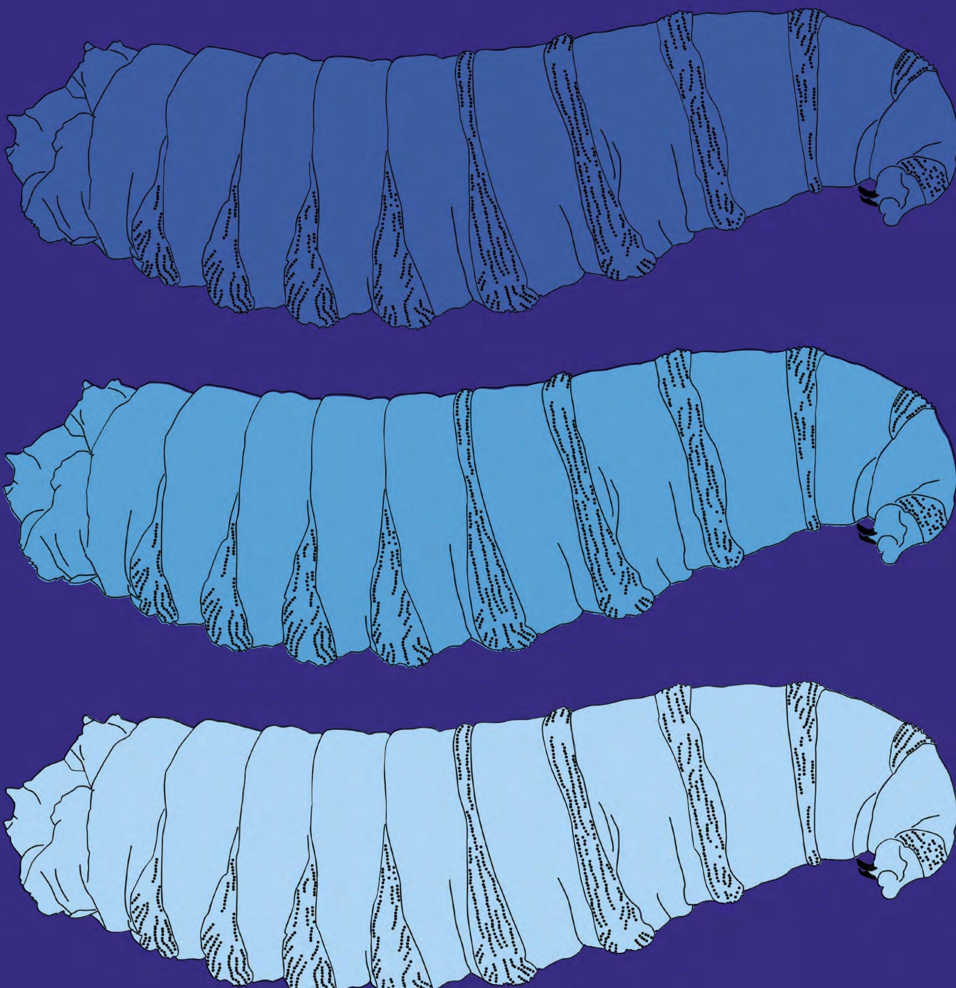
A COMPLETE GUIDE TO MAGGOT THERAPY

Clinical Practice, Therapeutic Principles, Production, Distribution, and Ethics



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17. Distribution Logistics

Frank Stadler

Speedy delivery to the point of care and application to the wound should occur within 24–48 hours of dispatch from the production facility. Consequently, there is a need for reliable and efficient logistics infrastructure and a diversity of distribution models tailored to regional and local conditions. This chapter describes supply chain architectures and logistics solutions that can be adopted for medicinal maggots. In particular, it explores the case of a small Kenyan medicinal maggot supply chain and the wider Kenyan transport logistics infrastructure for medical commodities with similar characteristics.

