EXPERT REVIEWS

Toward the elimination of lymphatic filariasis by 2020: treatment update and impact assessment for the endgame

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Lymphatic filariasis (LF) is an important public health problem endemic in 73 countries, where it is a major cause of acute and chronic morbidity and a significant impediment to socioeconomic development. It is targeted for elimination by 2020, through preventive chemotherapy using albendazole in combination with either ivermectin or diethylcarbamazine citrate. Preventive chemotherapy enables the regular and coordinated administration of safe, single-dose medications delivered through mass drug administration (MDA). Many countries are now scaling down MDA activities after achieving 100% geographic coverage and instituting monitoring and evaluation procedures to establish the impact of several consecutive rounds of MDA and determine if transmission has been interrupted. At the same time, countries yet to initiate MDA for elimination of LF will adopt improved mapping and coverage assessment protocols to accelerate the efforts for achieving global elimination by 2020. This review provides an update on treatment for LF and describes the current global status of the elimination efforts, transmission control processes and strategies for measuring impact and continuing surveillance after MDA has ceased.

Keywords: endgame • London declaration • lymphatic filariasis • mass drug administration • monitoring and evaluation • neglected tropical diseases • preventive chemotherapy • transmission assessment surveys • xenomonitoring

Lymphatic filariasis (LF) affects 120 million people in 73 countries and 1.4 billion people are also at risk of acquiring the disease. It is an important public health problem and a major impediment to socioeconomic development in many endemic countries [1]. Over 90% of the infections are caused by *Wuchereria bancrofti*. *Brugia malayi* and *Brugia timori* are responsible for the remaining infections, and they are mainly found in the Southeast Asian region. These nematode parasites are carried by various species of mosquito vectors from the genera *Anopheles*, *Aedes*, *Culex*, *Mansonia* and *Ochlerotatus*. Eliminating LF can provide economic benefits in excess of US$22 billion over an 8-year period [2,3].

The Global Program to Eliminate LF (GPELF) was launched in 2000 as a disease-specific intervention initiative to interrupt transmission and alleviate morbidity. The goal is achieved through two main objectives: interruption of parasite transmission through mass drug administration (MDA) using albendazole in combination with either ivermectin or diethylecarbamazine citrate and morbidity management and disability prevention through care for those who suffer the devastating clinical manifestations of the disease.

Drugs currently used for interruption of LF transmission, albendazole, ivermectin and/or diethylcarbamazine citrate (DEC), are used mostly in combination to reduce microfilariae in blood. They are mainly microfilaricidal and temporarily clear microfilariae without significantly affecting adult worms. However, in areas in Africa where LF coexists with loiasis, progressive neurologic decline and encephalopathy following treatment with ivermectin or DEC have caused great concern. Comprehensive reviews of the attributes, safety and efficacy of these drugs have been published [4–7]. To achieve the second objective associated with morbidity management, access to a basic package of care should be provided to every affected person for management of lymphodema and prevention of

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disabilities. This includes simple hygiene measures and access to antibiotics. Surgery is recommended for hydrocele and is offered to an increasing number of communities in endemic countries [7].

Disease-specific vertical approaches to tackle neglected tropical diseases (NTDs) are being discouraged in favor of a common integrated approach to prevention and control [8–10]. A clear vision for an integrated approach to tackling NTDs is presented in a roadmap published by WHO in January 2012 [11]. Inspired by this, 22 partners signed up to the London Declaration 'Uniting to Combat NTDs', including the UK and US governments, WHO, Bill & Melinda Gates Foundation, World Bank and major pharmaceutical companies committed to sustaining and expanding NTD programs to control or eliminate ten NTDs, including LF, by 2020 [101]. Nearly two decades of collaborative work between the WHO and partners including pharmaceutical companies, academic institutions, nongovernmental organizations and endemic country governments have produced the drugs and tools necessary to achieve this goal [1].

Many countries are now scaling down MDA activities after reaching 100% geographic coverage and instituting monitoring and evaluation processes to establish the impact of several rounds of MDA and determine that transmission had been interrupted. At the same time, countries that are yet to initiate MDA for LF elimination will adopt improved mapping and coverage assessment protocols to accelerate the efforts for achieving global elimination. This review provides an update on treatment for LF and describes the current global status of the elimination efforts, transmission control strategies, importance of determining the impact of MDA and the role of surveillance after MDA has been stopped.

