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REVIEW

After 70 years of fighting an age-old scourge, onchocerciasis in Uganda, the end is in sight

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Onchocerciasis causes severe itching, serious skin disease and ocular damage leading to visual impairment or permanent blindness. It is associated with hanging groin, epilepsy, Nakalanga dwarfism and, most recently, nodding disease. This disease affected communities in 17 transmission foci in 37 districts of Uganda, where about 6.7 million people are once at risk. The efforts against onchocerciasis in Uganda commenced in the late 1940s, when vector control was launched using dichlorodiphenyltrichloroethane; by 1973, *Simulium damnosum* had been eliminated in the Victoria focus. Success outside of the Victoria focus was short-lived due to changes in government priorities and the political upheavals of the 1970s and 1980s. With the return of political stability, annual treatment with ivermectin through mass drug administration was launched in the early 1990s. Control of the disease has been successful, but there has been failure in interrupting transmission after more than 15 years. In 2007 Uganda launched a nationwide transmission elimination policy based on twice-per-year treatment and vector control/elimination, with a goal of eliminating river blindness nationwide by 2020. By 2017, 1 157 303 people from six foci had been freed from river blindness. This is the largest population ever declared free under World Health Organization elimination guidelines, providing evidence that elimination of river blindness in Africa is possible.

Keywords: Onchocerciasis, Control, Elimination, Larvicide, Ivermectin

Introduction

Human onchocerciasis is caused by the filarial nematode *Onchocerca volvulus*, which is transmitted by the bites of *Simulium* flies that breed in fast-flowing rivers, hence its common name in Africa, 'river blindness.' Unlike in West Africa, onchocerciasis is a highly focal disease in East and Central Africa, Yemen and the Americas. The disease can cause severe itching, skin lesions and eyesight impairment, and can lead to permanent blindness when not treated.[1] It has been hypothesized that onchocerciasis is responsible for a condition known as 'Nakalanga syndrome,' a form of dwarfism that is observed in some parts of Uganda with high onchocerciasis prevalence rates,[2,3] and has been associated with epilepsy and 'nodding syndrome.'[4] In addition, 'hanging groin' and hernia are also known complications of the disease.

Early history of onchocerciasis in Uganda

In the late 1950s it was estimated that at least 1.18 million people out of a total population of 6.5 million living in Uganda were at risk of being infected with onchocerciasis.[5] About 40% (472 000) of the at-risk population were estimated to be infected with onchocerciasis. In Uganda, the vectors of onchocerciasis include *Simulium neavei*, which develops in a phoretic association with freshwater crabs, and members of the *Simulium damnosum* complex.[5] It is known that *S. damnosum* thrives at low altitudes and in warm, open, fast-running rivers and streams. *S. damnosum* has a long flight range of 45 to 65 km from its breeding sites and does not need corridors of bush for protection.[6] In contrast, *S. neavei* requires a closed canopy that provides shade to migrate and tends to breed at a higher altitude than *S. damnosum*. *S. neavei* is usually found in moist,

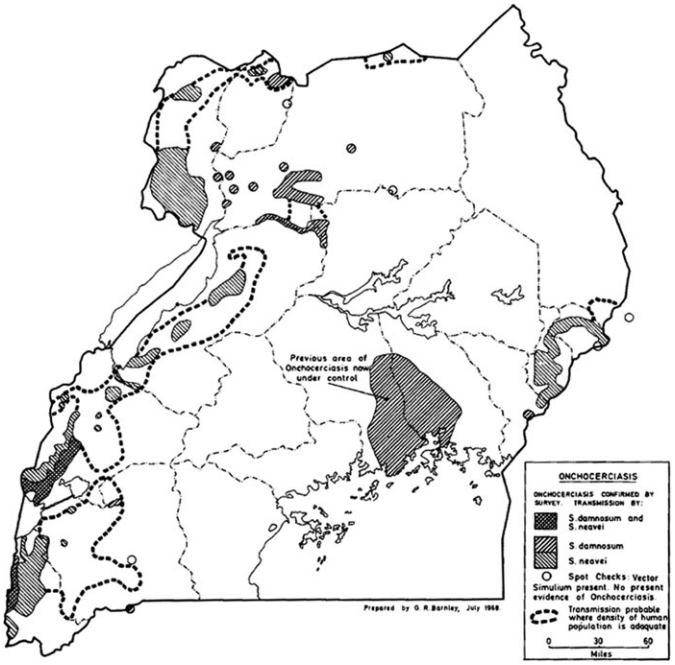

Figure 1. Map of Uganda showing the status of onchocerciasis in 1975.[1]

cool, green forests, as well as riverine fringing forest environments. Their flight range of less than 6 km is much less than *S. damnosum*.[7]

The main historical habitats for *S. damnosum* s.l. in Uganda during the 1950s were the Victoria Nile River, where Christy originally described *S. damnosum*, with almost 100% of the inhabitants afflicted with onchocerciasis; the Murchison Nile from the Atura River ending in Murchison Falls; and the Rwenzori focus that extended into the Democratic Republic of the Congo (DRC), with a prevalence of onchocerciasis ranging from 54 to 91%.[6]