Introduction

Medicinal maggots should be delivered at a transit temperature of between 6–25°C and application to the wound should occur within 24–48 hours of dispatch from the production facility [1]. These requisite conditions significantly limit the number of healthcare providers and patients that can be reached, especially in low- and middle-income countries with poor infrastructure [2]. Consequently, under current supply chain models around the world, medicinal maggots are either produced centrally and shipped to locations that can be reached within 24–48 hours with available courier services [3], or produced very close to or at the point of care, for example at a hospital or research organisation [4]. For maggot therapy to be considered a viable

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alternative to conventional wound care options and for it to become available to patients worldwide, there is a need for reliable and efficient logistics infrastructure and a diversity of distribution models tailored to regional and local conditions [2]. This chapter first describes supply chain architectures that can be adopted by medicinal maggot producers and transport service or healthcare providers to achieve this end. Key is the placement of production facilities relative to the points of care and the utilisation of technological advances from portable healthcare infrastructure to drone delivery—which is further elaborated in Chapter 18 of this book [5]. The second part of this chapter explores the case of a small Kenyan medicinal maggot supply chain and the wider Kenyan transport logistics infrastructure for medical commodities with similar characteristics. Since there is little information on maggot therapy supply chain management in the public domain [6], the Kenyan case study provides a suitable lens through which to view medicinal maggot distribution, particularly in low- and middle-income countries. Note that Chapter 15 of this book describes the establishment of a maggot therapy service in Kenya from the vantage point of the implementation team [7].

Medicinal Maggot Distribution Models

Hub-and-spokes Model

The hub-and-spokes model for distribution of goods is tried and tested. Production facilities are strategically located and supply customers that surround them. The distance over which supply takes place depends on the perishability of the goods and the logistics infrastructure that supports distribution. When visualising the geographic map of a production and distribution system as a bicycle tyre, the production facility is located at the centre (hub), connected by spokes to all the customers. These may be end-users of the supplies or wholesalers or retailers who in turn distribute the goods further. However, there are many factors that influence the location of fixed production facilities, for example, i) the distribution of customers, ii) the volume of sales per individual customer, iii) proximity to natural resources and suppliers, iv) freight costs, or v) workforce requirements. In the case of medicinal maggot production and the tight time window in which the maggots must be transported, it makes sense to co-locate with the largest market and thereby reduce distribution time and costs while increasing supply reliability.

Importantly, however, in the maggot therapy supply-chain context, it should be noted that such population centres are not necessarily the geographic centre of the serviced country or region. For example, Dar es Salaam is the most populous city in Tanzania but is located in the far-east of the country, on the shores of the Indian Ocean. Therefore, this model of medicinal maggot production and distribution relies heavily on sophisticated producer coordination, reliable logistics infrastructure, and highly efficient third-party transport service providers. For example, producers need to have convenient communication channels for customers to place orders and make enquiries. This may happen via phone, fax, email, online order forms, or e-commerce shop fronts. It is important that producers also communicate clearly to customers i) the geographic areas that can be serviced, ii) how fast deliveries can be made to a particular location, and iii) what the order placement deadlines are. Once an order has been placed, its details need to be shared with the production laboratory, which will prepare and package the requested medicinal maggots and dressing products, if they are also offered by the supplier. A third-party transport provider (courier service) is usually used to deliver the consignment to the customer. The producer has the choice to either deliver the parcels to the nearest courier service centre or let the courier come to the production facility for pickup. It is generally the responsibility of the producer to ensure that during transit the content (in this case medicinal maggots) is adequately ventilated and protected from excessive heat or cold. Couriers only take responsibility for timely and accurate delivery of the consignment.

A good example of such a functioning hub-and-spokes distribution system that is supported by advanced logistics infrastructure and third-party transport providers is that operated by Monarch Labs based in Irvine, California, USA [3]. Customers can choose from

- standard overnight (arrival by 3:30pm),
- priority overnight (arrival by 10:30am),
- first overnight (arrival by 8:30am), and
- immediate delivery via Midnight Express.

