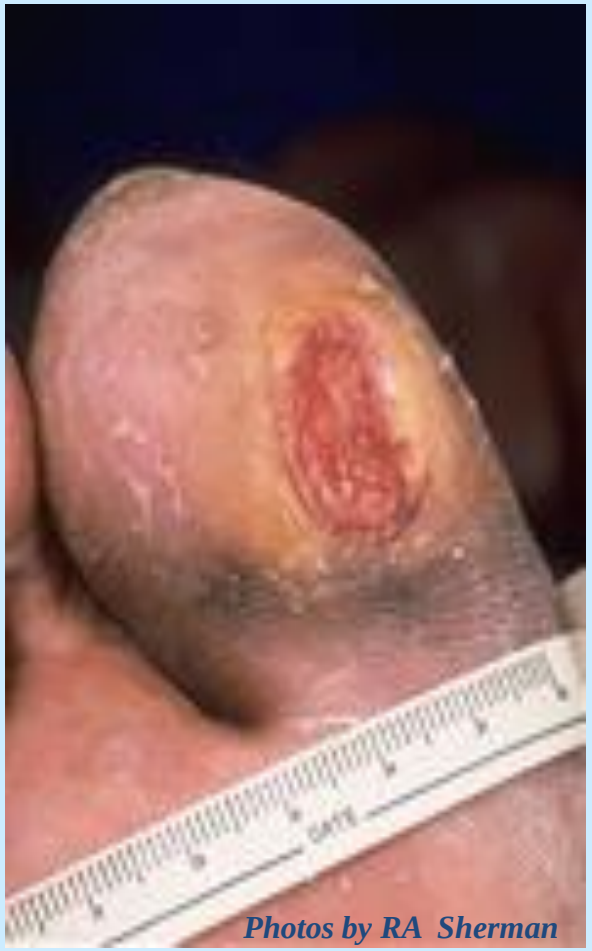


73 yo man with sclerodactyly and bilat. foot ulcers for 3 yrs; seen here before and after first maggot treatment, and then 1 year later.

Photos by RA Sherman

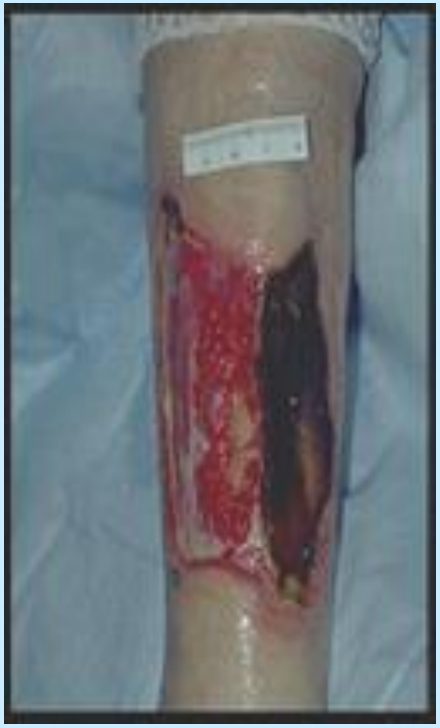
Maggot Debridement Therapy

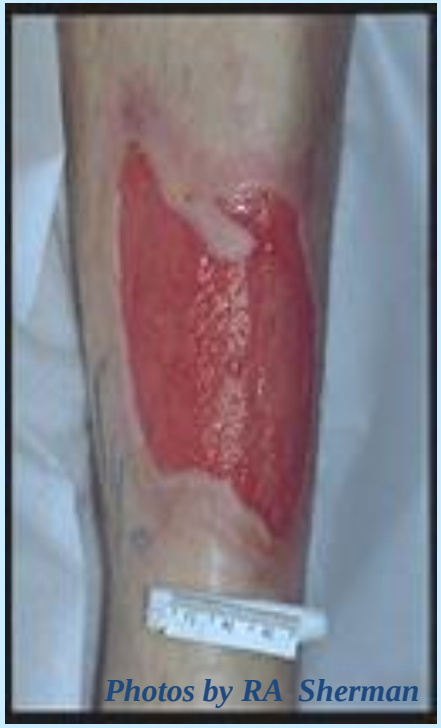




61 year old diabetic man, receiving surgical and IV antibiotic Rx for weeks, without improvement of foot ulcer. After 3 weeks of MDT, his wound was debrided and healing rapidly.

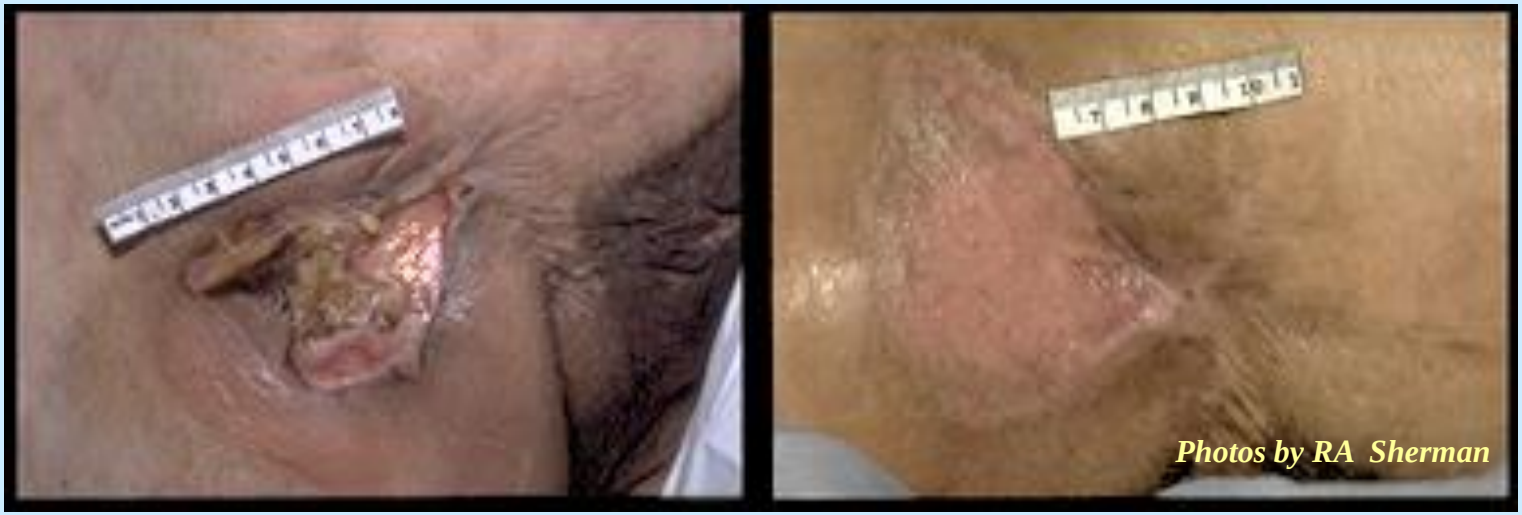
Maggot Debridement Therapy



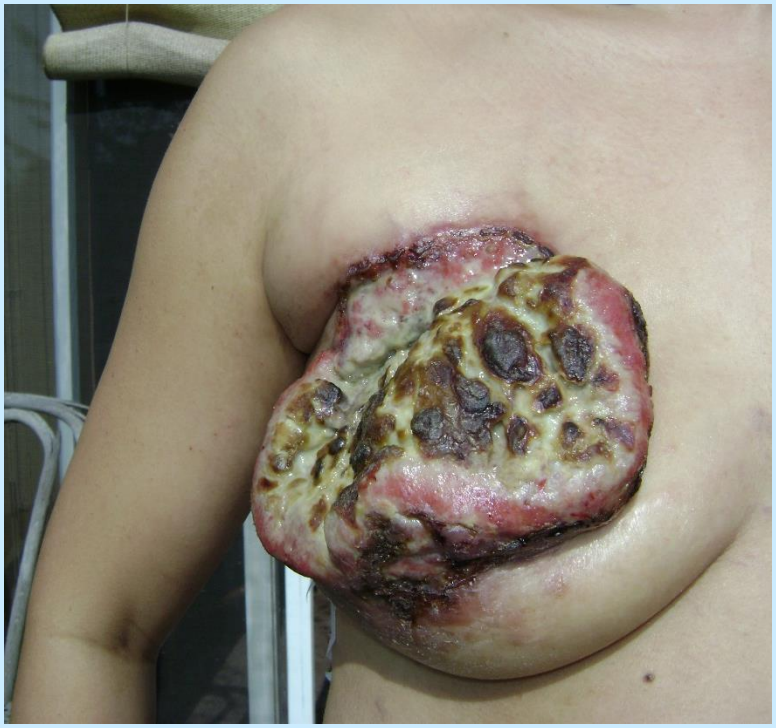


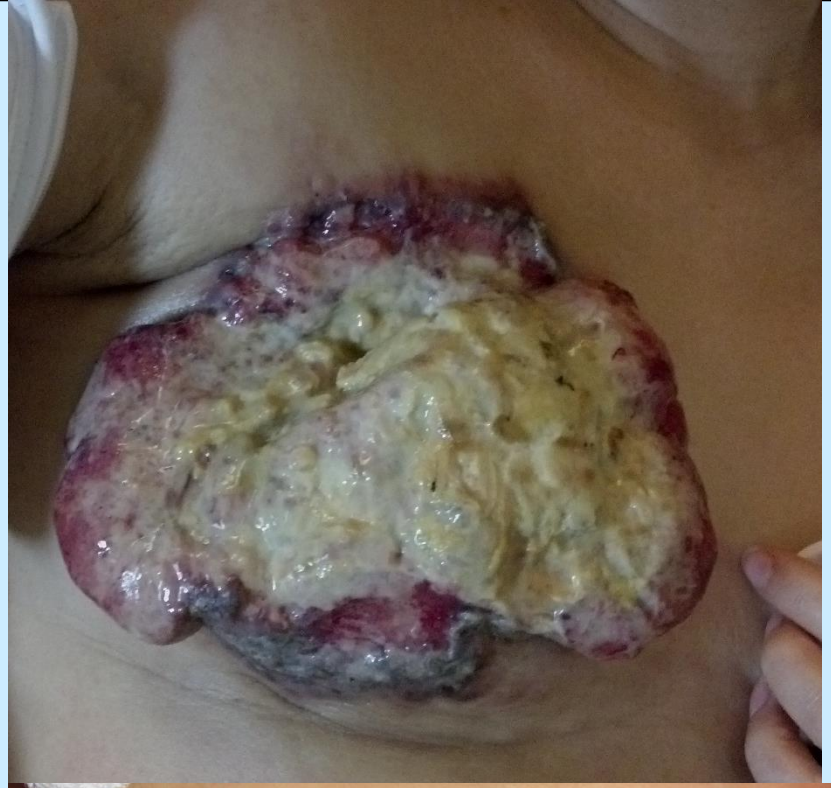
43 year old paraplegic man after IV adrenergic drugs infiltrated during ICU treatment for acute MI. He could not tolerate surgery, so his wound was debrided with MDT. Seen here before, during, and 5 weeks following MDT.

Maggot Debridement Therapy



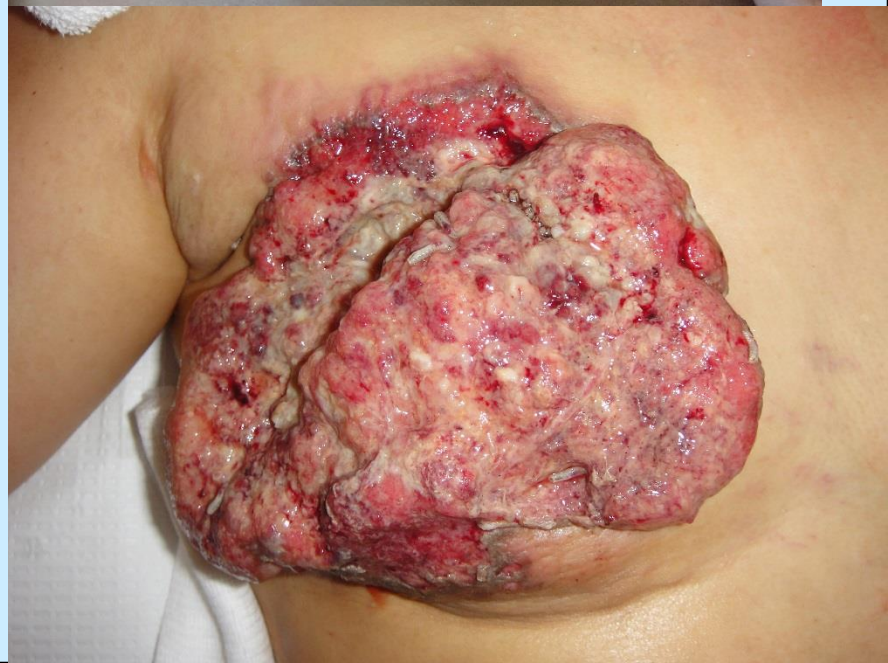
67 year old man, who's ischial pressure ulcer was treated with 2 cycles of MDT. Seen here before MDT and 10 days later.

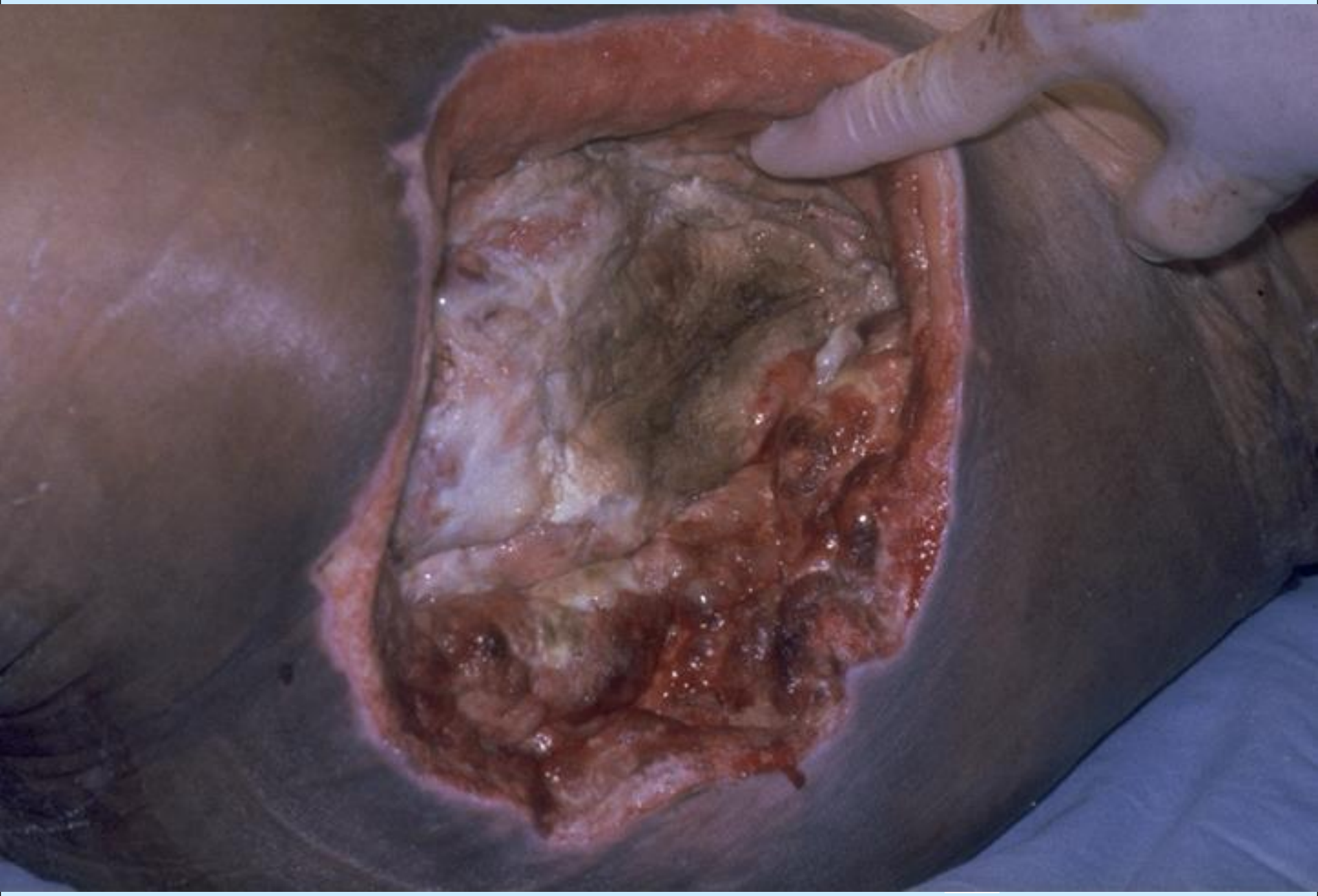




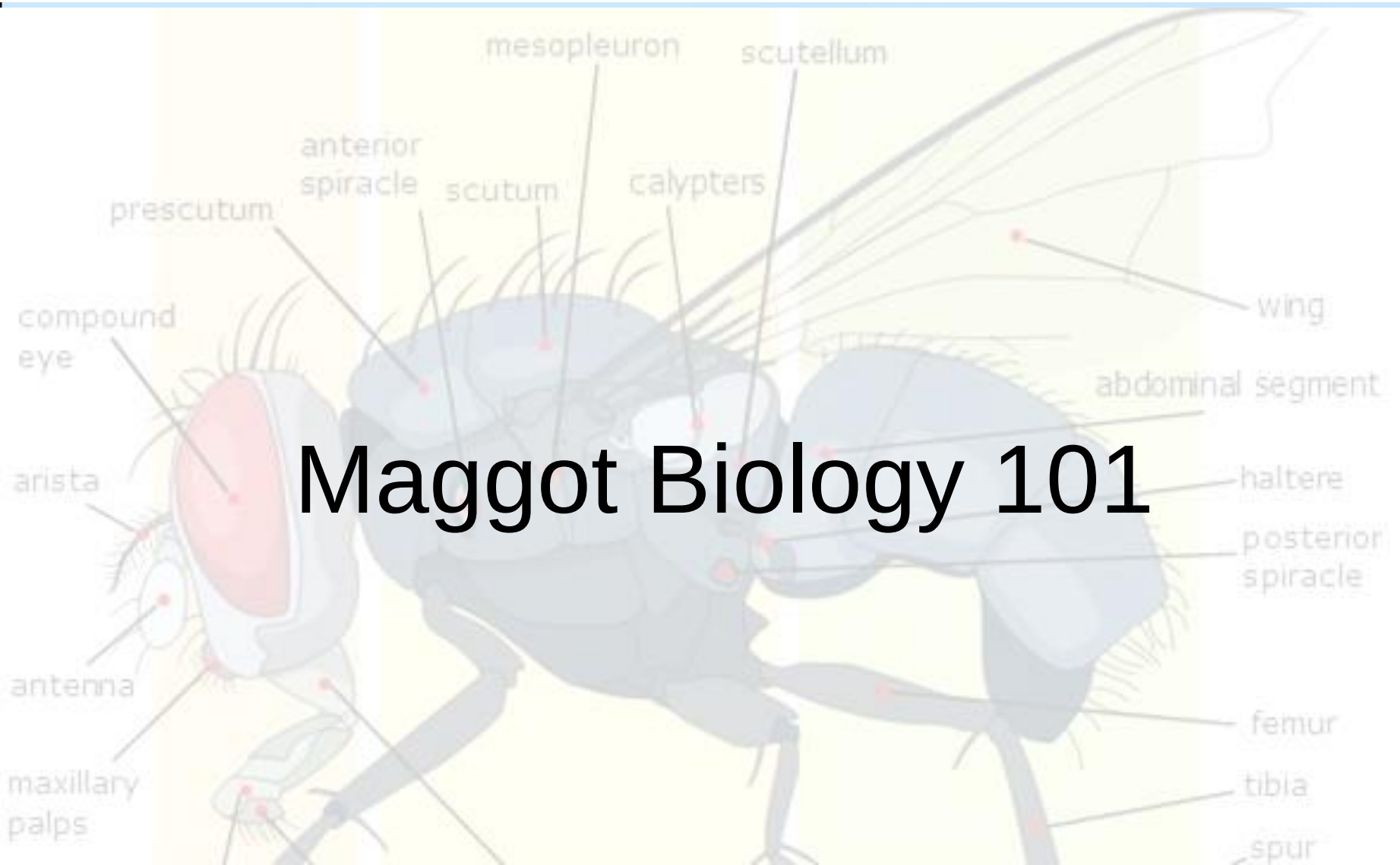
Fungating Breast CA

55 yo woman treated "conservatively" for 2 months; (still draining, malodorous, painful); then treated with MDT for less than 24 hours.