Onchocerciasis transmitted by *S. neavei* was originally reported in the following areas of Uganda: Budongo Forest, where the baseline skin microfilaria (mf) rate for sawmill workers was 78%, and 46% among students in the forestry college[8]; Mount Elgon, where the baseline mf prevalence rate was 80%; West Nile, where the mf prevalence rate was 56%[3]; and Kigezi (now known as the Bwindi focus), where the prevalence rate was 80%[9] (Figure 1). In 1973 a new onchocerciasis focus east and southeast of Lake George (now designated the Kashoya-Kitomi focus) was reported, but no prevalence rate was provided.[10]

Control of onchocerciasis (1950–1973)

Previously, dichlorodiphenyltrichloroethane (DDT) was widely used for onchocerciasis control in Uganda. Successful intermittent control efforts in the Victoria Nile focus on the Nile River commenced in 1952.[11,12] This resulted in *S. damnosum* elimination along a 70 km stretch of the Nile River between Lake Victoria and Lake Kyoga by 1973. In 1974, after a military coup, all the expatriate leaders of national vector control activities were forced to leave Uganda and further monitoring of the Victoria Nile focus was halted; however, activities by the Vector Control Division of the Ministry of Health continued there until 1977.

In the Murchison Nile focus, a trial of DDT vector control of *S. damnosum* was attempted in 1959 to protect workers constructing a hydroelectric power station. After that trial a reinvasion by *S. damnosum* from Atura on the Murchison Nile was documented.[13] In 1971, DDT larviciding was extended to cover the whole Rwenzori focus.[13] In the Budongo *S. neavei* focus, the vector was nearly eliminated by 1962.[14,15] Mass drug administration (MDA) with diethylcarbamazine citrate (DEC) was also provided.[15] In the Mount Elgon focus, vector control was initiated in 1957, and in 1972 the prevalence was determined to have dropped to 5–10%. Vector control was also piloted in the West Nile focus in 1955.[3] In the Kigezi onchocerciasis endemic area, DEC was provided to patients at health facilities until 1992, when the program introduced ivermectin through community-based MDA programs. There is no evidence that any vector control or MDA was carried out in the Kashoya-Kitomi onchocerciasis focus during this period.

Re-establishment of the national onchocerciasis control program (1987–2006)

In 1987, MSD, also known as Merck & Co., Inc., Kenilworth, NJ, USA, committed to donating ivermectin (Mectizan) 'as long as necessary' for the control of onchocerciasis, an event that coincided with the return of peace to Uganda. In 1989, the Uganda Foundation for the Blind, with Sightsavers' funding, began mass treatment with ivermectin in the Budongo onchocerciasis focus. Treatment with ivermectin followed in the Itwara onchocerciasis focus of western Uganda in the Kabarole and Kyejonjo districts, with assistance from the German Technical Cooperation Agency (GTZ). However, it was not until mid-1992 that a comprehensive and systematic nationwide program was established, led by the Uganda Ministry of Health with support from the River Blindness Foundation (RBF). The Maracha-Terego focus in Maracha and Terego counties and the West Nile focus in the Maracha-Terego, Koboko and Yumbe districts provided treatment from 1993 to 1996, supported by the Christoffel Blinden Mission (CBM). Apart from northern Uganda, most onchocerciasis endemic areas were mapped during early and mid-1990s with support from the RBF and the United Nations Children's Fund, United Nations Development Programme, World Bank and World Health Organization (WHO) Program for Research and Training in Tropical Disease Research (TDR). A nationwide rapid epidemiological mapping of onchocerciasis (REMO) based on rapid epidemiological assessment with nodule palpation in *S. damnosum* and *S. neavei* areas was conducted between 1993 and 1997 (Figure 2).[16,17] In 1996, The Carter Center assumed responsibility for the RBF and later in the year a partnership program known as the African Programme for Onchocerciasis Control (APOC) was launched with World Bank trust funds and the WHO as its executing agency. By 1996 the Uganda Onchocerciasis Control Programme had received financial support from the APOC, Sightsavers (the Bulisa, Hoima and Masindi districts) and The Carter Center (assisting the other endemic districts in the country).[18]

Comprehensive assistance for community-directed treatment with ivermectin (CDTI) from the APOC was provided for 5 years. Afterwards, APOC financial support was more limited and

