Case 7

Controlling Onchocerciasis (River Blindness) in Sub-Saharan Africa

Geographic area: Sub-Saharan Africa

Health condition: In 11 west African countries in 1974, nearly 2 million of the area's 20 million inhabitants were infected with onchocerciasis, and approximately 200,000 were blind.

Global importance of the health condition: Onchocerciasis, or river blindness, afflicts approximately 42 million people worldwide, with well over 99 percent of its victims in sub-Saharan Africa. An estimated 600,000 people are blind, and an additional 1.5 million Africans are visually impaired due to onchocerciasis.

Intervention or program: The Onchocerciasis Control Program (OCP) was launched in 1974 in 11 west African countries. Weekly aerial spraying with environmentally safe insecticides helped control the disease vector—blackflies that bred in fast-moving waterways, thereby halting transmission of the disease. In 1995, a second program, the African Programme for Onchocerciasis Control (APOC), was established to control the disease in 19 central, east, and southern African countries. Through a broad international partnership and the participation of 115,000 remote, rural communities, APOC and OCP distributed a drug donated by Merck & Co., Inc., Mectizan (ivermectin), to more than 45 million people in sub-Saharan Africa in 2005. The drug prevents and alleviates the symptoms of the disease with one annual dose.

Cost-effectiveness: OCP operated with an annual cost of less than $1 per protected person. Commitments from 27 donors during the 28-year project totaled $600 million. The annual return on investment was calculated to be about 20 percent, primarily attributable to increased agricultural output; about $3.7 billion will be generated from improved labor and agricultural productivity. The annual cost of APOC operations, taking into account the donation of all needed drugs, is approximately $0.58 per person treated.

Impact: OCP produced an impressive change in health between 1974 and 2002: Transmission of the disease-causing parasite was halted in 11 west African countries, 600,000 cases of blindness were prevented, and 22 million children born in the OCP area are now free from the risk of contracting river blindness. About 25 million hectares of arable land—enough to feed an additional 17 million people per annum—is now safe for resettlement. APOC is expanding this success to central, east, and southern Africa, where 54,000 cases of blindness are expected to be prevented each year.

At the headquarters of the World Bank, the WHO, the Carter Center, the multinational pharmaceutical firm Merck, and the Royal Tropical Institute of the Netherlands, as well as in a prominent square in Ouagadougou, Burkina Faso, visitors see a distinctive statue of a child leading a blind man—a symbolic reminder to passersby of the part each partner played in the control of one of Africa's most devastating diseases. The Onchocerciasis Control Program (OCP) has earned its place as one of the signal achievements of international

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public health, demonstrating the power of collaboration across countries and agencies, the importance of long-term funding from the donor community, and the benefits of public-private partnership to bring pharmaceutical innovation into large-scale use in developing countries.

The Disease

Onchocerciasis, or "river blindness," is a pernicious disease that afflicts approximately 42 million people worldwide, with well over 99 percent of its victims residing in sub-Saharan Africa. Primarily a rural disease, onchocerciasis disproportionately burdens the inhabitants of some of the poorest and most remote areas in Africa. Small, isolated areas in Latin America and Yemen also are affected. In the most endemic areas, more than one third of the adult population is blind, and infection often approaches 90 percent of the population.[1]

The disease is caused by a worm, *Onchocerca volvulus*, which enters its human victim through the bite of an infected blackfly. In the arable riverine areas where the flies breed, residents are bitten as many as 10,000 times a day. Once inside a human, the tiny worm grows to two to three feet in length, each year producing millions of microscopic offspring called microfilaria. These tiny worms are so abundant that a simple snip of the skin can expose hundreds of writhing worms.