Update on global status of LF elimination

Globally, 1.393 million people required preventive chemotherapy (PC) in 2011 [12]. The great majority are from the WHO's Southeast Asia and African regions with 884 million people requiring treatment in nine countries (63%) in the Southeast Asia region and 432 million people in 35 countries (31%) in the Africa region. The other six Asian countries in the Mekong Plus area (Brunei Darussalam, Cambodia, the Lao People's Democratic Republic, Malaysia, the Philippines and Vietnam) accounted for 3% of the global population requiring treatment. The Americas (four endemic countries), the Eastern Mediterranean region (three endemic countries) and Oceania (16 endemic countries), account for the remaining 3%.

GPELF is one of the most rapidly expanding global health programs in the history of public health [1]. MDA coverage for LF increased from three million people treated in 12 countries in 2000, to more than 539 million in 53 countries in 2011. During that period, the disease was eliminated in China and Korea and nine countries no longer require MDA because of a natural decline in transmission intensity attributed to vector control, provision of safe water, sanitation and hygiene. Among the countries implementing MDA, 12 have moved to a post-MDA surveillance phase. The MDA campaign has been most effective in the middle-income economies of Asia, and 15 endemic countries in the region have initiated MDA. In Africa, only 17 of the 34 endemic countries were implementing MDA in 2011 [12]. Papua New Guinea, the country with the highest burden of LF in the Pacific region can benefit from the experiences of the community directed intervention strategy to scale up MDA to achieve the target of LF elimination by 2020 [13].

Treatment update

In countries where LF is coendemic with onchocerciasis, ivermectin (400 µg/kg) plus albendazole (400 mg) is the recommended regimen. A graduated dose pole is used to determine dosage of medicine for public health interventions [102]. Where *Loa loa* infection is present and onchocerciasis is nonendemic or hypoendemic MDA for LF should be done using albendazol alone (400 mg twice per year). Elsewhere, the regimen is DEC 6 mg/kg plus albendazole 400 mg. During 2000–2011, GPELF delivered more than 3.9 billion doses of medicine to a cumulative targeted population of 952 million people [12].

The treatment for LF presents an excellent platform for integrated control of NTDs where several diseases coexist, given that either or both ivermectin and albendazole are effective against onchocerciasis and soil-transmitted helminthiasis. New drugs and alternative treatment strategies, including semiannual treatment schedules, may also be necessary to achieve global elimination of LF by 2020. Stolk *et al.* used computer simulation modeling and cost projections to demonstrate that administering MDA twice a year was cheaper than annual MDA due to efficiency gains [14]. Semiannual MDA could therefore improve the prospect of achieving the interruption of LF globally 2020.

In areas where LF is co-endemic with loiasis, the use of doxycycline, which is effective at eliminating the *Wolbachia* symbiont from the LF parasite, is an alternative treatment option. The *Loa loa* parasite that causes loiasis is free of *Wolbachia* and therefore not affected by doxycycline leading to reduced risk of serious adverse events emanating from the rapid death of microfilaria [15–18]. Daily doses of doxycycline (100–200 mg) over a period of 4, 6 or 8 weeks result in long-term sterility and death of adult worms [19–21]. Treatment with doxycycline can also lead to significant improvements in the severity of lymphoedema and hydrocele [22,23]. However, the use of doxycycline in MDA campaigns could be hindered by the logistical challenges related to the relatively long course of treatment and the fact that it is not recommended for treatment of children under 8 years and pregnant women [17,24]. A potential antifilarial drug (moxidectin) that has been developed for onchocerciasis may also be effective against LF. It is closely related to ivermectin but more effective in reducing microfilaria load [25].

Monitoring & evaluation for the endgame

The 132nd Executive Board of the WHO recommended, to the 66th World Health Assembly meeting in January 2013, a resolution on all 17 NTDs that urges Member States to ensure country ownership of national NTD control and elimination programs [1]. It also advocates for predictable, long-term international support to finance implementation activities. For neglected diseases affecting the people who live in resource poor environments, capacity

strengthening in data management and monitoring and evaluation will be paramount on the sustainability and ownership agenda [26]. Cross-cutting activities for the target diseases will demand coordination of monitoring and evaluation (M&E) activities for the different PC diseases and making linkages to other components of the health delivery system [26–30].

