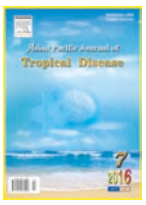
HOSTED BY

Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Disease

journal homepage: www.elsevier.com/locate/apjtd



Parasitological research doi: 10.1016/S2222-1808(16)61081-2

Lymphatic filariasis: Surveillance action among immigrants from endemic areas, Acre State, Brazilian Amazon

Lucineide Valentin Nunes[1,2], Abraham Rocha[3*], Josué Araújo[3], Cynthia Braga[3], Paula Alcantara[3], Karina Fiorillo[4], Camila Ximenes[3], Eduardo Brandão[3], Claudia Dávila Modesto[2], Thayna Maria Holanda de Souza[5], Andreia Fernandes Brilhante[1,6]

[1]*Meta Faculty, Rio Branco, Acre, Brazil*

[2]*Central Laboratory of Public Health, Rio Branco, Acre, Brazil*

[3]*National Filariasis Referral Service, Parasitology Department, Aggeu Magalhães, Research Center, Oswaldo Cruz Foundation, Recife, Pernambuco, Brazil*

[4]*General Coordination of Leprosy and Diseases in Disposal, Secretariat of Health Surveillance, Ministry of Health, Brasília, Distrito Federal, Brazil*

[5]*Department of Health, Rio Branco, Acre, Brazil*

[6]*Epidemiology Department, School of Public Health, São Paulo University, São Paulo, Brazil*

ARTICLE INFO

Article history:
Received 26 May 2016
Received in revised form 14 Jun 2016
Accepted 18 Jun 2016
Available online 22 Jun 2016

Keywords:
Wuchereria bancrofti
Filariasis
Surveillance
Immigrants
Diagnosis

ABSTRACT

Objective: To investigate the positivity of *Wuchereria bancrofti* (*W. bancrofti*) in immigrants who entered the country through Rio Branco, reducing the risk of introduction of parasites into new areas and endemic areas of the past.

Methods: It was realized a descriptive study. The AD12-ICT card test was applied on all immigrants living temporarily in the Chacara Alliance shelter, located in the metropolitan area of Rio Branco-AC, Brazil. For the positive patients, 10 mL of venous blood was collected between 11:00 pm and 1:00 am. About 4 mL of venous blood was collected to detect the presence of microfilariae in circulation in the tube using ethylene diamine tetraacetic acid and 6 mL of venous blood was collected to obtain blood serum for the Og4C3-ELISA, antibody Bm-14 and DNA-*W. bancrofti* tests.

Results: The present study evaluated 415 individuals in September 2014 by circulating filarial antigen for *W. bancrofti* using the AD12-ICT card test. A total of 15/415 (3.61%) positive cases were found, all from Haiti. Night blood collection and serum were performed on 1/14 for confirmation the infection of *W. bancrofti*, which presented 34 microfilariae/mL, antigen, antibodies and PCR positives.

Conclusions: This surveillance action reveals, in a pioneering and unequivocal manner, that Brazil is an influx of immigrants carrying lymphatic filariasis and there is an urgent need to step up surveillance at the main entry point for immigrants. Active surveillance may prevent the reintroduction of lymphatic filariasis in areas under control, or prevent its introduction into other states of Brazil.

1. Introduction

Lymphatic filariasis (LF), which is a parasitic disease caused by the infection of three species of nematodes, *Wuchereria bancrofti* (*W. bancrofti*), *Brugia malayi* and *Brugia timori*, was considered one among the six potentially eliminable infectious diseases of the globe for more than two decades. *W. bancrofti* accounts for nearly 91% of LF infections in humans worldwide and is a major cause of disabilities, disfigurement and incapacitated morbidity in endemic countries, affecting about 40 million people. The presence of these nematodes in the lymphatic system, its preferred site location, causes damage to the lymphatic system and produces the main chronic LF manifestations: lymphedema, hydrocele, chyluria and elephantiasis[1-3].

Eighteen years ago, the World Health Assembly, through Resolution 50.29, declared global elimination of LF as a public health problem[3,4]. From the resolution, World Health Assembly/50.29, through the Ministry of Health and the Conselho Nacional de Saúde, Brazil endorsed the resolution of Conselho

*Corresponding author: Abraham Rocha, National Filariasis Referral Service, Parasitology Department, Aggeu Magalhães, Research Center, Oswaldo Cruz Foundation, Recife, Pernambuco, Brazil.
Tel: +55 81 2101-2575
Fax: +55 81 2101-2671
E-mail: rocha@cpqam.fiocruz.br

The study protocol was performed according to the Helsinki declaration and approved by Ethics in Research Committee of the Clinical Hospital of Rio Branco, Acre-Fundhacre nº 040776/2015. Informed written consent was obtained from all participants.

Foundation Project: Supported by by the Department of Health Surveillance / Oswaldo Cruz Foundation/Foundation for Technological Development in Health - Vice-President for Research and Referral Laboratories (Fiocruz/FIOTECVPPLR)-002-LIV11-2-1 Project.