The constant movement of the microfilarie through the infected person's skin causes a wide range of debilitating symptoms, including disabling and torturous itching, skin lesions, rashes, muscle pain, weakness, and, in its most severe cases, blindness. The disease is spread when a new blackfly bites an infected person and then bites another person, thus repeating the infection cycle. Today, an estimated 600,000 people are blind due to onchocerciasis, and nearly 1.5 million are severely visually impaired.[2]

Beyond the disabling health burden, onchocerciasis inflicts tremendous social and economic damage on individuals and entire communities. Self-esteem and concentration suffer, and the disease reduces marriage prospects for both women and men. Infected individuals often earn less money as a result of decreased productivity and spend a large portion of their income on extra health costs.[3]

On a community level, the disease has hindered economic growth. The threat of the disease has led people to abandon more than 250,000 square kilometers of some of the best arable land in west Africa. In the words of Dr. Ebrahim Samba, OCP's director from 1980 to 1994, "Onchocerciasis therefore is a disease of human beings and also of the land. It directly retards development and aggravates poverty."

Combating the Disease: The Onchocerciasis Control Program

Colonial and ex-colonial entomologists attempted for many years to control the disease in the hardest-hit areas, but achieved mixed results. Lasting results proved elusive because the blackflies cover long distances (exceeding 400 kilometers with the wind currents) and cross national boundaries, rendering uncoordinated national control efforts ineffective.

The small-scale control efforts of the 1950s and 1960s provided the seeds for the first regional OCP, which were codified at an international conference in Tunisia in 1968.[4] The disease, concluded conference participants, would be controlled if it could be addressed on a sufficiently large scale. Scientists from WHO and other experts contributed to the preparation of a regional control plan. Several donors expressed mild interest, but none was able to commit alone what was expected to be a 20-year, $120 million program covering at least seven countries.

Serendipity intervened. In 1972, the then-president of the World Bank, Robert McNamara, visited west Africa to observe the impact of a long drought that was underway. While visiting the rural areas of Upper Volta (now Burkina Faso), he witnessed the devastation caused by onchocerciasis; he saw many children leading blind adults, and communities in which nearly all the adults were blind. McNamara decided to spearhead an international effort to control the disease, committing his own institution to a catalytic financing role.[1]

The OCP was launched in 1974 under the leadership of the WHO, the World Bank, the Food and Agriculture

Organization (FAO), and the United Nations Development Program (UNDP). Financing and donor support were mobilized through the World Bank from a wide range of donor countries, multilateral institutions, and private foundations.

The program, the first large-scale health program ever supported by the World Bank, set out to eliminate the disease first in 7—and eventually in 11—west African countries.[a] The primary intervention was vector control of the disease-spreading blackflies, with the goal of ultimately halting disease transmission. Helicopters facilitated the weekly spraying of larvicides during rainy seasons on the riverine areas most heavily populated by blackflies. The aerial treatment, as well as hand spraying of breeding grounds, persisted even through civil and regional conflicts and coups.

Up-to-date information was a key element in program implementation. Detailed mapping of the 12,000 miles of remote rivers and epidemiological mapping of onchocerciasis prevalence facilitated these efforts. A significant operational research budget was built into the program to respond to emerging challenges and problems and to investigate effective prevention and treatment options.

The duration of the program and its phasing were special features. Because of the time needed for the adult worms in the human population to die off, which at the time was thought to be at least 18 years,[b] the program was expected to last 20 years. The administrative and financial agreements were broken into 6-year phases, allowing for both firm commitment and flexibility in planning cycles. Most of the original nine donors supported the program for 28 years, and the number of bilateral and multilateral donors increased three-fold over that period.

Striking Success in West Africa

The OCP's success in controlling onchocerciasis in west Africa has been remarkable. At the start of the program in 1974, nearly 2.5 million of the program area's 30 million inhabitants were infected, and approximately 100,000 were blind. Today, transmission of the disease has been virtually halted, and some 1.5 million people who once were infected with the disease no longer experience any symptoms. An estimated 600,000 cases of blindness have been prevented, and 22 million children born in the area since the program's inception are free from the risk of river blindness.