All four WHO-recommended sequential steps to implement and monitor MDA (Figure 1) are based on well-defined epidemiological indicators:

- Determine the geographical distribution of the disease (mapping);
- Implement MDA annually for 5 years while reporting drug coverage, monitoring baseline burden of infection and impact (through sentinel and spot-check sites) before the first and fourth rounds of MDA and after the fifth and assessing transmission to determine whether it is possible to stop MDA;
- Initiate surveillance after MDA has been discontinued;
- Verify that transmission has been interrupted.

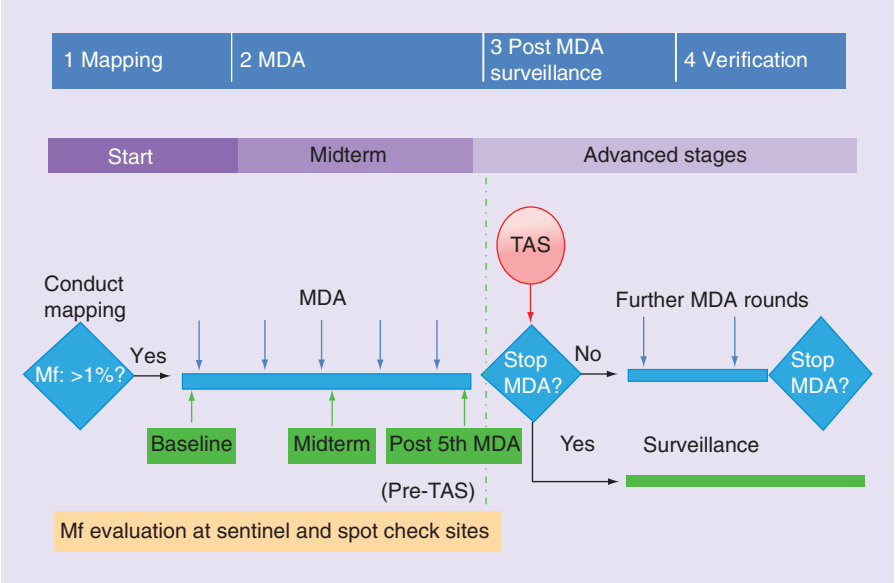

Figure 1. Program steps taken by Global Program to Eliminate Lymphatic Filariasis to interrupt transmission of lymphatic filariasis.
MDA; Mass drug administration; Mf: Microfilaremia; TAS: Transmission assessment survey. Adapted from [27].

Monitoring and evaluation therefore plays a fundamental role within the LF elimination program to inform where drugs should be targeted to initiate MDA, assess the performance of the program, determine when transmission has been interrupted, detect recrudescence after stopping MDA, before finally verifying that the disease has been eliminated.

Mapping is ongoing in 13 endemic countries, but Eritrea is yet to start the process. Mapping the overlap of multiple NTDs in an implementation unit is crucial for informing treatment strategies for integrated control. This is particularly important for areas where loiasis is coendemic with LF [31,32]. From the 59 countries that have completed mapping by 2011, 53 countries, many of which are middle income economies, have started MDA. Seventeen countries in Africa as well as Brunei Darussalam, New Caledonia and Palau have not yet started MDA. In 2011, GPELF targeted 736.9 million people to receive MDA and treated 538.6 million people; thus, reported coverage was 73% [12].

Reporting on the targets laid out in the WHO roadmap for an integrated PC approach requires reporting of treatment coverage. The main goal of M&E for PC is therefore to provide a user-friendly set of standardized tools to ensure uniform reporting of coverage [26]. This is essential for determining early indications of progress, or lack thereof, the achievement of roadmap targets and preparing for the endgame. Verification of the achievement of the specific targets of each disease, produce feedback to the programs to improve quality of interventions and develop transition strategies between different stages of the program are additional monitoring and evaluation objectives. Coverage indicators include:

- Program coverage, where the denominator is the population targeted for treatment;
- Geographical coverage, where the denominator is the number of administrative units requiring treatment;
- National coverage, where the denominator is the population requiring treatment;
- PC coverage by age groups of interest, namely preschool-age children (1–4 years), school-age children (5–14 years) and adults (>15 years);
- PC coverage by gender which facilitates monitoring of special groups (especially children, women of childbearing age and pregnant women) and enables compliance with the UN/WHO organization wide policy on gender mainstreaming of program-generated data.