The journal implements double-blind peer review practiced by specially invited international editorial board members.

Nacional de Saúde n° 190/96, implementing the National Plan for the Elimination of LF (NPELF)[5].

In 2000, the Global Programme to Eliminate LF (GPELF) elaborated a plan to achieve the elimination of LF, in locations where it is endemic, by the year of 2020. The elimination strategy has two components: i) stoping the spread of infection by breaking the transmission cycle of vector-human parasite, by applying community-wide mass drug administration (MDA) to the population under risk of infection. The goal of GPELF is a yearly dose of albendazole (400 mg) associated with ivermectin (150–200 μg) or diethylcarbamazine (DEC) (6 mg/kg), reaching at least 65% population coverage yearly, for 5–6 years in areas where the prevalence of LF is equal to or greater than 1%, and ii) mitigating the suffering of affected individuals by controlling morbidity[3,6,7].

In the last half century, several countries have successfully eliminated LF, including Japan, China, South Korea, the Solomon Islands, Egypt and Togo[8]. In the Americas, only occurs infection of *W. bancrofti* and at the start of the GPELF, seven countries in the region were considered endemic for LF. In 2011, a review of epidemiological data led to the reclassification of Costa Rica, Suriname and Trinidad and Tobago as they are non-endemic. Thus, in the Americas, the remaining endemic countries are Brazil, Guyana, Dominican Republic and Haiti, with the latter being the country with the most cases of diseases and infection[9].

Epidemiological studies conducted in Brazil in the 1950s verified the existence of active transmission of LF in 11 cities from different States. With the control measures implemented over the years by the Ministry of Health, studies carried after the year of 1980 have shown a significant reduction, from 11 to only 2 and some areas are considered as active focus including Recife-Pernambuco and Belem-Pará[10]. Currently, Belem-Pará has eliminated LF under control and it is seeking full eradication. On the other hand, the metropolitan area of Recife, Olinda, Jaboatão dos Guararapes and Paulista, despite the significant decrease in prevalence (6.5% of microfilaremia in 1996 came to 0.002% in 2014 in Recife), is still considered the main focus of LF in Brazil[11-13].

The state of Santa Catarina is worth mention, where the years of 1951 and 1967 were considered endemic for LF. In both cases, a control action based on selective treatment of the microfilaremics and MDA using DEC was successful in eliminating the LF in that state[14].

Over the past 5 years, Brazil has become a migratory route of thousands of immigrants from African countries (Senegal, Gambia, Ghana), the Caribbean (Dominican Republic and Haiti) and Asian (Bangladesh and India), most considered transmission areas of filariasis by *W. bancrofti*. It is estimated that in the 2010–2014 period, about 42 000 immigrants from the Dominican Republic, Haiti and Africa settled in Brazilian States, of which approximately 11 500 (27.4%) resided in Southern Brazil[15-17].

The city of Rio Branco-Acre is the main gateway for immigrants, mostly from Haiti, considered hyper-endemic for LF and the source of over 90% of the total LF cases in the Americas. Immigrants are housed in a shelter in Rio Branco's metropolitan region, and then traveled by bus to the city of São Paulo, São Paulo, where they seeked jobs available especially in Southern and Southeastern Brazil[18,19]. Thus, the aim of this study is to investigate the positivity of *W. bancrofti* of immigrants who entered the country through Rio Branco, reducing the risk of reintroduction of parasites into new areas and endemic areas of the past.

2. Materials and methods

2.1. Study design and setting

This descriptive study was based on records from the databank of the Environmental Management Laboratory and Central Laboratory of Acre, Brazil. This data were generated by a surveillance action involving immigrants from endemic areas for LF, which took place during 1 week on September 2014 as part of Brazil's NPELF, conducted by the Central Laboratory of Acre, Rio Branco Municipal and State Health/Epidemiological Surveillance, the Brazilian Ministry of Health, and the National Filariasis Referral Service of the Aggeu Magalhães Research Center, Oswaldo Cruz Foundation of Pernambuco.

All immigrants living temporarily in the Chacara Alliance shelter, located in the metropolitan area of Rio Branco-AC, Brazil, during the period of the surveillance action were invited to attend the Lymphatic Filariasis Diagnostic Investigation Laboratory (LFDIL)[19].

2.2. Data analysis

The database analysis of Environmental Management Laboratory began in May 2015, after consideration and approval by the Ethics in Research Committee of the Clinical Hospital of Rio Branco, Acre- Fundhacre n° 040776/2015.

2.3. Study population

Before the LFDIL began, a lecture was given on the general aspects of LF (epidemiology, clinical features, diagnosis and treatment), as well as the objectives of this surveillance action coordinated by the Health Institutions of Brazil, with an emphasis on the enormous importance of diagnostic evaluation and treatment of positive cases. For better understanding of the information given, Haitian immigrants fluent in Portuguese provided simultaneous translation from Portuguese to French and Haitian Creole.

