

## Maggot therapy could provide affordable and efficacious wound care in Lebanon and other low- and middle-income countries

Salman Shayya,<sup>1,2</sup> Frank Stadler<sup>3,4</sup>

<sup>1</sup>Institute of Legal Medicine, University Hospital Frankfurt, Goethe-University, Frankfurt am Main, Germany;

<sup>2</sup>Lebanese University, Faculty of Science Hadath Beirut, Faculty of Public Health Fanar and Ain W Zain, Lebanon;

<sup>3</sup>Applied BioSciences, Macquarie University, Sydney, New South Wales, Australia; <sup>4</sup>School of Medicine and Dentistry, Griffith University, Gold Coast, Queensland, Australia

### Abstract

The poor economic situation, ongoing political instability, and the 2020 Beirut explosion have seriously eroded the capacity of the Lebanese healthcare system. Insecure fuel supplies and the rationing of electricity to a few hours per day make matters worse. New strategies are required to deliver healthcare that is more resilient in the face of ongoing disruption. Maggot therapy for the treatment of chronic and infected wounds could make a meaningful difference in Lebanon. When placed in a wound, medicinal maggots remove dead tissue, control infection and stimulate wound healing. It is an inexpensive, easy to use, and highly efficacious therapy, even under austere conditions. This review provides an introduction to maggot therapy and briefly explains its therapeutic benefits before discussing the role it can play in the Lebanese healthcare system. Finally, the prerequisites and enablers for successful integration of maggot therapy into the Lebanese healthcare system are outlined.

### Introduction

Maggot therapy (MT) is the use of live fly larvae (maggots) for the treatment of wounds that fail to heal. MT is used for the treatment of a wide range of chronic wounds including infected wounds and wounds with dead tissue and/or slough such as leg ulcers, pressure ulcers, diabetic foot ulcers, gangrenous wounds, osteomyelitis, surgical wounds, and burns.<sup>1</sup> When applied

to the wound, medicinal maggots remove dead tissue, control infection, and stimulate wound healing.<sup>2</sup> Maggot therapy compares favorably with conventional wound treatment while it can also be cost effective compared to conventional treatment approaches.<sup>3,4</sup>

For wounds to heal, it is necessary that dead tissue and other debris are removed. This process is known as debridement. When placed into a wound, medicinal maggots crawl about with the aid of their paired mouth hooks while excreting digestive enzymes into the wound environment.<sup>5</sup> This leads to the liquefaction of dead tissue which is then either ingested by the maggots or it drains from the wound.<sup>6</sup>

Infection often plays an important part in preventing chronic wounds from healing. Medicinal maggots control infection in a number of ways. First, their feeding activity in the wound removes dead tissue which is a source of nutrition for bacteria, and it disrupts bacterial biofilm via mechanical means. The very act of ingestion and digestion of bacteria-rich necrotic tissue by the maggots contributes to the reduction of the bacterial burden in the wound. Moreover, the maggots' secretions and excretions have potent antibacterial properties and contain sodium bicarbonate which increases the pH of the wound and inhibits bacterial growth.<sup>6,7</sup>

Wounds are said to be chronic when they fail to pass in an orderly manner through the three phases of healing: inflammation, proliferation, and remodeling. In such wounds, maggot therapy interrupts chronic inflammation and promotes the growth of new tissue, including blood vessels.<sup>8</sup> A successfully healing wound exhibits the growth of granulation tissue, but for this to occur, fibroblasts must migrate into the clean wound bed to bring about granulation. The secretions of medicinal maggots have been shown to promote fibroblast growth and their migration across the wound bed.<sup>9,10</sup> Full healing and tissue regeneration can only succeed if the growing tissue is supplied with blood and oxygen which in turn depends on the growth of new blood vessels. Maggot therapy promotes the formation of new blood vessels and increases the blood supply to the wound.<sup>11</sup> In addition; maggot excretions stimulate the production of the patients' own tissue growth factors that promote healing of the wound<sup>12</sup>, while also contributing maggot-derived growth factors and other hormones that closely resemble those of the human body. This way maggots further stimulate tissue growth in the wound.<sup>13</sup>

In summary, medicinal maggots bring about wound healing through multiple com-

Correspondence: Frank Stadler, Applied BioSciences, Macquarie University, Sydney, New South Wales, Australia.  
Tel: +61.422731540.  
E-mail: frank.stadler@mq.edu.au

Key words: maggot therapy; larval debridement therapy; wound care; low- and middle-income country; Lebanon.