While overnight delivery using air and land transport is the standard for medicinal maggot distribution in the US and Europe, this may not be logistically feasible or financially viable for remote low- and middle-income country communities. However, it should be noted that research at the Walter Reed Army Institute of Research demonstrated that medicinal maggots can withstand vibrations and pressure changes due to airlift in rotary or fixed-wing military aircraft [8] and that 'Golden Hour Containers' for military use [9] successfully maintained red blood cells at 1–10°C during shipment and protected this payload during airlift to above 1000 ft altitude and on airdrops [10]. This suggests that medicinal maggots could also be delivered via airdrop to remote, inaccessible locations in humanitarian aid and disaster response, or in rural and remote care situations. Moreover, emergent remotely piloted aircraft systems, otherwise known as 'drones', may offer an additional flexible and cost-competitive alternative for medicinal maggot shipment to rural and remote healthcare centres and during disaster response [11]. Chapter 18 of this book is dedicated to the logistics of drone-assisted medicinal maggot delivery [5].

Airdrops and drone delivery aside, when certain regions with a demand for maggot therapy cannot be reached in a timely or economical manner, it may be necessary to set up production hubs closer to customers to ensure reliable supply (Figure 17.1). Alternatively, if remote care needs are highly localised, there is the option to co-locate small-scale production facilities at the point of care (see Point-of-care Production below).

Point-of-care Production

Production in existing clinical laboratories. Maggot therapy programmes often start out in research or clinical laboratories [12]. Commercial large-scale production only becomes viable when regulatory approvals have been obtained, health insurance reimbursement is in place, and markets for maggot therapy have been established. Non-commercial medicinal maggot production in existing research and clinical settings is mainly for in-house use or to meet limited demand from healthcare providers further afield [13].

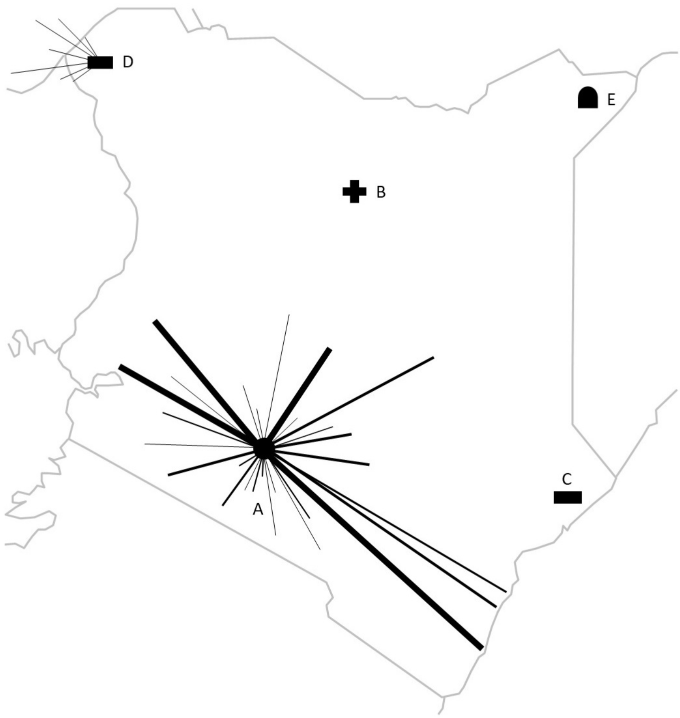

Figure 17.1 Simplified representation of medicinal maggot supply and distribution models. Kenya has been chosen for illustration purposes only. The Kenyan medicinal maggot supply chain is still in its infancy and has not progressed significantly beyond supply to few healthcare providers across greater Nairobi [7]. **A**) Hub-and-spokes model supplying medicinal maggots from Nairobi. The varying thickness of lines indicates that there would be differences in supply volume. **B**) Point-of-care supply with production integrated in healthcare facility operations. **C**) Relocatable medicinal maggot facility deployed in response to a natural disaster or other temporary healthcare crisis. **D**) Relocatable production facility supplying medicinal maggots on and off the battlefield. **E**) Isolated community operating a do-it-yourself (DIY) medicinal maggot laboratory.