Participation was voluntary and prior to the LFDIL, consent for the tests was obtained from all participants, including minors who were accompanied by their parents, who authorized the participation of their children in the LFDIL. Sociodemographic information (full name, sex, age, parents and hometown) was collected, and individuals with difficulty in understanding the questionnaire in Portuguese were assisted by a translator.

2.4. Laboratory assays

The AD12-immunochromatographic (ICT) card test was applied according to the manufacturer's instructions and the results read by technicians trained in the field, precisely 10 min after taking the blood sample. The appearance of two lines (test and control) was interpreted as a positive result[20-22]. All positive cards were repeated on the same occasion to confirm the results, following the same criteria listed above. For the positive patients, 10 mL of venous blood was collected between 11:00 pm and 1:00 am. About 4 mL of venous blood was collected to detect the presence of microfilariae in circulation in the tube using ethylene diamine tetraacetic acid and 6 mL of venous blood was collected to obtain blood serum for the Og4C3-ELISA, antibody Bm-14 and DNA-*W. bancrofti* tests. Three drops of blood were placed on two slides for study of microfilariae morphology. Blood, serum and slides were stored at temperatures of 4°–20 °C and ambient temperature, respectively, and then sent to the SRNF/CPqAM/Fiocruz-PE until the application of the standard operating procedures for each specific test.

Assessment of microfilariae was carried out using diagnosis and quantification of microfilariae (DQM) and thick blood film (TBF), circulating filarial antigen (CFA) by Og4C3-ELISA, antibody Bm-

14 and DNA-*W. bancrofti* for PCR[21-24].

3. Results

The presence of CFA was examined in 415 immigrants [313 (75.42%) males and 102 (24.58%) females aged between 2 and 55 years, and median of the 30 years] living temporarily in the shelter of Chacara Alliance at the moment of the surveillance action, agreed to perform in LFDIL by the point of care AD12-ICT card test. Table 1, showing the distribution of sex and age, reveals that the majority of participants (50.6%) were in the 26–35 year age group. The second largest concentration of young adults was in the 21–25 year age group (18.31%). All AD12-ICT test cards used in the quality control test showed satisfactory results.

Table 1

Distribution of the individuals according to age and gender in September 2014, Rio Branco, Acre, Brazil.

Age group (years)	Male	Female	Total (%)
0–5	2	0	2 (0.48)
6–10	1	2	3 (0.73)
11–15	0	3	3 (0.73)
16–20	17	7	24 (5.78)
21–25	59	17	76 (18.31)
26–30	96	22	118 (28.43)
31–35	67	25	92 (22.17)
36–40	32	15	47 (11.33)
41–45	19	6	25 (6.02)
46–50	14	5	19 (4.58)
51–55	4	0	4 (0.96)
56–60	0	0	0 (0.00)
> 60	0	0	0 (0.00)
No age	2	0	2 (0.48)
Total (%)	313 (75.42%)	102 (24.58%)	415 (100.00)

Table 2 shows the place of origin of the participants. Only 3 individuals were from areas not endemic for LF (Colombia and Cuba) and the place of origin of one individual could not be identified. On the other hand, 411/415 (99.04%) participants were from endemic areas (the Republic of Haiti, the Dominican Republic and Senegal), and the largest number of immigrants were from Haiti (375 individuals). The LFDIL by CFA AD12-ICT card test diagnosed 15/415 (3.61%) positive cases. However, considering only the immigrants from Haiti, the prevalence of a positive CFA point of care AD12-ICT card test, would be higher [14/375 (4%)]. Of this subgroup of immigrants, 12/15 (80.0%) were men and 3/15 (20.0%) were women and the mean age for both sexes was 26.5 years, ranging from 23 to 38 years. They came from the nine districts of the Republic of Haiti, all endemic for LF. These 7/15 (46.7%) participants, more specifically, were from the Gonaives District, the capital of the Department of Artibonite, which had locations with a prevalence of CFA estimated by the point of care AD12-ICT card test to be between 10% and 45%, as well as 91/375 (24.3%) negatives.

Table 2

Result of AD12-ICT card test according to country of origin.

Country of origin	Investigated number	ICT card positive (%)	ICT card negative (%)
Colombia	1	0 (0)	1 (100)
Cuba	2	0 (0)	2 (100)
Haiti	375	15 (4)	360 (96)
Dominican Republic	16	0 (0)	16 (100)
Senegal	20	0 (0)	20 (100)
Not identified	1	0 (0)	1 (100)
Total	415	15 (3.61)	400 (96.39)

In order to avoid false positive results, all individuals positively diagnosed using the CFA point of care AD12-ICT card test (15/15) were subjected to a new test and there was a 100% concordance between the first and second tests. Only 1/15 individuals with a positive CFA point of care AD12-ICT card test remained at the shelter for 2 days after the completion of the LFDIL to carry out the collection of nocturnal venous blood for parasitological research (research and quantification of microfilariae) by DQM and TBF, CFA Og4C3 by ELISA, antibody Bm-14 and DNA *W. bancrofti*, obtaining the following results: 34 microfilariae/mL, morphology of microfilariae compatible with *W. bancrofti*, 7.054 AU, 0.432 DO and positive, respectively.