Contributions: the article is a collaborative effort between the authors in response to the Beirut port explosion and subsequent medical emergency. Preparation of the article was led by SS, particularly concerning the Lebanese healthcare system and the potential for maggot therapy integration. FS provided overall guidance and contributed the maggot-therapy-related technical content.

Conflict of interest: FS is currently Adjunct Fellow at Macquarie University, Centre Manager for the ARC Training Centre for Facilitated Advancement of Australia's Bioactives (FAAB), also at Macquarie University, and founder/director of MedMagLabs, a Similitude Pty Ltd business, seeking to bring affordable maggot therapy services to Australia and underserved healthcare settings around the world. This article was conceived and written prior to spin-out of MedMagLabs from research conducted at Griffith University. SS has no conflicts of interest to report.

Ethics approval and consent to participate: not applicable.

Informed consent: not applicable.

Patient consent for publication: not applicable.

Availability of data and materials: all data generated or analyzed during this study are included in this published article.

Received for publication: 17 January 2023.  
Accepted for publication: 2 May 2023

This work is licensed under a Creative Commons Attribution 4.0 License (by-nc 4.0).

©Copyright: the Author(s), 2023  
Licensee PAGEPress, Italy  
Healthcare in Low-resource Settings 2023; 11:11161  
doi:10.4081/hls.2023.11161

*Publisher's note: all claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article or claim that may be made by its manufacturer is not guaranteed or endorsed by the publisher.*

plex interactions with the wound environment, resident microbes, and the patients' physiological response to the injury. This is

difficult to replicate with any other single wound care intervention - may it be drug or device.

## Where is maggot therapy used?

Maggot therapy has been used for thousands of years and records date back to antiquity. However, it was the orthopedic surgeon William S. Baer at Johns Hopkins Hospital, Baltimore, who in the 1920's established maggot therapy in modern clinical wound care.<sup>14</sup> Unfortunately, the initial popularity of maggot therapy was relatively short-lived and declined in the 1940s with the emergence and widespread availability of antibiotics like penicillin, and the improvement of surgical techniques.<sup>15</sup> Then, beginning in the 1980s and 90s, maggot therapy experienced a renaissance due to the growing prevalence of wound infections caused by antibiotic-resistant bacteria<sup>15</sup> and a growing burden of wounds related to chronic health conditions such as diabetes and cardiovascular disease. In 2004, maggot therapy was approved by the United States Food and Drug Administration as a device for the debridement of wounds. Now, maggot therapy has once again become an accepted and widely used wound treatment in the United States, Europe, and elsewhere. As for the Middle East, maggot therapy is regularly used in Egypt<sup>16</sup> and Iran,<sup>17</sup> as well as in Turkey and Israel.<sup>18</sup> However, it appears that Lebanese wound care providers have no access to medicinal maggots.

## Maggot therapy in Lebanon

As the economic situation in Lebanon worsens due to ongoing political instability, the 2020 Beirut blast, and COVID 19 it becomes necessary to consider new strategies to strengthen the healthcare system. It follows a brief discussion as to how the implementation of maggot therapy could assist Lebanon in the treatment of infected and necrotic wounds sustained in sudden-onset disasters such as the Beirut blast, as well as the affordable management of chronic wounds resulting from diabetes or cancer.

In the Beirut port blast on 4 August 2020, flying and falling glass shards from building facades and interiors were the main cause of injury and death.<sup>19</sup> The injuries were accompanied by severe lacerations and abrasions as witnessed in the emergency wards of treating hospitals. Blindness and loss of limbs have been the main causes for lasting disability suffered

by casualties.<sup>20</sup> According to reports from the American University of Beirut Hospital AUH, some patients required extensive reconstructive surgery.<sup>20</sup> As has been evident in the aftermath of the Beirut blast, such sudden-onset disasters can easily overwhelm local healthcare systems not only because of mass casualties but because healthcare facilities and other infrastructure may also be damaged. For example, Saint George Hospital University Medical Center was severely damaged after the explosion.<sup>21</sup> More than 100 of its healthcare professionals, doctors, residents, nurses and administrative staff, sustained injuries ranging from mild to critical.<sup>21</sup> In the Achrafieh area, the Hotel Dieu de France hospital took in over 700 wounded victims.<sup>22</sup> Teams from Médecins Sans Frontières (MSF) who have been providing assistance reported 737 people who received treatment for wounds.<sup>23</sup> Moreover, on August 15, 2021, a fuel tank blast in Akkar North Lebanon killed 28 people and injured nearly 80 people.