Mobile production facilities. Remote locations may be serviced by means of transportable production facilities consisting of stand-alone or combined insectary and laboratory modules. For example, MedMagLabs at Griffith University, Australia have designed and built the first version of a mobile medicinal maggot laboratory (Figure 17.2). For this prototype, a standard, 20-ft-high cube shipping container was modified to house an insectary for the maintenance of medicinal fly colonies and a laboratory space for disinfection and incubation of eggs, quality control work, and packaging [14].

Mobile (relocatable) production laboratories would also facilitate maggot therapy in times of disaster and conflict when logistics infrastructure is damaged and access to the point of care is dangerous. However, the deployment of sophisticated mobile production facilities still requires initial access to the point of care. This can be achieved by pre-positioning ready-to-operate mobile systems in regions that are prone to conflict. Alternatively, mobile production facilities can be transported to the point of care via land or air, only when needed, but potentially at great cost and/or security risk. Along with the physical laboratory infrastructure, personnel will also need to be deployed, either permanently, or temporarily to train the local operators of the production facility.

Informal do-it-yourself production. There will always be communities that are too hard to reach in the aftermath of disasters, during war, or simply because of their extreme remoteness. Under austere conditions and when wound care needs are great, it is quite feasible to source medicinal fly eggs and maggots from the wild for the purpose of maggot therapy without breeding flies and producing medicinal maggots [15, 16]. However, it is better to provide isolated communities with the guidance to establish and permanently run small-scale medicinal maggot production laboratories with local resources. This would ensure a greater level of quality control and supply security. Such guidance has been developed by MedMagLabs. The research group translated evidence-based treatment guidance and medicinal maggot production know-how from the literature into easy-to-understand, highly illustrated, multilingual, and user-tested Treatment and Production Manuals [14]. The aim was to ensure the performance, safety, and user-friendliness of solutions. While DIY medicinal maggot production has its place, there remains the risk of adverse outcomes due to poor operation or treatment by lay-producers and -carers. Therefore, it is important that DIY medicinal maggot production and maggot therapy is reserved for austere environments and collapsed healthcare systems. In healthcare settings with adequate resources and functioning governance, medicinal maggots must be produced and maggot therapy performed under regulatory and expert clinical supervision.

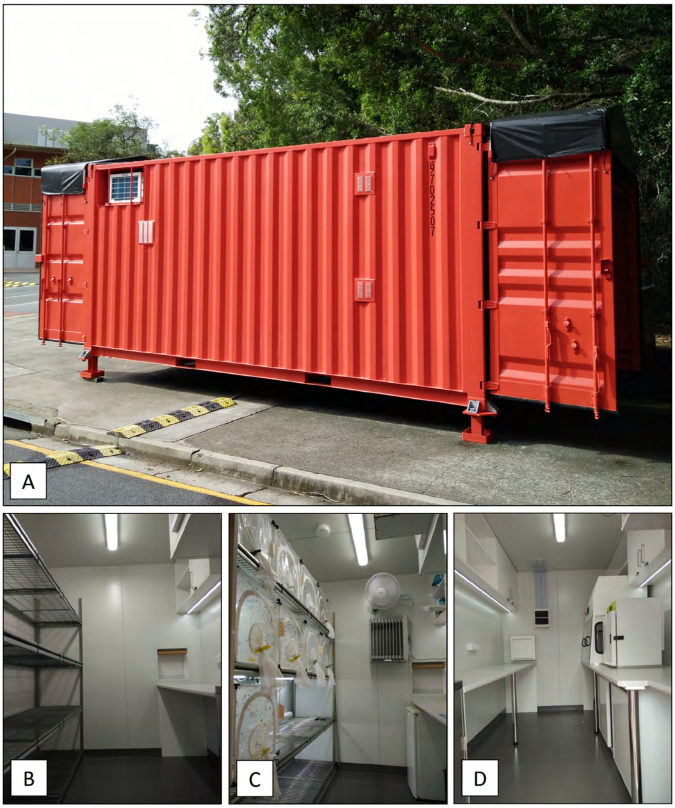

Figure 17.2 A converted shipping container laboratory for the production of medicinal maggots. A) Full side view of laboratory at Griffith University, Australia. B) Insectary room with separate access door and a pass-through hatch for transfer of specimens to the lab. C) Modified insectary, partially stocked with fly cages. D) Laboratory room equipped with a laminar flow cabinet, an incubator, fridge, freezer and sink. Photos by F. Stadler, MedMagLabs and Creating Hope in Conflict: A Humanitarian Grand Challenge, CC BY-ND.