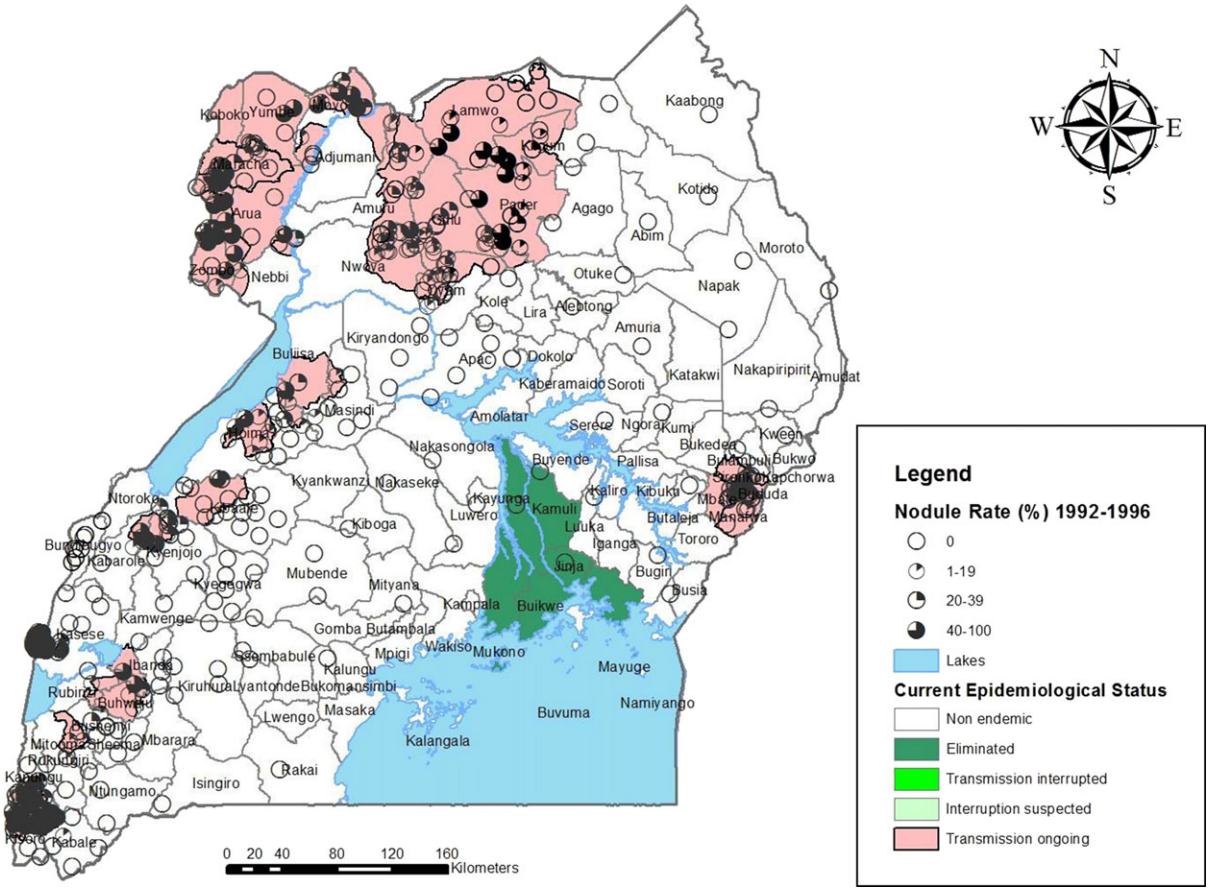

Figure 2. REMO map of Uganda showing the status of onchocerciasis in 1996.

focused on replacement of capital equipment and advocacy. The goal of the APOC and Uganda at the time was to control the disease as a public health problem by limiting the morbidity arising from the disease, thereby fostering economic development. The control approach was not expected to interrupt transmission of the infection, with the exception of two *S. neavei* foci (Mpamba-Nkusi and Itwara), where the APOC supported ground larviciding for vector elimination activities. These two foci made considerable progress, proving the durability of localized vector elimination in *S. neavei* areas after 2–3 years of larviciding.[19,20]

Inspiration from the Americas

Uganda policymakers were concerned that the country, with more than 50 years of sporadic onchocerciasis control activities, could not continue with business as usual. With the return of peace and political stability nationwide, the government of Uganda was keen to break the legacy of onchocerciasis, interrupt its transmission and achieve national elimination. Noting that the 2001 Conference on Eradicability of Onchocerciasis at The Carter Center indicated the feasibility of onchocerciasis elimination in the Americas,[21,22] Ugandan policymakers began to study the Onchocerciasis Elimination Program for the Americas (OEPA) twice-per-year treatment policy. In particular, rethinking onchocerciasis elimination gained traction with the publication of a report by Cupp and Cupp.[23] In this report, data analysis from the Americas concluded that twice-per-year ivermectin MDA achieving ≥85% eligible population coverage reduced the lifespan of adult *O. volvulus*, leading to their demise within 6.5 years. A pilot onchocerciasis elimination project using twice-yearly ivermectin treatment in the Wadelai focus of Uganda conducted in 2005–2006 found that CDTI could attain a treatment coverage of at least 90% of the eligible population in both rounds.[24] At the same time, a combination of vector control and ivermectin treatment in some foci was found to be an effective approach for rapid transmission interruption.[25]

In 2006, a delegation from the Ministry of Health of Uganda travelled to Guatemala to attend the Inter-American Conference on Onchocerciasis (IACO). While attending the IACO meeting, the Uganda delegation visited the Universidad del Valle de Guatemala/Centers for Disease Control laboratory that was providing laboratory-based molecular testing to verify progress towards elimination for OEPA. They learned about lab training and equipment requirements for conducting enzyme-linked immunosorbent assay (ELISA) tests for detecting IgG4 antibodies to the OV16 recombinant antigen and vector pool screening for *O. volvulus* DNA using the O-150 polymerase chain reaction (PCR).[26] Energized by their visit, the delegates returned home determined to undertake a nationwide elimination effort in Uganda.