As a rule, disasters of this nature result not only in acute injury from the impact itself but also in many infections that prevent wounds from healing. Maggot therapy is an ideal treatment for such wounds for reasons explained earlier. In addition, the availability of medicinal maggots in disasters would give first responders greater freedom and a larger window of opportunity to treat casualties without having to fear the consequences of either infection or injury-related tissue necrosis. This is because both infection and tissue necrosis can be successfully treated with maggot therapy.<sup>24</sup>

In Lebanon, as in other low- and middle-income countries, the transition to a modern life style and the rapid economic, cultural and social changes are associated with a rapid rise in obesity, vascular disease, and diabetes.<sup>25</sup> Over a 12-year study period, the change in obesity prevalence annual rates ranged between +4.1% in children and adolescents and +5.2% in adults.<sup>26</sup> Up to 25% of diabetes patients will suffer one or more lower limb ulcers.<sup>26</sup> These diabetes-related health complications are common in the Arab world with a higher prevalence in eastern Arab countries. Given the high cost of chronic wound care and the impact of ulcers on the patient's quality of life, it is easy to see how access to maggot therapy could deliver affordable and highly efficacious wound care.

At best of times, the Lebanese population has insufficient access to healthcare. According to 2017 statistics, the distribution of healthcare professionals per 10,000 citizens was 31.3 physicians, 36.4 nurses and midwives, 15.2 dentists, and 18.9 pharmacists.<sup>27</sup> Likewise, the WHO<sup>28</sup> records

Lebanon as having 49.42 skilled health personnel per 10,000 population (in 2014) compared to 162.4 for Australia (in 2015). It is against this backdrop of an ailing healthcare system and the ever-present threat of natural and man-made disasters (including conflict), that the introduction of maggot therapy to the Lebanese healthcare system should be considered. This will require i) local production or just-in-time international supply of medicinal maggots, ii) regulatory approval, iii) health insurance cover, iv) clinical workforce training, and v) patient education.

Local production in Lebanon could be performed using the calliphorid fly *Lucilia sericata* which is identified at the taxonomic and molecular level.<sup>29</sup> Moreover, it has been shown to produce a variety of bioactive compounds that promote wound healing, angiogenesis and tissue regeneration. Also it attenuates inflammation and eliminates bacteria.<sup>30</sup>

The objectives for maggot therapy in chronic wound care in Lebanon would be to prevent the deterioration of existing wounds and symptoms management to ensure patient comfort and an improved quality of life.<sup>31</sup> In patient-centric care, wellbeing is defined as attaining physical, psychological, social, and spiritual resources to overcome physical, psychological and/or social challenges.<sup>32</sup> The definition of wellbeing in relation to wound management is detailed in *A Complete Guide to Maggot Therapy*.<sup>33</sup>

Medicinal maggots are highly perishable and must be delivered within 24-48 hours from dispatch.<sup>34</sup> This means they cannot be stored in distribution centers like ordinary medicines but must be delivered just-in-time to the point of care.<sup>34</sup> Production and supply of Lebanese clinics may or may not be possible from regional businesses in neighboring countries. The requirements for medicinal maggot production can range from fairly low-tech to sophisticated, which means that during the introduction of maggot therapy in Lebanon, a local university or other research institution could produce the maggots at modest expense. However, professionalization of production and marketing of medicinal maggots to wound care providers is necessary for maggot therapy to become a mainstream treatment in Lebanon or any other jurisdiction for that matter.

The commercial supply of medicinal maggots and their routine use generally requires the approval by national health authorities. In the case of Lebanon, this would be the Ministry of Public Health (MOPH). The testing and introduction of new drugs or treatments should also be reviewed by the country's physicians and

public health experts to ensure adequate treatment, palliative care, and optimized pain control in Lebanon. If medicinal maggots are to be approved as pharmaceutical drugs, then a dossier needs to be prepared that demonstrates the quality, safety and efficacy of the drug and follows the specifications of the Common Technical Document (CTD).<sup>27</sup> The complete dossier should be registered at the pharmacy department of the MOPH.

