

Progress Toward Global Eradication of Dracunculiasis — January 2015–June 2016

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Dracunculiasis (Guinea worm disease) is caused by *Dracunculus medinensis*, a parasitic worm. Approximately 1 year after a person acquires infection from drinking contaminated water, the worm emerges through the skin, usually on the leg. Pain and secondary bacterial infection can cause temporary or permanent disability that disrupts work and schooling. The campaign to eradicate dracunculiasis worldwide began in 1980 at CDC. In 1986, the World Health Assembly called for dracunculiasis elimination (1), and the global Guinea Worm Eradication Program, led by the Carter Center and supported by the World Health Organization (WHO), United Nations Children's Fund (UNICEF), CDC, and other partners, began assisting ministries of health in countries where dracunculiasis was endemic. In 1986, an estimated 3.5 million cases were occurring each year in 20 countries in Africa and Asia (1,2). Since then, although the goal of eradicating dracunculiasis has not been achieved, substantial progress has been made. Compared with the 1986 estimate, the annual number of reported cases in 2015 has been reduced by >99%, and cases are confined to four countries with endemic disease. This report updates published (3–5) and unpublished surveillance data reported by ministries of health and describes progress toward dracunculiasis eradication during January 2015–June 2016. In 2015, a total of 22 cases were reported from four countries (Chad [nine cases], Mali [five], South Sudan [five], and Ethiopia [three]), compared with 126 cases reported in 2014 from the same four countries (Table 1). The overall 83% reduction in cases from 2014 to 2015 is the largest such annual overall reduction ever achieved during this global campaign. During the first 6 months of 2016, however, cases increased 25% compared with the same period in 2015. Continued active surveillance and aggressive detection and appropriate management of cases are essential eradication program components; however, epidemiologic challenges and civil unrest and insecurity pose potential barriers to eradication.

Because the life cycle of *D. medinensis* is complex, several strategies are used to interrupt its transmission (4). Dracunculiasis can be prevented with four main interventions: 1) educating residents in communities where the disease is endemic, particularly persons from whom worms are emerging, to avoid immersing affected body parts in sources of drinking water; 2) filtering potentially contaminated drinking water through a cloth filter or pipe filter to remove copepods (small crustaceans that host *D. medinensis* larvae); 3) treating potentially contaminated surface water with the organophosphate

larvicide temephos (Abate) to kill the copepods; and 4) providing safe drinking water from bore-hole or protected hand-dug wells (6). Containment of transmission* is achieved through four complementary measures: 1) voluntary isolation and education of each patient to prevent contamination of drinking water sources, 2) provision of first aid to prevent secondary infections, 3) manual extraction of the worm, and 4) application of occlusive bandages. No vaccine or medicine to prevent or treat Guinea worm disease currently exists.

D. medinensis has an approximate 1-year incubation period (range = 10–14 months) following infection (6). A case of dracunculiasis is defined as an infection occurring in a person exhibiting a skin lesion or lesions with emergence of one or more Guinea worms. Each infected person is counted as a case only once during a calendar year. Countries enter the WHO precertification stage of eradication after 1 full year with no reported indigenous† cases. An imported case is an infection resulting from ingestion of contaminated water from a source identified through patient interviews and epidemiologic investigation in a place other than in the community where the patient is identified and the case reported (i.e., another country or another village within the same country). Since 2012, no international importations have been reported.

In each affected country, a national dracunculiasis eradication program receives monthly reports regarding cases from each village under active surveillance. Reporting rates are calculated as the proportion of all villages under active surveillance reporting monthly (Table 2). Active surveillance is conducted in all villages with endemic dracunculiasis or at high risk for importation, with daily searches of households for persons with signs or symptoms of dracunculiasis, to ensure case detection

* Transmission from a patient with dracunculiasis is contained only if all of the following conditions are met for each emerged worm: 1) the infected patient is identified ≤24 hours after worm emergence; 2) the patient has not entered any water source since the worm emerged; 3) a village volunteer or other health care provider has managed the patient properly, by cleaning and bandaging the lesion until the worm has been fully removed manually and by providing health education to discourage the patient from contaminating any water source (if two or more emerging worms are present, transmission is not contained until the last worm is removed); 4) the containment process, including verification of dracunculiasis, is validated by a Guinea Worm Eradication Program supervisor within 7 days of emergence of the worm; and 5) temephos is used if any uncertainty about contamination of sources of drinking water exists, or if a source of drinking water is known to have been contaminated.

† An indigenous case of dracunculiasis is defined as an infection consisting of a skin lesion or lesions with emergence of one or more Guinea worms in a person who had no history of travel outside his or her residential locality during the preceding year.