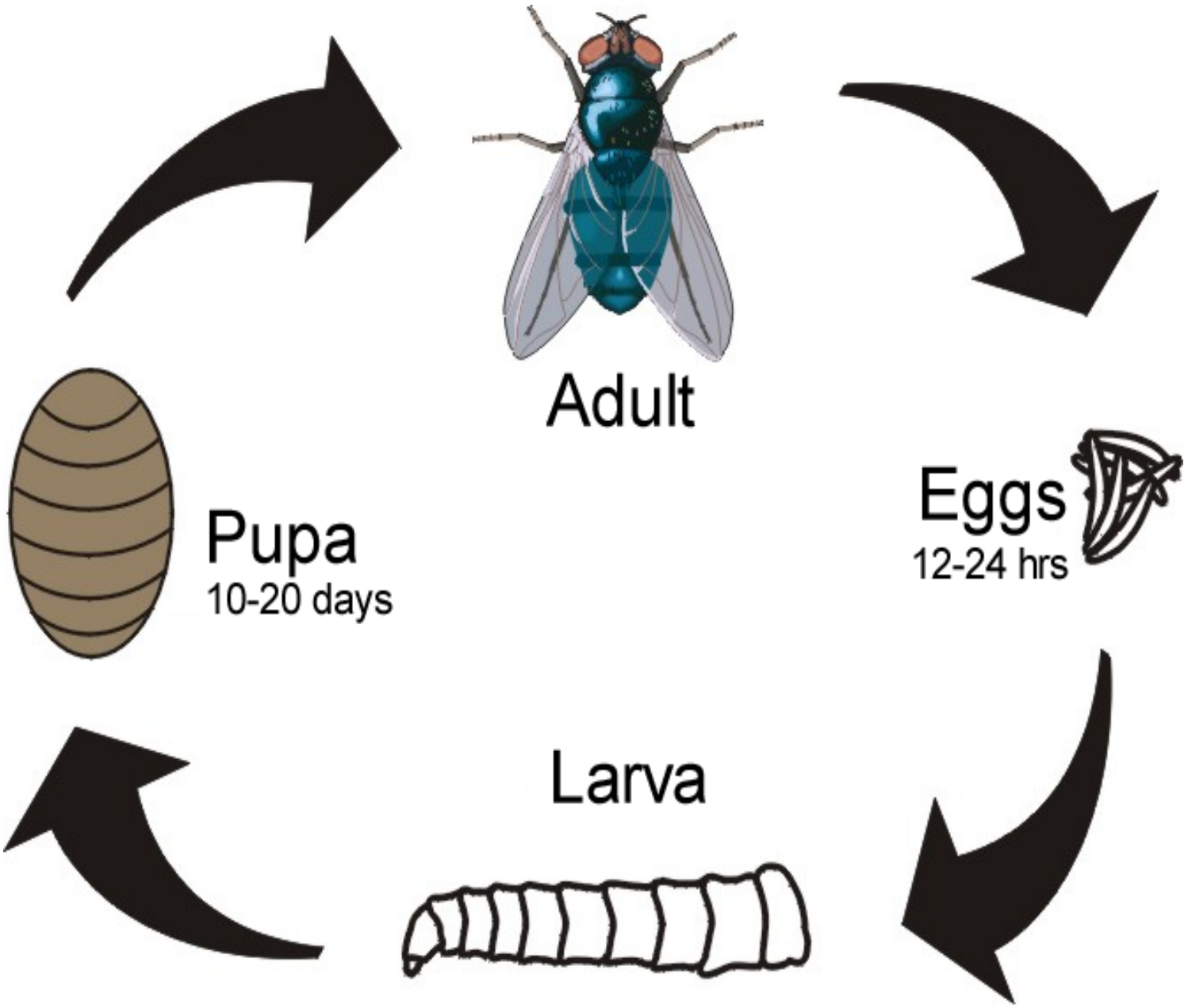




Maggot Therapy: Back to the Future of Wound Care



Maggot Biology 101


Adult
Eggs
12-24 hrs
Larva
Pupa
10-20 days

Controlled, Therapeutic myiasis

. . . use only species and strains proven to be safe and effective

Controlled, Therapeutic myiasis

. . . controlled environments

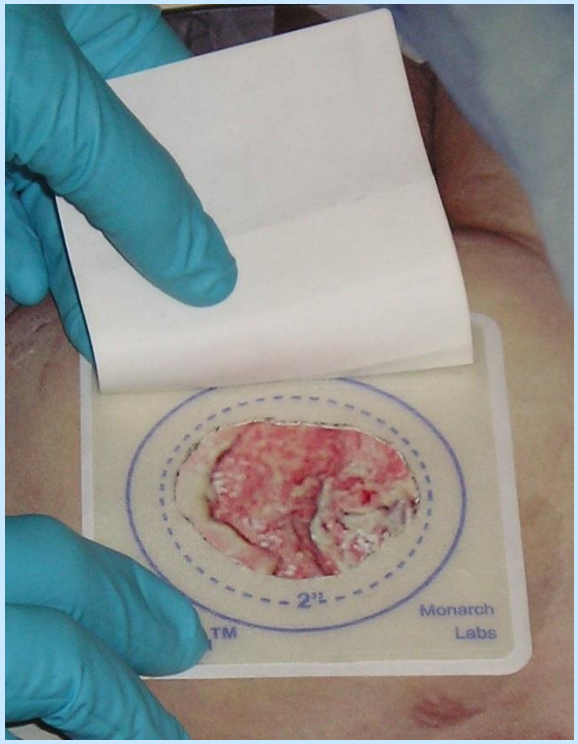
Controlled, Therapeutic myiasis

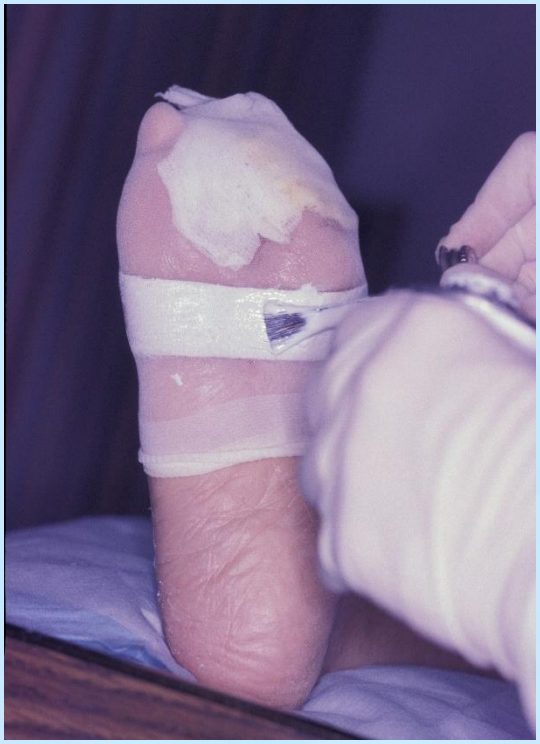
. . . disinfect the maggots (“germ-free”)

Controlled, Therapeutic myiasis

. . . quality control, inspection, testing

Controlled, Therapeutic myiasis





. . . controlled access to wound -
"cage dressings"

Maggot Therapy: Back to the Future of Wound Care

Clinical Data &
Review of the Literature

Maggot Therapy – Mechanisms of Action

1. Debridement
   - ✓ enzymatic
   - ✓ mechanical
2. Disinfection
   - ✓ kills bacteria
   - ✓ dissolves and inhibits biofilm
3. Promotion of wound healing
   - ✓ granulation tissue growth
   - ✓ epithelial proliferation and migration
   - ✓ tissue oxygenation

Studies Demonstrating Debridement

- Baer - 1929
- Hobson - 1931
- Maseritz - 1934
- Ziffren et al - 1953
- Waterhouse & Irzykiewicz - 1957
- Fraser et al; Brookes - 1961
- Pendola & Greenberg - 1975
- Vistnes et al - 1981
- Casu et al - 1994
- Sherman et al - 1991, 1995, 2001, 2002
- Schmidtchen et al - 2003
- Chambers et al - 2003
- Dumville et al – 2009
- Marineau et al - 2011

Proteolytic activity of blowfly larvae secretions in experimental burns

Lars M. Vistnes, M.D., Rita Lee, M.S., *and* George A. Ksander, A.M.,
Stanford and Palo Alto, Calif.

Secretions of larvae of the blowfly Calliphora erythrocephala digested experimental rat skin burn eschar in vivo and in vitro when applied topically in a vanishing cream base. Debridement was characterized by de-epithelialization and digestion of dermal collagen to a subfollicular level over a 3-day period. Analytic investigation of the secretions demonstrated the presence of enzymes with activities characteristic of trypsin, leucine aminopeptidase, and carboxypeptidases A and B. These were partially characterized. There was no evidence of chymotrypsin, elastase, or collagenase. Preparation of a suitable therapeutic form could result in a preparation useful for enzymatic debridement.

Vistnes LM, et al. Surgery. 90: 835, 1981

Experimental burns in rats; eschar debrided by larval secretions. Trypsin, leucine aminopeptidase, and carboxypeptidase activities identified; chymotrypsin-like activity and collagenases not identified.

Acta Derm Venereol 83

Detection of Serine Proteases Secreted by *Lucilia sericata* In vitro and During Treatment of a Chronic Leg Ulcer

Artur Schmidtchen[1], Hélène Wolff[2], Victoria Rydengård[1] and Carita Hansson[2]
[1]Section for Dermatology, Department of Medical Microbiology, Dermatology and Infection, Lund University, Biomedical Center, B14, Tornavägen 10, SE-221 84 Lund, and [2]Department of Dermatology, University Hospital, Sahlgrenska, Göteborg, Sweden.
E-mail: artur.schmidtchen@derm.lu.se
Accepted March 21, 2003.

Sir,

For centuries, larval therapy has been recognized as an aid in wound healing. During the 1930s and 1940s, before the antibiotic era, larval therapy was commonly used by surgeons in the USA and Europe when treating various soft-tissue and bone infections. The most commonly used larval species is *Lucilia sericata* (LS). From a clinical point of view, the two major effects of larval therapy have been ascribed to their antibacterial and debriding mechanisms (1-4). In regard to the latter function it has been speculated that the larvae, when introduced into the wound, secrete proteolytic enzymes that enable them to degrade and ingest necrotic tissue. Here, we address this question and demonstrate that these larvae secrete a group of serine proteases when cultured in vitro. Furthermore, these serine proteases were detected in the wound fluid of a patient with a chronic leg ulcer treated with larvae. The data suggest that serine proteases of LS are released during treatment.

Phaenicia (*Lucilia*) *sericata*

Figure 5 from: Fleischmann, Grassberger & Sherman:

Maggot Therapy – A Handbook of Maggot-Assisted Wound Healing.

Thieme, 2004

Maggot Therapy vs Conventional Therapy for Treatment of Chronic Wounds.

VAMC, Long Beach, CA; 1990-1995

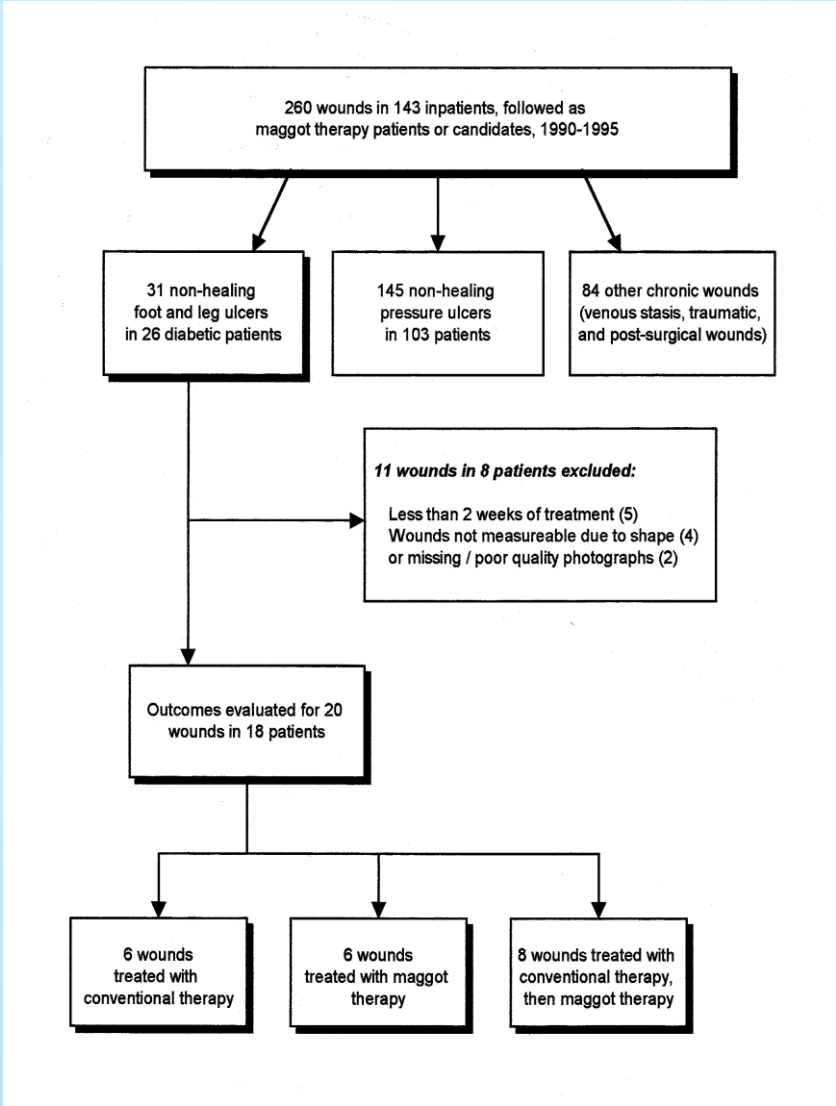
Pressure ulcers (145)

Diabetic foot ulcers (31)

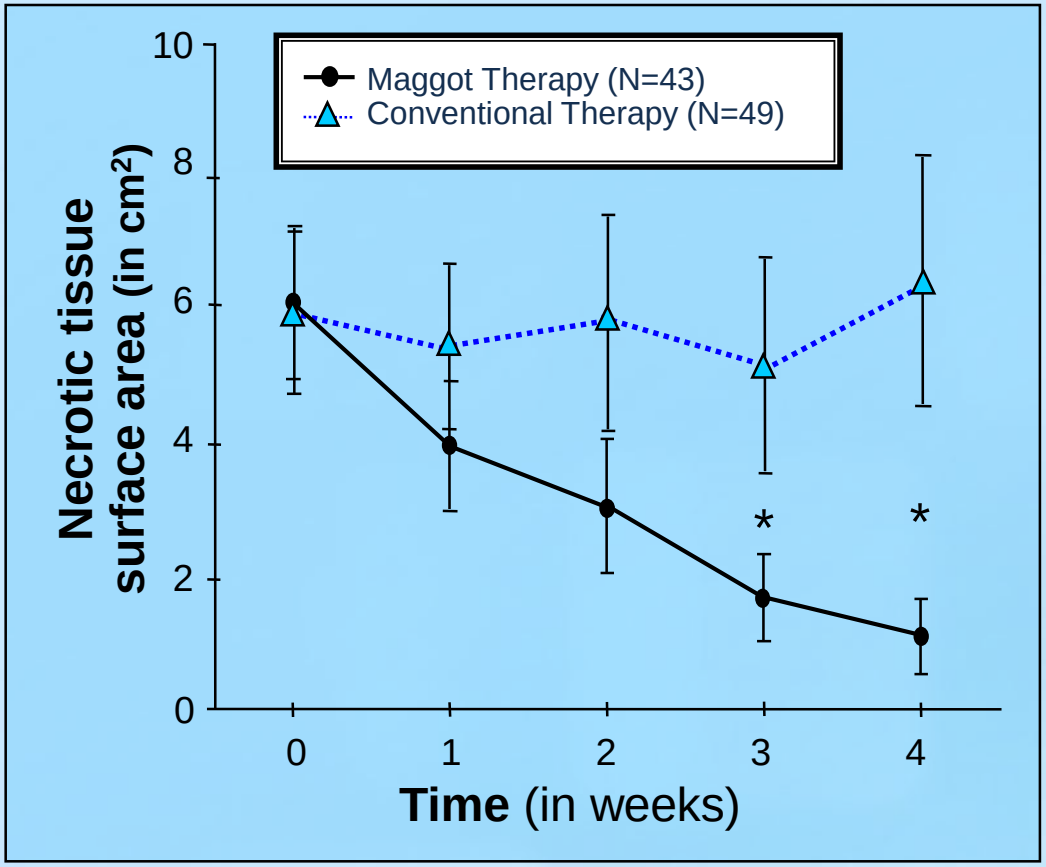
Venous stasis ulcers

Post-operative wounds

Burns



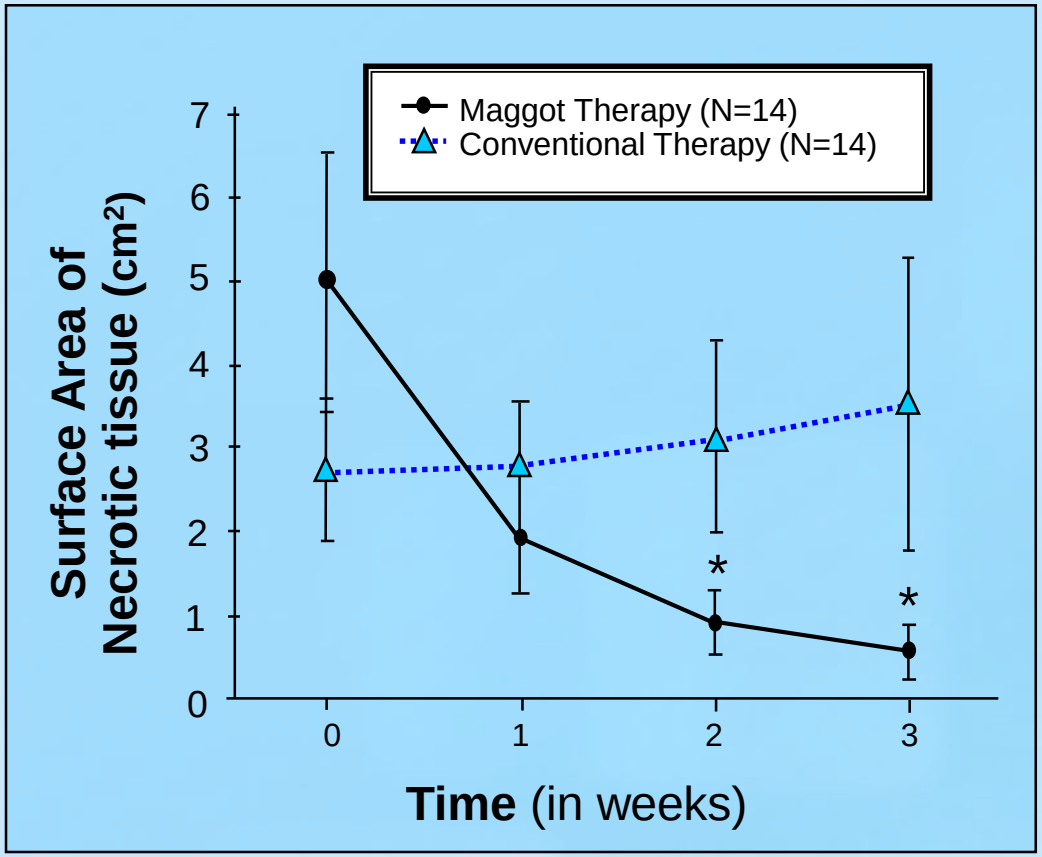
Maggot vs Conservative Debridement Therapy for the Treatment of Pressure Ulcers



Error bars indicate standard error. * = p<0.05

Sherman RA: Wound Repair Regen 2002; 10:208-14

Maggot vs Conservative Debridement Therapy for the Diabetic Foot Ulcers



Error bars indicate standard error. * = p<0.05

Sherman RA: Diabetes Care 2003; 26:446-51

Maggot Therapy for Diabetic Neuropathic Foot Wounds: A Randomized Study

Y.O. Markevich, McLeod-Roberts, M. Mousley, E. Melloy

Lviv Medical University, Lviv, Ukraine

Nene-University College, Northampton, UK

Aim: We have performed the first randomized, multicentre, double-blind controlled clinical trial (of 30 months duration) to evaluate the efficacy and safety of maggot therapy for diabetic neuropathic foot lesions as compared with conventional modern treatment.

Materials and Methods: 140 diabetic patients (the average age was 53.6 ± 15.4 years, an average diabetes mellitus duration - 15.8 ± 10.7 years) with neuropathic foot wounds required debridement were randomly assigned to treatment with maggots (larvae) of the green-bottle fly Lucilia sericata (n = 70) or Hydrogel (n = 70). Sterile maggots were applied to the wound (6-10 per 1 cm^2) and removed after 72 hours, the absorbent dressings were changed as frequently as required. Wounds were evaluated visually and photografically. The average surface area of wounds was 14.9 cm^2 in the maggot therapy group and 15.14 cm^2 in the Hydrogel group ($p < 0.001$). Measurement of wounds surface area, depth and volume, the evaluation of surrounding skin, tissue quality (necrotic, slough, fibrotic or granulation) and healing rates, exudate, odour and glucosae levels were comparable at baseline and then checked every 3 days during first 10 days.