Importantly, wide uptake of maggot therapy depends on national or private health insurance reimbursement. In Lebanon, the health care system is characterized by an array of financing intermediaries including the National Social Security Fund (NSSF) that covers formal sector employees, the Civil Servant Cooperative (CSC) that covers civil servants, four military schemes that cover the uniformed armed forces, and the private healthcare insurers and the MOPH.<sup>35</sup> However, insurance covers only 75% of hospitalisation and is limited to life threatening and obstetric conditions. Therefore, it is a large financial burden for Lebanese patients to access advanced diagnostics and other care for conditions which do not fall under the current coverage including illnesses such as cancer and chronic health conditions like diabetes and its complications.<sup>36</sup> In addition, many refugees from neighboring countries find it difficult to access healthcare in Lebanon because most have no health insurance coverage and rely solely on the United Nations Relief and Works Agency UNRWA services.<sup>36</sup> Furthermore, Lebanese elderly and retired workers still lack a social insurance system that provides them with adequate health cover.<sup>35</sup> Currently, initiatives are under way with international support to strengthen the health system and enhance institutional resilience.<sup>32</sup> Introduction of maggot therapy may well align with these reform objectives but close cooperation and negotiation with insurance providers would still be required for making maggot therapy eligible for reimbursement.

Maggot therapy is a relatively simple treatment and does not require surgical expertise which means that nurses and, with guidance, even laypersons such as family members can conduct maggot therapy.<sup>17</sup> Nevertheless, practitioners will need at least basic training to learn how to apply medicinal maggots and how to make sure only patients and wounds benefiting from the treatment will receive the therapy. For the past two decades, there have been numerous practitioner-focused publications explaining in detail the indications and contraindications for maggot therapy as well as the various application techniques. For exam-

ple, Chadwick and colleagues<sup>37</sup> articulate the consensus for the treatment of the diabetic foot with maggot therapy, and commercial medicinal maggot producers support their clients with clinical advice. Multilingual and highly visual treatment guidance for healthcare providers and patients, especially in compromised healthcare settings, has been developed at MedMagLabs and can be accessed free-of-charge via [www.medmaglabs.com](http://www.medmaglabs.com) in English, French, and Arabic language.

Maggot therapy can only be used when the patient agrees to it. Therefore, it is important that wound care patients and the general public are aware of the treatment and understand how it works. The idea of maggot therapy may provoke in some patients and healthcare providers strong feelings of disgust, or what has also been coined the 'yuk' factor. However, feelings of disgust or fear are actually not a major barrier to maggot therapy acceptance, especially for patients who are confronted with an ostracizing chronic wound. Patient concerns about the treatment are best addressed with accurate information provided by trusted wound care providers.

## Conclusions

In the context of Lebanon's ailing healthcare system and precarious social and economic situation, it would be prudent to introduce maggot therapy to treat chronic wounds and to strengthen the country's resilience in the face of ever-looming natural and man-made disasters in a volatile region. What is true for Lebanon applies also to many other countries struggling in a climate of COVID 19, economic depression, and/or conflict. Maggot therapy has not yet reached its full potential and remains underutilised, especially in low- and middle-income countries. However, efforts are under way to build capacity in conflict-affected communities and other compromised healthcare settings to produce medicinal maggots and treat chronic wounds with maggot therapy.<sup>24,38,39</sup>

## References

1. Mexican Association for Wound Care and Healing. "Clinical Practice Guidelines for the Treatment of Acute and Chronic Wounds with Maggot Debridement Therapy; 2010. Accessed 15 August 2021. Available from: [https://s3.amazonaws.com/aawc-new/memberclicks/GPC\\_larvathera-](https://s3.amazonaws.com/aawc-new/memberclicks/GPC_larvathera-)

