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ONCHOCERCIASIS – A PUBLIC HEALTH PERSPECTIVE

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Onchocerciasis is a chronic parasitic disease with a wide range of cutaneous and ocular manifestations. It is caused by the tissue nematode, *Onchocerca volvulus*, and it is transmitted by the bite of a female black fly, *Simulium damnosum*. Onchocerciasis is a serious public health and socio-economic problem with 95% of all cases being found in Africa south of the Sahara. The WHO Expert Committee has estimated that over 80 million people are at the risk of infection worldwide, some 18 million infected, and 1 million people visually impaired of which some 340,000 are blind. Nigeria is highly endemic for this disease, to the extent that 40% of all cases worldwide are believed to occur in the country. The prevalence of blindness in villages near to fast flowing rivers may reach 15%, often, affecting males (of working age, perhaps 30-40 years old) more frequently than females. In spite of these ravaging consequences of this disease however, remarkable successes have been achieved by the control effort of the Onchocerciasis Control Programme (OCP), which uses chemical and biological larvicides with low environmental impact to kill black fly larvae flies. Other methods of effecting Onchocerciasis control include: (i) Reducing the number of bites by the *Simulium* fly on man; (ii) Killing the microfilariae with microfilaricides; and (iii) Killing the adult worms. The social and economic consequences of the disease in Nigeria and other African countries are huge, with considerable human suffering. It thus demands unrelenting intensive and concerted effort at the international, national and community levels, making optimal use of the identified modes of control for effective control of this disease which has serious public health and economic consequences.

Key words: Onchocerciasis, Public Health, Control

INTRODUCTION

Onchocerciasis is a chronic parasitic disease with a wide range of cutaneous and ocular manifestations. It is caused by the tissue nematode, *Onchocerca volvulus*, and it is transmitted by the bite of a female black fly, *Simulium damnosum*. The black fly breeds in rivers, with a preference for turbulent and highly oxygenated waters. Thus there is a high prevalence of disease in communities located near rivers and turbulent streams. Two basic ecology-related clinical and epidemiological varieties exist in Nigeria: the savannah and the rain forest belt types of onchocerciasis. The rain forest belt variety that causes little blindness had not received much public health attention till lately. However, recent studies have shown dermatological and psychosocial consequences, which have serious public health implications (1). Genetic research on *Onchocerca volvulus* has shown that there is intra-and inter-strain variation in polymorphic microsatellite loci between savannah and forest strains of the parasite, suggesting that different genetic constitutions are associated with the different clinical manifestations (2).

LIFE CYCLE OF ONCHOCERCA VOLVULUS

When a person is already infected by the worm and is bitten by the *Simulium* fly, the small embryo worms (microfilariae) present in the skin of the infected person enter the body of the fly. There they pass through the gut wall and travel to the thoracic muscles. Further development takes place and after about 7 days, the larvae move to the head of the fly,

ready to be transmitted to the next human host when the fly requires another blood meal. In this way, the microfilariae of *O. volvulus* are transmitted *to* another person. Microfilariae do sometimes appear in the blood and are also found in the eye in heavy infections. Worms normally take about a year to mature and for the female to start producing microfilariae. At this time, symptoms first appear in the form of itching and microfilariae can be found in the skin at about the same time. One female worm can produce 0.5-1 million microfilariae in 1 year. Thus, the cycle of transmission from person to person continues.

EPIDEMIOLOGY OF ONCHOCERCIASIS

Onchocerciasis is a serious public health and socio-economic problem found in about 27 countries in sub-Saharan Africa, parts of Latin America and in the Arabian Peninsula. The WHO Expert Committee has estimated that over 80 million people are at risk of infection worldwide, some 18 million infected, and 1 million people visually impaired of which some 340,000 are blind (3). Ninety-five percent (95%) of all cases of onchocerciasis are found in Africa south of the Sahara, in a wide belt stretching from West to East (4). The period of greatest transmission is in the rainy season coinciding, as expected with the period of maximal *Simulium* breeding.

The social and economic consequences of the disease are huge, with considerable human suffering. The prevalence of blindness in villages near fast flowing rivers may reach 15%, often affecting males (working age, perhaps 30-40 years old) more frequently than females, but this probably an occupational hazard. The blindness is usually bilateral, the victim gradually loses the visual field in each eye, and vision becomes severely impaired leading to blindness (5).