Results: At 10 days the proportion of patients with granulation tissue covering over 50% of the wound was significantly higher in the patients of maggot therapy group compared to the patients of Hydrogel treated group (60% vs 34.3%; $p < 0.001$) and there was a greater proportion of patients with a reduction more than 50% wound area (51.1% vs 27.1%) (maggot therapy vs Hydrogel; $p < 0.05$). Complete healing was achieved in 5 (7.1%) patients of the maggot therapy group and in 2 (2.8%) of the Hydrogel treated group. There was, also, a noticable reduction in odour after a few application of maggots.

Conclusions: Thus, our control study suggests that maggot therapy is a really successful, safe and rapid method for debriding necrotic tissue in the wounds of diabetic neuropathic foot, stimulates tissue growth and significantly improves the rate of healing.

Maggot Debridement Therapy in the Treatment of Complex Diabetic Wounds

Michelle L. Marineau PhD, APRN; Mark T. Herrington APRN;
Karen M. Swenor APRN; and Lawrence J. Eron MD, FACP, FIDSA

Abstract

The growth and aging of the population of Hawai'i with a high incidence of diabetes mandates a need for more effective strategies to manage the healing of complicated wounds. Maggot debridement therapy (MDT) is one alternative utilized with successful results. Observations have indicated that maggots have the ability to debride wound beds, provide anti-microbial activity and also stimulate wound healing in diabetic patients. None of the patients refused MDT due to aversion of this treatment modality and the majority of patients had minimal discomfort. In 17 of 23 patients with multiple co-morbidities, the treatment of their complex diabetic wounds by MDT resulted in improvement or cure. Maggot debridement therapy is an effective treatment of diabetic wounds.

The cost effectiveness of larval therapy in venous ulcers

John Wayman[1], Vijaya Nirojogi[2], Anne Walker[3], Adam Sowinski[4] and Michael A Walker[4]

[1]*Specialist Registrar in Surgery;* [2]*Senior House Officer;* [3]*Vascular Nurse Specialist and* [4]*Consultant Surgeon, West Cumberland Hospital, Whitehaven, Cumbria, UK*

The treatment of necrotic ulcers involves considerable nursing time and expense. The current standard treatment involves repeated application of hydrogels. Larval debridement therapy (LDT) has been shown anecdotally to clear ulcers of necrotic slough but has never been compared directly with 'modern' therapies. The aim of this study has been to compare LDT with hydrogel dressings in the treatment of necrotic venous ulcers. 12 patients with sloughy venous ulcers were randomised to receive either LDT or the control therapy – a hydrogel. Effective debridement occurred with a maximum of one larval application in 6/6 patients. 2/6 in the hydrogel group still required dressings at one month. The median cost of treatment of the larval group was £78.64 compared with £136.23 for the control treatment group ($p<0.05$). The study confirms both the clinical efficacy and cost effectiveness of larval therapy in the debridement of sloughy venous ulcers.

BMJ

RESEARCH

Larval therapy for leg ulcers (VenUS II): randomised controlled trial

Jo C Dumville, research fellow,[1] Gill Worthy, trial statistician,[1] J Martin Bland, professor of health statistics,[1] Nicky Cullum, professor, deputy head of department,[1] Christopher Dowson, professor,[2] Cynthia Iglesias, senior research fellow,[1] Joanne L Mitchell, research scientist,[3] E Andrea Nelson, reader in wound healing and director of research,[4] Marta O Soares, research fellow,[1] David J Torgerson, professor, director of York trials unit[1] on behalf of the VenUS II team

[1]Department of Health Sciences, University of York, York YO10 5DD
[2]Biological Sciences, University of Warwick
[3]Micropathology Ltd, Coventry
[4]School of Healthcare, University of Leeds
Correspondence to: Jo C Dumville jd34@york.ac.uk

Cite this as: *BMJ* 2009;338:b773
doi:10.1136/bmj.b773

Time to debridement differed significantly between the three groups (25.38, df=2, log rank test <0.001). The median time to debridement with loose larvae was shorter (14 days, 95%confidence interval 10 to 17) than with bagged larvae (28 days, 13 to 55) and with hydrogel (72 days, 56 to 131).

The rate of debridement at any time in either larvae groups was about twice that of the hydrogel group; the hazard ratio for the combined larvae group compared with hydrogel was 2.31 (95% confidence interval 1.65 to 3.24, P<0.001).

Studies Demonstrating Disinfection

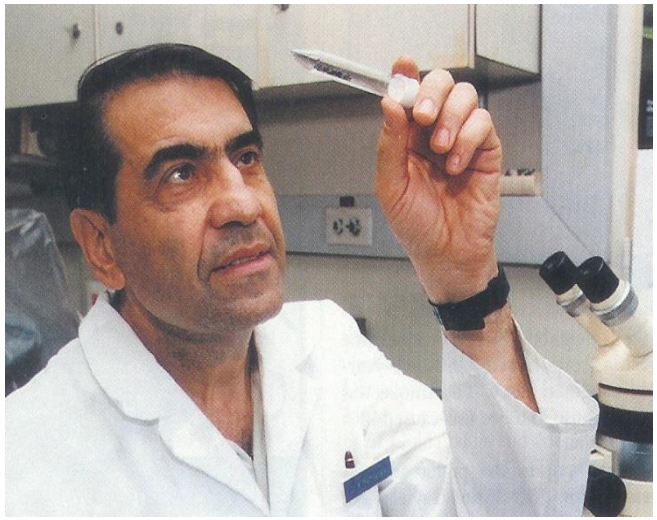
- Baer, 1929
- Livingston & Prince, 1932
- Robinson & Norwood, 1933
- Simmons, 1935
- Pavillard & Wright, 1957
- Greenberg, 1968
- Erdmann & Khalil, 1986
- Mumcuoglu et al, 2001
- Armstrong et al, 2005
- Contreras-Ruiz et al, 2005
- Tantawi et al, 2007
- Bowling, Boulton et al, 2008
- Cazander, Jukema, et al, 2008, 2010

Presurgical Maggot Debridement of Soft Tissue Wounds Is Associated with Decreased Rates of Postoperative Infection

Ronald A. Sherman[1,2] and Kathleen J. Shimoda[3]

[1]Department of Pathology, University of California, Irvine, and [2]BioTherapeutics, Education, and Research Foundation, Irvine, and [3]Veterans Affairs Long Beach Healthcare System, Long Beach, California

Postoperative complications were assessed for all patients who received presurgical maggot debridement therapy (MDT) and for a matched group of patients who did not. Ten wounds were debrided by maggots within 1–17 days prior to surgical closure. Debridement was effective in all cases, and there were no postoperative wound infections. Six (32%) of 19 wounds not treated presurgically with MDT developed postoperative wound infections (95% CI, 10%–54%; $P < .05$). Presurgical MDT was effective in preparing the wound bed for surgical closure, without increased risk of postsurgical wound infection.



ARTICLE

Destruction of Bacteria in the Digestive Tract of the Maggot of *Lucilia sericata* (Diptera: Calliphoridae)

KOSTA Y. MUMCUOGLU, JACQUELINE MILLER, MICHAEL MUMCUOGLU, MICHAEL FRIGER,[1] AND MARK TARSHIS[2]

Department of Parasitology, the Kuvin Center for the Study of Infectious and Tropical Diseases, Hebrew University-Hadassah Medical School, P.O. Box 12272, Jerusalem 91120, Israel

J. Med. Entomol. 38(2): 161–166 (2001)

ABSTRACT Green fluorescent protein-producing Escherichia coli were used to investigate the fate of bacteria in the alimentary tract of sterile grown maggots, Lucilia sericata (Meigen), using a laser scanning confocal microscope. A computer program was used to analyze the intensity of the fluorescence and to quantify the number of bacteria. The crop and the anterior midgut were the most heavily infected areas of the intestine. A significant decrease in the amount of bacteria was observed in the posterior midgut. The number of bacteria decreased even more significantly in the anterior hindgut and practically no bacteria were seen in the posterior end, near the anus. The viability of bacteria in the different gut sections was examined. It was shown that 66.7% of the crops, 52.8% of the midguts, 55.6% of the anterior hindguts, and 17.8% of posterior hindguts harbored living bacteria. In conclusion, during their passage through the digestive tract the majority of E. coli was destroyed in the midgut. Most of the remaining bacteria were killed in the hindgut, indicating that the feces were either sterile or contained only small numbers of bacteria.

Larval Debridement Therapy in Mexico

BY José Contreras-Ruiz, Adan Fuentes-Suarez, Marcia Karam-Orantes, Maria de Lourdes Escamilla-Mares and Judith Domínguez-Cherit

The benefit of maggots in wound healing has probably been known to humankind for ages. In Mexico, healers and herbalists comment, mainly through oral tradition, that maggots were known by the ancient Mayan culture to be beneficial in infected necrotic wounds. However, no

The Hospital General "Dr. Manuel Gea González," a National University of Mexico-affiliated teaching hospital. The wound-care centre is based within the Department of Dermatology,

José Contreras-Ruiz, MD, graduated from Universidad La Salle in Mexico and has served internships and

Maggot therapy and infection control in venous ulcers: a comparative study

José Contreras-Ruiz, MD; Sara Arroyo-Escalante; Adan Fuentes-Suarez, MD, Dr. Manuel Gea Gonzalez General Hospital, Mexico City, Mexico; Judith Dominguez-Cherit, MD; Cristina Sosa-de-Martinez, MS, National Institute of Pediatrics, Mexico City, Mexico; Ernesto Maravilla-Franco, National Institute of Medical Sciences and Nutrition, Mexico City, Mexico

Abstract: Maggot therapy (MT) has been reported as faster, less painful, and more selective than other methods of debridement. Apparently, the use of larvae to debride wounds has the added benefit of killing the bacteria in the wound bed.

We underwent a controlled trial to assess whether or not larval debridement therapy was more effective than conventional care.

Tantawi et al: et al, J Wound Care 2007; 16, 379

Clinical and microbiological efficacy of MDT in the treatment of diabetic foot ulcers

- **Objective:** To assess the clinical and microbiological efficacy of maggot debridement therapy (MDT) in the management of diabetic foot ulcers unresponsive to conventional treatment and surgical intervention.
- **Method:** Consecutive diabetic patients with foot wounds presenting at the vascular surgery unit and the diabetic foot unit of Alexandria Main University Hospital were selected for MDT. *Lucilia sericata* medicinal maggots were applied to the ulcers for three days per week. Changes in the percentage of necrotic tissue and ulcer surface area were recorded each week over the 12-week follow-up period. Semiquantitative swab technique was used to determine the bacterial load before and after MDT.
- **Results:** The sample comprised 10 patients with 13 diabetic foot ulcers. The mean baseline ulcer surface area was 23.5cm^2 (range 1.3–63.1), and the mean percentage of necrotic tissue was 74.9% (range 29.9–100). Complete debridement was achieved in all ulcers in a mean of 1.9 weeks (range 1–4). Five ulcers (38.5%) were completely debrided with one three-day MDT cycle. The mean reduction in ulcer size was significant at 90.2%, and this occurred in a mean of 8.1 weeks (range 2–12). The mean weekly reduction in ulcer size was 16.1% (range 8.3–50). Full wound healing occurred in 11 ulcers (84.6%) within a mean of 7.3 weeks (range 2–10). The bacterial load of all ulcers reduced sharply after the first MDT cycle to below the 10^5 threshold, which facilitates healing.
- **Conclusion:** The results highlight the potential benefits of MDT in diabetic wound care in developing countries. MDT was proved to be a rapid, simple and efficient method of treating these ulcers.
- **Declaration of interest:** None.

Larval Therapy: A Novel Treatment in Eliminating Methicillin-Resistant *Staphylococcus aureus* From Diabetic Foot Ulcers

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ANDREW J.M. BOULTON, MD, FRCP[1,2]

Overuse of antibiotics and the selection of broad- rather than narrow-spectrum agents have contributed to the high prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) colonization in diabetic foot wounds. Consequently, MRSA is now an endemic in both the community and hospital environments (1,2). We previously highlighted the problem (3) of MRSA colonization in our diabetic foot clinic (40% of *S. aureus* isolates were MRSA). A follow-up study (4) demonstrated that the number of foot wounds from which MRSA was isolated doubled in a 3-year period. Although terms such as critical colonization are not clearly defined, the risk of MRSA infection and bacteremia in patients with colonized ulcers is recog-

RESEARCH DESIGN AND METHODS

— Consecutive patients aged 18–80 years with MRSA-colonized chronic diabetic foot ulcers for >3 weeks duration were included in the study. Subjects on antibiotic treatment specific for MRSA (vancomycin or linezolid), on anticoagulation therapy, or requiring immediate systemic antimicrobial treatment or urgent surgical management were excluded. All patients were assessed by the neuropathy disability score and vibration perception threshold (VPT) (9). Ischemia was defined as nonpalpable pedal pulses and ankle-branchial systolic blood pressure index. An ulcer was deemed to be neuropathic if VPT was >25 V, and/or neuropathy disability score was >3, and neuroischemic if VPT was >25 V with eradication of MRSA from the ulcer following a minimum of two and a maximum of eight larval applications per ulcer. Patients with MRSA-positive wound cultures were all screened for MRSA carriage at other sites (nose, perineum, or both) in accordance with the hospital MRSA screening policy. A 5-day self-treatment regime for MRSA eradication was followed in those patients with positive MRSA body screening with the use of Mupirocin nasal ointment, Aquacept body wash, and Aquacept shampoo. Ulcer size was measured with the digital planimetry system (Visitrak) (10) by the same clinician after debridement. Appropriate pressure-relieving dressings (e.g., Allevyn pads) were used to prevent damage of the larvae during treatment, in addition to off-loading modalities (DH Walker; Ossur, Aliso Viejo, CA). No topical antimicrobial agents or growth factors were used on the study ulcer.

Clin Orthop Relat Res
DOI 10.1007/s11999-010-1309-5

BASIC RESEARCH

Maggot Excretions Inhibit Biofilm Formation on Biomaterials

Gwendolyn Cazander MD, Mariëlle C. van de Veerdonk,
Christina M. J. E. Vandenbroucke-Grauls MD, PhD,
Marco W. J. Schreurs PhD, Gerrolt N. Jukema MD, PhD

Received: 28 September 2009 / Accepted: 2 March 2010

Abstract
Background Biofilm-associated infections in trauma surgery are difficult to treat with conventional therapies. Therefore, it is important to develop new treatment modalities. Maggots in captured bags, which are permeable for larval excretions/secretions, aid in healing severe, infected wounds, suspect for biofilm formation. Therefore we presumed maggot excretions/secretions would reduce biofilm formation.
Questions/purposes We studied biofilm formation of Staphylococcus aureus, Staphylococcus epidermidis, Klebsiella oxytoca, Enterococcus faecalis, and Enterobacter cloacae on polyethylene, titanium, and stainless steel. We compared the quantities of biofilm formation between the bacterial species on the various biomaterials and the quantity of biofilm formation after various incubation times. Maggot excretions/secretions were added to existing biofilms to examine their effect.
Methods Comb-like models fit in a 96-well microtiter pla terial suspension. The form crystal violet, which was el density (at 595 nm) of the quantify biofilm formation. were pipetted in different c 7-day-old biofilms, incubated
Results The strongest biofil and S. epidermidis on polye titanium. The highest quanti reached within 7 days for b excretions/secretions reduce biomaterials. A maximum of measured.
Conclusions Our observati tions/secretions decrease bi provide a new treatment for biomaterials.

Clin Orthop Relat Res
DOI 10.1007/s11999-008-0555-2

ORIGINAL ARTICLE

The Influence of Maggot Excretions on PAO1 Biofilm Formation on Different Biomaterials

Gwendolyn Cazander MD, Kiril E. B. van Veen,
Lee H. Bouwman MD, PhD, Alexandra T. Bernards MD, PhD,
Gerrolt N. Jukema MD, PhD

Received: 13 November 2007 / Accepted: 17 September 2008

Abstract Biofilm formation in wounds and on biomaterials is increasingly recognized as a problem. It therefore is important to focus on new strategies for eradicating severe biofilm-associated infections. The beneficial effects of maggots (Lucilia sericata) in wounds have been known for centuries. We hypothesized sterile maggot excretions and secretions (ES) could prevent, inhibit, and break down biofilms of Pseudomonas aeruginosa (PAO1) on different biomaterials. Therefore, we investigated biofilm formation on polyethylene, titanium, and stainless steel. Furthermore, we compared the biofilm reduction capacity of Instar-1 and Instar-3 maggot ES and tested the temperature tolerance of ES. After biofilms formed in M63 nutrient medium on comb-forming models of the biomaterials, ES solutions in phosphate-buffered saline or M63 were added in different concentrations. PAO1 biofilms adhered tightly to polyethylene and titanium but weakly to stainless steel. Maggot ES prevent and inhibit PAO1 biofilm formation and even break down existing biofilms. ES still had considerable biofilm reduction properties after storage at room temperature for 1 month. ES from Instar-3 maggots were more effective than ES from Instar-1 maggots. These results may be relevant to patient care as biofilms complicate the treatment of infections associated with orthopaedic implants.

Introduction

Biofilm formation (BF) on biomaterials is a major problem in trauma and orthopaedic surgery [6]. Bacteria adhering to prosthetic material can form a biofilm composed of a complex extracellular polysaccharide matrix in which they then become embedded [5]. The matrix prevents antibiotic penetration and as a result protects bacteria against antibiotics [7, 28]. Once infected, the implant often must be removed [18, 32]. Temporary implantation of antibiotic beads is sometimes necessary [19].

Maggot Therapy in "Lower-Extremity Hospice" Wound Care

Fewer Amputations and More Antibiotic-Free Days

David G. Armstrong, DPM, MSc, PhD*†
Precious Salas‡
Brian Short, DPM*
Billy R. Martin, DPM*
Heather R. Kimbriel, BS*
Brent P. Nixon, DPM*
Andrew J. M. Boulton, MD†§

We sought to assess, in a case-control model, the potential efficacy of maggot debridement therapy in 60 nonambulatory patients (mean ± SD age, 72.2 ± 6.8 years) with neuroischemic diabetic foot wounds (University of Texas grade C or D wounds below the malleoli) and peripheral vascular disease. Twenty-seven of these patients (45%) healed during 6 months of review. There was no significant difference in the proportion of patients healing in the maggot debridement therapy *versus* control group (57% *versus* 33%). Of patients who healed, time to healing was significantly shorter in the maggot therapy than in the control group (18.5 ± 4.8 *versus* 22.4 ± 4.4 weeks). Approximately one in five patients (22%) underwent a high-level (above-the-foot) amputation. Patients in the control group were three times as likely to undergo amputation (33% *versus* 10%). Although there was no significant difference in infection prevalence in patients undergoing maggot therapy *versus* controls (80% *versus* 60%), there were significantly more antibiotic-free days during follow-up in patients who received maggot therapy (126.8 ± 30.3 *versus* 81.9 ± 42.1 days). Maggot debridement therapy reduces short-term morbidity in nonambulatory patients with diabetic foot wounds. (J Am Podiatr Med Assoc 95(3): 254-257, 2005)

Lucifensin, the long-sought antimicrobial factor of medicinal maggots of the blowfly *Lucilia sericata*

Václav Čeřovský · Jan Žďárek · Vladimír Fučík · Lenka Monincová · Zdeněk Voburka · Robert Bém

Abstract A novel homologue of insect defensin designated lucifensin (*Lucilia* defensin) was purified from the extracts of various tissues (gut, salivary glands, fat body, haemolymph) of green bottle fly (*Lucilia sericata*) larvae and from their excretions/secretions. The primary sequence of this peptide of 40 residues and three intramolecular disulfide bridges was determined by ESI-QTOF mass spectrometry and Edman degradation and is very similar to that of sapecin and other dipteran defensins. We assume that lucifensin is the key antimicrobial component that protects the maggots when they are exposed to the highly infectious environment of a wound during the medicinal process known as maggot therapy. We also believe that lucifensin is that long-sought larger molecular weight antimicrobial factor of the *Lucilia sericata* excretions/secretions believed to be effective against pathogenic elements of the wound microbial flora.