Lessons from Kenya and Other Low- and Middle-income Countries

Thanks to modern logistics infrastructure and sophisticated third-party transport providers, the distribution of medicinal maggots in high-income countries is relatively straightforward and reliable. However, even for developed economies with a large land mass and remote communities like Australia, timely distribution to all parts of the country is still not technically or economically feasible. Therefore, operational and reliable distribution logistics are of critical importance to producers and wound care practitioners in low- and middle-income countries, or those wanting to service rural or remote communities at the margins of advanced economies. Learnings from a fledgling maggot therapy programme in Kenya provide some helpful insights regarding the management of medicinal maggot distribution in low- and middle-income country settings. This Kenyan case study is based on the findings of a qualitative research study which, for privacy reasons, was required to anonymise participants and relevant organisations [4]. What is important, however, is the overall picture of the distribution logistics environment in relation to medicinal maggots.

The logistics landscape in Kenya and other low- and middle-income countries is far more diverse than in high-income countries. For example, in Kenya, there are a multitude of operators from multinationals such as DHL to larger local companies like Fargo Couriers, and last-mile delivery is often provided by owner-driver motorbike taxis or coach and town bus services. The challenge for medicinal maggot producers will be to partner with a few larger reliable service providers for day-to-day transfers to the main distribution nodes in major population centres, but then to utilise unconventional providers of transport and courier services for last-mile delivery where the larger players cannot or will not deliver for technical or security reasons.

Kenyan courier service operators have become highly sophisticated in fleet management, network planning, contingency management, and consignment tracking. For example, one local courier company specialises in overnight and same-day delivery services covering all major towns. The product range offered includes Overnight Courier Service, Priority Overnight Courier Service, Same Day Express Delivery Service, One Hour Delivery Service, insurance, warehousing and distribution, and document archiving. About 200 vehicles are in service including motorbikes, closed pickups and two- to ten-ton cargo trucks. As of 2016, the company employed 950 trained staff in 176 locations across 38 Kenyan counties. Each location has its own workforce and fleet. Regional management consists of an area manager, branch managers, supervisors, hub managers, and courier drivers or riders.

A sign of progress made in transport service provision in Kenya is the presence of an advanced online marketplace. Kenya has well-developed Internet shopping supported by M-Pesa, a phone-based money transfer technology. An online search revealed that there are numerous online retailers operating in Kenya such as Jumia, Kilimall, Mimi, Jumia Market, Cheki, Chinabuy, VituMob, etc. Many also access international United Kingdom, United States, and Chinese online retail offerings [17]. To support this Internet shopping, there is a system of fast courier services in place that reach the remotest communities.

In the healthcare space, consumers who can afford it can order medicines remotely from a chemist and have them couriered to their home. The order is placed by phone then the chemist rings back with the price including cost of courier transport. The customer pays via M-Pesa, after which the chemist sends the package per overnight courier for arrival the next day.

When asked to envisage the delivery of a medicinal maggot consignment from Nairobi to a healthcare facility in Siaya County, the abovementioned courier company described the following schedule:

- The medicinal maggot producer books a courier on the day of pickup and collection takes place before 5 p.m.
- Usually, a waybill is raised and the customer pays for delivery in cash at pick-up. However, contract customers receive an invoice and pay within 30 days.
- The courier takes the consignment to the main hub in Nairobi. There, further verification and documentation takes place.
- Dispatch to Kisumu, a regional hub, occurs the same night and the consignment arrives at 5:30 am the next morning.
- Sorting of consignments and loading onto trucks destined for Siaya takes about 30 to 45 minutes from arrival in Kisumu.
- From Siaya office, last mile delivery to the healthcare provider takes place within one hour and, at worst, by 1:30 pm.
- The receiving healthcare provider signs Proof of Delivery.