- py.pdf
2. Sherman RA. Mechanisms of maggot-induced wound healing: what do we know, and where do we go from here? *Evid Based Complement Alternat Med* 2014;2014:592419.
3. Eamkong S, Pongpanich S, Rojanaworarit C. Comparison of curing costs between maggot and conventional therapies for chronic wound care. *J Health Res* 2010;24:21-5.
4. Bennett SB, Abnderson SP, Rai MK, et al. Cost-effectiveness of interventions for chronic wound debridement: an evaluation in search of data. *Wounds UK* 2013;9:9.
5. Wood L, Hughes M. Reviewing the effectiveness of larval therapy. *J Comm Nursing* 2013;27:11-14.
6. Choudhary V, Choudhary M, Pandey S, et al. Maggot debridement therapy as primary tool to treat chronic wound of animals. *Veterinary World* 2016;9:403-9.
7. Cazander G, Pritchard DI, Nigam Y, et al. Multiple actions of *Lucilia sericata* larvae in hard-to-heal wounds: larval secretions contain molecules that accelerate wound healing, reduce chronic inflammation and inhibit bacterial infection. *Bioessays* 2013;35:1083-1092.
8. Nigam Y, Morgan C. Does maggot therapy promote wound healing? The clinical and cellular evidence. *J Eur Acad Dermatol Venereol* 2016;30:776-82.
9. Horobin AJ, Shakesheff KM, Pritchard DI. 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. *Wound Repair and Regeneration* 2005;13:422-33.
10. Smith AG, Powis RA, Pritchard DI, et al. Greenbottle (*Lucilia sericata*) larval secretions delivered from a prototype hydrogel wound dressing accelerate the closure of model wounds. *Biotechnol Progress* 2006;22:1690-6.
11. Bexfield A, Bond AE, Morgan C, et al. Amino acid derivatives from *Lucilia sericata* excretions/secretions may contribute to the beneficial effects of maggot therapy via increased angiogenesis. *Br J Dermatol* 2010;162:554-62.
12. Honda K, Okamoto K, Mochida Y, et al. A novel mechanism in maggot debridement therapy: protease in excretion/secretion promotes hepatocyte growth factor production. *Am J Physiol Cell Physiology* 2011;301:C1423-30.
13. Evans R, Morgan C, Jones N, et al. Human growth factor homologues,