Studies Demonstrating Growth Stimulation

- Baer (clinical observations) - 1929
- Robinson (allantoin) - 1935
- Livingston, 1936
- Sherman et al, 1991, 1995, 2002, 2003
- Mumcuoglu et al, 1997
- Prete, 1998
- Markevich et al, 2000
- Wollina et al, 2002
- Horobin et al, 2003-06
- Sealby, 2004
- Armstrong et al, 2005
- Picazo et al, 2005
- Tanyuksel et al, 2005
- Steenvoorde et al, 2007
- Pecivova et al, 2008
- [Dumville et al, 2009]
- Bexfield et al. 2010
- Wang et al, 2010
- Zhang et al, 2010, 2010b
- Honda et al. 2011

Maggot vs Conservative Debridement for the Treatment of Pressure Ulcers

- Cohort,
  92 PU's, 63 pts
- MT x 8 wks vs
  Control x 8 wks
- Results:
  - Faster 4- and 8-wk healing rates
  - Faster wound bed preparation

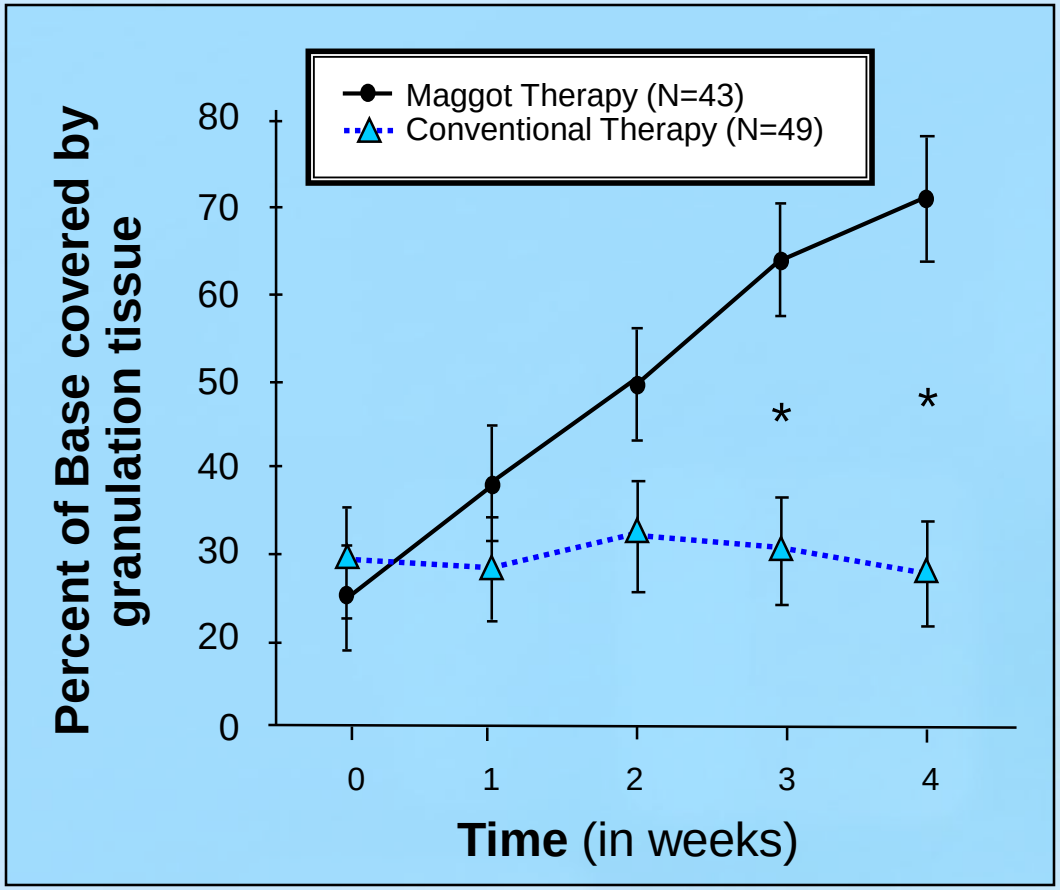
Maggot versus conservative debridement therapy for the treatment of pressure ulcers

RONALD A. SHERMAN, MD, MSC

To define the efficacy and safety of maggot therapy, a cohort of 103 inpatients with 145 pressure ulcers was evaluated. Sixty-one ulcers in 50 patients received maggot therapy at some point during their monitored course; 84 ulcers in 70 patients did not. Debridement and wound healing could be quantified for 43 maggot-treated wounds and 49 conventionally treated wounds. Eighty percent of maggot-treated wounds were completely debrided, while only 48% of wounds were completely debrided with conventional therapy alone ($p = 0.021$). Within 3 weeks, maggot-treated wounds contained one-third the necrotic tissue ($p = 0.05$) and twice the granulation tissue ($p < 0.001$), compared to non-maggot-treated wounds. Of the 31 measurable maggot-treated wounds monitored initially during conventional therapy, necrotic tissue decreased 0.2 cm^2 per week during conventional therapy, while total wound area increased 1.2 cm^2 per week. During maggot therapy, necrotic tissue decreased 0.8 cm^2 per week ($p = 0.003$) and total wound surface area decreased 1.2 cm^2 per week ($p = 0.001$). Maggot therapy was more effective and efficient in debriding chronic pressure ulcers than were the conventional treatments prescribed. Patients readily accepted maggot therapy, and adverse events were uncommon. **(WOUND REP REG 2002;10:208–214)**

Sherman RA: Wound Repair Regen 2002; 10:208-14

Maggot vs Conservative Debridement Therapy for the Treatment of Pressure Ulcers



Error bars indicate standard error. * = p<0.05

Sherman RA: Wound Repair Regen 2002; 10:208-14

Maggot vs Conservative Debridement for Diabetic Foot Ulcers

- Cohort; DM subjects;

  20 chronic wounds, 18 Pts; neuropathic and neuro-ischemic foot ulcers

- Results:
  - Faster 4- and 8-wk healing rates
  - Faster wound bed preparation

Maggot Therapy for Treating Diabetic Foot Ulcers Unresponsive to Conventional Therapy

RONALD A. SHERMAN, MD, MSC

OBJECTIVE — To assess the efficacy of maggot therapy for treating foot and leg ulcers in diabetic patients failing conventional therapy.

RESEARCH DESIGN AND METHODS — Retrospective comparison of changes in necrotic and total surface area of chronic wounds treated with either maggot therapy or standard (control) surgical or nonsurgical therapy.

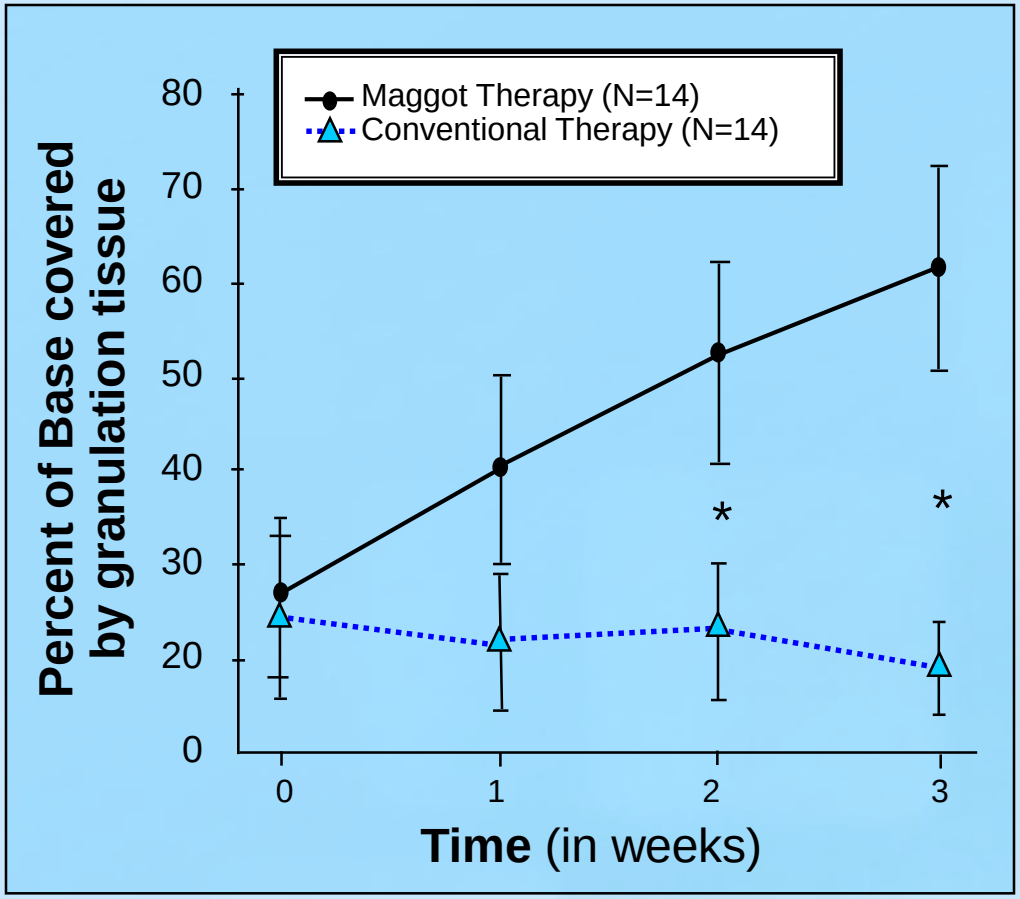
RESULTS — In this cohort of 18 patients with 20 nonhealing ulcers, six wounds were treated with conventional therapy, six with maggot therapy, and eight with conventional therapy first, then maggot therapy. Repeated measures ANOVA indicated no significant change in necrotic tissue, except when factoring for treatment (F [1.7, 34] = 5.27, P = 0.013). During the first 14 days of conventional therapy, there was no significant debridement of necrotic tissue; during the same period with maggot therapy, necrotic tissue decreased by an average of 4.1 cm^2 (P = 0.02). After 5 weeks of therapy, conventionally treated wounds were still covered with necrotic tissue over 33% of their surface, whereas after only 4 weeks of therapy maggot-treated wounds were completely debrided (P = 0.001). Maggot therapy was also associated with hastened growth of granulation tissue and greater wound healing rates.

hospitals around the world for treating bone and soft-tissue infections (14). With the introduction of antibiotics and other improvements in wound care, by the 1960s maggot therapy was used only as salvage therapy for the most serious wounds.

Over the past few years, there has been a resurgence in the use of maggot therapy (15), even though its optimal role has not been clearly defined. Large prospective clinical trials have not been conducted for maggot therapy, and there are no commercial backers to support such studies. To assess the utility of maggot therapy, we analyzed the clinical course and outcomes of a cohort of diabetic patients whose foot and leg ulcers were treated with conventional (control) or maggot therapy.

Sherman RA: Diabetes Care 2003; 26:446-51

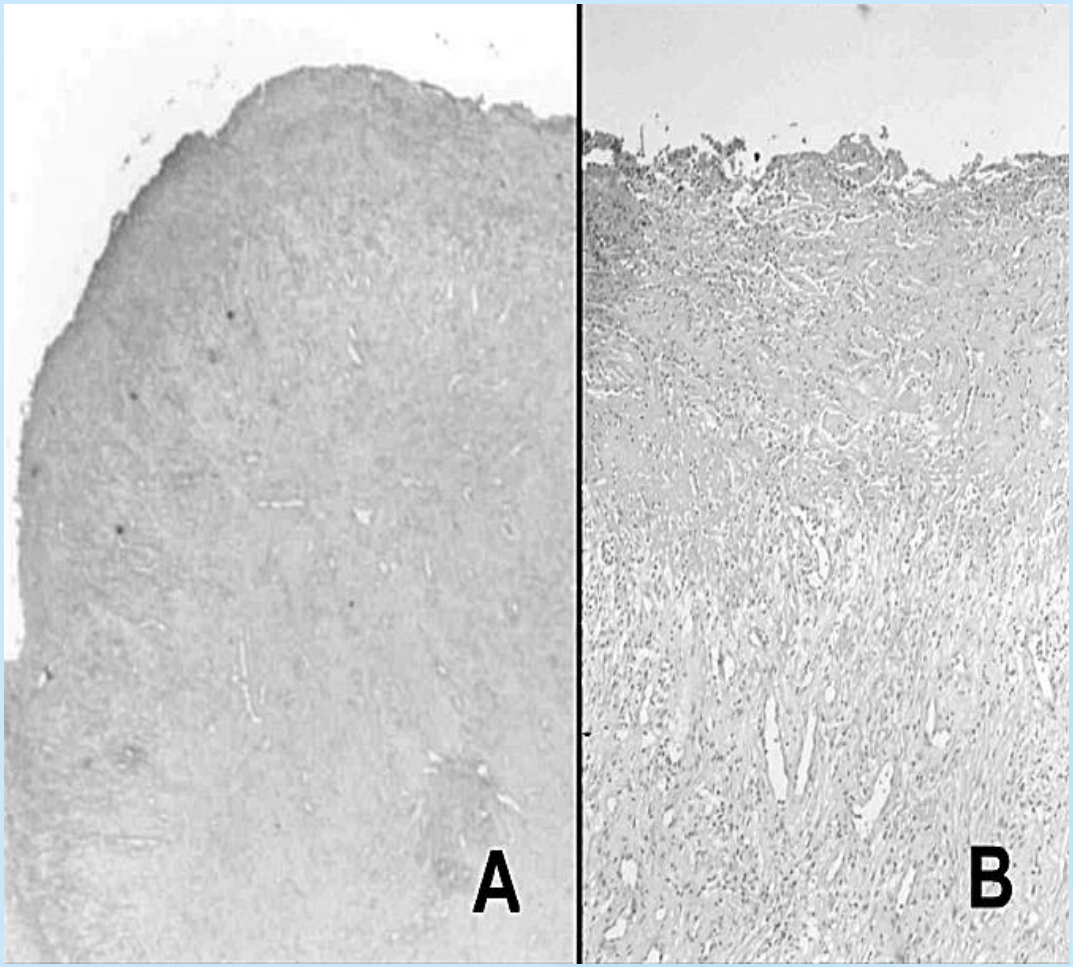
Maggot vs Conservative Debridement Therapy for the Treatment of Diabetic Foot Ulcers



Error bars indicate standard error. * = $p<0.05$

Sherman RA: Diabetes Care 2003; 26:446-51

Biopsy of rapidly granulating toe wound in patient undergoing MDT



Sherman RA: *Int J Foot Leg Wounds*. 2002; 1:79-86

ELSEVIER

Life Sciences, Vol. 60, No. 8, pp. 505-510, 1997

0024-3205/97 $17.00 + .00

PII S0024-3205(96)00688-1

GROWTH EFFECTS OF *PHAENICIA SERICATA* LARVAL EXTRACTS ON FIBROBLASTS: MECHANISM FOR WOUND HEALING BY MAGGOT THERAPY

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(Received in final form December 2, 1996)

Summary

The potential growth stimulating effects of the blow fly, *Phaenicia sericata*, on mammalian tissue were assessed by exposing human fibroblast tissue culture to maggot extracts. The growth effects of these extracts were compared to those of epidermal growth factor (EGF), recombinant interleukin 6 (IL6), and the insect hormone 20-hydroxyecdysone (EC). Results of dose-response experiments revealed that EGF had a maximum fibroblast stimulation at 66078 ± 1979 counts per minute (cpm), with peak counts on day 6 of culture, as measured by [^{3}H]-thymidine incorporation. *P. sericata* hemolymph (HL) and alimentary secretions (AS) and EC were also demonstrated to stimulate resting fibroblast tissue cultures, but the maximal stimulations only achieved 12% of EGF. Their growth rates plateaued between days 4 and 6. Addition of both HL and AS, as well as EC, significantly increased the growth rate of EGF-stimulated fibroblasts; AS increased the maximal stimulation of IL6-stimulated fibroblasts. These studies suggest the existence of intrinsic factors within the maggot which may be responsible for the growth-stimulating effects seen in maggot-infested wounds.

CLINICAL AND LABORATORY INVESTIGATIONS

BJD
British Journal of Dermatology

Amino acid derivatives from *Lucilia sericata* excretions/secretions may contribute to the beneficial effects of maggot therapy via increased angiogenesis

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22 September 2009

Key words
amino acids, angiogenesis, maggot therapy, metabolites

Conflicts of interest
None declared.

DOI 10.1111/j.1365-2133.2009.09530.x

Summary

Background Maggot therapy, utilizing the larvae of *Lucilia sericata*, has been reported to reduce the bacterial load within wounds and also to enhance wound healing. Maggot excretions/secretions (ES) have been shown to have a role in the success of maggot therapy. While the protein content of ES has been investigated, to date little research has focused on the small metabolites present in ES and their potential contribution to the therapy. Study of the molecular composition of the secretions and the potential bioactivities present will allow for a more detailed evaluation of the efficacy of maggot therapy.

Objectives We studied the amino acid-like compounds present in ES of *L. sericata* larvae in order to determine the compounds present and their potential role in the wound healing process.

Methods These included thin-layer chromatography/mass spectrometric analysis of ES to identify amino acid-like components, a turbidometric assay to investigate their potential antibacterial activity and cell proliferation studies to investigate their potential mitogenic ability.

Results Three prominent compounds were detected and identified as histidine, valinol and 3-guanidinopropionic acid. While these amino acids were not shown to exhibit antibacterial activity, a proliferative effect on the growth of human endothelial cells, but not fibroblasts, was noted.

Conclusions The demonstrated proliferative effect, selectively on endothelial cells, suggests that the amino acid-like compounds present in maggot ES may have a role in wound healing, by stimulating angiogenesis.

Wollina et al, International Journal of Dermatology 2002, 41, 635–9

Report

Biosurgery supports granulation and debridement in chronic wounds – clinical data and remittance spectroscopy measurement

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Abstract

Background Maggot therapy (biosurgery) has received increasing interest for the debridement of chronic wounds and for the improvement of wound healing. The purpose of this study was to investigate the clinical effects, side-effects, and possible mechanisms of action of biosurgery.

Methods Biosurgery was used for debridement in 30 patients with chronic leg ulcers of mixed origin. The effect of a single application of maggots for 1–4 days was evaluated by a clinical wound score and contact-free spectroscopy. Side-effects were recorded.

Results Debridement was rapid and selective. The wound secretion was temporarily increased. We observed a significant improvement of the wound score with a decrease from 13.5 ± 1.8 to 6.3 ± 2.7 ($P < 0.001$). The treatment was well tolerated in most patients. Twelve out of 30 patients reported temporary pain, but only two needed analgesic treatment. Other side-effects included venous bleeding in one patient. The remittance spectra showed an improvement of tissue oxygenation as revealed by the characteristic oxygen doublet peak (548 and 575 nm).

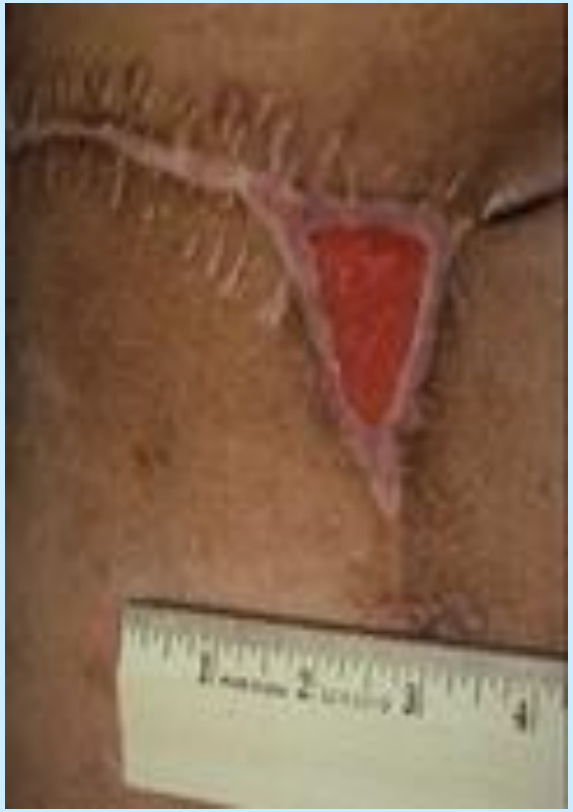
Conclusions Biosurgery is an effective and rapid treatment for the debridement of chronic wounds and the improvement of wound healing. A possible mode of action is the increase in tissue oxygenation. More studies are needed.