ONCHOCERCIASIS AS A PUBLIC HEALTH PROBLEM IN AFRICA

Onchocerciasis, popularly known as **River blindness disease** has been recognized as a public health problem in Nigeria since 1906. Nigeria is highly endemic for this disease to the extent that 40% of the world cases are believed to exist in the country. The manufacturer of the effective drug Mectizan, i.e. Merck, Sharp and Dohme, has promised to make the drug available to endemic countries free of charge for as long as it is required. However, the distribution cost to the rural endemic areas estimated at $ 0.1 per dose, is being financed jointly by the 3 levels of government and participating non-government development organization (NGDOS), involved in the control programme. The National Onchocerciasis Control Programme (NOCP) of the Federal Ministry of Health coordinates the control activities of all partners involved. The National Mectizan Treatment project was launched in 1991 at Minna, Niger state (6).

Many communities are endemic for onchocerciasis in Nigeria. These communities are usually those situated within 10km distance from a major river and its tributaries, and prevalence levels of 30-80% have been reported in them (7). The affected rural population predominantly engages in peasant farming while those who are closer to the river are also involved in fishing. Infection occurred mostly in the older age group 40 years and above, and farmers are proportionately more affected than the other occupational groups.

A prevalence survey of visual loss among 1,625 individuals in an onchocerciasis endemic community conducted in Sierra

Leone found that cataract and onchocerciasis were the major causes of visual loss in this population and more than half of the ocular morbidity was preventable or treatable by public measures or curative medicine (8). However, in our 5- year review of skin-snip results at the Medical Out–Patient laboratory of the University College Hospital, Ibadan, Nigeria, between 1.1% and 2.6% of the total number of patients sent for skin-snip examination yearly were found to be positive for onchocercal microfilaria (unpublished data). These relatively low figures may be largely due to the fact that treatment and control of onchocerciasis has been divulged and entrusted in the hands of members of the affected communities. A community now directs and takes charge of the responsibility that all it members get treated annually. Hence, few cases get reported to the health facility.

In a study of the perceptions of villagers on onchocerciasis conducted in a community in Plateau state, Nigeria, villagers in endemic areas were found to be aware of the nuisance of black fly bites but the majority of them lacked the aetiological knowledge of onchocercal lesion. Hence disease management is misdirected towards consulting the oracle and appeasing the gods (9). In another study conducted in Nebbi District, North-western Uganda, which involved the use of focus group discussion and semi structured interviews designed to explore the experiences, meanings and illness-related coping strategies employed by the community, the results indicated that onchocerciasis is considered to be mysterious elusive disease which cannot be treated by local herbs. The disease is often mistaken for measles and leprosy. Persons who suffer onchocerciasis believed that the cause of the disease is the small black fly, dirty water or rivers. However, non-infected individuals believed that the condition is caused by poor personal and environmental hygiene, and personal contact with persons affected by onchocerciasis. Affected people recommended public education to control the disease while non-affected people recommended the avoidance of personal contact with affected people, ensuring hygiene and improvement of environmental sanitation and the nutritional status of the community. The belief systems of the community are probably responsible for the discriminatory practices of the people against those affected by the condition (10).

In an epidemiological study on onchocerciasis in the lower Jos Plateau in Nigeria (11), a 7-month old baby delivered by a mother suffering from onchocerciasis showed early clinical signs of the disease; pruritus was present all over the body. The infant's skin snip on incubation revealed microfilariae of *Onchocerca volvulus*. Also, one in 20 babies born in heavily infected areas have microfilariae in the skin soon after birth due to transplacental transmission of microfilariae when the adults may become established in newborn infants (4).

CLINICAL MANIFESTATIONS

The microfilariae of *Onchocerca volvulus* have a particular predilection for the skin and the eyes of the infected person, but may also give rise to musculoskeletal pain interpreted as 'rheumatism' and probably including epilepsy and growth retardation. **Dermatological manifestations** include generalized or localized body itching, acute papular onchodermatitis (APOD), chronic

papular onchodermatitis (CPOD), atrophy of the skin, depigmentation of the skin (leopard skin), and thickened and rough skin (lizard skin). Other lesions associated with onchocercal skin disease are subcutaneous nodule, lymphadenopathy, hanging groin and lympho-edema. **Ocular manifestations** that have been associated with the onchocerciasis include iridocyclitis, punctuate keratitis, sclerosing keratitis, anterior uveitis, choroido-retinitis, pupillary abnormalities and its most dreaded complication blindness (12).