A national elimination policy (2007–2016)

The Uganda Ministry of Health crafted a new policy for nationwide onchocerciasis transmission elimination that was launched by the president of Uganda, His Excellency, Yoweri Museveni, at a national meeting held in Kampala in January 2007. The renamed Uganda Onchocerciasis Elimination Program (UOEP) had several charges. First, it was no longer business as usual, and all tools (ivermectin and vector control) were to be used in combination when and where necessary. Twice-per-year ivermectin treatment was to be the norm except in areas where once-per-year had been clearly effective in breaking transmission. Second, a molecular laboratory based on the Guatemala model was established to help monitor progress towards elimination. Third, an independent technical advisory committee, the Uganda Onchocerciasis Elimination Expert Advisory Committee (UOEEAC), was established to help the ministry progress towards nationwide elimination. Key assisting partners (The Carter Center, Lion Clubs of Uganda and Lion Clubs International Foundation [LCIF], Mectizan Donation Program and Sightsavers) would have seats on the UOEEAC. The UOEP and UOEEAC embarked on the following:

Refining the onchocerciasis map and launching twice-per-year treatment

The UOEP aggressively embarked on refining and completing the onchocerciasis map of Uganda in order to include any hypoendemic communities that may have been left untreated. Vector elimination was achieved in the Victoria focus and (likely) in the Itwara and Mpamba-Nkusi foci in 2007 (Figure 3). A population of 4.9 million people living in 37 districts were still at risk of onchocerciasis in 16 foci (not counting Victoria) and transmission interruption appeared to have been reached in the Nyamugasani, Maracha-Terego, Obongi, Imaramagambo, Itwara and West Nile foci. Twice-per-year treatment with ivermectin through CDTI continued in Wadelai and was launched in the Budongo, Bwindi, Kashoya-Kitomi, Mount Elgon and Mpamba-Nkusi foci in 2007, Wambabya-Rwamarongo in 2008 and later in Nyagak-Bondo (2012), Madi-Mid North (2013) and Lhubiriha (2015).

Establishment of the molecular laboratory

In 2008 the Ministry of Health provided space for the UOEP's molecular laboratory at the Vector Control Division as well as personnel to run it. The Carter Center provided equipment and financial support to the laboratory and the University of South Florida laboratory trained the Uganda laboratory personnel. The new laboratory has allowed close monitoring of the impact of interventions on onchocerciasis transmission. Its experience, the largest operation among onchocerciasis molecular laboratories in Africa, has been published.[26] By mid-2016 it had analysed more than 65 000 blood spot samples with the OV16 ELISA, as well as thousands of *Simulium* flies and skin snips from some foci using the O-150 PCR. The University of South Florida continues to ensure acceptable quality control standards.