Despite having been offered treatment with DEC, none of the immigrants who tested positive on the CFA point of care AD12-ICT card test, including those who were microfilaremic, accepted the treatment, since everyone was waiting for the ground transportation (bus) to the city of São Paulo-SP, Brazil where they would be recruited to work in companies and industries in the major states of the South and Southeast of Brazil.

4. Discussion

Several studies have noted the importance of surveillance actions focused on migrant populations from areas endemic for LF to non-endemic areas, or areas under control of the MDA[25-28]. After the disaster in Haiti in 2010, Brazil has been the main country in the Americas to receive a large number of immigrants from this country, as well as from other regions endemic for LF (the Dominican Republic, Africa, India and Bangladesh)[15-17].

The results presented in this LFDIL action used the point of care AD12-ICT card test for the presence of CFA for *W. bancrofti* and was the first to confirm the high prevalence of 3.61% (15/415) in the CFA positive immigrant population. Moreover, the CFA prevalence was higher than 4% (15/375) in the population of Haitian immigrants alone.

Although the LFDIL only diagnosed individuals from Haiti, an area known to be endemic for LF, examination of CFA point of care AD12-ICT card tests drew attention to the need for confirmation of infection with *W. bancrofti*, since Brazil also has many immigrants from the African continent, where there are co-infections with other filarial worms, such as *Loa loa* (*L. loa*), which depending on the parasite density, may also react positively to CFA in the point of care AD12-ICT card test[29]. The drug of choice for LF treatment in Brazil is the DEC[30]. The use of DEC for the treatment of loiasisis is limited, especially in cases with high parasite loads, where there is a risk of developing severe reactions, such as encephalopathies, which may lead to death[31]. Despite not being the drug of choice for LF treatment in Brazil, the use of ivermectin is worth mentioning, as its use against infection with *L. loa* can also cause severe adverse reactions, leading to coma and death[32].

In Brazil, nowadays, the TBF for microfilariae is still widely used for laboratory diagnosis of LF[30]. The microfilariae stages of *W. bancrofti* and *L. loa* have similar characteristics. In spite of *L. loa* is diurnally periodic, microfilariae can be found in night blood (individuals with large numbers of microfilariae *L. loa*) like *W. bancrofti*. Both has sheath visible under microscopy. On the other hand, the differences between species can be identified by skilled technicians. Microfilariae with a single nucleus in the tip of the tail is classified as *L. loa*. Predicting this potential problem of differentiation between species, the secretary of Health Surveillance, Ministry of Health of Brazil, published a technical note (TN) n°

09/2013 (Guidelines for LF Surveillance)[33]. The TN was sent to all Central Laboratories of the Brazilian states, recommending that all microfilaremic individuals must undergo morphological identification of filarial worms before treatment with DEC. It also recommends the use of other diagnostic tools, such as CFA by Og4C3-ELISA and DQM by the polycarbonate membrane filtration technique using venous blood. This TN also recommends that both morphological differentiation of parasites and other complementary tests (antibody research Bm-14 and DNA *W. bancrofti*) should be carried out by the SRNF/CPqAM/Fiocruz-PE[21,22,24].

Only 1/15 immigrants had undergone other complementary tests (TBF, DQM, Og4C3-ELISA, antibody research Bm-14 and DNA *W. bancrofti*), confirming the results found by the LFDIL and in all cases tested positive for infection with *W. bancrofti*. This individual had a parasite load of 34 microfilariae/mL. Jayasekera *et al*. draw attention to the high capacity of *C. quinquefasciatus* to become infected when feeding on people with very different levels of microfilaremia and even those with very low levels (< 5 microfilariae/mL) were capable of producing infectious larvae (L3)[34]. These authors also observed that with a density of between 31 and 100 microfilariae/mL, 165/259 (63.7%) of the mosquitoes dissected were infected, with an average of 3.27 (1–15) L3 per mosquito. It should be noted that in both the Republic of Haiti and Brazil, the main vector of LF is *C. quinquefasciatus*, with a high prevalence and density of individuals in both countries[30,35].