The pathology is thought to be due to the cumulative effects of cellular inflammatory response to the immobile and dead microfilariae in the skin and eyes (13). Recent reports however, indicate that the first step towards the development of blindness is due to certain *Onchocerca volvulus* proteins, which are implicated in the growth of new blood vessels in the eye, and that the proteins are neither immunogens nor mitogens, thus ruling out an immunological mechanism. In addition, the role of eosinophil eotaxin (a type of cytokine) in diethylcarbamazine (DEC)-induced skin lesions has been confirmed (2).

IgG antibodies are also known to play a major role in protective immunity to *O. volvulus* with infected individuals having paradoxically high IgG4 level and individual with putative protective immunity having significantly lower worm specific antibodies than infected subjects (14). Increased IgG4 levels were correlated with clinical severity and microfilarial load. IgG4 may be induced by worm or microfilarial antigens and may contribute to the immunopathology of disease by blocking microfilarial clearance and destruction.

DIAGNOSIS

Clinical features

The symptoms and signs of onchocerciasis; onchodermatitis, signs of scratching, depigmentation of the skin, 'lizard' skin and subcutaneous nodules, are often sufficient to make a certain diagnosis.

Skin-snip examination

Definitive diagnosis is made by demonstrating microfilariae of *O. volvulus* in the skin snips or at times, conjunctival snips. While the skin snip method has been useful both in diagnosis and in monitoring of infection, the test is insensitive when ivermectin has reduced the microfilaria burden. In addition, skin snip testing also fails to detect prepatent infections.

Serological tests

The success of ivermectin treatment in onchocercal infection has given further impetus to the development of serological tests. Bradley (15) has used a cocktail of three recombinant proteins, which achieved a sensitivity of 96% and a specificity of 100%. This could be useful for seroepidemiological studies detecting prepatent infection in control areas. The IgG subclass response to the recombinant antigen cocktail showed that the IgG1 response declined after interruption of transmission but the IgG4 response remained raised even eight years after transmission had stopped (16). An assay based on the polymerase chain reaction has also been developed that uses primers and probes specific to *Onchocerca volvulus* and achieved a sensitivity of 100% (17).

Other methods of diagnosis

Presence of microfilariae in the anterior chamber or in the cornea may be seen using the slit-lamp microscope. Biopsy of subcutaneous nodules can reveal adult worms at histology. Positive mazzotti test; severe body itching as a result of dead and dying microfilariae following the use of diethylcarbamazine (banoside), may occur.

A recently introduced epidemiological tool is the Rapid Epidemiological Assessment (REA), which is used to determine the endemicity levels of onchocerciasis. The prevalence of nodules is the simplest, most acceptable, non-invasive and reasonably reliable method of REA. It involves determining the prevalence of nodules in a random sample of 30-50 adult males over 20 years of age, who have been resident in the community concerned for at least 10 years. The percentage prevalence in the community is 5 times the number of nodule carries (18).

MISDIAGNOSIS

Onchocerca nodules present in the forehead, eyelid, brow and post auricular areas may be clinically misdiagnosed as dermoid cyst, fibroma, cancer, fibroadenoma and tuberculosis.

CONTROL OF ONHOCERCIASIS

Onchocerciasis control can be effected in four ways;

(i.) Inhibiting the development of the *Simulium* flies. This can be achieved through insecticide spraying by aircraft to stop vector breeding and removal of obstacles that creates water turbulence such as rocks or man-made structures. (ii). Reducing the number of bites by the *Simulium* fly on man through wearing clothing that covers most of the skin surface, or communities relocating from sites near the breeding area of *Simulium* fly. (iii). Killing the microfilariae with microfilaricides. (iv.) Killing the adult worms by removal of the subcutaneous nodules (nodulectomy) or chemotherapy with macrofilaricides.

Drug treatment and control of onchocerciasis have been unsatisfactory in the past. The available drugs, diethylcarbamazine citrate (DEC) and suramin are too toxic for mass distribution, while nodulectomy is ineffective and impractical in Africa (14). Mectizan (Ivermectin) is an effective microfilaricide with presumed macrofilarial effect suitable for large-scale treatment.

