

## The Tail End of Guinea Worm — Global Eradication without a Drug or a Vaccine

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**G**uinea worm disease, or dracunculiasis — Latin for “affliction with little dragons” — is a plague so ancient that it has been found in Egyptian mummies and has been proposed by

some to have been the “fiery serpent” described in the Old Testament as torturing the Israelites in the desert. The global Dracunculiasis Eradication Program spearheaded by former President Jimmy Carter and the Carter Center has now reached its final stages (see graph). This accomplishment is unprecedented — the only disease previously eradicated was smallpox, not a parasitic disease — and it has been achieved through grassroots public health initiatives involving thousands of village volunteers.

Thanks to the two-decade campaign against guinea worm disease, the global incidence has fallen from an estimated 3.5 million cases in 1986 to 25,217 in

2006.<sup>1</sup> A slight increase in the reported incidence during 2006 is attributable to improved detection in newly accessible areas of southern Sudan.<sup>1</sup> The eradication program has reduced the number of countries with endemic dracunculiasis from 20 in 1986 to 9 in 2006 (with 5 of the 9 having reported fewer than 30 cases each). The World Health Organization (WHO) has now certified 180 countries as free of guinea worm disease, and all countries where the disease was endemic have signed a WHO Geneva declaration pledging to wipe out the parasite by 2009.<sup>2</sup> Whereas massive funding is funneled into campaigns to eradicate poliovirus, to control malaria and tuberculosis, and to prevent the

spread of human immunodeficiency virus, guinea worm disease is about to be eradicated without any drug therapy or vaccine. Its demise will be proof that people can be persuaded to change their behavior through innovative health education.

Dracunculiasis is transmitted to humans through drinking water contaminated with microscopic copepods (water fleas) that are infected with larvae of the worm. About a year after a person has become infected, adult female worms emerge from the skin (usually 1 to 3 emerge simultaneously, but as many as 40 have been documented to emerge from a given person in a season). If the emerging worms make contact with water, they expel larvae into the water, which copepods ingest, beginning the cycle anew.<sup>2</sup> The emergence of the worms, which can be more than 2 ft (0.6 m) long, is painful and often incapacitates

people for 2 to 3 months. Humans are the only reservoir, and there is no effective anthelmintic agent or vaccine. Infection can be prevented by filtering drinking water through finely woven cloth, which removes the copepods; by killing copepods and larvae with temephos applied to open ponds; by educating villagers about not entering sources of drinking water; or by providing clean drinking water from safe sources such as borehole wells or hand-dug wells. In areas where guinea worm is endemic, the parasite often predominantly infects women, who tend to do most of the washing and the gathering of water for households. During planting or harvest season, dracunculiasis has sometimes been reported in more than half the population of a given village.

The global eradication campaign began at the Centers for Disease Control (CDC) in 1980 and was then adopted as a subgoal of the United Nations International Drinking-Water Supply and Sanitation Decade (1981–1990).<sup>3</sup> Since 1986, the Carter Center has led the effort with the help of the CDC,

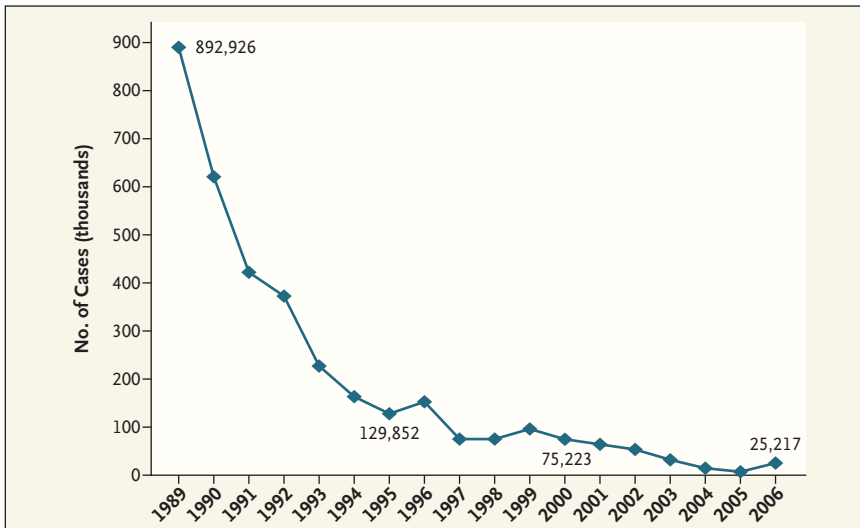


Emerging Guinea Worm.