In 2010, as GPELF reached the halfway point for the 2020 target for the elimination of LF, WHO published the 2000–2009 progress report and 2010–2020 strategic plan reviewing the progress made in the first decade [33]. The endgame strategies were laid out addressing the challenges for the next 10 years and outlining an approach and milestones towards global LF elimination by 2020. The milestones for the program's strategic plan are to ensure that by 2015 full geographical coverage with MDA has been achieved in all endemic countries and by 2020, 70% of the endemic countries have been free of LF and 30% are engaging in post intervention surveillance.

The scaling up of interventions to meet the milestones for GPELF strategic plan for 2010–2020 would require a significant

strengthening of the technical, managerial and programmatic capacity of low-income endemic countries to ensure implementation can be carried out and maintained for as long as necessary. Without this capacity development, it is unlikely that the 17 poorest countries yet to start MDA will simultaneously be able to scale up their programs. Robust M&E strategies need to be in place to allow for adjustments that will enable the implementation strategies to reach the roadmap's targets in the most cost-effective manner. Impact indicators inform the scaling down process and the start of the endgame. These are derived mostly from sentinel-site monitoring and transmission assessment surveys (TASs). Developing an integrated M&E framework for monitoring the different PC diseases would be important for identifying ancillary benefits from treatments that affect multiple NTDs.

Sentinel-site surveys

Only humans harbor *W. bancrofti* and a very minor animal reservoir exists for *B. Malayi*. Transmission of LF can therefore be interrupted by either clearing microfilaria in the reservoir of infection through community-wide treatment or reducing human–vector contact. This is known as transmission control [34].

A cost-effective and convenient way of assessing infection prevalence and program impact is through a small number of sentinel sites selected within implementation units. These sites are determined prior to the commencement of MDA and used to determine the baseline parasitological and serological indicators. Selection is from high-risk or hard-to-reach areas, which are unlikely to achieve effective treatment coverage. Areas that are not affected by migration and with the same demographic characteristics as the implementation units (IUs) are preferable. Ideally, at least one sentinel site should be identified for each IU while ensuring that for more heavily populated areas at least one sentinel site is available for a population of 1 million people.

The sampling strategy for sentinel sites is not informed by statistical criteria as it is intended as a convenient sample from a predetermined high-risk population. Spot-checks are used to counteract potential sentinel-site bias. Unlike the sentinel sites, which remain the same over the course of the program, different spot-check sites are selected for different sampling occasions. The sample size for both sentinel and spot-checks could be up to 500 with a minimum of 300 individuals aged over 5 years.

A mid-term survey performed before the fourth round of MDA will be useful in determining, if drug coverage results are reflected in the impact on the parasitological indicators derived from baseline sentinel- and spot-site surveys. Results from this mid-term assessment could also be used in community awareness campaigns to report back to the people about changes in the infection profile and to provide data for advocacy and motivation of staff.

At least five rounds of MDA are recommended for the interruption of LF transmission [27,35,36]. Therefore, performing a sentinel-site survey at least 6 months after the fifth round of MDA would help to track the programs impact on the baseline and midterm results to inform whether a TAS to stop MDA can be initiated [35,37].

The diagnostic tools used in sentinel surveys including blood films for microfilaria, immunochromatographic tests (ICT) for antigenemia and PCR assays have been described in detail in the WHO M&E manual for national elimination programs [27]. The counting chamber technique is another method that enables speedy and accurate counts of microfilariae [38]. In addition to night blood tests, a recombinant BmR1 antigen-based IgG4 detection test, named Brugia Rapid can be used to determine endemicity of *Brugian filariasis*. As observed for ICT card tests used for *Bancroftian filariasis*, antifilarial IgG4 antibodies to BmR1, as detected by the Brugia Rapid test, can remain positive for more than a year after MF disappearance [39]. Weil *et al.* have also published a comprehensive review of these methods [40]. The method of choice will be determined by the epidemiological setting, local laboratory capacity and technical capabilities as described in the program managers' manual for M&E [27].