TABLE 1. Number of reported indigenous dracunculiasis cases, by country -- worldwide, January 2014–June 2016

Country	Cases by year				Cases by 6-month period, January–June*			
	2014	2015		1-yr. change (%)	2015	2016		6-mo. change (%)
	No.	No.	Contained (%)		No.	No.	Contained (%)	
Chad	13	9	(0)	(-31)	6	4	(75)	(-33)
Ethiopia	3	3	(100)	(0)	1	2	(100)	(+100)
Mali†	40	5	(60)	(-88)	0	0	—	—
South Sudan	70	5	(40)	(-93)	1	4	(75)	(+300)
Total	126	22	(36)	(-83)	8	10	(80)	(+25)

* No international importations were reported during the 18-month period January 2015–June 2016.

† Civil unrest and insecurity following a coup in April 2012 continued to constrain program operations in regions with endemic dracunculiasis (Gao, Kidal, Mopti, and Timbuktu) during 2015–2016.

TABLE 2. Reported dracunculiasis cases, surveillance, and status of local interventions in villages with endemic disease, by country — worldwide, 2015

Cases/Surveillance/Status	Country				
	Chad*	Ethiopia	Mali†	South Sudan	Total
Reported cases					
No. indigenous, 2015	9	3	5	5	22
No. imported,§ 2015	0	0	0	0	0
Contained in 2015 (%)	(0)	(100)	(60)	(40)	(36)
Change in indigenous cases in villages/localities under surveillance, same period, 2014 and 2015 (%)	(-100)	(0)	(-88)	(-93)	(-83)
Villages under active surveillance, 2015					
No. of villages	1,015	173	574	2,610	4,372
Reporting monthly (%)	(100)	(99)	(100)	(99)	(99)
No. reporting ≥1 case	9	3	1	5	18
No. reporting only imported¶ cases	1	0	0	0	1
No. reporting indigenous cases	8	3	3	5	19
Status of interventions in villages with endemic dracunculiasis, 2014–2015					
No. of villages with endemic dracunculiasis	20	3	1	15	39
Reporting monthly** (%)	(100)	(100)	(100)	(100)	(100)
Filters in all households** (%)	(100)	(100)	(100)	(100)	(100)
Using temephos** (%)	(30)	(100)	(100)	(100)	(83)
≥1 source of safe water** (%)	(88)	(100)	(66)	(33)	(72)
Providing health education** (%)	(100)	(100)	(100)	(100)	(100)

* Participants at the annual Chad Guinea Worm Eradication Program review meeting in November 2014 adopted "1+ case village" as a new description for villages in Chad affected by human cases of Guinea worm disease or dogs infected with Guinea worms and defined as "a village with one or more indigenous and/or imported cases of Guinea worm infections in humans, dogs, or cats in the current calendar year or previous year."

† Civil unrest and insecurity following a coup in 2012 continued to constrain Guinea Worm Eradication Program operations (supervision, surveillance, and interventions in Gao, Kidal, Mopti, and Timbuktu regions).

§ Imported from another country.

¶ Imported from another country or from another in-country village with endemic disease.

** The denominator is the number of villages/localities where the program applied interventions during 2014–2015.

within 24 hours of worm emergence and prompt patient management to prevent contamination of water sources. Villages in which endemic transmission of dracunculiasis is interrupted (i.e., zero cases reported for ≥12 consecutive months) are kept under active surveillance for 3 consecutive years. WHO certifies a country free from dracunculiasis after that country maintains adequate nationwide surveillance for ≥3 consecutive years and demonstrates that no cases of indigenous dracunculiasis occurred during that period. As of January 2016, WHO had certified 198 countries, areas, and territories as free from dracunculiasis (3). Eight countries remain to be certified: four where dracunculiasis is currently endemic (Chad,

Ethiopia, Mali, and South Sudan), two in the precertification stage (Kenya and Sudan), and two never known to have had endemic dracunculiasis since the global eradication program began in 1980 (Angola and the Democratic Republic of the Congo, which are in the process of completing the requirements towards certification).

During January 2015–June 2016, CDC evaluated 209 specimens that emerged from humans, 207 from the four countries with endemic dracunculiasis and two from Kenya, a country where dracunculiasis was formerly endemic. Because some patients have multiple Guinea worms emerge, more laboratory-confirmed specimens than cases might be reported in any given period.

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Chad. After a decade with no reported cases, Chad reported 10 indigenous cases in 2010. After indigenous cases were confirmed during 3 consecutive years, dracunculiasis was declared to be endemic in 2012 (7). In 2015, Chad reported nine cases (none contained) in nine villages, compared with 13 cases in 2014. During the first half of 2016, four cases (three contained) were reported in four villages. None of the 13 villages that reported a case in 2015 or during January–June 2016 had reported a case previously.