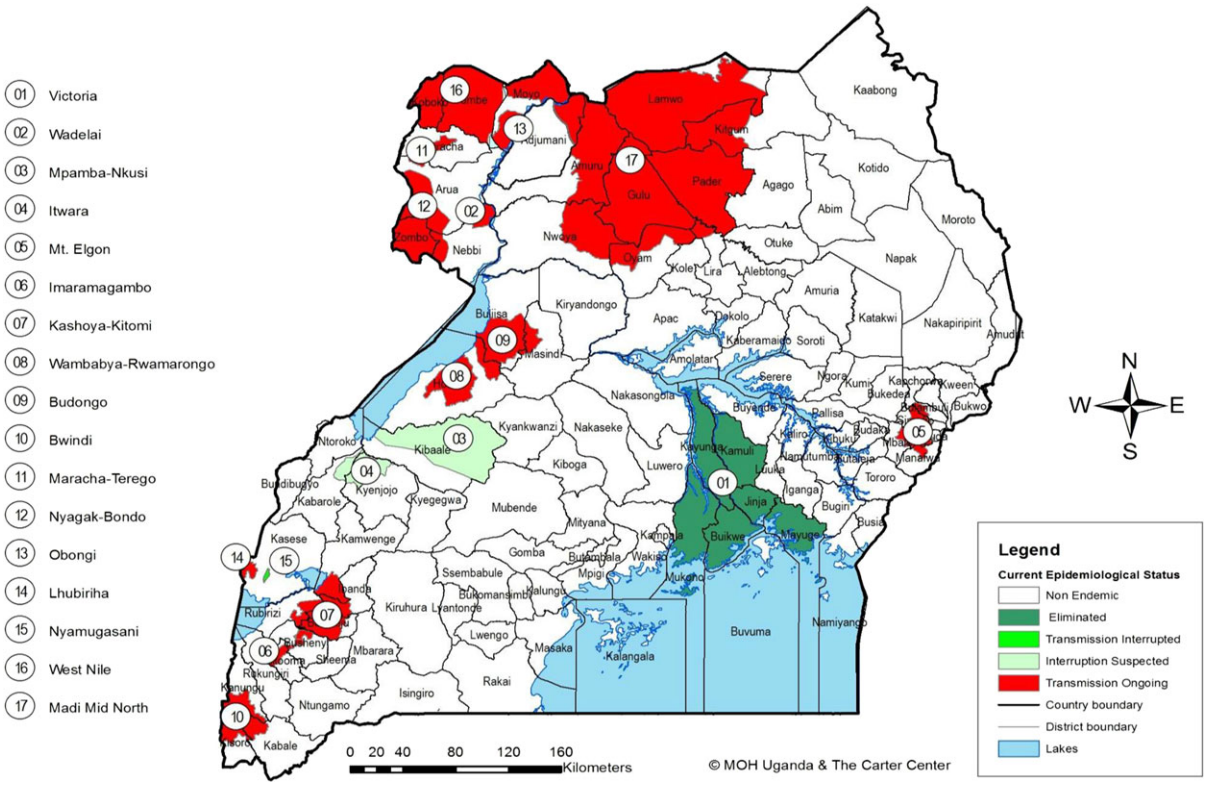

Figure 3. Map of Uganda showing the status of onchocerciasis in 2007.

Uganda Onchocerciasis Elimination Expert Advisory Committee

The UOEEAC held its first meeting in 2008. Its membership is comprised of the Ministry of Health (including representatives from district health services), non-governmental development organization partners and independent national and international experts on the disease. The WHO and Mectizan Donation Program representatives are usually in attendance as observers.[27–29] The UOEEAC provides technical advice to the UOEP through review, monitoring and evaluation of each of the 17 foci and recommends effective approaches and methods for hastening onchocerciasis elimination. The UOEEAC also reviews strategic guidelines from various onchocerciasis global or regional technical committees and vets them from the Ugandan perspective. It meets once a year in Kampala, Uganda. The UOEEAC is charged with the provision of credible, independent and cutting-edge technical advice to help Uganda eliminate onchocerciasis by 2020. Second, the expert technical committee is entrusted with the responsibility of providing evidence-based recommendations on the progress of interruption of onchocerciasis transmission to the Ministry of Health for timely decision making. Recommendations from the UOEEAC flow to the National Certification Committee, a technical committee established in the hierarchy of the Ministry of Health structure.

National criteria for determining the elimination of onchocerciasis in Uganda

The first assignment of the UOEEAC was to formulate national guidelines for determining elimination in Uganda. The committee worked to synthesize two different sets of elimination criteria: those based on the 2001 WHO criteria for onchocerciasis elimination[30] and those put forward by the APOC/TDR, as described by Diawara et al.[31] and Traore et al.[32] The UOEEAC drafted the national guidelines and the Ministry of Health reviewed and accepted them in 2011.[27] In its review of the WHO and APOC guidelines the UOEEAC noted a lack of entomological indicators for *S. neavei* areas where elimination of the vector had been achieved. Thus the UOEEAC developed totally new guidelines that used crab collections as one of the principal monitoring elements. The UOEEAC defined *S. neavei* elimination indicators as a lack of positive crabs for larvae/pupae of *S. neavei* species in a series of surveys and the absence of adult flies collected in a defined focus over a period of 3 years implies interruption of transmission of onchocerciasis.[27,29] The UOEEAC's work on developing *S. neavei* guidelines was later incorporated into the revised 2016 WHO onchocerciasis elimination guidelines.[33]

Post-treatment surveillance (PTS) period

After interruption of transmission has been attained and interventions stopped, the focus moves to at least 3 years of PTS activities. Official communication about interruption of transmission and the 3-year PTS period is provided to concerned districts and communities. Surveillance for adult *S. neavei* or crabs infested with *S. neavei* aquatic stages during the PTS period in *S. neavei* foci is continued at intervals deemed adequate for monitoring vector elimination. At the end of the PTS period an OV16 serology survey of children less than 10 years of age is conducted to document that infection rates are <0.1% with 95% statistical confidence. This is in contrast to guidelines for the *S. damnosum* areas, where WHO PTS recommendations call only for an entomological survey that shows infective rates to be <1/2000 (with 95% confidence) or that ATPs are <20 L3/person/year (L3 is the infective larval stage of the filarial worm of Onchocerca volvulus usually in the blackr fly's head and ready to be transmitted to the next human being during bitting). If these PTS criteria are met, the UOEEAC will recommend that the focus concerned be declared 'transmission eliminated' and its population considered free from risk of onchocerciasis.

What has been achieved? Current status in 2017

Uganda is closing in on its goal of eliminating river blindness (onchocerciasis) nationwide by 2020. Six foci have been determined to have met the WHO criteria for elimination by successfully completing the 3-year PTS period: Mpamba-Nkusi, Mount Elgon, Itwara and Imaramagambo (in 2016) and Kashoya-Kitomi and Wambabya-Rwamarongo (in 2017) (Figures 4 and 5). An estimated 1 157 303 persons living in these districts are no longer at risk of acquiring onchocerciasis. To our knowledge, this is the largest population ever declared free of onchocerciasis based on the latest WHO guidelines. These six foci now join the Victoria focus in central Uganda, which achieved elimination in the 1970s, where 2 626 544 people were protected from the infection by ground larviciding with DDT to control the vectors of onchocerciasis. Currently a total of about 3 783 847 Ugandans are no longer at risk of acquiring onchocerciasis. Uganda's accomplishment is evidence that elimination of river blindness may be possible in Africa.