Transmission assessment surveys

The decision on whether to stop or to continue MDA is critical for program managers. If MDA is stopped prematurely, several years may pass before active transmission is detected, and restarting MDA may be extremely difficult for logistical and financial reasons. Infection indicators decrease after MDA, but microfilaria- and antigenemia-positive individuals may persist even after transmission has been interrupted. Therefore, WHO has published a program manager's manual [27] for monitoring and epidemiological assessment of MDA with a standard methodology called TAS to assess if MDA can be stopped after a series of MDAs have successfully reduced the prevalence of infection levels in children (measuring newly infected children as an indicator of incidence of the disease) below a predetermined critical cutoff threshold for the various vector–parasite relationships that influence transmission efficiency.

After five rounds of MDA, an implementation unit is considered eligible for TAS if treatment coverage exceeds 65% and the prevalence of microfilaremia is below 1%.

The area covered by a TAS is known as the evaluation unit (EU), which may comprise multiple IUs or part of an IU. IUs within an EU do not have to be geographically contiguous, but should meet the conditions for initiating a TAS, share the same vector and share similar epidemiological and ecological characteristics. To reduce costs, combining IUs into a single EU may be inevitable in many countries, where the IUs are districts with small populations. The EU should not exceed 2 million people. However, one limitation of linking different implementation units into one EU is that if the critical threshold is exceeded, all IUs that comprise the EU will have to resume MDA. Moreover, the EU may pass infection prevalence below the TAS threshold even though the prevalence of infection in one or more IUs is above the antigenemia threshold rate and therefore ongoing transmission [41].

The target population for these surveys is children aged 6–7 years as this age group should not have prior exposure to LF infection, provided MDAs have been successful in interrupting transmission. In young children, antigenemia is a marker for

relatively recent exposure to the parasite while antigenemia in older children or adults may be related to infections that occurred before MDA. The TAS survey design depends on the vector–parasite relationship in the EU, the net rate of primary school enrollment, the size of the population aged 6–7 years, the number of schools or enumeration areas, and the capacity to perform the different survey options. The target age group corresponding to the age of first- and second-year primary school children in these classes can be used to approximate the study population, realizing that there may be a few children outside of these ages. In community-based household surveys, children aged 6–7 years are specifically targeted in the selected households. An excel-based tool called Survey Sample Builder [103] helps program managers to automatically calculate sample sizes. Children found to be antigen positive should be treated and monitored annually until infection is cleared.

Post-MDA surveillance

Routine surveillance is required after MDA has stopped, to detect if recrudescence of transmission has occurred. Very sensitive tools are required for this process in order to detect new infections. Post-MDA surveillance was performed for 6 years in South India after ten rounds of MDA [42]. There was a decreasing trend in overall MF prevalence and vector infection rates. Two villages maintained zero MF status 4 years after MDA was stopped, and vector infection rate was zero from the third year onward, and antigenemia prevalence in adults was 0.4%. In two other villages, despite persistence of MF and vector infection, there was zero vector infectivity rate during the third to sixth year, and antigenemia prevalence among children was zero. The authors concluded that 6 years of post-MDA monitoring and evaluation appeared to be adequate to verify the status of transmission interruption and inform appropriate decision making.

After stopping MDA in 2009, Togo initiated post-MDA surveillance activities including passive surveillance in health facilities and laboratories [35]. Active and sentinel surveillance could also be included in the post-MDA surveillance activities. Active surveillance, based on repeated cross-sectional surveys in humans and mosquitoes will also provide information on existing infections. So will data from sentinel groups such as military personnel (during the medical check up on recruitment), university students (during medical check-ups) and blood banks [27].

Antibody prevalence rates tend to be higher than antigen or MF rates in young children in LF endemic areas. Moreover, antibody rates in school aged children have been shown to decrease rapidly after MDA has been initiated [43]. However, the early use of antibody tests to monitor the impact on interventions on LF transmission has been hindered by low specificity. Highly specific IgG4 antibody tests are now available for detecting antibodies to recombinant filarial antigens such as Bm14 and BmR1 [43–48].