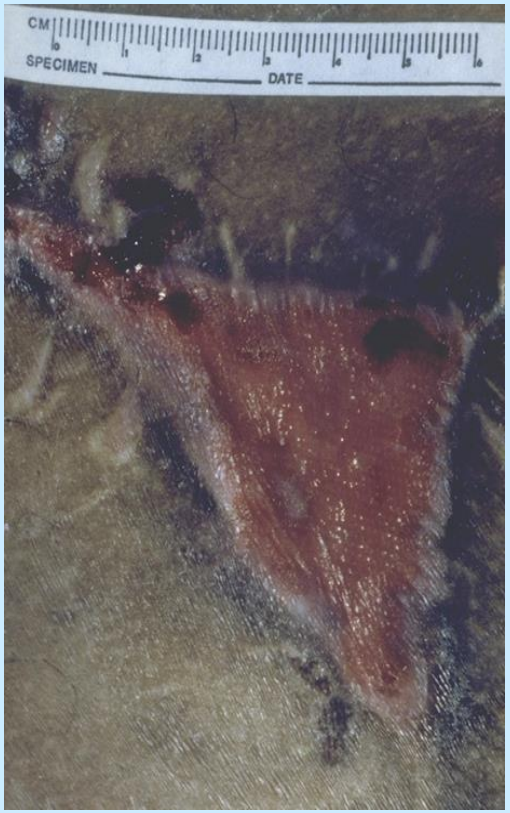
Maggots and wound healing: an investigation of the effects of secretions from *Lucilia sericata* larvae upon the migration of human dermal fibroblasts over a fibronectin-coated surface

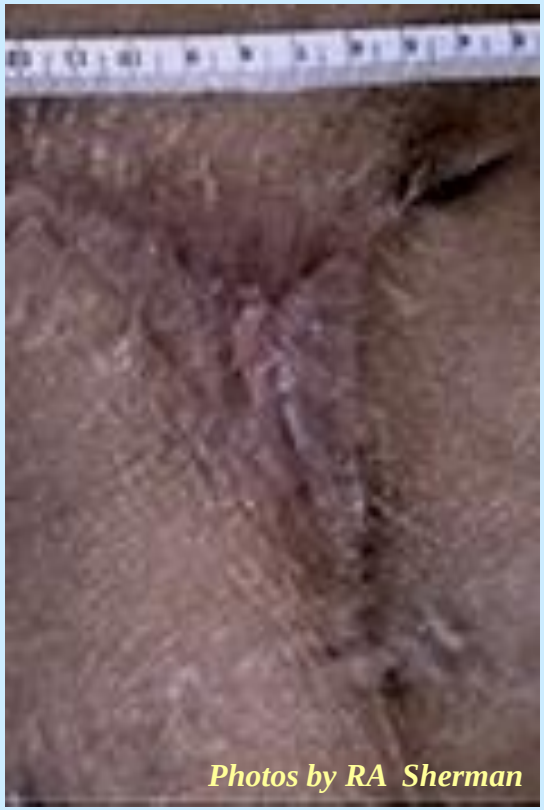
ADELE J. HOROBIN, PhD; KEVIN M. SHAKESHEFF, PhD; DAVID I. PRITCHARD, PhD

Lucilia sericata larvae, or greenbottle fly maggots, placed within chronic wounds have been observed to remove necrotic tissue and infection. They are also believed to actively promote granulation tissue formation. Interactions between fibroblasts and the surrounding extracellular matrix play a crucial role in tissue formation, influencing fibroblast proliferation, migration, and tissue remodeling. For example, the strength of cell adhesion to surfaces coated with extracellular matrix influences cell motility. *L. sericata* larval excretory/secretory products having previously been shown to modify fibroblast adhesion to collagen and particularly fibronectin, it was hypothesized that these products would alter fibroblast migration. This was investigated using a two-dimensional in vitro wound assay, time-lapse digital photography, enzyme class-specific substrates and inhibitors, and gel electrophoresis. Results showed that *L. sericata* excretory/secretory products promoted fibroblast migration upon a fibronectin-coated surface. This was related to the degradation of fibronectin by serine proteinases within maggot excretion/secretions. The presence of a metalloproteinase activity may also have played a role. Thus, a possible mechanism by which maggots enhance tissue formation within wounds may be via the promotion of fibroblast motility, providing for a wider distribution of viable fibroblasts. **(WOUND REP REG 2005;13:422–433)**

Maggot (Debridement) Therapy







46 year old paraplegic man, s/p bilateral flaps for trochanteric pressure ulcers. Maggot therapy healed the 4-month old sacral donor site as he awaited his scheduled STSG.

BMJ

RESEARCH

Larval therapy for leg ulcers (VenUS II): randomised controlled trial

Jo C Dumville, research fellow,[1] Gill Worthy, trial statistician,[1] J Martin Bland, professor of health statistics,[1] Nicky Cullum, professor, deputy head of department,[1] Christopher Dowson, professor,[2] Cynthia Iglesias, senior research fellow,[1] Joanne L Mitchell, research scientist,[3] E Andrea Nelson, reader in wound healing and director of research,[4] Marta O Soares, research fellow,[1] David J Torgerson, professor, director of York trials unit[1] on behalf of the VenUS II team

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[2]Biological Sciences, University of Warwick

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Cite this as: *BMJ* 2009;338:b773
doi:10.1136/bmj.b773

ABSTRACT

Objective To compare the clinical effectiveness of larval therapy with a standard debridement technique (hydrogel) for sloughy or necrotic leg ulcers.

Design Pragmatic, three armed randomised controlled trial.

Setting Community nurse led services, hospital wards, and hospital outpatient leg ulcer clinics in urban and rural settings, United Kingdom.

Participants 267 patients with at least one venous or mixed venous and arterial ulcer with at least 25% coverage of slough or necrotic tissue, and an ankle brachial pressure index of 0.6 or more.

Interventions Loose larvae, bagged larvae, and hydrogel.

Main outcome measures The primary outcome was time to healing of the largest eligible ulcer. Secondary outcomes were time to debridement, health related quality of life (SF-12), bacterial load, presence of meticillin resistant *Staphylococcus aureus*, adverse events, and ulcer related pain (visual analogue scale, from 0 mm for no pain to 150 mm for worst pain imaginable).

load compared with hydrogel but did significantly reduce the time to debridement and increase ulcer pain.

Trial registration Current Controlled Trials ISRCTN55114812 and National Research Register N0484123692.

INTRODUCTION

Venous leg ulcers develop from underlying venous disease and are one of the most common chronic wound types.[1] High compression bandaging is effective but only about 50% of leg ulcers are healed within 16 weeks, leaving scope for further improvements.[2-4]

An important aspect of wound management is thought to be removal of devitalised tissue from the surface of the ulcer; a process called debridement.[5 6] It has been suggested that larval therapy debrides wounds more swiftly than standard treatments[7 8] as well as stimulating healing,[9-12] reducing bacterial load,[13-17] and eradicating meticillin resistant *Staphylococcus aureus*.[18] Larvae used for medicinal purposes are available in loose and bagged formulations. Although

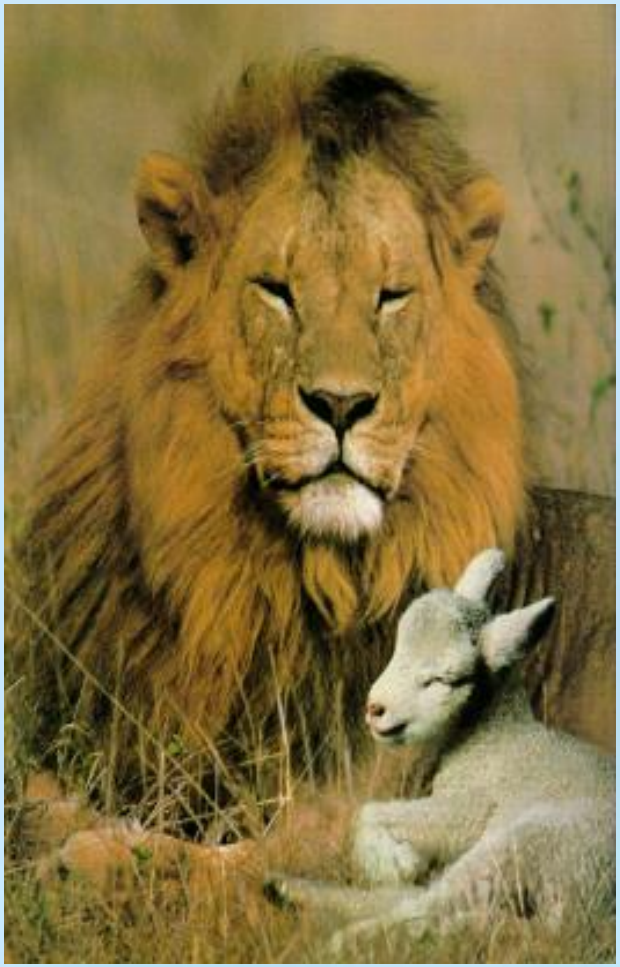
William Baer

Proc Intern Assembly Inter-state Postgrad Med Assoc N Am; 1929

Debride with maggots, and the wound heals normally. Continue applying maggots after the wound has been debrided, and the wound heals even faster than normal.

Photo furnished by
The Alan Mason Chesney Medical Archives
of The Johns Hopkins Medical Institutions

Maggot Therapy – Mechanisms of Action



1. Debridement
   - ✓ enzymatic
   - ✓ mechanical
2. Disinfection
   - ✓ kills bacteria
   - ✓ dissolves and inhibits biofilm
3. Promotion of wound healing
   - ✓ granulation tissue growth
   - ✓ epithelial proliferation and migration
   - ✓ tissue oxygenation

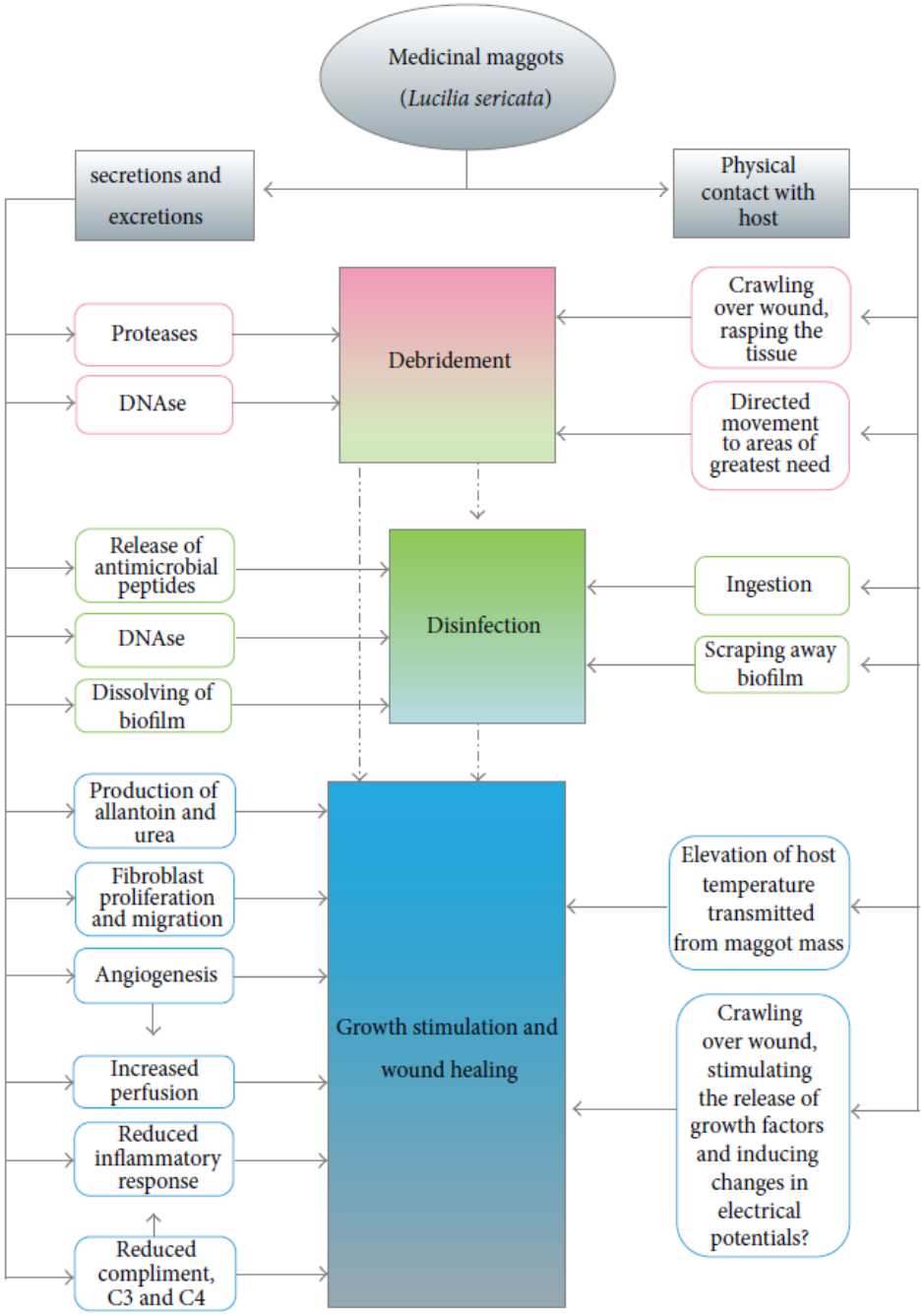


FIGURE 2: Schematic drawing of proven and postulated mechanisms by which medicinal maggots promote wound healing.

Maggot Therapy:
Back to the Future of Wound Care

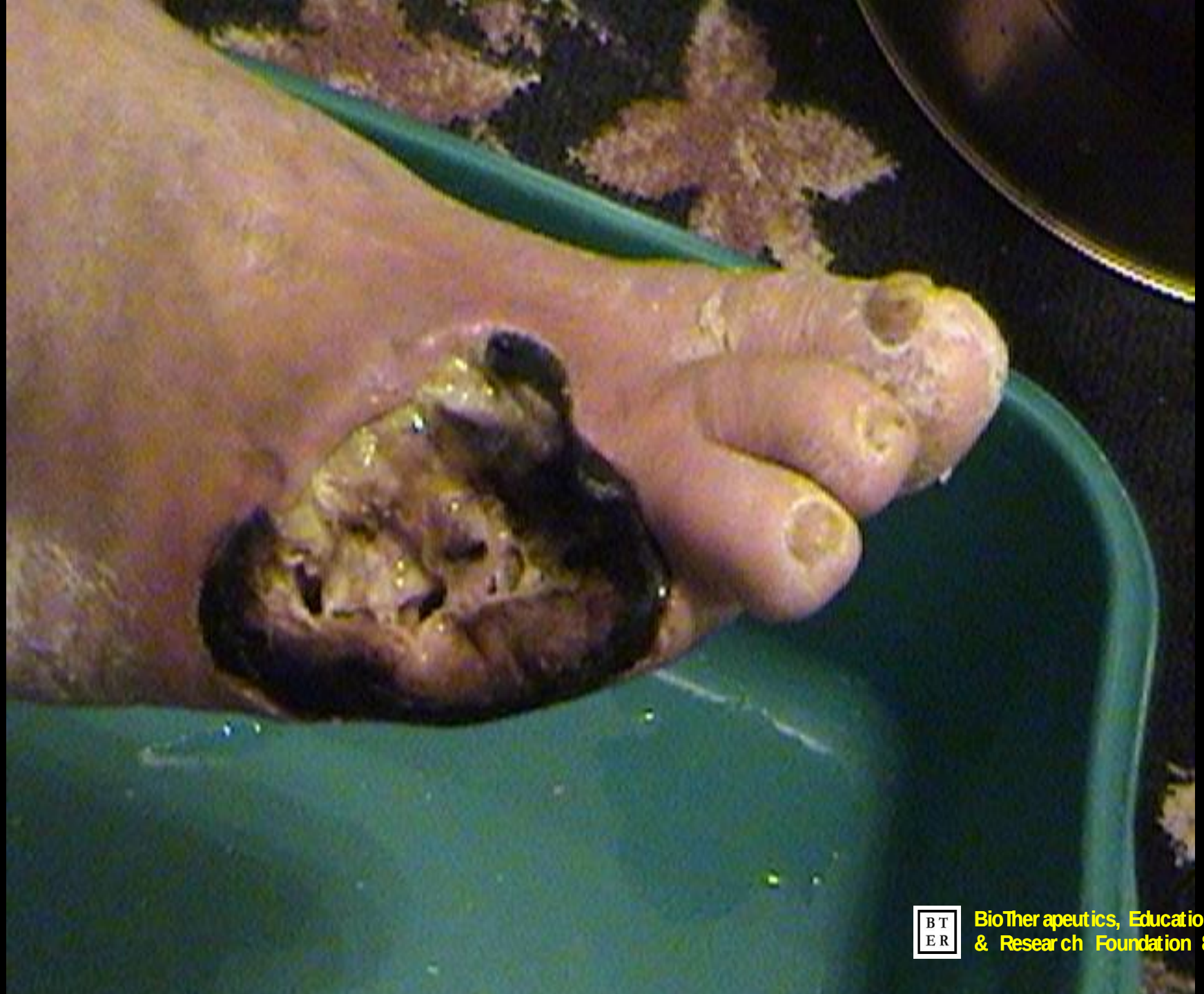
Indications & Contraindications

Maggot Therapy - Indications

“ . . . debrideing non-healing necrotic skin and soft-tissue wounds, including pressure ulcers, venous stasis ulcers, neuropathic foot ulcers, and non-healing traumatic or post surgical wounds.”

Adverse Events

- Pain or Discomfort
- Anxiety
- Inconvenience due to courier-delayed deliveries



Maggot Therapy: Back to the Future of Wound Care

Concluding Remarks

Maggot Therapy:
Back to the Future of Wound Care

Objectives

- List 4 indications and 3 warnings or relative contraindications for MDT
- Describe 3 ways that we control therapeutic myiasis (maggot therapy) to ensure safety & efficacy
- Describe 3 mechanisms of action
- Apply MDT dressings with confidence

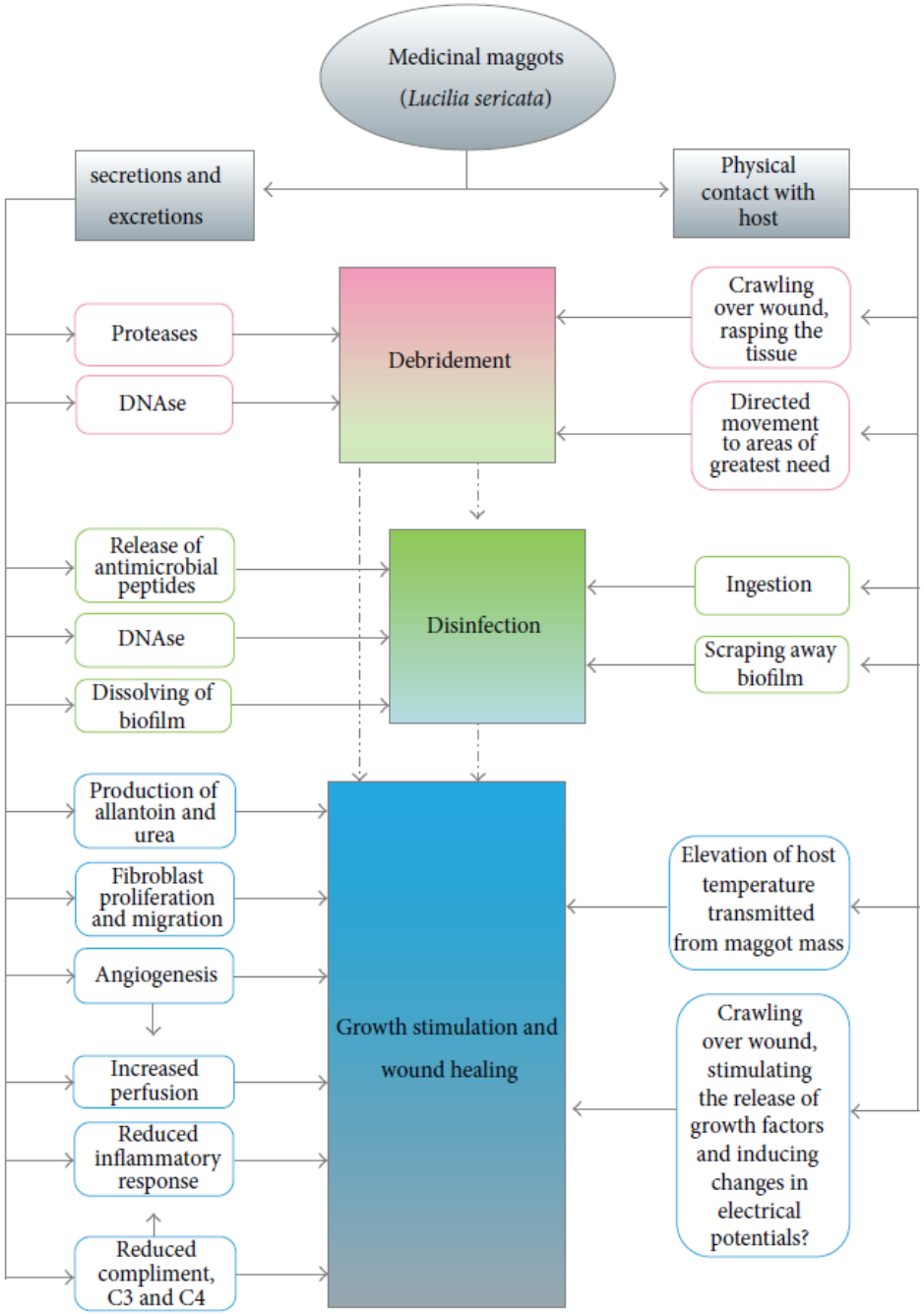


FIGURE 2: Schematic drawing of proven and postulated mechanisms by which medicinal maggots promote wound healing.

