Lymphatic Filariasis: Epidemiology, Diagnosis, Treatment, and Global Elimination Strategies

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***Abstract*—Lymphatic filariasis (LF) is a neglected tropical disease caused by nematode parasites Wuchereria bancrofti, Brugia malayi, and Brugia mori, transmitted through mosquito vectors such as Culex, Anopheles, and Aedes. It is a major cause of permanent disability worldwide, leading to lymphedema, hydrocele, and social. More than 51 million people across 44 endemic countries are affected, with millions at risk of infection on. Despite significant progress under the Global Programme to Eliminate Lymphatic Filariasis (GPELF), complete eradication on remains a challenge. The introduction of improved diagnosis tools such as the Filariasis Test Strip (FTS), a gen and a body detection on assays (Wb123, BmR1, Ov16), and molecular methods have enhanced early diagnosis. Treatment strategies now emphasize triple-drug therapy (IDA: Ivermec n, Diethylcarbamazine, and Albendazole) and community-wide Mass Drug Administration on (MDA) to interrupt transmission. This review focuses on the history, epidemiology, mode of transmission, pathogenesis, diagnosis advancements, treatment approaches, prevention on strategies, and future prospects for global elimination of lymphatic filariasis by 2030.**

***Index Terms*—Lymphatic Filariasis, Wuchereria bancrofti, Brugia malayi, Vector-borne Disease,**

I. INTRODUCTION

Nematode parasites called "filariae," which are members of the "Filarioidea" family, are the cause of filariasis, an endemic disease in the tropics and subtropics. It is made up of numerous kinds of long, slender worms that live in the tissues of different vertebrates.(1)After leprosy, it is the second leadingcause of irreversible deformity and impairment globally. Nowadays, lymphatic filariasis (LF) isregarded as a neglected tropical illness. In an effort to eradicate lymphatic filariasis, the Global Programme to Eliminate it is giving mass drug administrations (MDA) to people living in endemic areas.(2) Any elimination campaign must include both surveillance and monitoring. Every stage of an elimination program requires the use of the proper evaluation tools and techniques, such as mapping to determine which areas need intervention, monitoring to evaluate the effectiveness of interventions, and post-intervention surveillance to confirm eradication or identify recrudescence.(3) Every human-pathogenic species of filaria has a distinct geographic range: Mansonella perstans is found throughout Central Africa and northeast South America, whereas restricted to the humid regions of West and Central Africa. An estimated 80 million tourists travel to these nations annually.(4)

II. HISTORY OF FILARIASIS

Early Scientific Landmarks in the History of Filariasis. (5)

- In 1863, Demarquay in Paris first identified *microfilariae* in the hydrocele fluid of a Cuban patient.
- In 1866, Wucherer detected *microfilariae* in individuals with chyluria.
- Lewis observed *microfilariae* in human blood in 1872.
- In 1877, Bancroft discovered an adult female filarial worm in a lymph node lesion of the arm.
- The same year (1877), Manson found *microfilariae* in the gut of a mosquito after feeding on infected blood — a discovery that marked the beginning of medical entomology.

• In 1879, Manson further revealed the nocturnal periodicity of *microfilariae* in human blood.
• Finally, in 1888, Sibthorpe identified the adult male filarial worm, completing the early foundation of filariasis research.

III. ETIOLOGY AND CAUSATIVE AGENT

Nematodes, or roundworms, enter the lymphatic or subcutaneous tissues and cause filariasis. Wuchereria bancrofti, Brugia malayi, and Brugia timori are the main mosquito-borne carriers of lymphatic filariasis. (Brugia malayi and Wuchereria bancrofti).(2) At least three nematode parasite species—Wuchereria bancrofti, Brugia malayi, and Brugia timori—cause filariasis, which is spread by five mosquito genera—Aedes, Anopheles, Culex, Mansonia, and Ochlerotatus..(2) Five mosquito genera—Aedes, Anopheles, Culex, Mansonia, and Ochlerotatus—transmit filariasis, which is caused by at least three nematode parasite species: Wuchereria bancrofti, Brugia malayi, and Brugia timori.(6)
• Blackflies that reside close to rivers are the vectors of Onchocerca volvulus, which causes onchocerciasis.