In August 2017 the West Nile and Wadelai foci were reclassified as 'transmission interrupted,' joining the Obongi and Nyamugasani foci. There are three foci (Budongo, Bwindi and Nyagak-Bondo) where interruption of transmission of river blindness is thought to have been achieved. Two of these (Bwindi and Nyagak-Bondo) have cross-border transmission with the DRC and therefore require ascertaining the status of onchocerciasis on the DRC side of the border before declaring transmission interruption in Uganda.

Transmission of river blindness continues in only two of Uganda's original 17 focus areas: the large Madi-Mid North focus (with a population of 1 437 565) and the smaller (population 135 046) Lhubiriha focus (Figure 5). The Madi-Mid North and Lhubiriha foci share a border with the Republic of South Sudan and DRC, respectively.

Lessons learned from the campaign to eliminate onchocerciasis from Uganda

Failure of annual ivermectin treatment to break transmission in some areas

The original approach to the elimination of onchocerciasis transmission in Uganda was to liberally advance from a single annual dose of ivermectin to twice-per-year treatment supplemented

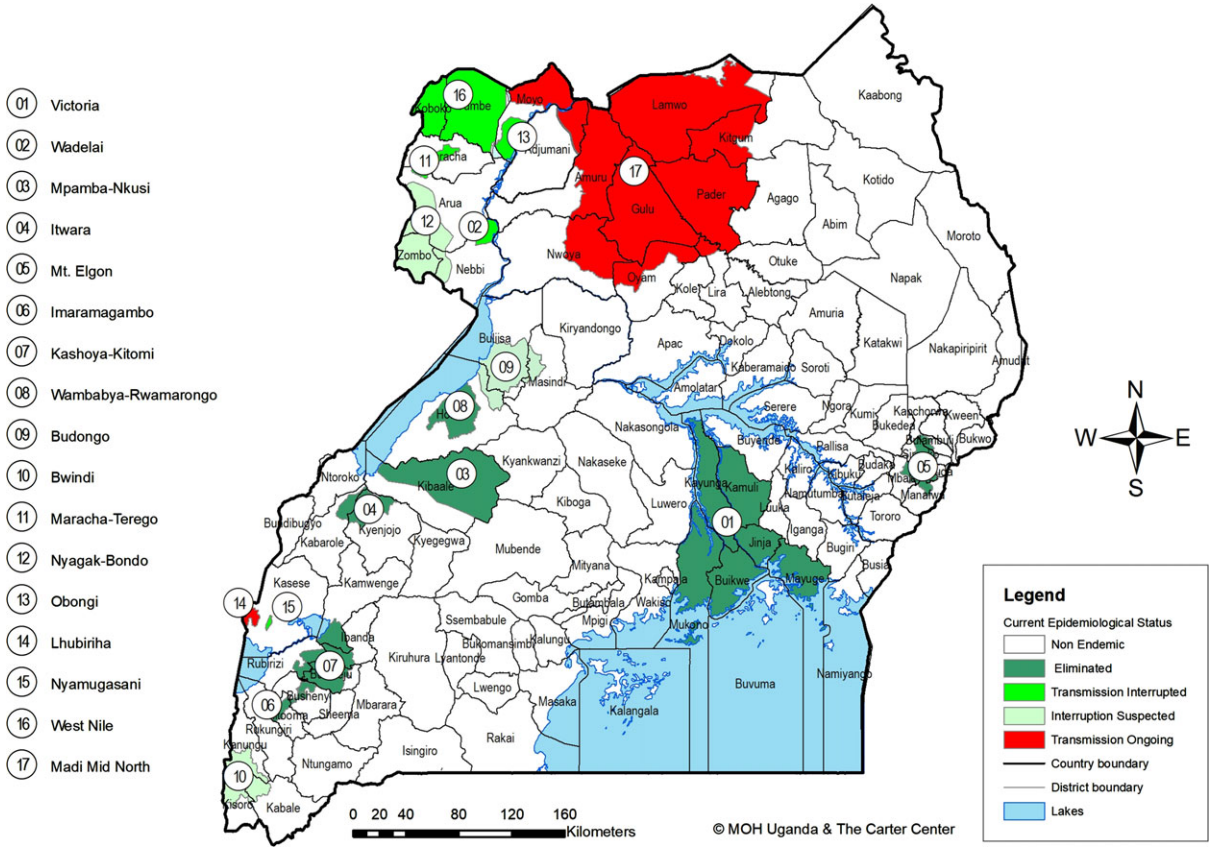

Figure 4. Map of Uganda showing the status of onchocerciasis in 2017.