The economic impact has also been impressive. An estimated 25 million hectares of unusable arable land—enough to feed an additional 17 million people per annum—has become available for agricultural production and resettlement.[5] In Burkina Faso, for example, 15 percent of the country's land that had been deserted because of the disease has been completely reclaimed, and its new residents now enjoy a thriving agricultural economy.[6]

The program, which formally concluded in December 2002, was extremely cost-effective and had a yearly cost of less than $1 per person protected. Total commitments from 27 donors during the 28-year project amounted to $600 million. The World Bank calculated the annual return on investment (attributable mainly to increased agricultural output) to be 20 percent, and it is estimated that $3.7 billion will be generated from improved labor and agricultural productivity.[4]

A Medical Breakthrough: Mectizan Is Discovered

While OCP was proving its success in controlling onchocerciasis in the 11 designated west African countries during the 1970s and 1980s, the disease remained endemic in 19 central, east, and southern African countries not covered by OCP.[c] Controlling the disease was technically and organizationally more complex, because aerial spraying—the only control option available at the time—was considered neither technically feasible nor cost-effective given the area's longer distances and thick forests.[5]

An important scientific breakthrough brought new hope to these 70 million people at risk in the region. In

a Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Mali, Niger, Senegal, Sierra Leone, and Togo.

b Later determined to be 14–15 years.

c Angola, Burundi, Cameroon, Central African Republic, Chad, Democratic Republic of the Congo, Republic of Congo, Equatorial Guinea, Ethiopia, Gabon, Kenya, Liberia, Malawi, Mozambique, Nigeria, Rwanda, Sudan, Tanzania, and Uganda.

1978, Dr. William Campbell, a veterinary researcher at Merck & Co., Inc., discovered that the new antiparasitic agent he had developed to treat gastrointestinal worms in cattle and horses was also effective against the family of worms responsible for onchocerciasis. Clinical trials in Africa sponsored by Merck and the WHO demonstrated that just one dose of Mectizan (ivermectin) could relieve the disabling symptoms of river blindness and kill up to 95 percent of the tiny worms—offspring of the adult worm—for up to a full year.[7] Dr. Kenneth Brown, one of the developers of the drug, explained the significance of this new one-dose medicine: "Most drugs for the treatment of tropical diseases have to be given in multiple doses over days, weeks, even years. The ability to treat and control an important disease, such as river blindness, with a single dose each year is nothing short of spectacular."

Getting the Drugs to Africa: Merck Donates Mectizan

The battle against river blindness now had a powerful new weapon in its arsenal. The great challenge facing Merck and the public health community, however, was to make sure that those most in need of the drug—and also the least able to pay—could access this critical medicine. Even at a discounted price of $1.50 per treatment, it was clear that the drug would be out of reach to the developing countries where onchocerciasis was endemic. Moreover, resources from the donor community were unable to cover the additional cost for the drug, which would have more than doubled program costs.

Merck was eager to donate Mectizan, but the company's initial attempts to find a partner organization to manage the drug's distribution were unsuccessful. After neither the WHO nor the US Agency for International Development accepted Merck's offer, the company turned to Dr. William Foege, then executive director at the Carter Center. Foege, a veteran of the smallpox eradication effort, agreed to lead the donation program at the Task Force for Child Survival and Development, an affiliate of Emory University, only when Merck pledged that its donation would be long term. In 1987, Ray Vagelos, then CEO of Merck, made the historic announcement that his company would donate Mectizan "to anyone who needed it, for as long as it was needed"—marking the launch of the world's longest ongoing medical donation program, and one of the largest public-private partnerships ever created.[7]

Dr. Foege explained that the program's goal was to "reach as many people with Mectizan as possible, and to make the rules reasonable but not too difficult" (personal communication, June 2004). The Mectizan Expert Committee—a group of experts in tropical medicine, epidemiology, and public health—was established to lay the rules for how the drug would have to be delivered and who would receive it. The committee set up an annual application process through which requests for the drug would be granted based on the applicant's capacity to distribute the product for at least three years. The ministries of health had to endorse the applications, which were submitted mostly by international nongovernmental organizations (NGOs), medical mission groups, foundations, and the ministries of health themselves.[8]

On the ground, the task of reaching millions of residents of remote villages in east, central, and southern African countries with the drug was daunting. Public health systems were either weak or nonexistent in these countries, health workers were in short supply, and combating onchocerciasis was not seen as a public health priority.