In the case of the other positive cases (14/15) that did not undergo parasitological research, it is possible that this group contains individuals with microfilariae, given that 46.7% of these individuals come from the Gonaives District, categorized as a highly endemic area, with CFA > 10%[25]. The Republic of Haiti was the first country in the Americas to carry out MDA with a combination of DEC and albendazole, in the city of Léogâne, with extensive social mobilization and successful distribution of medication to the population. The National Program for Elimination of Lymphatic Filariasis in Haiti (NPELFH) was able to expand this pilot MDA, undertaken in 2000, to other endemic regions of the country. Despite all the NPELFH's efforts to maintain and expand MDA over the past 14 years, financial, political and climate problems have led to discontinue MDA in various areas of the country, preventing the expansion of MDA to other districts[36]. According to Oscar *et al*., a MDA was scheduled in the Gonaives District in 2008[36]. However, successive hurricanes in this region caused frequent flooding and the implementation of the MDA was not possible. Furthermore, in 2010, earthquake interrupted the NPELFH itself and it was only in 2012 that the NPELFH was able to cover all endemic areas of the country with at least one MDA cycle. The World Health Organization recommends 4–6 cycles of treatment. In this study, over 24% of the Haitian immigrants testing negative on the point of care AD12-ICT card test were from Gonaives District. Some of these individuals who were reported to participate in an MDA cycle (data not shown) that might not have been enough to overcome the infection, but may have decreased the parasite load. Iqbal and Sher conducted a study in Kuwait to determine the prevalence of LF in groups of immigrants from India, the Philippines and Sri Lanka[37]. The authors found that the point of care AD12-ICT card test failed to detect CFA in a group of individuals with microfilariae and low parasite load (< 20 microfilariae/mL), suggesting a decrease in sensitivity of the point of care AD12-ICT card test in cases of low parasitaemia. If so, probably the Gonaives immigrants (prevalence in this area > 10%) testing negative on the LFDIL CFA by point of care AD12-ICT card test can be infected with low or very low microfilaremia, which, nevertheless, has the potential to infect the *C. quinquefasciatus* vector present throughout the national territory of Brazil[30,34].

There is still a large gap in scientific knowledge regarding the potential of immigrants to contribute to the development of a new source of LF and/or re-transmission in areas under control (microfilaremia > 1 or CFA by point of care AD12-ICT card test > 2%) after several cycles of MDA[38]. A recent review conducted by Ramaiah assesses the extent to which immigrants may jeopardize the achievements of elimination programs, particularly when the local *Culex* strain is highly susceptible to infection[27]. The author highlights four categories of immigrants that may affect the efforts of the LF elimination plan: A) immigrants from endemic areas migrating to non-endemic areas; B) immigrants from rural to urban areas; C) immigrants from endemic areas to areas with control/elimination of LF and D) immigrants in border areas. In Brazil, there are three classifications regarding the situation of the LF: 1) non-endemic areas; 2) areas with control/elimination of LF and 3) former foci where LF is considered to have been eliminated[10,12-14]. Immigrants from countries endemic for LF can be found in all areas and according to Ramaiah classification, immigrants of category A and C are found in Brazil[16,17,19,27]. However, Hairston and de Meillon reported the inefficiency of transmission of *W. bancrofti* from *C. quinquefasciatus* to human[39]. The authors suggest that it would take 15 500 bites by L3 *Culex* to infect an individual. They also conclude that the individual would need to have had contact with > 9 000 L3 before becoming microfilaremic, which would require an average of 298 bites per year. Furthermore, evaluation of other powerful vectors of *W. bancrofti* (*Aedes* and *Anopheles*) in different parts of the world indicates that between 2 700 and 100 000 infective bites are needed for each new case of microfilaremia[40]. Recent data contest this evaluation of vector-host transmission efficiency[41]. Jones points out that if there were such a high inefficiency of transmission, it would not be possible to detect microfilaremia in children in endemic areas, since they would allegedly have been exposed to a significantly smaller number of infectious bites than the number estimated by the authors cited above[41]. Furthermore, Wartman also draws attention to the case of a US serviceman who became infected during a short period of exposure (1 year) while serving the army in the South Pacific during World War II[42]. Notification of acquiring LF in short-term tourists and travelers in endemic areas is not very common, particularly infection with *W. bancrofti*. On the other hand, Rubin used fine-needle aspiration cytology of a nodule in the neck of an individual who spent a short period of time in Nepal and India to demonstrate the presence of *W. bancrofti* microfilariae[43]. Another recent case of short-term exposure to infective larvae of *W. bancrofti* leading to infection, occurred with a US missionary/volunteer who spent a week in the city of Leogane, Haiti, an area known to be hyperendemic. This city, despite having undergone seven cycles of MDA, was still capable of transmitting *W. bancrofti*[44,45].

The data reported above regarding the acquisition of LF in a short period of time (ranging from 1 week to 1 year), raise the following question: despite the inefficiency of transmission of *W. bancrofti* from *C. quinquefasciatus* pointed to by Hairston and de Meillon[39], would it be possible for migrants with microfilariae to introduce or re-introduce the transmission cycle of LF in areas where LF is under control, but which have a high density of the *C. quinquefasciatus* vector, which is present in most regions of Brazil? This question as yet remains unanswered, since this study is the first to present data that point to a high prevalence of LF in migrants from areas endemic for LF. Other studies, however, have attributed the spread

of LF around the world from the migration of infected individuals to non-endemic areas, possibly introducing the transmission cycle or creating new endemic areas[40].