the WHO, the United Nations Children’s Fund (UNICEF), the Bill and Melinda Gates Foundation, and many other donors and non-governmental organizations, as well as governments of the countries where guinea worms are endemic and thousands of village volunteers. Working with this public–private coalition, the Carter Center has been able to initiate village-based surveillance, health education, and distribution of cloth filters and to provide larvicides and solicit operational support for the digging of wells.

The Carter Center provides financial and technical assistance

to national guinea worm programs that include participants from ministries and from non-governmental organizations, traditional leadership, political leadership, and village volunteers; these programs put eradication activities and surveillance into motion and empower communities to provide clean drinking water. When the eradication program encounters an impasse, those involved often deploy unusual tactics. At a 1989 lunch with Edgar Bronfman, the Seagram’s liquor heir, President Carter explained the technique of filtering copepods out of water, demonstrating with a damask napkin. Bronfman, who held a major stake in the DuPont chemical company, had DuPont scientists develop the tough fine mesh that is now used to filter water. In Uganda, the eradication program has employed elderly men as “pond caretakers” to guard ponds against contamination by worms emerging from people.<sup>4</sup> When infected people are identified at a pond, the caretakers assist them with water gathering, preventing contamination of the water, and distribute nylon filters for ongoing prevention. Cash rewards are sometimes offered to those who report cases or to infected villagers who agree to be



Number of Reported Cases of Dracunculiasis Worldwide, 1989–2006.

Data are from the Carter Center.

Elizabeth Wolfe, the Carter Center.



Emily Staub, the Carter Center.

Manual Extraction of Guinea Worm.



Louise Gubb, the Carter Center.

Jimmy Carter in Ghana.

quarantined while the worm is emerging; often such persons receive free care and food during that period.<sup>4</sup>

Water sources are monitored, and the level of coverage by control measures is reported monthly or quarterly to heads of state, who are also given documentation listing areas free of guinea worm. The WHO has convened an International Commission for the Certification of Dracunculiasis Eradication to certify countries that have eradicated the parasite.

Such a transnational global campaign for improving health requires a nuanced understanding of global health diplomacy. Faced with one of the most imposing barriers to eradication of guinea worm — the civil war in southern Sudan — Carter negotiated a 4-month “guinea worm ceasefire” in 1995, which also allowed public health officials to kick-start Sudan’s onchocerciasis control program.<sup>3</sup> Inadequate security in other countries where guinea worm disease is endemic, inadequate political will on the part of national leaders, and the absence of a “magic bullet” treatment have all presented challenges to the eradication program. Health care initiatives have had to

be linked with diplomatic efforts to overcome these challenges.

Much has been written about the inadequacy of “vertical,” single-disease programs that fail to focus on widespread reductions in poverty, on infrastructure development, and on the broad-based provision of primary care. But the Dracunculiasis Eradication Program is leaving a legacy of development in sync with the United Nations Millennium Development Goals. It has helped to improve the quality of water sources for communities that previously lacked access to clean and safe water, created jobs for the (often elderly) unemployed, and empowered volunteers, frequently inspiring them to pursue health-related employment. In communities where guinea worm was endemic, networks of women have been created for education campaigns; Ghana alone has 6500 female Red Cross volunteers assisting in the program, and in Benin newly created women’s clubs have helped to stop transmission of the disease.<sup>3</sup> School absenteeism has decreased as fewer children have become infected. Research in Mali had linked a 5% decrease in production of two food crops to guinea worm disease, and the annual economic losses due

to guinea worm in three rice-growing Nigerian states was estimated to be over \$20 million, but now agricultural productivity has improved.<sup>5</sup> Thus, this vertical program has been shown to combat poverty, hunger, and even illiteracy (by decreasing school absenteeism), as well as to empower women — all Millennium Development Goals.