The same courier company also provides reverse logistics services, which is relevant to maggot therapy supply chains because producers may decide to use reusable cool chain shipping boxes for environmental and economic reasons as discussed in Chapter 16 [18]. In the case of medicinal maggot distribution, the reverse logistics service would play out as follows:

- A courier collects a medicinal maggot consignment packaged in a reusable shipper and delivers it to a healthcare facility as described above.
- Once the goods have been delivered, there are three alternatives for collection and return of reusable packaging items.
  - If the consignment is processed within 15 minutes, it is feasible for the courier to wait for the return freight.
  - If it takes longer than 15 minutes to unpack the medicinal maggots, the courier drops off the consignment in the morning and picks up the packaging in the afternoon.
  - Alternatively, the courier delivers the medicinal maggot consignment one day and picks up the packaging another day after notification by the client.

It appears that the Kenyan medicinal maggot producer has not yet utilised these courier distribution options but an example of already practiced reverse logistics in healthcare is the pathology supply chain. Specimens are collected from hospitals and clinics and transported to a hub where they are placed in multi-use cooler boxes. These specimens are then shipped either by bus or courier to a pathology laboratory. The cooler boxes are then sent back to the collection hub.

In 2016, the Communications Authority of Kenya published guidelines for courier and postal operators to improve and promote e-commerce [19]. These guidelines require measures such as tracking and insurance for high-risk items like lab samples, specimens, and medicines [20]. Companies who adopted such systems benefit from improved efficiency and customer confidence. The automated tracking of shipments provides accurate performance details which means that deviations are captured, followed up and corrective action can be taken. Medicinal maggot producers seeking to engage courier companies in low- and middle-income countries should also enquire whether the courier has a Business Continuity Plan in place that outlines the measures to be taken in the event of service failure (e.g. blocked roads due to rains and floods, or riots and civil unrest).

Transport costs can be as much or more than the actual costs of medicinal maggots. Therefore, it is important to patients who pay out of pocket (in the absence of health insurance cover for maggot therapy) that cost effective transport options are provided that also satisfy safety and reliability expectations. The courier delivery of a medicinal maggot consignment weighing no more than 5 kg from Nairobi to a hospital in Siaya County would cost in the order of KES850 (USD8.40) plus Value Added Tax (16%). According to a healthcare consumer living in Gilgil, 120 km from Nairobi, an overnight courier delivery of medicines costs KES230 (USD2.30). For high-income healthcare consumers these costs appear negligible, but they are prohibitive for many Kenyans living on less than the average yearly income (2018) of around KES727,000 or USD7,197 [21].

Formal Healthcare Supply Chains

The vaccine and blood supply chain. The acceptable temperature range for medicinal maggots in transit, and short-term storage ahead of maggot therapy, overlaps with that of many heat- and freeze-sensitive vaccines, which must be stored at all times between 2°C and 8°C [22], and red blood cell products which must be stored between 1°C and 10°C [23]. Thus, the management of vaccine and blood supply chains faces the same challenges as medicinal maggot distribution, and it may well be possible to utilise these existing cold and cool chains for the distribution of medicinal maggots. For example, the Kenya National Blood Transfusion Service collects, tests, processes, and distributes blood to all transfusing healthcare facilities across Kenya. They use a range of transport options for blood and blood products that are shipped between 21 satellite blood collection centres, the 6 Regional Blood Transfusion Centres and the transfusing hospitals, including ambulances, motorcycles, and public transport. Their cold chain utilises modern equipment such as reliable fridges and cooler boxes and is capable of maintaining a safe cool chain for blood products [24].