The presence of the appropriate vector, and its ability to sustain transmission, is one of the main requirements for such dissemination to occur. As the main vector, in both Brazil and Haiti, is *C. quinquefasciatus*, which is highly susceptible to infection, and the same strain of *W. bancrofti* may be present in Brazil as in Haiti, it may be possible to maintain the LF transmission cycle in areas 1, 2 and 3 of Brazil, as per the classification previously mentioned[30,35,40]. According to the news media, there is a higher concentration of immigrants in the south and southeast regions of Brazil, which are traditionally non-endemic regions for LF, except for the southern part of the state of Santa Catarina, where positive cases were reported in 1951 and 1967[14,16,17]. As it is a silent progressive disease, *W. bancrofti* infection is usually subclinical and does not show any specific signs or symptoms (such as itching, edema or subcutaneous evident urogenital problems). Thus, clinical identification of cases of LF is a big challenge in non-endemic areas. It is therefore of great importance that the medical staff in these areas have a high degree of clinical suspicion of LF, given the presence of this population of immigrants from endemic areas.

It also highlights that many Haitian immigrants return to their home towns and many of these areas today have completed 4–6 rounds of MDA and are carrying out a transmission assessment survey[12]. Thus, the return of native microfilariae may jeopardize the success achieved by the NPELFH and could restart the transmission cycle of LF in areas already considered under control. The *sine qua non* for the success of PGELF is reducing microfilaremia in the blood of infected individuals to a level that makes maintenance of the vector transmission cycle unsustainable. To achieve this, it is important to keep up active surveillance to identify and treat individuals with microfilaremia.

Finally, the surveillance system should be simple and active, with targeted actions that can be easily implemented by the healthcare system to systematically identify and treat positive cases of LF, thereby sustaining the progress made by the NPELF[12]. To achieve this goal, the following surveillance strategy activities are recommended: 1) training of technicians from municipal laboratories and state LACENs in collection of thick blood samples and the point of care AD12-ICT card test; 2) in positive cases, following the protocol issued by the Brazilian Ministry of Health through the NT; 3) training Family Health Program health workers to identify and advise immigrants on the importance of undergoing the LFDIL, focusing on the preservation of their health and their families; 4) raising awareness and encouraging immigrants from areas endemic for LF to undergo the LFDIL exams. Actions such as lectures in churches, associations, and companies that have higher concentrations of workers and institutions that represent these individuals are possible starting points for such guidance; 5) maintaining active surveillance on the borders of Brazil that have the largest influx of immigrants; 6) the medical profession in non-endemic areas needs to be aware and to be trained to perform differential diagnosis among this immigrant population coming from areas endemic for LF and 7) for all investigated individuals, using the official Brazilian Health System (Ministry of Health) to release the results of the negatives and of the positives treated and, after laboratory screening, releasing their cure certificates.

In conclusion, this surveillance action, conducted in partnership with the various health institutions in Brazil, to identify LF carriers among immigrants from endemic areas has produced pioneering results that clearly reveal that there is an influx of immigrants carrying LF to Brazil and points to the urgent need to step up surveillance on the busiest borders. As LF is a silent and progressive parasitic disease, it is extremely important that healthcare professionals are properly trained to identify and encourage immigrants to undergo diagnostic tests for infection with *W. bancrofti* and other parasites (and all testing positive to be treated with DEC), thereby safeguarding both their own health and that of their families and all the benefits that NPELF has given Brazil. It is noteworthy that Haiti, despite all the adversities the NPELFH suffered, has established MDA since 2000, covering all endemic areas of the country, with satisfactory coverage. It is thus critical that Haitian immigrants are diagnosed and treated so that they do not return to their hometowns and potentially restart the cycle of transmission in areas where this has been broken.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

This surveillance action was funded by the Department of Health Surveillance/Oswaldo Cruz Foundation/Foundation for Technological Development in Health-Vice-President for Research and Referral Laboratories (Fiocruz/FIOTECVPPLR)-002-LIV11-2-1 Project. General Coordination of Hanseniasis and Diseases under Elimination, Department of Health Surveillance/Ministry of Health, DF and the Acre State Department of Health is also appreciated.

References

[1] Center for Diseases Control and Prevention. Recommendations of international task force for disease eradication. *MMWR Morb Mortal Wkly Rep* 1993; **42**(16): 1-38.

[2] Rebollo MP, Bockarie MJ. Shrinking the lymphatic filariasis map: update on diagnostic tools for mapping and transmission monitoring. *Parasitology* 2014; **141**(14): 1912-7.

[3] World Health Organization. Global programme to eliminate lymphatic filariasis: progress report for 2012. *Wkly Epidemiol Rec* 2013; **88**(37): 389-400.

[4] World Health Organization. Fiftieth World Health Assembly, Geneva, 5-14 May 1997: resolutions and decisions, annexes. Geneva: World Health Organization; 1997. [Online] Available from: http://apps.who.int/iris/bitstream/10665/179638/1/WHA50_1997-REC-1_eng.pdf [Accessed on 18th May, 2016]

[5] National Health Foundation. National Epidemiology Center. [Elimination Program of lymphatic filariasis in the Americas]. *Bol Epidemiol* 1997; **1**(6): 12. Portuguese.

[6] Ottesen EA. The global programme to eliminate lymphatic filariasis. *Trop Med Int Health* 2000; **5**(9): 591-4.