In an era when unprecedented global health funding is being directed toward vaccines and drug therapy, guinea worm eradication has been successful on a modest budget of about \$225 million for the entire 20-year campaign. It has done so, according to Dr. Donald Hopkins, vice president for health programs at the Carter Center, by relying on the old-fashioned public health tactic of educating people about changing their behavior. With its charismatic leader practicing global health diplomacy, a public-private coalition has been able to empower a marginalized, infected population to slay its not-so-little dragons.

**An interview with Jimmy Carter and Donald Hopkins is available at [www.nejm.org](http://www.nejm.org).**

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1. Dracunculiasis eradication: global surveillance summary, 2006. *Wkly Epidemiol Rec* 2007;82:133-40.

2. Dracunculiasis eradication: Geneva declaration on guinea-worm eradication. *Wkly Epidemiol Rec* 2004;79:234-5.

3. Hopkins DR, Ruiz-Tiben E, Downs P, Withers PC Jr, Maguire JH. Dracunculiasis eradication: the final inch. *Am J Trop Med Hyg* 2005;73:669-75.

4. Rwakimari JB, Hopkins DR, Ruiz-Tiben E. Uganda's successful Guinea Worm Eradica-

tion Program. *Am J Trop Med Hyg* 2006;75:3-8.

5. The Carter Center home page. (Accessed June 1, 2007, at <http://www.cartercenter.org>.)

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## Providing the Providers — Remediating Africa's Shortage of Health Care Workers

Pooja Kumar, M.D.

Dr. Cyril Nkabinde, an intern at Prince Mshiyeni Memorial Hospital in Durban, South Africa, grew up dreaming of becoming a doctor — an ambition he inherited from his mother, whose own dream had been thwarted by apartheid. Nkabinde's goal of working as a family physician in rural KwaZulu-Natal has kept him on track, even as he's watched medical school classmates depart for business careers and superiors quit medicine because of a chronic lack of health care resources. Now, as he prepares to marry a fellow physician, Nkabinde realizes that his dream may not be achievable.

"The hope is to go into a rural or public setting," he says, "but if we have kids, it definitely won't be a long-term thing. Obviously, we would have to provide for them — schooling and so on — and the best case is for us to be in the city."

Dr. Gloria Mfeka, Nkabinde's fiancée, recently completed her mandated year of community service in rural Bethesda Hospital. She notes that though rural work can be rewarding, its difficulties can also be overwhelming for a young physician. "If we got the bare necessities in outlying hospitals, like an ECG machine . . . that would make a

world of a difference. In the outlying hospitals, to get CD4-count results there's a 6-week waiting list. . . . It's just crazy."

The pressures on Mfeka and Nkabinde reflect a global problem that is finally receiving attention from donors and international agencies: a critical shortage of health care workers in many parts of the world. Although this shortage is not new, recent international efforts to vaccinate children and to fight human immunodeficiency virus (HIV) infection and AIDS, malaria, tuberculosis, and other diseases have brought it into sharper focus. Donors are increasingly realizing that without enough trained workers to deliver drugs, vaccines, and care, pumping money into projects will not have the desired effects. "Even if you have the medicine, the vaccines, and the bed nets, you need the health workers to deliver the service," says Manuel Dayrit, director of the Department of Human Resources for Health at the World Health Organization (WHO). "With the experience of the last few years, where you have had huge global funds move into an activity to provide resources . . . we've found that the bottleneck is really the delivery."

Africa has been hit the hardest by the crisis: according to



Patients Waiting to Be Seen at the HIV Clinic at Bethesda Hospital in Rural KwaZulu-Natal Province.