It is important to note that the vaccine and blood supply chains have more distribution points than the maggot therapy supply chain can afford because both commodities can be stored for longer than medicinal maggots [25] which must be delivered directly from producer to treating health centre within 24 to 48 hours. Moreover, temperature control in vaccine and blood supply chains can be unreliable in both developed and developing regions [e.g. 26]. Ineffective refrigeration with temperatures rising beyond recommended levels has been observed for blood product shipping containers [23]. However, this would not be a significant issue for medicinal maggots with a tolerable temperature range of up to 25°C in transit. Accidental freezing of vaccines, however, is a serious problem and such temperature extremes would be lethal to medicinal maggots. It appears that temperature management in vaccine supply chains fails because i) healthcare workers are insufficiently trained, and/or ii) storage and transport equipment is inadequate, and/or iii) there is an unreliable power supply, or other disruptions to refrigeration equipment [27]. Improved training, education, systems and standards, and implementation of equipment upgrades can lead to significant improvements in cold/cool chain management [28]. In summary, there is much to be learned from the management of vaccine and blood supply chains. Indeed, there is scope for medicinal maggot supply integration provided that the supply chain infrastructure and services that are used meet, or can be modified to meet, medicinal maggot distribution requirements.

Medical goods suppliers. Both faith-based (operated by religious groups) and public health supply organisations, such as the Mission for Essential Drugs and Supplies (MEDS) in Kenya or the Kenya Medical Supplies Authority (KEMSA), respectively, may offer unique distribution partnership opportunities for medicinal maggot producers in low- and middle-income countries. A typical pharmaceutical purchase from MEDS by a faith-based hospital takes place as follows:

- The pharmacist orders via email.
- MEDS provides a quotation.
- The hospital confirms the purchase and pays with bank cheque. Account processing takes three days and hospitals follow up on payment by phone. While M-Pesa payments would speed up orders, this is usually reserved for small purchases. Larger-volume and higher-value purchases are made with a bank cheque.

- It takes one week from order to delivery by MEDS or a courier.

This is how the procurement process with KEMSA works [29]:

- The healthcare facility orders online using the KEMSA Logistics Management Information System.
- Transport is coordinated and Expected Time of Arrival determined.
- Customer Service representatives communicate shipment status and Expected Time of Arrival to the facility.
- Upon delivery the completeness of the delivery is checked, and Proof of Delivery is confirmed.
- Invoicing occurs after Proof of Delivery is confirmed.

It is important to note that for immediate or next-day needs, both faith-based and public healthcare providers buy from private pharmacies that are often located close to healthcare facilities. Moreover, in the event of stockouts and if medical products recommended by doctors are not typically stocked by the facility, patients routinely purchase these items themselves from a nearby pharmacy. This indicates that the public and faith-based health systems permit the procurement of medicinal maggots directly from private suppliers. Of course, this assumes affordability of the treatment.

Whether faith-based, government, or private pharma suppliers and their medical supply-chain logistics are suitable for the distribution of medicinal maggots remains to be explored and tested. The necessity for rapid distribution of highly perishable medicinal maggots is likely to prohibit wholesale supply of medicinal maggots to pharma distributors.

Informal Supply Chains

The informal sector in Kenya and other low- and middle-income countries exhibits some of the most inventive supply-chain solutions and these should not be ignored when designing and managing last-mile delivery of medicinal maggots. In Kenya, matatu minibus drivers are happy to deliver parcels at the cost of a bus fare. The driver rings the recipient of the delivery shortly before passing by a convenient stop where she then waits for the bus to pick up the parcel. Although cheaper than ordinary courier services, safe delivery is not guaranteed by either the sender or the matatu driver, and the loss of a consignment is not reimbursed. The motorbike taxi is a common sight in Kenya and across the developing world. Although dangerous, it is a cheap and convenient way to transport people and goods especially where road infrastructure is poor and urban streets are chaotically congested. Where road infrastructure is poor, delivery of consignments is locally subcontracted to motorbike taxis, and goods may even be delivered by boat and oxen- or donkey-pulled carts.