WHO recommends that TAS surveys should be repeated at least twice, with an interval of 2–3 years, after MDA has been stopped following the first TAS with a pass result. Weil and coworkers have compared a new filarial antigen test (the AlereTM Filariasis Test Strip) to the ICT (BinaxNOW® Filariasis card) test that has been used for mapping and impact assessment to date [49]. The ICT card and the strip test showed similar high rates of sensitivity and specificity and greater than 99% agreement based on laboratory testing. However, the strip test was more sensitive in a field study in an LF endemic area in Liberia and had better test result stability than the card test. On the basis of its increased sensitivity and other practical advantages (like the fact that the strip test does not require cold chain), the authors concluded that the strip test represents a major step forward that will be valuable for post-MDA surveillance.

Molecular xenomonitoring

Currently, the main methods used to measure the impact of MDA have been based on the detection of parasites, parasite antigen or antiparasite antibodies in humans. Intensity of microfilaremia and antigenemia decreases after MDA yet both indicators of infection may persist in humans after transmission has been interrupted. Detection of LF microfilaria in mosquitoes indicates the existence of a reservoir of microfilaria in the human host while the presence of infective third-stage larva unequivocally signifies and quantifies transmission potential. Molecular diagnostic methods that distinguish between microfilaria and infective larvae are now available [50].

Molecular xenomonitoring is a term used to describe the detection of filarial DNA in mosquitoes [51]. It is a useful tool for evaluating the impact of LF intervention programs on the infectious microfilaria reservoir in the human host. Traditionally, the infection status of blood-feeding mosquitoes was determined by labor-intensive, tedious and time-consuming individual dissection of live female mosquitoes. It may be impractical and imprecise in many LF endemic countries to rely on traditional mosquito dissection and microscopic detection methods to follow the progress of MDA, especially when infection rates are low after several rounds of MDA. In recent years, several PCR-based assays have been shown to offer more rapid, sensitive and species specific methods of detecting the presence of LF in mosquitoes [47,52,53], and xenomonitoring has been used successfully to monitor national filariasis control programs [47]. However, the outcome of molecular xenomonitoring results depends on the vector–parasite relationship.

LF parasites undergo development in several genera of mosquitoes including *Aedes*, *Anopheles*, *Culex*, *Mansonia* and *Ochlerotatus* [54]. The interruption of transmission will be easier to achieve with some vector–parasite relationships because of a significant difference in ability of the various mosquito species to transmit the parasites [54,55]. A very important determinant of transmission intensity after several rounds of MDA, when parasite densities are low, is the ability of ingested microfilariae to develop to infective L3 larvae in the mosquito vector, and microfilaria load in the human host [54,55]. It is necessary to bring the microfilaria load below a certain threshold for transmission to be interrupted. Limitation and facilitation are vector–parasite relationships that have been shown to be epidemiologically important for the outcome of an intervention [56]. There is empirical evidence to suggest that for a given vector density, low levels of

Table 1. Targets as the proportion of 73 countries expected to interrupt transmission in the global program to eliminate lymphatic filariasis, by 2012–2020.

Year	Category (objective)			
	Starting (implementation begun)	*Scaling up MDA (full geographical coverage achieved)*	*Stopping interventions and starting surveillance (MDA stopped and post-MDA surveillance established)*	*Verifying absence of transmission (countries verified as free of lymphatic filariasis)*
2012	85	70	25	20
2014	100	75	40	20
2016	100	100	70	40
2018	100	100	75	45
2020	100	100	100	70

Values are the proportion of country-based programs that should achieve specified indicators for interrupting transmission.
MDA: mass drug administration.
Adapted from [33].

microfilaremia can initiate a resumption of transmission after six rounds of MDA, where culicine mosquitoes are vectors, whereas interruption can be sustained in areas of anopheline transmission for higher levels of microfilaremia. Facilitation, associated with *Anopheles*-transmitted filariasis, occurs when the proportion of ingested microfilariae, which survive to become L3 increases as residual microfilaria density increases from very low, up to some intermediate number, declining at higher microfilarial densities. In the case of limitation, which is associated with culicine mosquitoes (including *Aedes, Culex* and *Mansonia* species) the proportion of ingested microfilariae that survive to become L3 larvae decreases as more microfilariae are ingested [56]. Of less epidemiological value is a third relationship called proportionality when the parasite yield is a constant ratio, neither increasing nor decreasing as microfilaria intake increases.

Ramzy and colleagues evaluated the impact of five-yearly rounds of MDA on LF in four sentinel villages using MF rates and mosquito infection rates determined by xenomonitoring [47].