Principles & Practice of

Maggot Debridement Therapy

Excerpts taken from the educational workshops of the

BioTherapeutics, Education & Research Foundation

Supporting patient care, education and research in
Maggot Therapy and Symbiotic Medicine

MDT Dressing – Schematic

LAYERS

Absorbent gauze

Tape or adhesives

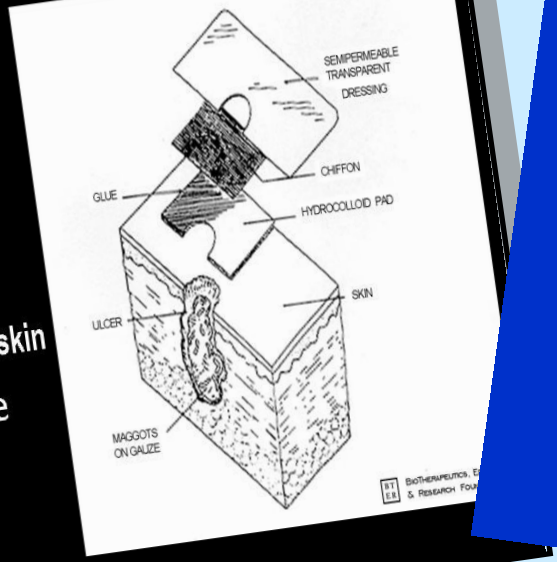
Chiffon or mesh

Glue or adhesive

Foundation on healthy skin

Maggots & gauze

Wound bed



Principles and Practice of

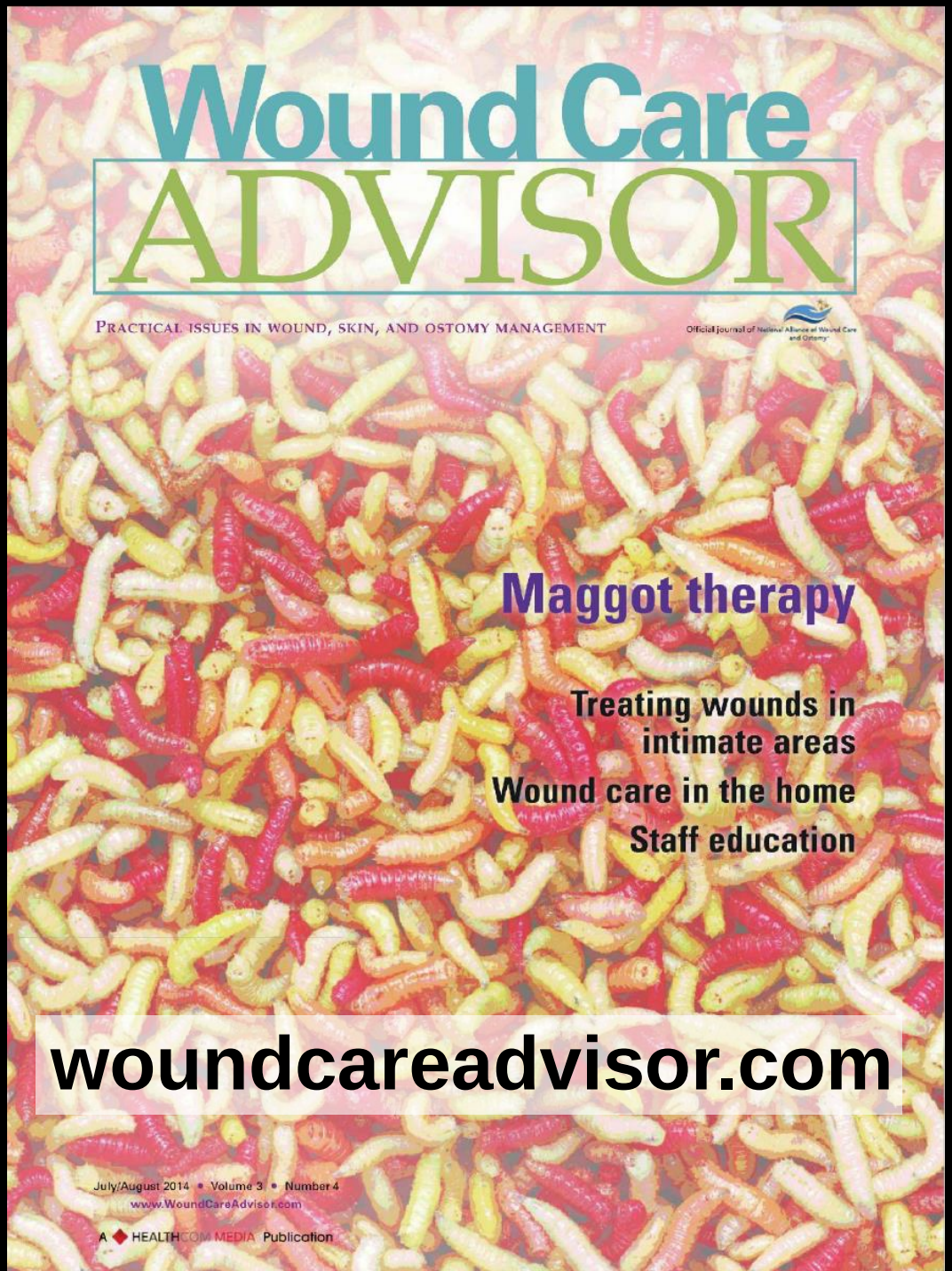
Maggot Debridement Therapy

Coming to

Your Place
Main Street
Anytown, State, U.S.A.

Another BioTherapy Workshop by the

BioTherapeutics, Education & Research Foundation


Wound Care
ADVISOR
PRACTICAL ISSUES IN WOUND, SKIN, AND OSTOMY MANAGEMENT
Official journal of National Alliance of Wound Care and Ostomy
Maggot therapy
Treating wounds in intimate areas
Wound care in the home
Staff education
woundcareadvisor.com
July/August 2014 • Volume 3 • Number 4
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olan mills


Lifetouch

Questions?

The making of Medicinal Maggots

Reimbursement & Coding

Confined vs contained (bagged) maggots

“Mr. Osborne,

May I be excused?

My brain is full”

Can we play with the people now?

Scene from Tim Burton's ***Corpse Bride*** ~ Warner Bros ©

Wound BioSurgery:

How to Train your Maggots & Leeches

Ronald A. Sherman, MD, DTM&H
Director, BTER Foundation
RSherman@uci.edu

Reimbursement Eligibility for Maggot Therapy

- Medicare reimbursement is based on site of delivery of care.
- Documentation is more important than “the right code.”
- Insurers’ goal is to keep as much money as possible.
- “Appeal” is the process wherein someone knowledgeable actually listens to your claim.
- BTER Foundation will assist with your appeal (nominal cost to non-members).
- BTER Foundation will cover some or all of cost of maggots & dressings for eligible patients, through its Patient Assistance program.

Reimbursement Eligibility for Maggot Therapy

Inpatient	
Acute Hospital Care	Wound care and dressings are included within the DRG (Diagnosis Related Group) payment.
Rehabilitation Facility	Wound care and dressings are included within the CMG (Case-Mix Group) payment.
Long-Term Care facility	Wound care and dressings are included within the MS-LTC-DRG (Medicare Severity Long-term Care Diagnosis-Related Groups.
Skilled Nursing Facility	For Part A Recipients: Wound care and dressings are included within the RUG (Resource Utilization Group) payment. For Non-Part A Recipients: Dressings may be billed separately to Medicare Part B

Reimbursement Eligibility for Maggot Therapy

Outpatient

Hospital Outpatient

Wound Care: Use CPT® * debridement codes. Normally, dressings used on the day of service are included within the APC (Ambulatory Payment Classification) payment. However, MDT dressings and supplies are considered non-routine (see AMA's guidance document, ***CPT Assistant***, September 2008, Vol 18, Issue 9, page 11), and should be billed separately, either by adding their HCPCS codes (if existent and known), or describing them in detail, under a miscellaneous CPT (99070) or HCPCS (A4649) code.

Dressings used at home between visits may be billed separately to Medicare Part B if coverage criteria are met.

Reimbursement Eligibility for Maggot Therapy

Outpatient

Physician/Podiatrist Office

Wound Care: Use CPT® * debridement codes. Routine dressings used during an office visit are the responsibility of the provider; compensation is considered to be “covered” by the CPT code. However, MDT dressings and supplies are considered non-routine (see AMA’s guidance document, ***CPT Assistant***,), and should be billed separately, either by adding their HCPCS codes (if existent and known), or describing them in detail, under a miscellaneous CPT (99070) or HCPCS (A4649) code.

Dressings used at home between visits may be supplied by a DME and billed separately to Medicare Part B if coverage criteria are met.

Reimbursement Eligibility for Maggot Therapy

Outpatient	
Beneficiary themselves (+/- family assistance) at Home	Dressings used at home may be billed separately to Part B if coverage criteria are met.
Home Health Agency	Wound Care: Use HHRG (Home Health Resource Group) payment codes. Dressings: Routine dressings can not be billed separately; but non-routine dressings (such as MDT dressings and supplies) may be billed separately.

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The making of Medicinal Maggots

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The Making of a Maggot-Doctor

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How to Train your Maggots

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How to Train your Maggots

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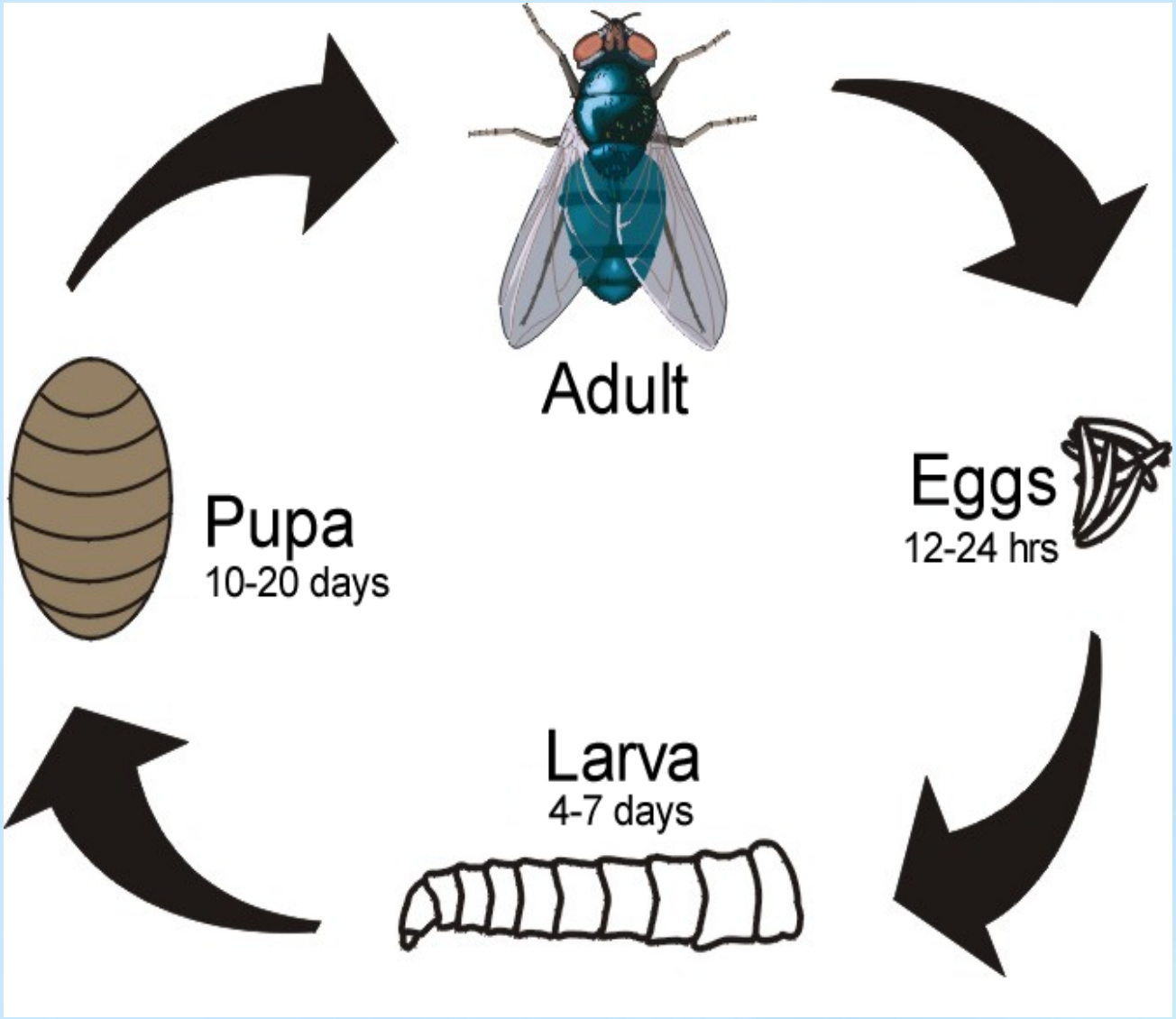
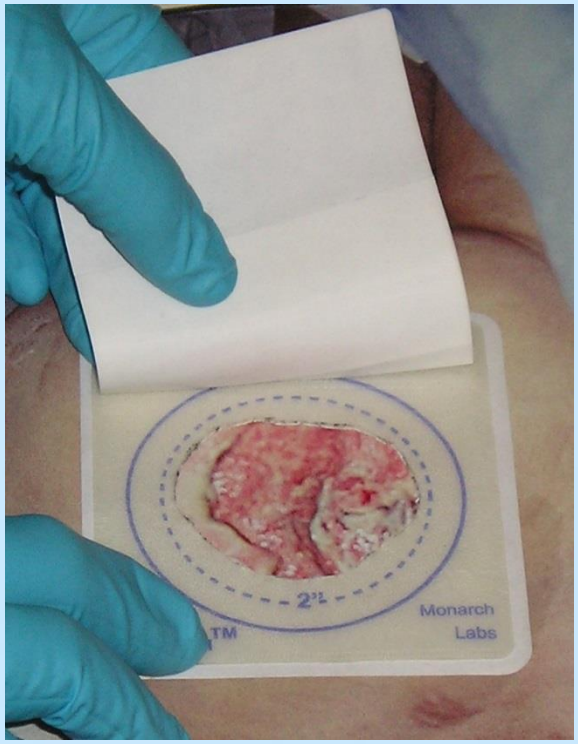
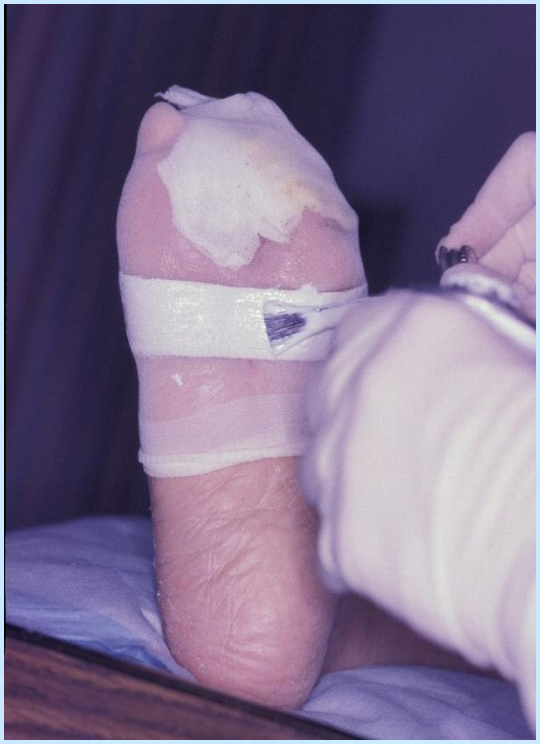
Typical Blow Fly Life cycle



Controlled, Therapeutic myiasis

Controlled, Therapeutic myiasis





. . . controlled access to wound -
"cage dressings"

Principles & Practice of

Maggot Debridement Therapy

What is a Maggot Dressing?

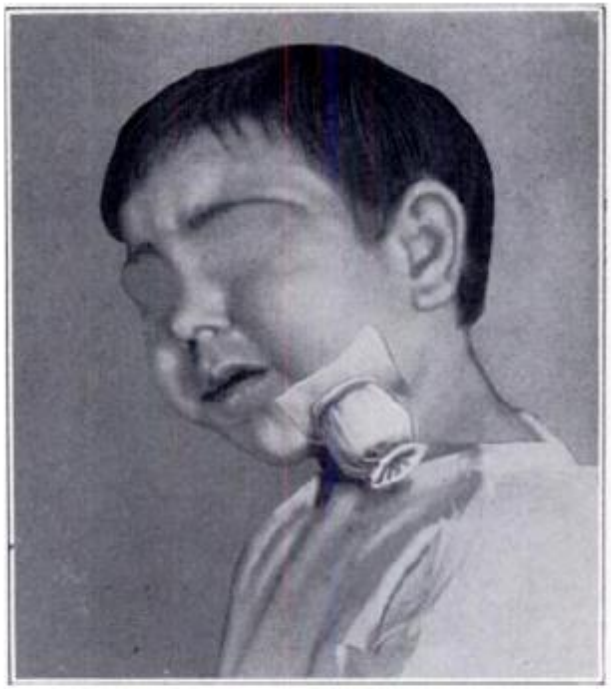
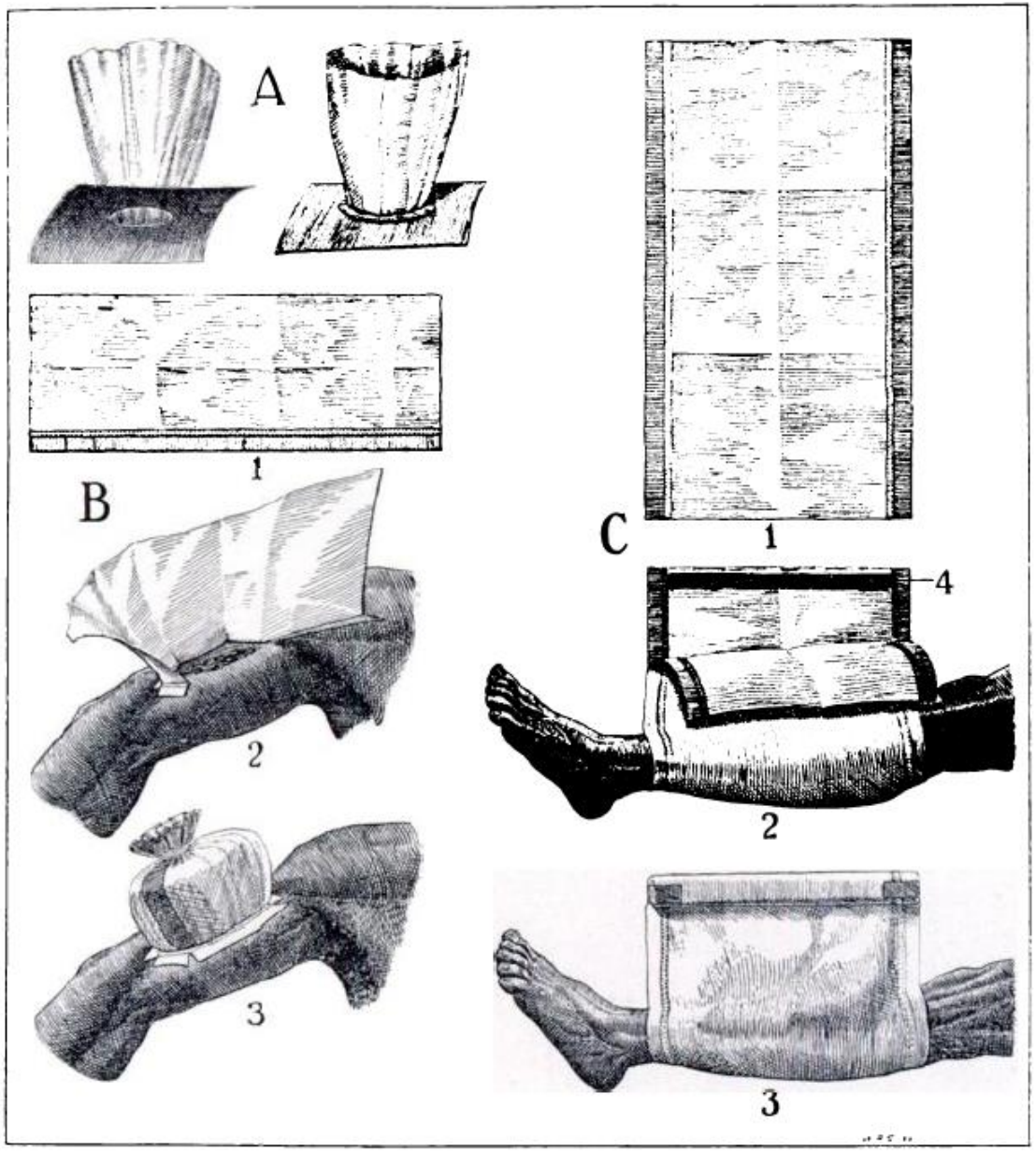
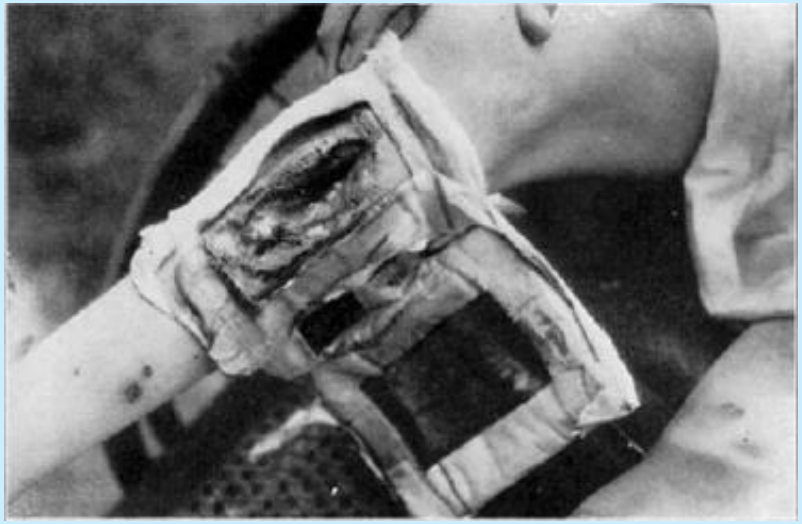


FIG. 6

Case 4. Photograph showing Type A cage in place in the treatment of osteitis of the jaw.