Two important factors aided the NGO effort: more than $30 million in grants from the River Blindness Foundation,[9] and the popularity that Mectizan acquired because of its effectiveness in combating many troublesome parasites, including intestinal worms, head lice, and scabies, as well as *O. vovulus*. The drug rapidly alleviates incessant itching and is nearly 100 percent effective in treating round worms and whipworms, so improvement in quality of life is observable almost immediately after the first dose. So, despite the fact that the drug must be taken annually for nearly 20 years to interrupt transmission of the disease, Mectizan proved popular and uptake across endemic villages was fast.

The Mectizan Donation Program far exceeded its initial goal of 6 million treatments in six years. Since 1988, the program has provided more than 472 million annual treatments.[10] Merck recommitted to indefinite donation of the drug, and in 1998 extended its pledge to also treat lymphatic filariasis (also known as elephantiasis). Transmission of lymphatic filariasis, which WHO has

designated as the fourth largest cause of long-term disability in the world, can be successfully interrupted with Mectizan from Merck and albendazole, donated by Smith-Kline Beecham.

Two important economic factors have helped to reinforce Merck's decision to make its contribution, which is estimated to have a value of over US$1.5 billion: US tax benefits that reduce the net cost of the program; and successful marketing of the drug in the veterinary field, which have offset the upfront research and development costs.[11] In 1984, Mectizan was the highest selling animal product and ranked as Merck's second-best selling drug in 1987.[12] The donation program, made more feasible by these economic offsets, represents an important milestone in the global effort to eliminate onchocerciasis and helped pave the way for later donations from multinational pharmaceutical companies.

Reaching the 19 Remaining Countries: APOC Is Launched

By 1995, however, onchocerciasis still persisted in 19 endemic countries not covered by the OCP. To meet the scale of the problem there, it was clear that more resources were needed to support the efforts of the organizations working on the ground, and that a more cost-effective, affordable, and sustainable approach than the clinic-based Mectizan delivery was necessary.[13]

Building on the work of the NGOs in central and east Africa, a new program was launched in 1995 with the goal of "eliminating onchocerciasis as a disease of public health and socio-economic importance throughout Africa." The African Programme for Onchocerciasis Control (APOC) was designed as a 15-year partnership under the leadership of the World Bank, WHO, UNDP, and FAO, which would build on the success of the OCP and extend its reach to the remaining 19 endemic countries in Africa. The program aimed to treat 86 million people a year by 2010, eventually scaling up to about 90 million treatments annually; to prevent 54,000 cases of blindness per year; to protect the OCP area from reinvasion; and to make an estimated 7.5 million additional years of productive adult labor available for the region's developing countries.[6]

APOC involved the participation of a wide range of organizations and groups, many of which were also involved in the OCP, including the same 4 sponsoring agencies, the governments of 19 developing countries, 21 bilateral and multilateral donors, more than 30 participating NGOs, Merck, and more than 100,000 rural African communities. The primary role of the program was to build the capacity of local communities supported by the NGOs and the ministries of health to deliver Mectizan and to increase the efficiency and sustainability of drug treatment at the local level.

Unlike the OCP, which involved very limited local participation, APOC was not a vertical program but rather was integrated within the national health systems of the participating African countries.[5] Ultimate ownership for controlling the disease would be the responsibility of the affected communities themselves. The fundamental strategy would be based on community empowerment with training, oversight, and supervision provided by the local health services and collaborating NGOs.

This donor-funded program is scheduled to end shortly after 2010. Effectively interrupting transmission of the disease requires annual drug treatment for some 15 to 20 years after outside donor funding ceases. Hence, APOC has placed a strong emphasis on long-term sustainability.