- detected in externalised secretions of medicinal larvae, could be responsible for maggot-induced wound healing. *Int J Res Pharm Biosci* 2019;6:1–10.
14. Baer WS. The treatment of chronic osteomyelitis with the maggot (larva of the blowfly). *J Bone Joint Surg* 1931;13:438–75.
  15. Sherman RA. Maggot therapy takes us back to the future of wound care: new and improved maggot therapy for the 21st century. *J Diabetes Sci Technol* 2009;3:336–44.
  16. Hassan MI, Hammad KM, Fouda MA, et al. The using of *Lucilia cuprina* maggots in the treatment of diabetic foot wounds. *J Egypt Soc Parasitology* 2014;44:125–9.
  17. Mirabzadeh A, Ladani M J, Imani B, et al. Maggot therapy for wound care in Iran: a case series of the first 28 patients. *J Wound Care* 2017;26:137–143.
  18. Mumcuoglu K Y n.d. Maggot Debridement Therapy. Accessed 15 August 2021. Available from: [https://medicine.ekmd.huji.ac.il/en/research/kostasm/Pages/project\\_10.aspx](https://medicine.ekmd.huji.ac.il/en/research/kostasm/Pages/project_10.aspx)
  19. Abu-Faraj ZO. Shattered Glass is Allegedly Blamable for Most of the Victims of Beirut's Blast. LinkedIn; 2020. Accessed 15 August 2021. Available from: [https://www.linkedin.com/pulse/shattered-glass-allegedly-blamable-most-victims-blast-abu-faraj\\_](https://www.linkedin.com/pulse/shattered-glass-allegedly-blamable-most-victims-blast-abu-faraj_)
  20. Ibrahim A. Scarred for life: Beirut blast victims and life-altering wounds. Aljazeera; 2020. Accessed: 15 August 2021. Available from: [https://www.aljazeera.com/news/2020/8/25/scarred-for-life-beirut-blast-victims-and-life-altering-wounds\\_](https://www.aljazeera.com/news/2020/8/25/scarred-for-life-beirut-blast-victims-and-life-altering-wounds_)
  21. Joujou EE, Nehme AH. Nehme Saint George Hospital University Medical Center is a nonprofit academic medical center, owned by the Orthodox Archdiocese of Beirut SGHUMC has sustained severe damages from the recent explosion in Beirut; 2020. Accessed 15 August 2021. Available from: <https://www.stgeorgehospital.org/stgeorge-donation>,
  22. Sanford A, Davies P, Tidey A. Beirut blast: Macron pledges international aid as protests erupt in Lebanon; 2020. Accessed 15 August 2021. Available from: <https://www.euronews.com/2020/08/06/beirut-blast-port-officials-under-house-arrest-as-angergrows-at-lebanon-s-elite>
  23. Whittall J. MSF supporting Beirut's health services in wake of massive blast; 2020 Accessed 15 August 2021. [https://www.msf.org/msf-supporting-beirut-health-services-wake-massive-blast-lebanon\\_](https://www.msf.org/msf-supporting-beirut-health-services-wake-massive-blast-lebanon_)
  24. Stadler F, Shaban R Z, Tatham P. Maggot debridement therapy in disaster medicine. *Prehosp Disaster Med* 2016;31:79–84.
  25. Nasreddine L, Naja F, Chamieh M C, et al. Trends in overweight and obesity in Lebanon: evidence from two national cross-sectional surveys (1997 and 2009). *BMC Public Health* 2012;12:798.
  26. Alexiadou K, Doupis J. Management of diabetic foot ulcers. *Diabetes therapy* 2012; 3(1): 4. doi: 10.1007/s13300-012-0004-9. Epub 2012 Apr 20. PMID: 22529027; PMCID: PMC3508111.
  27. Ministry of Public Health. Republic of Lebanon Ministry of Public Health. Accessed 10 January 2021. Available from: <https://www.moph.gov.lb/>
  28. WHO n.d. Skilled health professionals density (per 10000 population). The Global Health Observatory. Accessed 15 August 2021. Available from: [https://www.who.int/data/gho/data/indicators/indicator-details/GHO/skilled-health-professionals-density-\(per-10-000-population](https://www.who.int/data/gho/data/indicators/indicator-details/GHO/skilled-health-professionals-density-(per-10-000-population)
  29. Shayya S, Debruyne R, Nel A et al. Forensically relevant blow flies in Lebanon survey and identification using molecular markers (Diptera: Calliphoridae). *J Med Entomol* 2018;55:1113–1123.
  30. Čičková H, Kozánek M, Takáč P. Growth and survival of blowfly *Lucilia sericata* larvae under simulated wound conditions: Implications for maggot debridement therapy. *Med Veterinary Entomol* 2015;29:416–24.
  31. Nenna M. Pressure ulcers at end life: an overview from home care and hospice clinicians. *Home health care nurse* 2011;29:350–65.
  32. Dodge R, Daly AP, Huyton J, et al. The challenge of defining wellbeing. *Int J Wellbeing* 2012;2:222–35.
  33. Ogrin R, Elder K J. Living with a Chronic Wound. In Stadler F. (ed.). *A Complete Guide to Maggot Therapy: Clinical Practice, Therapeutic Principles, Production, Distribution, and Ethics*. Cambridge, UK: Open book publishers 2022. <https://doi.org/10.11647/obp.0300.02>
  34. Stadler F. The maggot therapy supply chain: review of the literature and practice. *Med Veter Entomol* 2020; doi:10.1111/mve.12397
  35. El-Jardali F, Bou Karroum L, Bawab L, et al. Health reporting in print media in Lebanon: evidence, quality and role in informing policymaking. *PLoS ONE* 2015;10:e0136435.
  36. Lebanon Crisis Response Plan LCRP. Produced by the government of Lebanon and United Nations; 2019. Accessed 15 August 2021. Available from: [https://reliefweb.int/sites/reliefweb.int/files/resources/LCRP\\_2021FIN\\_AL\\_v1.pdf\\_](https://reliefweb.int/sites/reliefweb.int/files/resources/LCRP_2021FIN_AL_v1.pdf_)
  37. Chadwick P, McCardle J, Ricci E, et al. Appropriate use of larval debridement therapy in diabetic foot management: consensus recommendations. *Diabetic Foot J* 2015;18:37–42.
  38. Sherman R A, Hetzler M R. Maggot Therapy for Wound Care in Austere Environments. *J Spec Oper Med* 2017;17:154–162.
  39. MedMagLabs. Production and supply of medicinal maggots in compromised healthcare settings; 2021. Accessed 15 August 2021. Available from: <http://medmaglabs.com/creating-hope-in-conflict-production/>