• Brugia spp. and Wuchereria bancrofti are the causative agents of lymphatic filariasis, which is spread by mosquitoes.

• Blackflies or midges that bite humans can transmit the mansonella species that cause mansonellosis.

• Mosquitoes are the vector of Dirofilariasis, which is caused by Dirofilaria (including Dirofilaria repens and Dirofilaria immitis).

• The parasitic worm Dracunculus medinensis is the cause of dracunculiasis. Drinking water tainted with copepods, which serve as intermediary hosts for the infectious parasite larvae, causes transmission. (6)

IV. EPIDEMIOLOGY

Mostly found in the tropical and subtropical regions of Asia, Africa, the Western Pacific, South America, and the Caribbean, it affects 120 million people across 72 nations. Haiti, the Dominican Republic, Guyana, and Brazil are the four endemic countries in America. (2).With an estimated 51 million people in 44 countries now affected and approximately 859 million living in endemic areas at risk of infection, lymphatic filariasis (LF) continues to rank among the world's top causes of irreversible disability.(7) For endemic communities, lymphatic filariasis causes significant financial and health burdens. According to modeling research, the average yearly economic cost of each chronic LF case is $114.69 USD, with productivity losses bearing the majority of the burden (about 95%). (6) Taking into account the millions of impacted people, these losses amount to tens of billions of dollars worldwide. Crucially, without effective morbidity management programs, many individuals with chronic morbidity (such as lymphoedema or hydrocele) may continue to have lifelong effects even as transmission decreases through mass drug administration (MDA). This will prolong the health and socioeconomic burden.(7)
Study space and layout: The Bidar district is situated in the northeastern region of Karnataka state, adjacent to the states of Maharashtra and Telangana (17°35' and 18°25' North latitudes and 76°42' and 77°39' East longitudes).(8) (9) It has an average literacy rate of 71% and a population of approximately 1.7 million (Census 2011), distributed in 5448 km2 across 8 taluks, 30 hoblies (a group of nearby villages handled jointly for tax and land tenure purposes in the state of Karnataka), and 635 villages.(9)

V. LIFE CYCLE OF FILARIA

The intermediate host is the mosquito, while the definitive host is man, where the mature adult male and female parasites mate and generate microfilariae. The human lymphatic system is typically home to mature parasites. (10) Every day, they give birth to up to 50,000 microfilariae, which enter the bloodstream. Although their exact lifespan is unknown, microfilaria may live for a few months at most. (10) Third-stage filarial larvae are introduced into the human host's skin by an infected mosquito during a blood meal, when they enter the bite wound. They often live in the lymphatics and develop in adults. (11)(13)(14) In endemic places, filariasis has a substantial economic and psychological burden, disfiguring and/or incapacitating over 40 million people. Depression with filariasis is thought to be

responsible for 5.09 million disability-adjusted life years (DALYs) and has a strong correlation with mental disorders. (12)(15)(16)

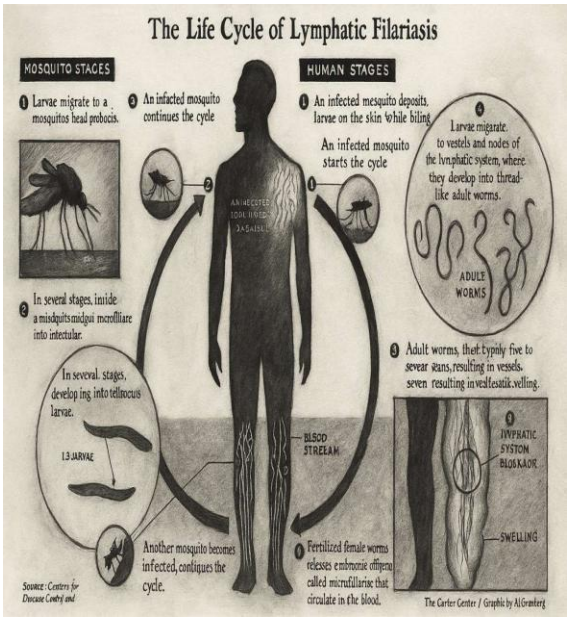

Fig 1. Life cycle of Lymphatic Filariasis (17)