To achieve the program's goal of developing a self-sustainable, fully African-owned and managed program in the post-2010 period, APOC has pioneered a system of Community-Directed Treatment with Mectizan (ComDT). Through this framework, many hundreds of thousands of communities effectively organize and manage the local Mectizan treatment, taking full responsibility for developing and implementing the strategy for comprehensive drug distribution and thus enhancing prospects for long-term sustainability of the program after donor funding ends.[14] The communities select the community-directed distributor, and the distribution efforts are adapted to the local culture and conditions. Community volunteers receive training and supervision from the national public health systems and from the program's NGO partners.

The ComDT system has demonstrated its value not only as a cost-effective intervention but also as a successful

framework for delivering treatment with high coverage rates to remote populations. In 2000, the WHO estimated that the ComDT network achieved an average treatment coverage rate of 74 percent, exceeding the minimum 65 percent rate necessary to eventually interrupt transmission and thereby eliminate the disease as a major public health problem throughout Africa.[1] A further indicator of the strong prospects for the program's long-term sustainability is the increasing rates of coverage in subsequent rounds of treatment, a trend that illustrates the popularity of the drug and the success of both the education campaigns and the locally run distribution systems.[5]

APOC's Success in Central, Southern, and East Africa

Approximately 41 million people were treated in the 19 APOC countries with Mectizan by APOC in 2005 alone. The WHO estimates that the program prevents approximately 54,000 cases of blindness each year. As it extends its coverage, the benefits will spread over a wider population and encompass a number of additional positive impacts. These include an 80 percent reduction in the incidence of optic nerve disease, a 50 percent reduction in severe itching, and a 45 percent reduction in visual deterioration for those with atrophied optic nerves.[13] By the time the program begins to phase out at the end of the decade, it is expected that the sight of more than 800 million individuals will have been saved in the 19 APOC countries alone.[15]

Furthermore, the impact of the successful ComDT system extends beyond the treatment and prevention of river blindness. The system offers a valuable entry point for other community-directed health interventions in neglected communities with little or no access to traditional health services.[14] In the Central African Republic, for example, ComDT has provided a stimulus for expanded primary health care, where the coordinators of the Mectizan distribution program are often the only health workers to reach every village.[16] Suggestions for health interventions that could utilize the ComDT framework include long-lasting vitamin A capsules to save lives of children under five by 25–35 percent, improve maternal health and prevent deaths; the antibiotic azythromycin, donated by Pfizer to prevent trachoma; albendazole and Mectizan to halt transmission of lymphatic filariasis; and praziquantel to cure schistosomiasis.

The Cost

APOC bears a total price tag of $180 million. Donor funding accounts for 75 percent of this figure, and African governments and NGOs contribute the remaining 25 percent.[5] Merck's donation of Mectizan and its coverage of shipping costs of the drug have kept the program's cost below US$0.60 per person treated per year. Because the World Bank and the WHO waive all administrative fees, 100 percent of donor funds reach country operations with minimal overhead costs.

A preliminary analysis prepared by the World Bank demonstrated that the economic rate of return for the program is 17 percent for 1996 through 2017.[17] This rate is comparable to World Bank projects in the most productive sectors, such as industry, transportation, and agriculture.

Lessons Learned from the Control of Onchocerciasis Throughout Africa

Bruce Benton, manager of the Onchocerciasis Coordination Unit in the World Bank from 1985 to 2005, attributes the success of the programs to a number of factors that he believes provide lessons for other disease control programs.

A Comprehensive Regional Approach

Given the natural history of the disease, characterized by the movement of blackfly vectors across national borders, a comprehensive regional approach has been essential. The participating African countries were prepared to contribute to the achievement of a common objective provided all would benefit and the burden would be shared relatively equitably. Frequent multicountry deliberations have exerted peer pressure on the countries and their professional staff to deliver results. The comprehensive approach employed, and the well-defined exit strategies, have helped reassure the donors that the efforts would come to a successful conclusion.