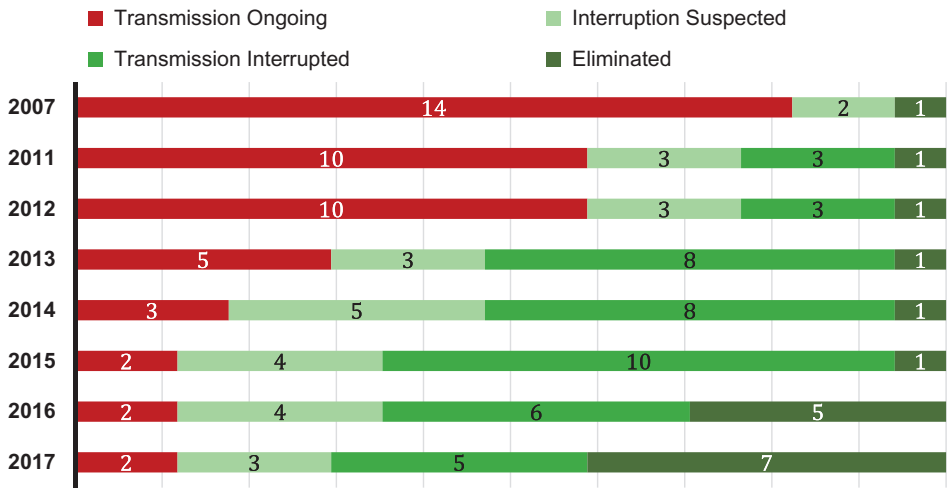

Figure 5. Change in endemic status in foci (n=17) between 2007 and 2017.

with vector control/elimination to accelerate the program toward success by 2020. Twice-per-year was to be used because models predicted that interruption of transmission with an annual treatment program was unachievable in areas with high infection rates.[34,41] Although Diawara et al.[31] demonstrated entomologically that a single annual dose of ivermectin was able to interrupt transmission in foci in Mali and Senegal, failure of annual treatment after 15–25 years has been documented in several areas.[35–40] The important lesson is that a single annual dose of ivermectin administered with adequate coverage may not break transmission if the force of transmission is high.[38–40] Uganda's overarching support for a 'flexible policy' allowed for annual treatment to continue where sufficient progress could be documented.

Lymphatic filariasis (LF) co-endemicity

A number of foci where the national guidelines indicated that ivermectin MDA could be halted could not do so because of co-endemicity with LF. In such foci, the UOEEAC recommended that transmission interruption be declared but that the 3-year PTS period would not begin until LF MDA interventions (with ivermectin and albendazole) were discontinued. Examples of this situation include the Maracha-Terego, West Nile and Wadelai foci (Table 1). Wadelai is a particularly telling example, where onchocerciasis transmission was declared interrupted in 2010 but the PTS period did not begin until 7 years later (2017) when LF MDA was finally halted. Other onchocerciasis–LF co-endemic foci that are likely to encounter this challenge of coordinated PTS are the Nyagak-Bondo and Madi-Mid North foci. The presence of the Ministry of Health LF focal person as a participant (observer status) at the UOEEAC has been particularly important for reporting the status of the LF initiative to allow PTS coordination of the two programs.

Coordination with the LF program has implications for finances, personnel and time given the need for extended monitoring of entomological indicators stipulated in guidelines. It should be noted that while the current WHO onchocerciasis guidelines require that onchocerciasis PTS can only begin after MDA for LF has stopped, the reciprocal situation is not found in LF operating procedures; for example, post-MDA LF surveillance may launch without regard to ongoing onchocerciasis ivermectin monotherapy MDA since the WHO recommended LF treatment is combined therapy.

Cross-border transmission

Uganda has possible cross-border transmission with the DRC in the Bwindi, Lhubiriha and Nyagak-Bondo foci as well as with the Republic of South Sudan (RSS) in the Madi-Mid North focus (Table 1). The WHO guidelines will not allow these Uganda foci to be declared as transmission interrupted or eliminated until the extent of these cross-border transmission zones and the status of onchocerciasis elimination efforts on the other side of the border are known. The Ministry of Health in Uganda has recently established effective coordination with its sister Ministry of Health in the DRC that resulted in joint 2016 epidemiological and entomological surveys in border areas. Discussions have also begun with health officials in the RSS to develop similar surveys and other coordinated activities. The Carter Center and Sightsavers have been assisting these activities. Ideally, coordinated joint implementation efforts will soon be carried out in order to interrupt transmission in these shared onchocerciasis foci. However, such shared activities must take into account the security problems in the DRC areas bordering the Bwindi and Lhubiriha foci and in the RSS adjacent to the Madi-Mid North focus. People from the DRC and RSS who cross into Uganda as refugees are highly mobile, moving back and forth between Uganda and their respective countries as the situation dictates. Uganda has made every effort to treat the refugees with ivermectin, but obtaining adequate treatment coverage among these highly mobile populations will be a challenge.

Advantages of a national molecular laboratory

The presence of a national laboratory avoids the bureaucracy associated with the export of samples and provides timely access to the results by the UOEP and UOEEAC. The personnel in the laboratory are program staff and their workflow is based on priorities set by the UOEEAC. The UOEEAC has recommended that PCR pool screening be used in analysing flies rather than dissections, because of the risk of confusing larvae of *Onchocerca* (especially *O. ochengi*).[40] The annual cost of laboratory operations is about $35 000 to $40 000.