VI. EFFECTS OF FILARIA ON HUMAN BODY

In addition to physically harming the lymphatic channels, lymphatic filarial worms (mostly Wuchereria bancrofti, Brugia malayi, and B. mori) significantly change host immunity. Adult worms and their symbionts tilt innate and adaptive responses toward regulatory/an-inflammatory pathways (e.g., elevated IL-10, regulatory T cell activity) that allow for long-term parasite survival while suppressing protective inflammation, according to recent immunology reviews. (22) In addition to localized swelling, lymphatic filariasis's physical manifestations—recurrent adenolymphangi, lymphedema, elephantiasis, and hydrocele—have significant functional and systemic repercussions. (23) Numerous cohort and mechanism studies show that persistent helminth infections, such as filariasis, can change metabolic indicators and systemic inflammation. For instance, several species have been linked to altered lipid profiles and reduced fasting glucose. The parasite's systemic effects extend beyond the lymphatic tree to whole-body physiology because the immunoregulatory milieu it creates may guard against specific inflammatory metabolic conditions, but it also makes co-morbid management and immunological recovery more difficult after filarial therapy. (24)

Wolbachia, which are intracellular bacterial endosymbionts of numerous filarial species, play a crucial role in the pathogenicity and host damage caused by filarial infections. (25) People with visible deformity (elephantiasis, hydrocele) have significant rates of depression, anxiety, SGM, social marginalization, and lost livelihoods, according to systematic reviews and qualitative investigations. The overall burden of disease is increased by these non-biological effects (18,19,20) disability resulting from lymphatic damage often results in decreased access to care, delayed presentation for treatable complications (such as hydrocele surgery), and decreased participation in prevention programs, all of which contribute to the persistence of disease in susceptible populations. (26) (21,22,23,24)

VII. MODE OF TRANSMISSION OF LYMPHATIC FILARIASIS

Human-to-human transmission of lymphatic filariasis (LF) occurs via specific mosquito species. The filarial nematodes that cause the disease are primarily Wuchereria bancro i, Brugia malayi, and Brugia mori, and their mature worms reside in human lymphatic capillaries. Microfilariae, which are released by female worms, travel throughout the bloodstream. A mosquito consumes microfilariae when it bites an infected human. These mature into infectious larvae (the L3 stage) inside the mosquito. (27)

Numerous mosquito species, with genus variations based on geographic location, serve as vectors. For instance, Aedes is found in island endemic species, Culex is prevalent in urban and semi-urban settings, and Anopheles is found in rural Asia and Africa. (28) Mosquito density, vector competence, microfilaria density in human hosts, and the frequency of human–mosquito contact are ecological and biological factors that affect transmission. Transmission is significantly influenced by human factors (housing, sanitation, and use of bed nets) and climate (temperature, humidity). (29)

The periodicity of microfilariae in human blood is another important consideration. Many filarial species exhibit nocturnal periodicity, with microfilariae being more prevalent at night, which corresponds with the feeding habits of some mosquito vectors. (30)
Adult worms reproduce in humans, whereas microfilariae transform into infectious larvae in mosquitoes, which act as intermediary hosts. Without a mosquito vector, no direct human-to-human transmission can take place. (27, 31)

VIII. DIAGNOSIS

Diagnosis requires the presence of microfilariae in the skin, blood, or ocular fluids. Clinicians commonly employ blood smears to diagnose lymphatic filariasis, Mansonella perstans, , whereas skin snips are advised for diagnosing Onchocerca volvulus and M streptocerca. For W bancrofti, circulating filarial and gen tests are the suggested diagnostic method. During a slit lamp examination, O volvulus microfilariae may be discovered in the eye. Imaging techniques that reveal the presence of live adult worms or lymphatic blockage, such as lympho scinography and ultrasonography, help with diagnosis and early problem detection. (36) (37) (38,39)