Effective Long-Term Partnership

Regional collaboration among partners was based upon comparative advantage, combined with grassroots community empowerment, and have proven to be highly effective models. The transparent delineation of partners' roles in a memorandum of agreement has maximized

effectiveness, minimized turf battles, and helped instill trust among partners. To maintain the partners' commitment and sustain the large coalition over a long period of time, communication has been active and credit has been shared liberally.

Community Participation and Grassroots Empowerment

ComDT, a unique feature of APOC, has been integral to the program's goal of eliminating river blindness as a public health problem throughout Africa. ComDT has given ownership of Mectizan distribution to the communities where the disease is endemic. The communities decide their strategies for ensuring the highest compliance with Mectizan treatment and select distributors in which they have highest confidence. This system has proven extremely cost-effective, given the donated drugs and the practice of compensating community distributors with food or other nonmonetary means. Both ownership and cost-effectiveness have increased the likelihood that the Mectizan treatment network will be sustainable over the long term—a prerequisite for eventual elimination of the disease. Furthermore, the system of community distributors has addressed the paucity of trained health staff in the remote, rural areas where onchocerciasis is most burdensome. Finally ComDT provides a platform for controlling other diseases, particularly those for which free drug treatment or other simple solutions can be "piggy-backed" onto the Mectizan distribution network.

Capacity Building and Africanization

The OCP and APOC programs have made deliberate efforts to strengthen African management and technical capacity. In the mid-1970s nearly 75 percent of OCP's roughly 30 professional staff were expatriate. Today 99 percent of program staff for both OCP and APOC is African, and every director has been African since the early 1980s. More than 100,000 community distributors have been trained and retrained since APOC was launched in 1995, and more than 500 former OCP staff members have returned to their home countries in west Africa, bringing advanced degrees, and the scientific, technical, and logistical capacity required to sustain the program's gains. Some of these staff will work on efforts to improve one of the notoriously weakest links in Africa's health system: surveillance of outbreaks, epidemics, and other diseases such as HIV/AIDS, malaria, cerebral spinal meningitis, and possibly avian influenza.

Operational Research

An important contributing factor to the successful control of the highly unpredictable biological agent was the program's emphasis on operational research. Funding for operational research was substantial, always exceeding 10 percent of the annual budgets. This research proved critical to sustaining OCP in 1985, when the blackfly vector became resistant to the principal insecticide used by the program since 1974. Fortunately, the program had developed seven backup insecticides, which it began to use in rotation until the resistance to the original chemical was overcome after several years, marking the first time that any program completely reversed resistance.

Operational research was also vital in determining whether ComDT would be cost-effective and achieve the program's objectives. The Tropical Disease Research (TDR) Program of WHO conducted extensive social surveys in the affected communities and concluded that ComDT would be cost-effective and reach a high enough portion of the population to eliminate onchocerciasis over time. It also determined that a much higher proportion of women community distributors would have to be recruited and trained if all members of the community were to be reached. Finally, TDR developed a system of rapid mapping of hyperendemic villages that allowed APOC to map the disease throughout Africa in less than 10 years. As a result, APOC operations could be scaled up much more rapidly than otherwise would have been possible.

Dr. Ebrahim Samba, winner of the 1992 Africa Prize for his contribution to the control of onchocerciasis, highlighted the importance of long-term financial commitments as a factor contributing to the programs' success. "Many programs in Africa last three to five years," Dr. Samba explained. Such short-term efforts are a "waste of time" because "this is the time one requires to study the situation, install, and start. One needs more time to get going, consolidate, and evaluate." The donor commitments of a minimum of 20 years, most of which lasted 30 years, combined with the commitment from Merck to donate Mectizan indefinitely, are an essential element of the effort's long-term success.[18]

A Health Program with a Development Outcome

In the final year of its operations in 2002, Robert McNamara described the success of the OCP he helped pioneer: "[OCP] has been an enormously effective program: a health program with a development outcome; it has empowered rural communities to banish this burden and thrive." Dr. Ebrahim Samba stated, "It proves it can be done—effective aid programs deliver lasting results. African member-states contributed in cash and kind, and donors have been steadfast in their support. This was achieved through hard work, transparency, and accountability."

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