ONCHOCERCIASIS CONTROL PROGRAMMES

Because there is no effective macrofilaricide, vector control to prevent the transmission of the parasite is an important available control method. This has been most effectively carried out in West Africa countries by the huge **Onchocerciasis Control Programme (OCP)**. The **OCP** in West Africa was launched in 1974. It uses chemical and biological larvicides with low environmental impact to kill black fly larvae and its aim is to control blinding onchocerciasis, which is caused by the savannah strain of *Onchocerca volvulus* transmitted by the *Simulium damnosum* complex. It covers virtually every river where the flies are found in West African countries (over 1.2 million square kilometers), serving a population of 25 million. This project has had good result over the last 20 years in West Africa. Some areas are now completely free of onchocerciasis transmission. Fertile tracts of land that had to be abandoned because of the ravages of the disease and the flies have been resettled and are contributing to the financial well being of host countries.

Since the adult female *Onchocerca volvulus* worm has an average life span of 11 years in its human host, it was estimated that 14 years of spraying would be required to eliminate the adult worm reservoir in humans. The possibilities of re-invasion by black flies when spraying is discontinued, the tendency to development of resistance to the larvicides by *Simulium* larvae, and the huge expense of $20-30 million per year, are weaknesses of this particular approach. The timely discovery that ivermectin, a drug used in veterinary practice, is a highly effective microfilaricide had enabled a dual approach to be taken in onchocerciasis control.

A similar multinational multi agency partnership programme for onchocerciasis control i.e. Onchocerciasis Elimination Programme for the Americas (OEPA) was later launched in the Americas in 1993. Since it's inception, the OEPA has provided more than $ 2 million in financial, managerial, and technical assistance to stimulate and/or support programs in Brazil, Columbia, Ecuador, Guatemala, Mexico, and Venezuela, so as to take full advantage of the Merck donation.

Building upon the success of the Onchocerciasis Control Programme in West Africa, which is on the verge of eliminating the disease from 11 West African countries, a new programme, **African Programme for Onchocerciasis Control (APOC)** was created in 1997 to establish sustainable control in the remaining 19 countries in Africa, where the disease is still a public health problem. Whereas the OCP used vector control, the new programme will control the disease in the non-OCP countries by establishing community-directed treatment programmes with the drug ivermectin, supplemented with vector eradication in a few isolated foci.

Ivermectin (Mectizan)

Ivermectin kills the microfilariae of the worm *O. volvulus* but typically with only mild reactions, unlike diethylcarbamazine. Of particular significance is the knowledge that ocular damage does not routinely occur. Ivermectin is providing real hope for the future in the treatment and control of onchocerciasis. Ivermectin is being donated free of charge by Merck, Sharp and Dohme. The main logistical problem in treating population with ivermectin is the provision of manpower and facilities to effectively deliver the drug to communities in need. Dose finding studies on ivermectin have confirmed that a single oral dose of 150 mg/kg body weight once a year significantly reduced and maintained the skin microfilarial counts at low levels over a period of one year following treatment (19). Ivermectin is being considered as a follow-up intervention after the OCP is disbanded through a process called "devolution".

CONCLUSION

Although onchocerciasis is not a life-threatening disease, it has severe public health and economic repercussion, as family providers are often stricken with blindness and other chronic effects of the disease. Vector control has been beneficial in highly endemic areas in which breeding sites are vulnerable to insecticide spraying. In view of the successes attained so far by the use of ivermectin, an effective microfilaricide, and the control effort of the OCP in West Africa, and the OEPA in the Americas and considering the magnitude of human suffering being impacted by this preventable disease, continued intensive and concerted effort is therefore needed at

International, National and Community levels in collaboration with non-governmental development organizations, making optimal use of the identified modes of control to ensure a sustainable and effective control of this disease which has serious public health and economic consequences. Also, epidemiological surveys in onchocerciasis endemic areas further emphasizes the need for intensive public health education programmes to be targeted at onchocerciasis endemic communities as a means of facilitating infection control, as well as to correct the discriminatory practices of the people against those affected by the condition.

To control onchocerciasis as a public health problem, ivermectin needs to be given at least once per year to the population of all seriously affected communities. It is known that ivermectin treatment is exceptionally popular among endemic populations and since these communities effectively take responsibility for their own treatment, it should be possible therefore to control onchocerciasis at minimal cost, with active community involvement. Community-directed treatment with ivermectin may also provide an important entry point for other community-directed health interventions and thus help to develop a practical basis for strengthening primary health care in the various affected communities in Africa.

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