[7] World Health Organization. Monitoring and epidemiological assessment of the programme to eliminate lymphatic filariasis at implementation unit level. Geneva: World Health Organization; 2005. [Online] Available from: http://apps.who.int/iris/bitstream/10665/179638/1/WHA50_1997-REC-1_eng.pdf [Accessed on 18th May, 2016]

[8] Cano J, Rebollo MP, Golding N, Pullan RL, Crellen T, Soler A, et al. The global distribution and transmission limits of lymphatic filariasis: past and present. *Parasit Vectors* 2014; **7**(1): 466-85.

[9] World Health Organization. Global programme to eliminate lymphatic filariasis. *Wkly Epidemiol Rec* 2014; **89**(38): 409-20.

[10] Superintendency of Public Health Campaigns. [*The control of endemic diseases in Brazil (1979-1984)*]. Brasilia: Ministry of Health; 1985, p.

154. Portuguese.

[11] Maciel A, Rocha A, Marzochi KB, Medeiros Z, Carvalho AB, Regis L, et al. Epidemiological study of bancroftian filariasis in Recife, northeastern Brazil. *Mem Inst Oswaldo Cruz* 1996; **91**(4): 449-55.

[12] Pan American Health Organization. [Lymphatic filariasis elimination in the Americas: 15th Regional Program Managers Meeting]. San Jose: Costa Rica Pan American Health Organization; 2014, p. 52. Portuguese.

[13] Pernambuco. State Health Department. Filariasis: PE hosts international event; 2015. [Online] Available from: http://portal.saude.pe.gov.br/noticias/secretaria-executiva-de-vigilancia-em-saude/filariose-pe-sedia-evento-internacional [Accessed on 18th May, 2016].

[14] Schlemper BR Jr, Steindel M, Grisard EC, Carvalho-Pinto CJ, Bernardini OJ, de Castilho CV, et al. Elimination of bancroftian filariasis (*Wuchereria bancrofti*) in Santa Catarina state, Brazil. *Trop Med Int Health* 2000; **5**(12): 848-54.

[15] Ottesen EA, Duke BO, Karam M, Behbehani K. Strategies and tools for the control/elimination of lymphatic filariasis. *Bull World Health Organ* 1997; **75**(6): 491-503.

[16] Rollsing C, Trezzi H. [New immigrants change the Rio Grande do Sul scenario]; 2014. [Online] Available from: http://zh.clicrbs.com.br/rs/noticias/noticia/2014/08/novos-migrantes-mudam-o-cenario-do-rio-grande-do-sul-4576728.html [Accessed on 18th May, 2016] Portuguese.

[17] Trezzi H. [Brazil adds 120000 immigrant workers]. [Online] Available from: http://zh.clicrbs.com.br/rs/noticias/noticia/2014/11/brasil-soma-120-mil-trabalhadores-imigrantes-4641728.html [Accessed on 18th May, 2016] Portuguese.

[18] Fellet J, Kawaguti L. [Sending Haitians SP opens wide migration crisis; understand]. São Paulo: British Broadcasting Corporation; 2014. [Online] Available from: http://www.bbc.com/portuguese/noticias/2014/04/140425_haitianos_entenda_jf.shtml [Accessed on 18th May, 2016] Portuguese.

[19] Fulgêncio C. [In BC, immigrants do tests elephantiasis, malaria and Chagas disease]. [Online] Available from: http://g1.globo.com/ac/acre/noticia/2014/09/no-ac-imigrantes-fazem-exames-de-elefantiase-malaria-e-mal-de-chagas.html [Accessed on 18th May, 2016] Portuguese.

[20] Rocha A, Lima G, Medeiros Z, Aguiar-Santos A, Alves S, Montarroyos U, et al. Circulating filarial antigen in the hydrocele fluid from individuals living in a bancroftian filariasis area-Recife, Brazil: detected by the monoclonal antibody Og4C3-assay. *Mem Inst Oswaldo Cruz* 2004; **99**(1): 101-5.

[21] Rocha A, Braga C, Belém M, Carrera A, Aguiar-Santos A, Oliveira P, et al. Comparison of tests for the detection of circulating filarial antigen (Og4C3-ELISA and AD12-ICT) and ultrasound in diagnosis of lymphatic filariasis in individuals with microfilariae. *Mem Inst Oswaldo Cruz* 2009; **104**(4): 621-5.

[22] Oliveira P, Braga C, Alexander N, Brandão E, Silva A, Wanderley L, et al. Evaluation of diagnostic tests for *Wuchereria bancrofti* infection in Brazilian schoolchildren. *Rev Soc Bras Med Trop* 2014; **47**(3): 359-66.

[23] Weil GJ, Curtis KC, Fischer PU, Won KY, Lammie PJ, Joseph H, et al. A multicenter evaluation of a new antibody test kit for lymphatic filariasis employing recombinant *Brugia malayi* antigen Bm-14. *Acta Trop* 2011; **120**(1): S19-22.

[24] Ximenes C, Brandão E, Oliveira P, Rocha A, Rego T, Medeiros R, et al. Detection of *Wuchereria bancrofti* DNA in paired serum and urine samples using polymerase chain reaction-based systems. *Mem Inst Oswaldo Cruz* 2014; **109**(8): 978-83.