IX. RECENT TREND AND CURRENT APPROACH IN DIAGNOSIS

Rapid and generation RDTs are the foundation of program (40,41,42) monitoring. For mapping, transmission assessment surveys (TAS), and programmatic decisions to discontinue MDA, rapid circularial gen (CFA) tests—most notably the Alere/Bioline Filariasis Test Strip (FTS)—remain the major field instrument. FTS is currently the gold standard in many national programs due to its field ease, stability, and sensitivity when compared to previous ICT cards. The WHO recommends it for the qualitative detection of Wuchereria bancrofti gen in blood. New quick and generation assays that are concordant with FTS are evaluated with fewer sample sizes and are simpler for field teams to apply. (43)

From FTS to next-generation assays (QFAT, STANDARD Q, etc.) on fast and gen. The STANDARDTM Q Filariasis An Gen Test (QFAT) is one of the new fast a gen formats that have been developed and field-evaluated to provide alternative supply chains and improve usability (lower blood volume, clearer readouts). Recent head-to-head laboratory and field comparisons in endemic settings (like Samoa) indicate encouraging concordance with FTS and indicate that these more recent RDTs may supplement existing tests when necessary or, pending DTAG/WHO review, replace them. (44)
Recombinant-an-gen serology for early warning and exposure monitoring. IgG4 and body assays that use recombinant genes (Wb123, Bm14, BmR1, and others) are sensitive indicators of exposure and can identify recent transmission before a gene or microfilariae manifest. In youngsters and for identifying recurrence of MDA, serology is very helpful. Multiplex methods that combine many genes can improve the sensitivity and specificity of surveillance in low-prevalence syndromes. (45,46,47,48).

X. TREATMENT

In many regions of the world, lymphatic filariasis (LF), a vector-borne disease, persists despite international efforts to eradicate it. (16) The WHO offers procedures and criteria for mapping, tracking, and assessing LF initiatives. The identification of Mf presence in a blood smear by a microscopic examination is the conventional way for diagnosing acve LF. (13)(49,50)
The sickness, which is caused by infection with a helminth parasite (Brugia malayi, Brugia mori, or Wuchereria bancrofti), can cause severe and irreversible lymphedema, including scrotal hydroceles. (17) A more recent study found that the triple-drug combination (Ivermec, diethylcarbamazine, and albendazole) is just as safe for LF as the double-drug approach. (18) Programs for mental health and rehabilitation are also promoted in order to improve the quality of life for

XI. PREVENTION

Avoiding bug bites is usually the best defense against filarial worm infections. Insects can be kept away

from you by sleeping under mosquito nets, applying insect repellent to exposed skin, and wearing long sleeves and long pants. (51,52,54,55) The World Health Organization (WHO) hopes to eliminate LF as a public health concern by 2030. This goal, known as the GPELF, is being pursued by a range of stakeholders, including national governments, international organizations, and communities affected by illness [52].

This is often accomplished through a number of strategies, including improved vector control and sanitation practices, greater access to diagnosis and treatment for affected persons, and mass drug administration (MDA) of an antiviral medication to populations at risk [53]. Avoiding and treating filariasis Since there is only symptomatic treatment for lymphoedema and no permanent cure once it starts, prevention is essential. The following methods can aid in the global eradication of filariasis.

XII. CONCLUSIONS

Lymphatic filariasis remains one of the world's most disabling neglected tropical diseases, continuing to threaten millions in endemic regions despite decades of control efforts. Significant progress has been achieved through the World Health Organization's Global Programme to Eliminate Lymphatic Filariasis (GPELF), particularly by implementing largescale Mass Drug Administration (MDA) and vector control strategies. Advances in diagnostic technologies—such as the Filariasis Test Strip (FTS), recombinant an gen assays (Wb123, BmR1, Ov16), and molecular detection on methods—have greatly improved early and accurate identification of. However, the persistence of transmission in certain endemic pockets highlights the need for surveillance, effective coverage of MDA campaigns,

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Conflict of interests

The authors declare no competing interests

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