Fine A and Alexander H: Maggot therapy - Technique and Clinical Application. *J Bone Jnt Surg Am*, 1934.



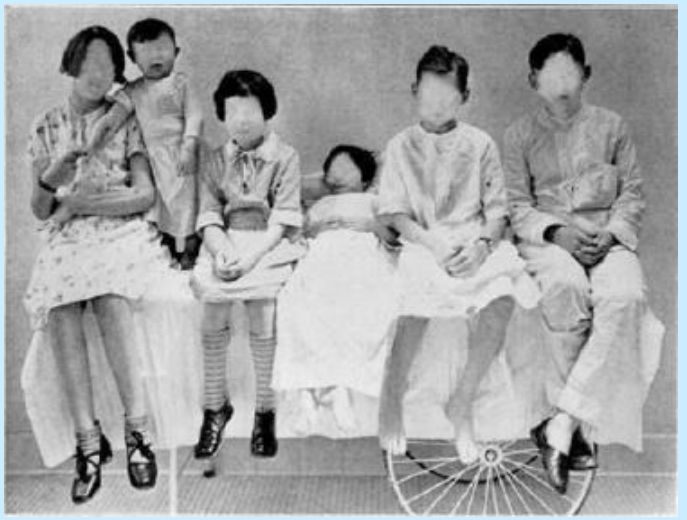


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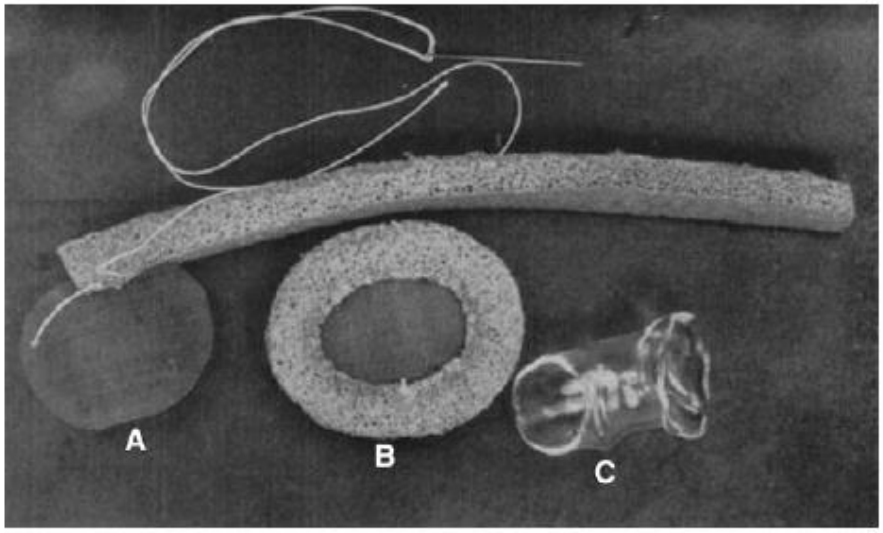
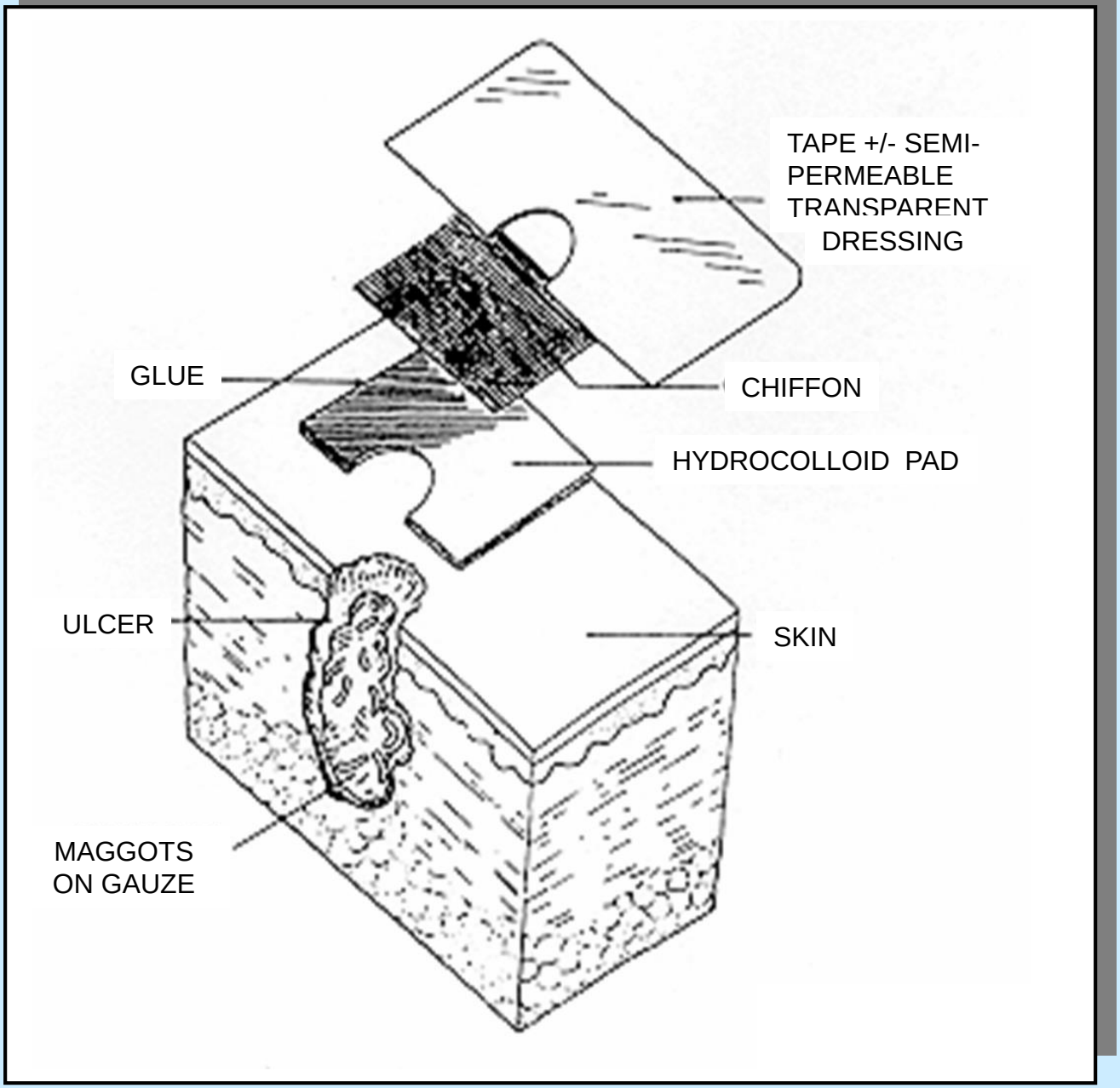
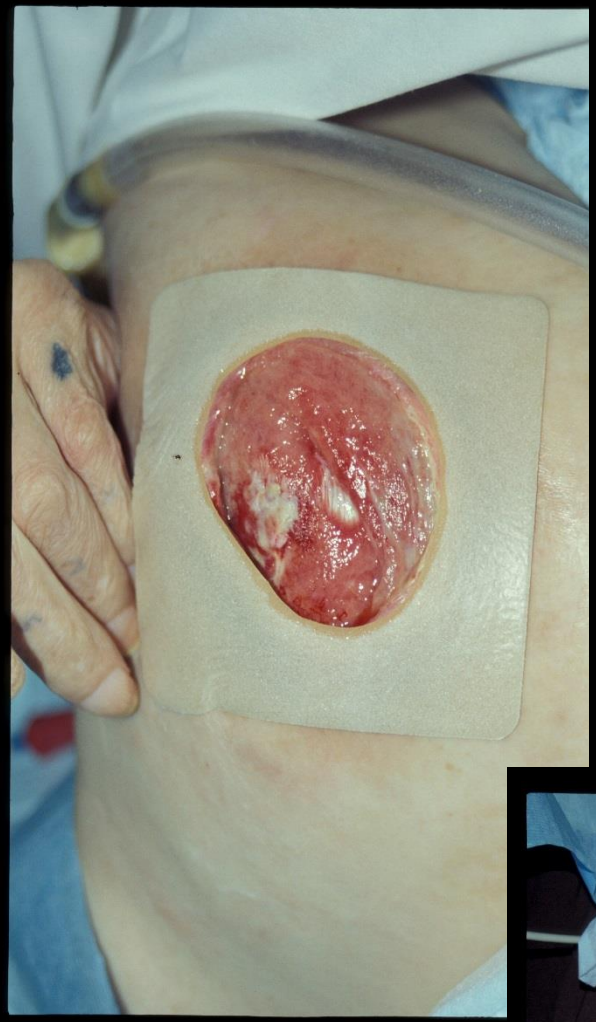
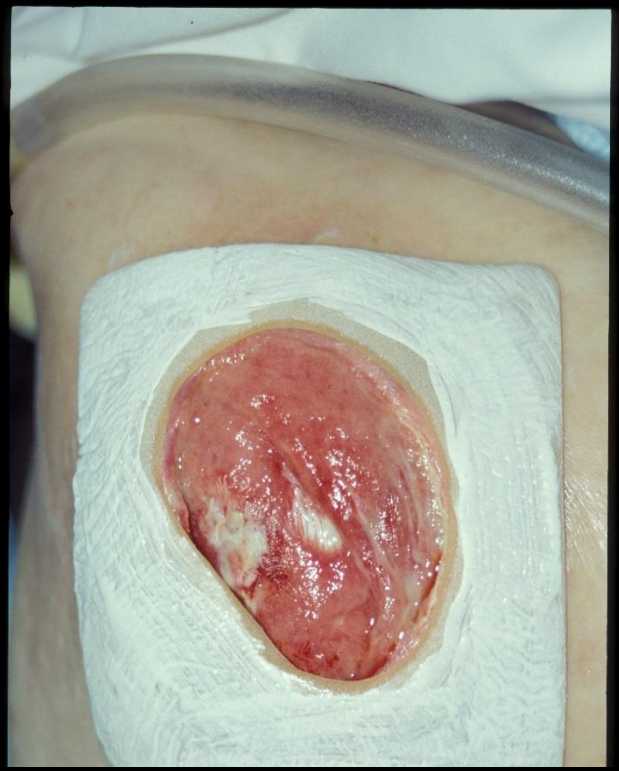
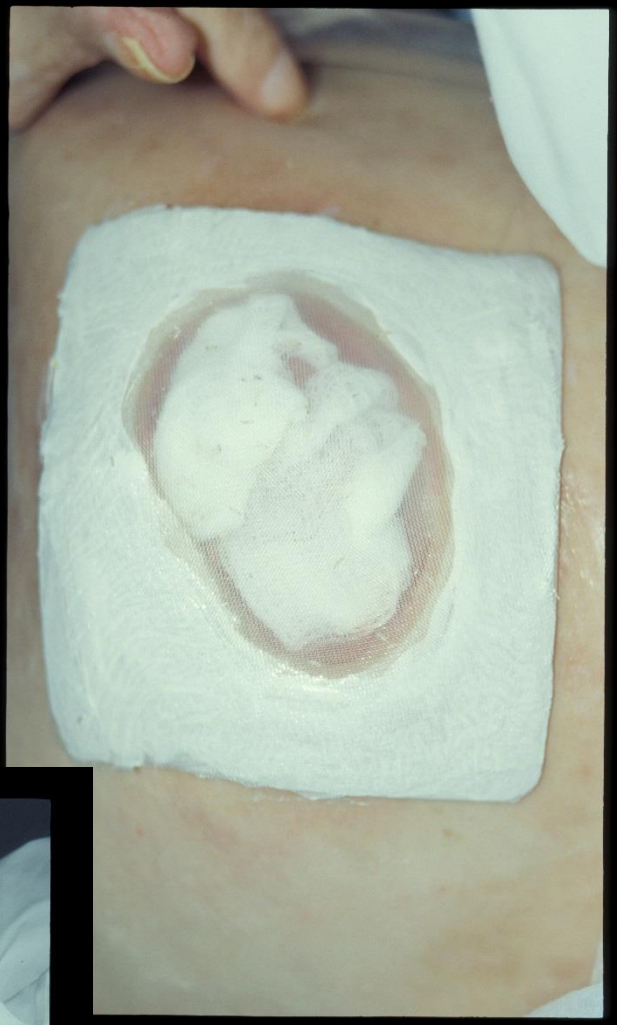
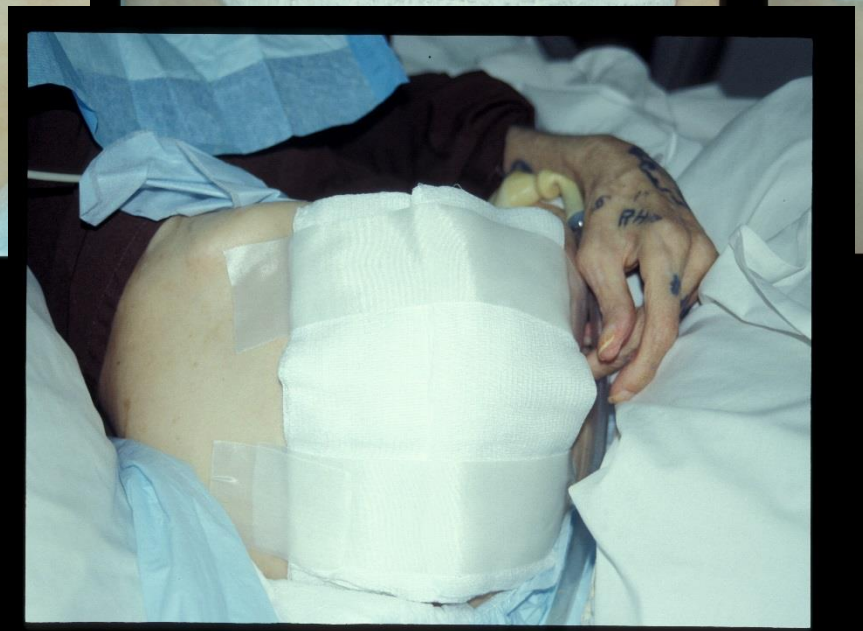
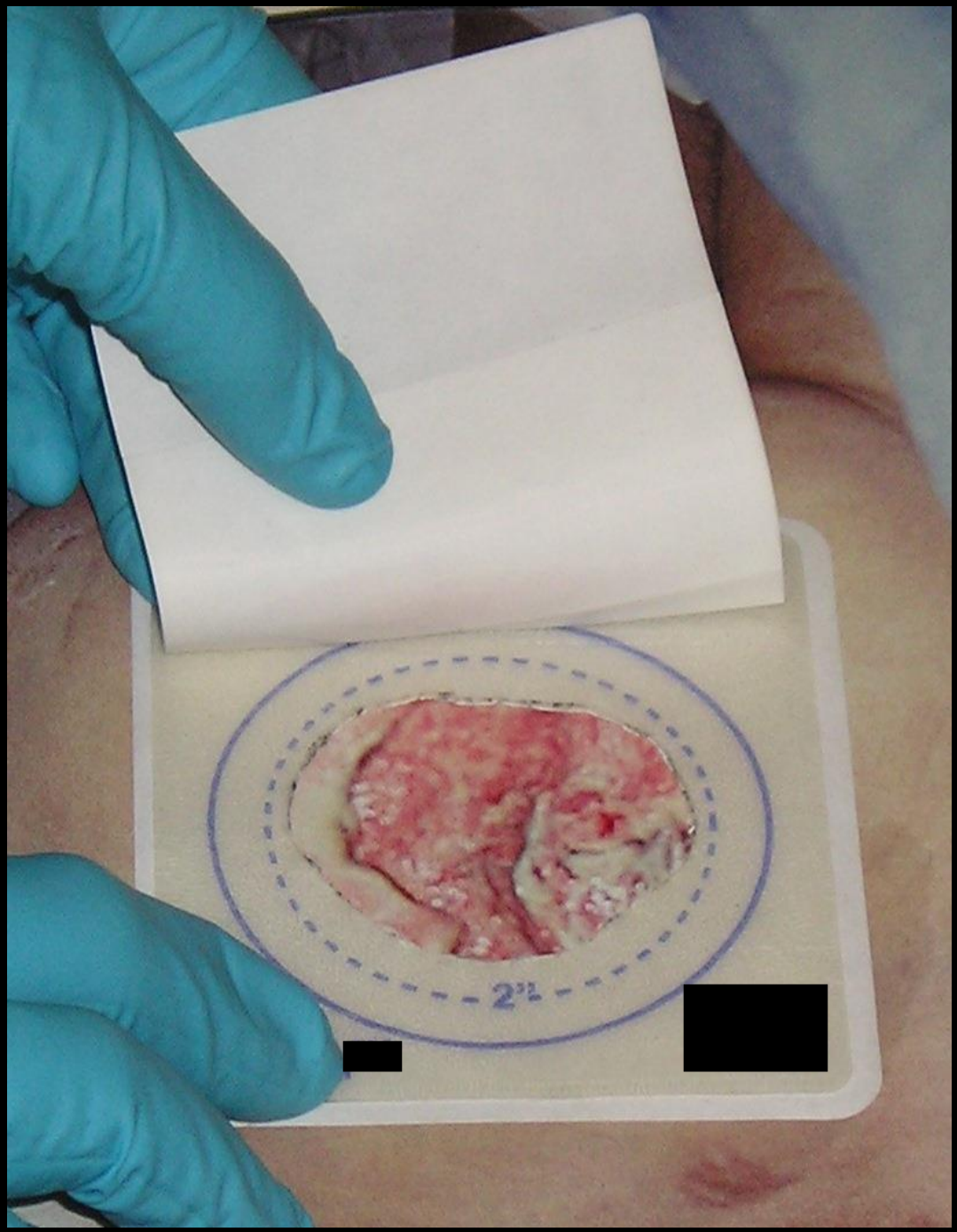
Fig. 4 (A) Method of edging screen with sponge rubber. (B) Completed screen. (C) Glass tube to be used in wound to allow drainage and prevent too early closing of the skin edges.