The effect of environmental changes

In some foci the vectors have disappeared, presumably the result of environmental changes. The absence of *S. neavei* is presumed to be due to the disappearance of the freshwater crabs essential for the development of its aquatic stages. This is possibly due to deforestation.[42,43] In the Wadelai focus where *S. damnosum* was presumed to have been the vector, no flies have been captured in recent years, yet no larviciding was ever done and there has been no noticeable change in the Ora and Aroga rivers.[43] Also, no vectors have been captured in the (presumed) *S. damnosum* Obongi focus. It is hypothesized that vector disappearance there was due to poor agricultural practices that increased soil erosion and siltation of vector breeding tributaries flowing into the Nile River. In the Imaramagambo focus, the disappearance of the vector could have been due to runoff into rivers of agricultural chemicals used intensively on the nearby tea plantations.[29]

Effective communication with communities when stopping MDA and throughout the PTS period

A carefully designed communication strategy is needed to explain to communities why MDA is being withdrawn, and these communications should continue throughout the PTS period. In Guatemala, the Knowledge, Attitudes and Practices (KAP) questionnaire surveys in the foci where onchocerciasis was eliminated showed that many persons still want ivermectin and more than a half did not believe that onchocerciasis had been eliminated.[44] Our recent KAP experience in Uganda (unpublished) has shown the same attitudes among the people in foci where onchocerciasis has been eliminated.

The importance of the UOEEAC in advising WHO guidelines

The basis for declaring elimination of onchocerciasis transmission in every Ugandan focus is being meticulously documented and archived so that it can ultimately be made available to the external WHO verification team. To enhance the quality and acceptability of the data, the UOEEAC has worked with Ministry of Health staff to publish the elimination history of each focus in peer-reviewed medical literature. In this way, it is hoped that the quality of the data placed in the national onchocerciasis elimination dossier for Uganda will be incontrovertible.[41]

Table 1. Progress of onchocerciasis elimination in Uganda

Focus	Interventions			Transmission		PTS	LF co-endemicity	Cross-border transmission
	Annual treatment	Bi-annual treatment	Vector elimination/control	Year declared	Status			
Victoria Nile	No provided	Not provided	Vector elimination (1950–1977)	1973	Eliminated	No information	No	No
Itwara	1991–2011	Not provided	Vector elimination (1993–2003)	2016	Eliminated	2012–2015	No	No
Mpamba-Nkusi	1997–2006	2007–2012	Vector elimination (2003–2007)	2016	Eliminated	2013–2016	No	No
Imaramagambo	1991–2012	Not provided	No vector control/elimination activities	2016	Eliminated	2013–2016	No	No
Mount Elgon	1994–2006	2007–2011	Vector elimination (2007–2009)	2016	Eliminated	2012–2015	No	No
Kashoya-Kitomi	1991–2006	2007–2013	Vector elimination (2008–2010)	2017	Eliminated	2014–2017	No	No
Wambabya-Rwamarongo	1991–2006	2007–2013	Vector elimination (2008–2010)	2017	Eliminated	2014–2017	No	No
Nyamugasani	1993–2015	Not provided	No vector control/elimination activities	2015	Interrupted	2016–2019	No	No
Maracha-Terego	1993–2012	Not provided	No vector control/elimination activities	2014	Interrupted	Not yet	Yes	No
Obongi	1993–2014	Not provided	No vector control/elimination activities	2014	Interrupted	2016–2019	No	No
Wadelai	1993–2005	2006–2010	No vector control/elimination activities	2014	Interrupted	2017–2020	No	No
West Nile	1993–2016	Not provided	No Vector control/elimination activities	2017	Interrupted	2017–2020	No	No
Nyagak-Bondo	1993–2011	2012–present	Vector elimination (2012–2013)	2014	Interruption suspected	Not yet	Yes	Yes
Bwindi	1993–2006	2007–present	No vector Control/elimination activities	2013	Interruption suspected	Not yet	No	Yes
Budongo	1990–2006	2012–present	Vector elimination (2012–2014)	2014	Interruption suspected	Not yet	No	No
Lhubiriha	1993–2014	2015–present	Vector control (2014–present)	Not applicable	Ongoing	Not yet	No	Yes
Madi-Mid North	1994–2011	2012–present	Vector control (2012–present)	Not applicable	Ongoing	Not yet	Yes	Yes

Conclusion

When Uganda declared an objective of nationwide onchocerciasis elimination by 2020, the tempo of activities accelerated dramatically. Treatment coverage improved under the twice-yearly ivermectin treatment and ground-based larviciding accelerated the interruption of transmission. The new energy motivated targeted communities and was instrumental in keeping health workers focused and interested. The establishment of an independent technical advisory committee, the availability of sensitive and highly specific diagnostic tools at a national laboratory and the obvious annual progress in moving foci along the pathway to elimination are other reasons for the rapid progress towards nationwide onchocerciasis elimination. The main challenge remains cross-border issues with the DRC and RSS, yet the 2020 target for nationwide elimination of onchocerciasis remains within reach.

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