Studies were performed in high and low endemicity Egyptian governorates where MF-positive rates of 11.4 and 4.1%, respectively; corresponding pretreatment LF infection rates in mosquitoes in the governorates were 3.07 and 1.76%, respectively. After five rounds of MDA, parasite DNA rates in mosquitoes was reduced to 0% in the low prevalence area. However, in the high prevalence area where post-MDA MF-positive rate in humans was 0.19%, LF-positive mosquitoes were sometimes detected by xenomonitoring in households where none of the residents were MF positive. Alternatively, no PCR-positive mosquitoes were detected in some houses with MF-positive residents.

There was no significant difference between the pretreatment mosquito infection rates in the high and low endemicity areas suggesting that xenomonitoring may not be appropriate for comparing filariasis endemicity levels in different areas where *Culex* mosquitoes are vectors. *Culex* mosquitoes are capable of ingesting microfilaria when feeding on infected individuals that are microfilaria negative by membrane filtration. This may partly explain why parasite DNA can also be detected in mosquitoes containing MF that never develop to infective L3 larvae because they are not competent vectors [57].

Mathematical modeling

Environmental factors are also important for resumption of transmission of LF after MDA has been stopped, and modeling has been used to show how changes in climate and population could influence the spread of infections. Slater and Michael have used ecological niche modeling to show that projected climate change and population growth will greatly affect the population at risk for LF infection [58]. On the basis of different parameters for threshold and climatic conditions, they estimated that the current at risk population for LF could rise to 1.86 billion in the future.

Expert commentary & five-year view

Our expert commentary and 5-year view of the management of LF treatment was presented in *Expert Reviews of Anti-infective Therapy* in 2009 [5]. In this article, we focus on the changing strategies, as we approach the endgame and surveillance during the post-MDA phase. The impact of MDA on the transmission of LF, in the 53 endemic countries now undergoing treatment, is critical for informing the endgame strategy. According to WHO projections (Table 1), in the next 5 years, all 73 endemic countries would have achieved 100% geographic coverage, and 55 countries would have stopped MDA and be in the post-MDA surveillance phase [33]. By 2018, 33 countries would have interrupted transmission and achieved verification from WHO. The next 5 years is therefore about ensuring that monitoring and evaluation processes are robust and sustainable. Meeting the 100% geographic coverage for all countries by 2020 would require a significant strengthening of the treatment delivery infrastructure for forecasting, customs clearance, storage, distribution and inventory control. This will be achieved by the following:

- Developing detailed strategic and work plans that will ensure partner committed resources match national requirements;
- Establishing an advocacy mechanism for securing long-term commitment of government and financing partners;
- Enabling and improving the supply chain management for donated drugs;

- Delivering treatment through the primary healthcare system;
- Building the capacity for implementation at the national, district and community levels.

To enhance the monitoring and evaluation process, there is a need over the next 5 years to:

- Build capacity in monitoring and evaluation including data management, surveillance and xenomonitoring;
- Improve on the sensitivity of diagnostic methods for the detection of low-density parasitemia during the post-MDA surveillance phase;
- Apply stronger epidemiological approaches to the selection of EUs for TAS to avoid the areas where transmission is still ongoing to stop MDA prematurely;
- Validate the current indicators, tools and sampling strategies for stopping MDA for *Brugia* infections;
- Strengthen the links with the national health management information system for surveillance activities during the post-MDA phase.

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Key issues

- The Global Program to Eliminate Lymphatic Filariasis (LF) is one of the most rapidly expanding global health program in the history of public health.
- Following many years of mass drug administration (MDA) to eliminate LF, some endemic countries are now scaling down treatment activities after reaching 100% geographic coverage.
- Disease-specific vertical approaches to tackle neglected tropical diseases, such as LF are being discouraged in favor of a common integrated approach for prevention, control and monitoring of multiple neglected tropical diseases.
- Instituting monitoring and evaluation procedures to establish if transmission has been interrupted is important for the endgame as we approach the 2020 target for eliminating LF.
- A standard methodology called transmission assessment survey has been developed to determine when MDA can be stopped after a series of annual treatments.
- Routine surveillance is required after MDA has been stopped, to detect if recrudescence of transmission has occurred.

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