[25] Huppatz C, Durrheim D, Lammie P, Kelly P, Melrose W. Eliminating lymphatic filariasis--the surveillance challenge. *Trop Med Int Health* 2008; **13**(3): 292-4.

[26] Kia EB, Sharifdini M, Hajjaran H, Shahbazi AE, Sayyad-Talaie Z. Impoted lymphatic filariasis in an Indian immigrant to Iran. *Iran J Parasitol* 2014; **9**(1): 145-8.

[27] Ramaiah KD. Population migration: implications for lymphatic filariasis elimination programmes. *PLoS Negl Trop Dis* 2013; **7**(1): e2079.

[28] Toothong T, Tipayamongkholgul M, Suwannapong N, Suvannadabba S. Evaluation of mass drug administration in the program to control imported lymphatic filariasis in Thailand. *BMC Public Health* 2015; **15**(1): 975.

[29] Wanji S, Amvongo-Adjia N, Koudou B, Njouendou AJ, Chounna Ndongmo PW, Kengne-Ouafo JA, et al. Cross-reactivity of filariasis ICT cards in areas of contrasting endemicity of *Loa loa* and *Mansonella perstans* in Cameroon: implications for shrinking of the lymphatic filariasis map in the Central African region. *PLoS Negl Trop Dis* 2015; **9**(1): e0004184.

[30] Ministry of Health. Secretariat of Health Surveillance. [*Guidelines for surveillance and elimination of lymphatic filariasis*]. Brasilia: Ministry of Health; 2009, p. 83. Portuguese.

[31] Carme B, Boulesteix J, Boutes H, Puruehnce MF. Five cases of encephalitis during treatment of loiasis with diethylcarbamazine. *Am J Trop Med Hyg* 1991; **44**(6): 684-90.

[32] Boussinesq M, Gardon J, Gardon-Wendel N, Chippaux JP. Clinical picture, epidemiology and outcome of *Loa*-associated serious adverse events related to mass ivermectin treatment of onchocerciasis in Cameroon. *Filaria J* 2003; **2**(1): S4.

[33] Secretariat of Health Surveillance. [*Guidelines on the monitoring of lymphatic filariasis*]. Brasilia: Ministry of Health; 2013, p. 57. Portuguese.

[34] Jayasekera N, Kalpage KS, De Silva CS. The significance of low density microfilaraemia in the transmission of *Wuchereria bancrofti* by *Culex* (*Culex*) *quinquefasciatus* Say in Sri Lanka. *Trans R Soc Trop Med Hyg* 1991; **85**(2): 250-4.

[35] Ben-Chetrit E, Schwartz E. Vector-borne disease in Hati: a review. *Travel Med Infect Dis* 2015; **13**(2): 150-8.

[36] Oscar R, Lemoine JF, Direny AN, Desir L, de Rochars VEMB, Poirier MJP, et al. Haiti national program for the elimination of lymphatic filariasis-A model of success in the face of adversity. *PLoS Negl Trop Dis* 2014; **8**(7): e2915.

[37] Iqbal J, Sher A. Determination of the prevalence of lymphatic filariasis among migrant workers in Kuwait by detecting circulating filarial antigen. *J Med Microbiol* 2006; **55**(4): 401-5.

[38] World Health Organization. Transmission assessment surveys in the global programme to eliminate lymphatic filariasis. Geneva: World Health Organization; 2015. [Online] Available from: http://apps.who.int/iris/bitstream/10665/77690/1/WHO_HTM_NTD_PCT_2012_9_eng.pdf [Accessed on 18th May, 2016].

[39] Hairston NG, de Meillon B. On the inefficiency of transmission of *Wuchereria bancrofti* from mosquito to human host. *Bull World Health Organ* 1968; **38**(6): 935-41.

[40] Southgate BA. Recent advances in the epidemiology and control of filarial infections including entomological aspects of transmission. *Trans R Soc Trop Med Hyg* 1984; **78**(1): 19-28.

[41] Jones RT. Non-endemic cases of lymphatic filariasis. *Trop Med Int Health* 2014; **19**(11): 1377-83.

[42] Wartman WB. Filariasis in American armed forces in World War II. *Medicine (Baltimore)* 1947; **26**(4): 333-96.

[43] Rubin A. Filariasis in a tourist diagnosed by fine needle aspiration cytology. *Cytopathology* 2002; **13**(6): 383-4.

[44] Boyd A, Won KY, McClintock SK, Donovan CV, Laney SJ, Williams SA, et al. A community-based study of factors associated with continuing transmission of lymphatic filariasis in Leogane, Haiti. *PLoS Negl Trop Dis* 2010; **4**(1): e640.

[45] Marcos LA, Shapley NP, Eberhard M, Epstein JI, Fox LM, Magill A, et al. Testicular swelling due to lymphatic filariasis after brief travel to Haiti. *Am J Trop Med Hyg* 2014; **91**(1): 89-91.