There is one informal supply chain that illustrates more than any other the capacity of transport operators in low- and middle-income countries to deliver highly perishable goods in a timely manner. Miraa is a plant whose leaves have narcotic properties and are chewed recreationally across the region. The leaves need to be kept fresh, not too cold and not too hot, and consumed within 24 to 48 hours from harvest, and therefore the supply-chain demands are similar to those for medicinal maggots. Miraa is grown in central Kenya but a speedy supply network extends across East Africa, into troubled Somalia, and even across the sea to Europe, the United States, and Australia [30]. Delivering Miraa is not for the faint-hearted as it involves risky driving, speeding, and frequent accidents. While this makes the Miraa supply chain unsuitable for medicinal maggot distribution, it illustrates that, if operators are sufficiently motivated, supply chains can be highly effective even under the most trying circumstances. The challenge is to learn from reliable formal and informal transport service providers when designing and operating medicinal maggot supply chains in Kenya and other low- and middle-income countries.

Regulations and Guidelines

Activities related to the distribution of medicinal maggots may well be regulated in a particular jurisdiction and this needs to be considered. For example, the production, trade, transport, and use of medicines and other medical products in Kenya is governed by the Ministry of Health. The Pharmacy and Poisons Board is the regulatory and licencing authority for producers, traders, distributors, and prescribers of medicines, as well as for practitioners. Licenced distributors are expected to comply with the Guidelines for Good Distribution Practice, which specifies fleet characteristics, as well as the effective, efficient and safe handling, storage and distribution of such products [31]. Given that medicinal maggots are medicinal goods, their distribution will need to comply with these and other relevant Pharmacy and Poisons Board rules, regulations, and guidelines.

The presence of a seemingly comprehensive regulatory framework is not a guarantee of compliance by transport service providers. Maggot therapy supply chain coordinators (usually the producer organisation) must, therefore, monitor the delivery progress and the environmental conditions during delivery to be certain of the safety and efficacy of medicinal maggots destined for treatment. Producers should only engage third-party transport providers that offer parcel tracking, which means that the delivery progress can be followed online by both the customer and producer, and problems with delivery can be quickly identified, investigated, and rectified. Critical to safe delivery of medicinal maggots is not only the speed of delivery but also the temperature during transit. The ideal transit temperature range of between 6–25°C for the period of shipment should be tested at least for frequent and representative delivery routes and during different seasons (e.g. summer/winter or dry/wet). It is possible to monitor transport temperatures inside cool- and cold-chain shippers either routinely or sporadically with modern temperature monitoring systems such as electronic data loggers. These are highly accurate and can record the payload temperature throughout the shipment period [32]. This is particularly necessary where last-mile service providers need to be engaged and regular parcel tracking may or may not be facilitated. See also Chapter 16 for guidance on temperature monitoring [18].

Summary

Medicinal maggots require distribution logistics solutions that consider the fragility of the medical commodity being transported and the transport infrastructure connecting the producer and healthcare providers. Physical distance between them is of secondary importance. Consignments may be delivered faster across continents thanks to air transport than over the last mile to much closer healthcare clinics. It is therefore important that the supply chain for maggot therapy adapts to the circumstances, and supply models are developed that ensure reliable and timely delivery of medicinal maggots to where there is demand for maggot therapy.

In the hub-and-spokes model producers supply medicinal maggots to many healthcare providers within timely and economical reach depending on the distribution options available. If reliable distribution to healthcare facilities cannot be achieved but demand exists, production can be geographically or indeed institutionally co-located with these healthcare settings. Point-of-care production facilities have generally been established and operated out of existing laboratories in research organisations and hospitals. However, in the case of severely compromised healthcare settings, such as when disasters strike or during war, there is also an opportunity to support maggot therapy with relocatable production facilities and with guidance for isolated communities to establish and operate their own small-scale medicinal-maggot and maggot-therapy programme with local resources.

Finally, the exploration of a Kenyan fledgling maggot therapy supply chain and the wider Kenyan supply chain for similar medical goods gives reason for optimism. Third-party transport providers continuously improve their capacity and capability due to governmental guidance and the rapid growth of phone-based payment and e-commerce. Although last-mile and remote-area delivery of goods remains a challenge, producers should consider utilising the informal transport sector where it exists. There are also opportunities for medicinal maggot producers to partner with other public health supply chains such as vaccination programmes or blood transfusion services as they share the need for reliable and safe temperature-controlled transport of medical commodities.

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