McKeever DC: Maggots in the Treatment of Osteomyelitis. Am J Nursing, 1932

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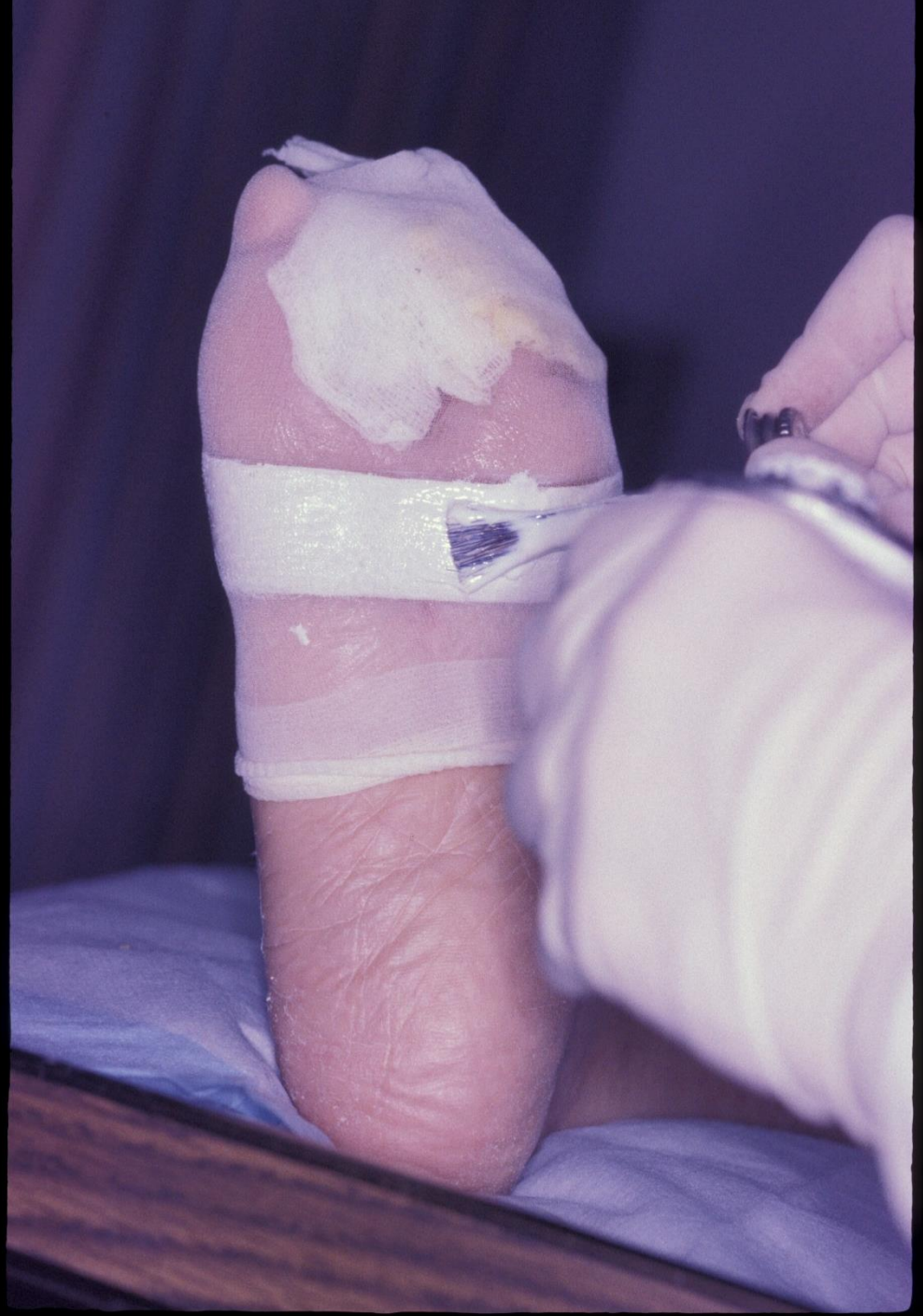

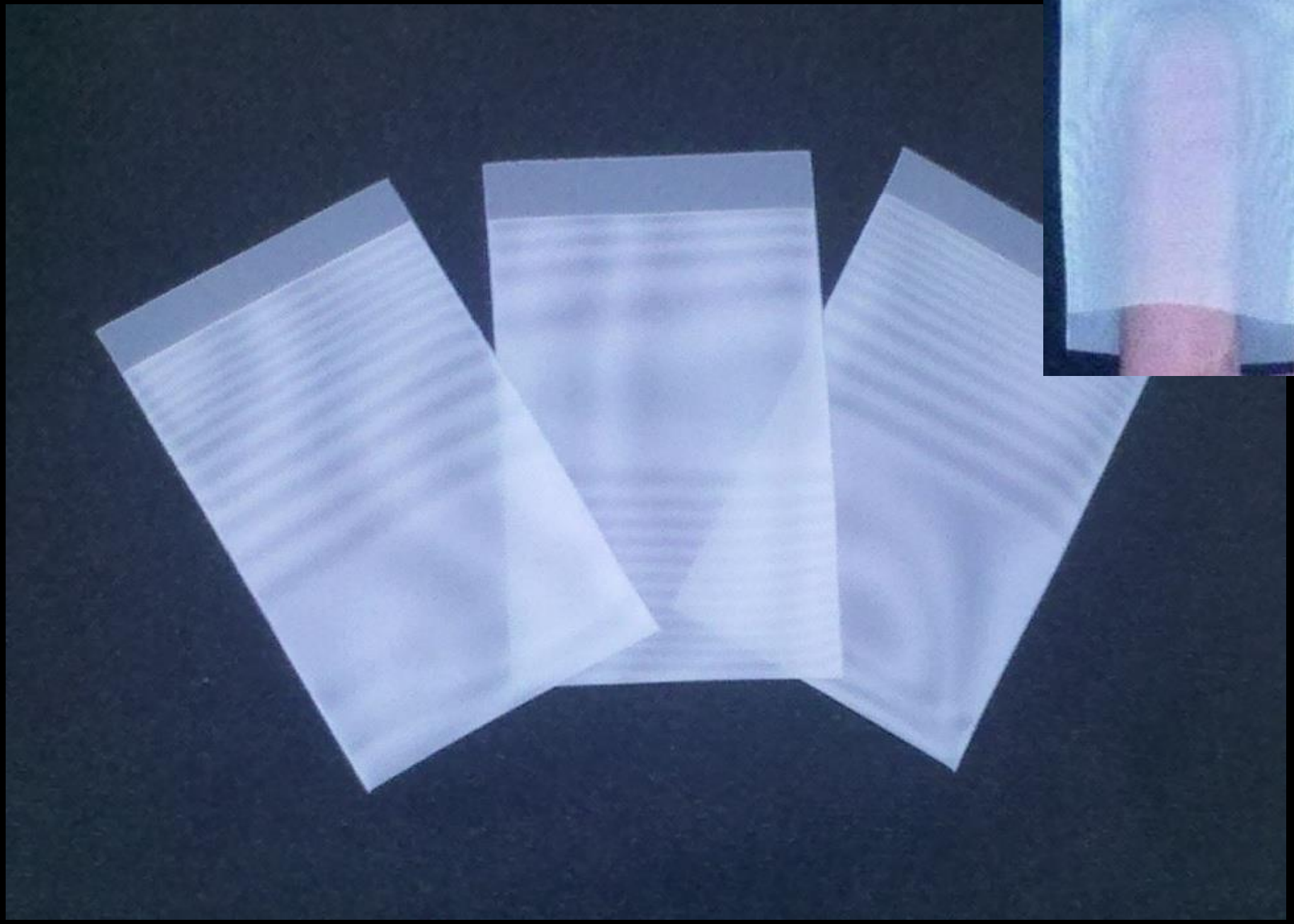

Confinement Maggot Dressings

"Free-Range Maggots"
"Loose Maggots"
"Plain Maggot therapy"

Containment Maggot Dressings

"Bagged Maggots"
"Tea-Bag Maggots"
"Maggot Ravioli"

Free-Range vs Bagged Maggots

Advantages of ***Contained*** Maggots

- Therapist does not touch maggots
- Faster application
- Do not need peri-wound skin to support the dressing

Free-Range vs Bagged Maggots

Disadvantages of ***Contained*** Maggots

- Maggots have no direct contact with necrotic tissue; can not access undermined areas, sinus tracts, etc
- Less effective and efficient
- More expensive (more labor-intensive to produce)

Free-Range vs Bagged Maggots

Advantages of ***Confined*** Maggots

- Maggots have direct contact with necrotic tissue, including undermined areas, sinus tracts, etc
- More effective and efficient
- Less expensive (less costly to produce)

Free-Range vs Bagged Maggots

Disadvantages of ***Confined*** Maggots

- Touching the maggot or maggot-impregnated gauze
- Requires “cage-dressing”
- Need 1 cm peri-wound skin to support the cage-dressing

Maggot Debridement Therapy: Free-Range or Contained? An In-vivo Study

Pascal Steenvoorde, MD, MSc; Cathrien E. Jacobi, PhD; and Jacques Oskam, MD, PhD

ABSTRACT

OBJECTIVE: To determine which method of maggot debridement therapy— free-range or contained—is more effective for wound healing.

METHODS: In vivo study of 64 patients with 69 chronic wounds that showed signs of gangrenous or necrotic tissue. Patients were treated with either free-range or contained maggot debridement therapy according to maggot availability, dressing difficulty, and physician preference.

RESULTS: Significantly better outcomes were achieved with the free-range technique versus the contained technique ($P = .028$). With the free-range technique, the mean number of maggot applications and the total number of maggots per treatment were significantly lower than with the contained application technique ($P = .028$ and $P < .001$, respectively).

CONCLUSION: This clinical in vivo study supports in vitro studies in which containment of maggots was found to reduce the effectiveness of maggot debridement therapy.

ADV SKIN WOUND CARE 2005;18:430-5

The effect of containment on the properties of sterile maggots

Stephen Thomas, Karen Wynn, Tony Fowler, Mary Jones

Abstract

A laboratory-based study undertaken to examine the effect of confinement in net bags upon the feeding mechanisms and growth rate of maggots of Lucilia sericata showed that free-range maggots survived better and grew significantly faster than maggots in bags (P<0.005). In a separate study it was also demonstrated that maggots in bags could survive on wound fluid that passed through the net without their having access to any form of solid food. This finding was consistent with clinical experience that suggests that although there may be some aesthetic advantages to the use of maggots in bags, their ability to combat infection or remove necrotic tissue from wounds is greatly reduced.

BMJ

RESEARCH

Larval therapy for leg ulcers (VenUS II): randomised controlled trial

Jo C Dumville, research fellow,[1] Gill Worthy, trial statistician,[1] J Martin Bland, professor of health statistics,[1] Nicky Cullum, professor, deputy head of department,[1] Christopher Dowson, professor,[2] Cynthia Iglesias, senior research fellow,[1] Joanne L Mitchell, research scientist,[3] E Andrea Nelson, reader in wound healing and director of research,[4] Marta O Soares, research fellow,[1] David J Torgerson, professor, director of York trials unit[1] on behalf of the VenUS II team

[1]Department of Health Sciences, University of York, York YO10 5DD
[2]Biological Sciences, University of Warwick
[3]Micropathology Ltd, Coventry
[4]School of Healthcare, University of Leeds
Correspondence to: Jo C Dumville jd34@york.ac.uk

Cite this as: *BMJ* 2009;338:b773
doi:10.1136/bmj.b773

Time to debridement differed significantly between the three groups (25.38, df=2, log rank test <0.001). The median time to debridement with loose larvae was shorter (14 days, 95%confidence interval 10 to 17) than with bagged larvae (28 days, 13 to 55) and with hydrogel (72 days, 56 to 131).

The rate of debridement at any time in either larvae groups was about twice that of the hydrogel group; the hazard ratio for the combined larvae group compared with hydrogel was 2.31 (95% confidence interval 1.65 to 3.24, P<0.001).

The biosurgical wound debridement: Experimental investigation of efficiency and practicability

Felix A. S. Blake, MD, DMD[1]; Norbert Abromeit, BS[1]; Michael Bubenheim, MD[2]; Lei Li, MD, DMD[1]; Rainer Schmelzle, MD, DMD[1]

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2. Institute for Medical Biometry and Epidemiology, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

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Accepted in final form: May 30, 2007

DOI:10.1111/j.1524-475X.2007.00298.x

ABSTRACT

The use of maggot therapy is experiencing a revival in the t
wounds. Although this alternative therapy is ancient, little s
been aimed at standardizing this therapy. The purpose of ou
determine the debridement efficiency of this therapy, i.e., t
freely crawling maggots with maggots in a Biobag and to est
maggots needed for debridement. We designed an artificial v
vestigated the rate of decomposition of porcine tissue. Two
tives were compared, each being carried out either for 3 or fo
that were allowed to crawl freely over the substrate and (2) m
Biobag with no direct contact with the wound. We found
was capable of debriding approximately 0.15 g of dead tissu
an absolute difference of <0.05 g per day and maggot as cli
debridement efficiency of free maggots appears to be similar
We were able to determine for the first time the average debr
gots and thus provide the clinician with data that may help
got therapy by facilitating more exact approximations of the
needed. Furthermore, the result that the maggots in the Bio
maggots in their debriding efficiency will promote its use, es
to the time saved for changing of the dressings. Also, we we
no direct contact is necessary between the maggots and the v
ing that the mechanical crawling effect appears to be neglect
icantly more tissue was metabolized after 4 than after
intervals of 4 days appear more appropriate than those of 3

Letters to the Editor

Comments on the paper, "The biosurgical wound debridement: experimental investigation of efficiency and practicability," by Blake FA et al.

To the Editor:

We would like to congratulate Dr. Blake and his co-authors with their recent publication on Maggot Debridement Therapy (MDT).[1] From their experimental study they concluded that the contained technique (Biobag) does not impair effectiveness of MDT. In their introduction it is stated that "to what extend this alternative (Biobag) impairs the effectiveness of the debridement has not been investigated." This is not true, this has been studied and published before. Already in 2002 Thomas et al.[2] published an experimental study called: The effect of containment on the properties of sterile maggots, in which they found that maggots were able to increase their weight in 48 hours to 23 times if they were used in the free-range technique, compared with an increase of only seven times if contained; this difference was highly significant.

Our own study group published, in 2005[3] an in vivo study on the effect of containment. With the free-range technique, we found that the mean number of maggot applications (2.4 vs. 4.3 applications, $p=0.028$) and the total number of maggots per treatment (156 vs. 277 maggots, $p<0.001$) were significantly lower than with the contained application technique. Dr. Blake concluded that the effectiveness of the Biobag is comparable to the free-range technique, especially taking into account the time for dressing changes. This is interesting, for time of dressing changes was not studied in their published study. In Figure 4 of their article, it is shown how the effect of the Biobag is studied; it is shown how a Biobag is sewn to the necrotic tissue. It is clear that this situation is not applicable to in vivo studies. In fact most of the times the Biobag does not exactly cover the entire wound and the debridement is not thorough as with the free-range technique.[4] Perhaps this could be overcome with a "personalized" Biobag in which the Biobag follows exactly the contours of the wound. Furthermore we would like to stress the differences in costs, the contained technique is about 40% more expensive compared with the free-range technique. Therefore, in our clinic, the free-range technique is the preferred technique (for dressing times are equal); the Biobag technique is used in special circumstances, like bleeding-disorders, patient preference and wounds close to large vessels or natural orifices.

Pascal Steenvoorde, MD, MSc, PhD and
Jacques Oskam, MD, PhD
Rijnland Hospital—Surgery
Simonsmitweg 1
Leiderdorp 2353 GA
the Netherlands

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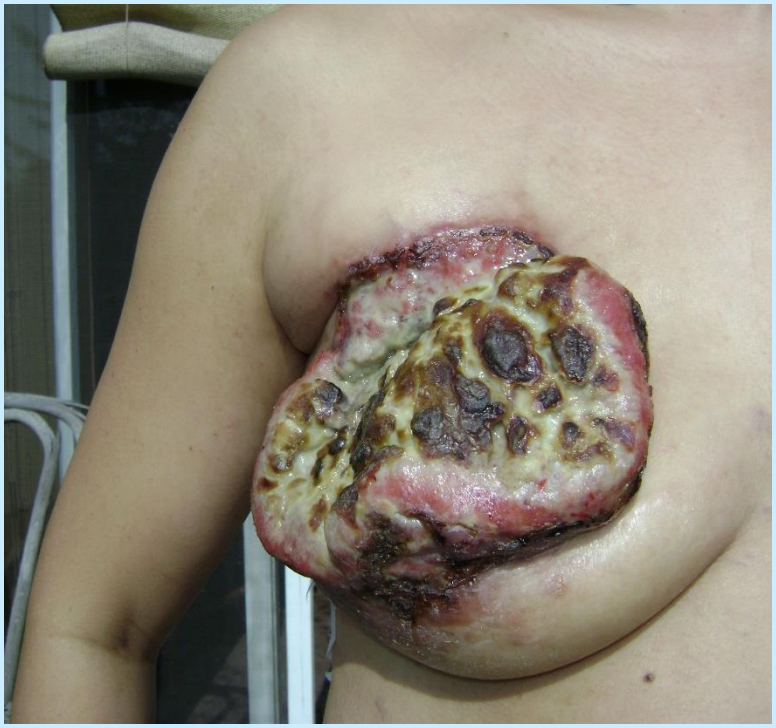
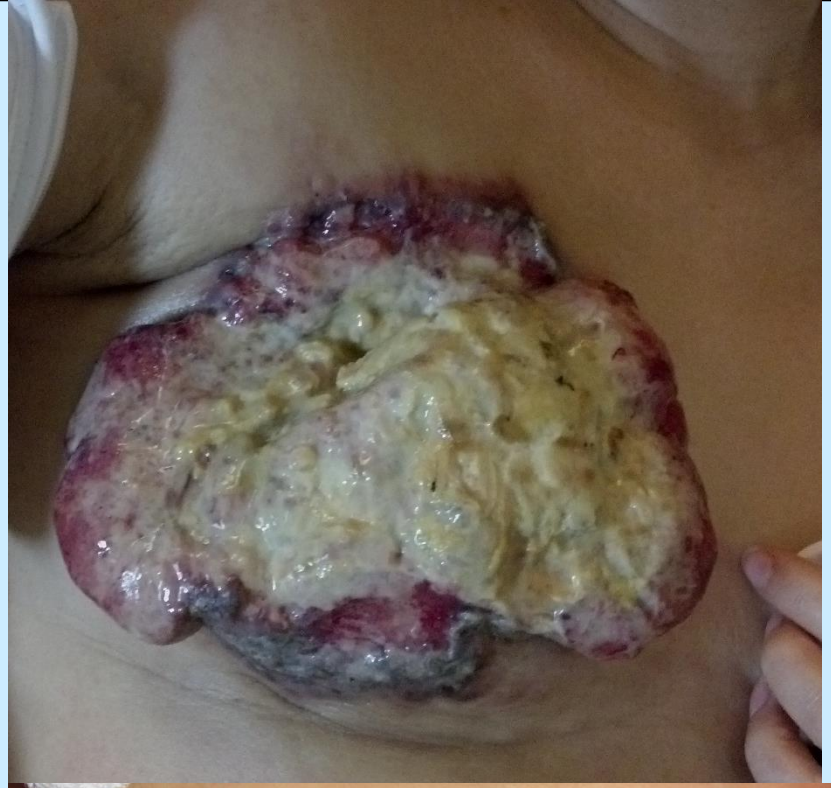
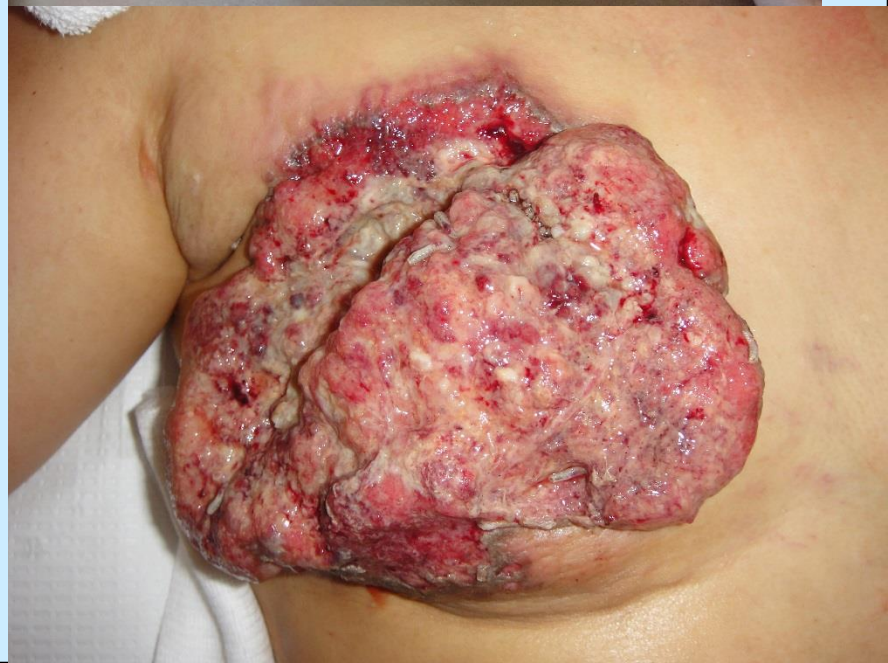
4. Grassberger M, Fleischmann W. The biobag—a new device for the applications of medicinal maggots. *Dermatology* 2002; 204: 306.





Fungating Breast CA

55 yo woman treated "conservatively" for 2 months; (still draining, malodorous, painful); then treated with MDT for less than 24 hours.



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How to apply MDT Dressings