In 2012, Guinea worm infections were first reported in domestic dogs in Chad, and since then, more dogs than humans have been identified with emerging Guinea worms. This substantial number of nonhuman infections has not occurred in any other country during the eradication campaign. Worm specimens obtained from dogs were determined to be genetically indistinguishable from *D. medinensis* worms removed from humans in Chad (7). Most infections during the current outbreak have occurred in communities along the Chari River. The Carter Center has assisted the Ministry of Health in implementing active village-based surveillance for the disease in more than 1,300 villages in the at-risk zone. The working hypothesis, based on biologic, environmental, and epidemiologic investigations by CDC and the Carter Center, is that human cases and dog infections are associated with the domestic and commercial fishing industry along the Chari River and involve fish or other aquatic species that serve as paratenic hosts (intermediate hosts in which no development of the parasite occurs). New human cases are thought to occur when inadequately cooked paratenic hosts are consumed by humans and when such hosts are consumed raw by dogs (7). Overall, 503 infected dogs (as well as five infected domestic cats) were reported during 2015; during January–June 2016, 653 infected dogs were reported, a 116% increase over the 302 reported during the same period in 2015. However, the increase in dog infections compared with the same months of the previous year has begun to decline. The overall 116% increase from January–June 2015 to January–June 2016 is much less than the 325% increase that occurred during the first 6 months of 2015 compared with the first 6 months of 2014 (4).

Beginning in October 2013, Chad's Guinea Worm Eradication Program urged villagers to be certain their fish were well cooked, bury fish entrails, and prevent dogs from eating fish entrails. By May 2016, according to monthly sample surveys, this intervention was being implemented by about 89% of respondents in surveyed communities with at-risk populations. In February 2014, health education efforts began to persuade villagers to tether infected dogs until the worms emerged to prevent contamination of water and infection of

copepods. In February 2015, the program introduced a reward equivalent to US\$20 for reporting and tethering an infected dog. Whereas 40% of infected dogs were tethered in 2014 and 68% were tethered in 2015, 81% of 498 infected dogs reported during January–May 2016 were tethered.

Chad has offered a cash reward equivalent to US\$100 for reporting a case of dracunculiasis in humans beginning before 2010. In areas under active surveillance, 85% of 66 residents surveyed in May 2016 knew of the cash reward for reporting a case of dracunculiasis, and 68% knew of the cash reward for reporting and tethering an infected dog.

As of June 2016, 88% of villages with endemic dracunculiasis had safe water (i.e., water sources free of copepods, such as rapidly flowing rivers, protected hand-dug wells, and borehole wells). Temephos usage is limited by the extremely large lagoons used for fishing and as sources of drinking water; however, beginning in August 2014, an innovative technique of applying temephos to smaller cordoned sections of the lagoons at entry points used by infected humans or dogs was introduced to protect 19 villages in 2014, 29 villages in 2015, and 32 villages during January–June 2016.

The Carter Center and the WHO Collaborating Center for Research, Training and Eradication of Dracunculiasis at CDC are supporting research to better understand the unusual epidemiology of the current outbreak of dracunculiasis in Chad, assess antihelminthic treatment of dogs to prevent maturation of worms, and study the food sources and movements of dogs in an area of Chad with endemic disease. In collaboration with researchers from the University of Georgia, this initiative has demonstrated for the first time that *D. medinensis* can use an amphibian (frog) as a paratenic host in the laboratory (8) and has recovered, for the first time ever, a *Dracunculus* larva from a frog captured in the wild in Chad (9).

Ethiopia. In 2015, Ethiopia reported three cases of dracunculiasis (all three contained), one each in two villages in Gog district and one in a village in Abobo district of Gambella Region; the latter case occurred in a patient who also appeared to have been infected in one of the implicated villages in Gog district. This is the same number of cases that Ethiopia reported in 2014. Ethiopia also reported 13 infected dogs and one infected baboon in 2015, compared with three infected dogs and one unconfirmed report of an infected baboon in 2014, all in the same area of Gog district. During January–June 2016, Ethiopia reported two human cases and three infected dogs, compared with one human case, one infected dog, and one infected baboon during the same period of 2015. The program applied temephos monthly to almost all water sources used by humans in the at-risk area of Gog district throughout 2015. Coverage was increased threefold to include numerous smaller water sources in 2016. The program also introduced

a cash reward equivalent to US\$20 in April 2015 for reporting an infected animal, and the Ministry of Health held two press conferences to publicize the eradication initiative during the first half of 2016. A total of 152 villages are under active surveillance in two districts of Gambella Region. Ethiopia offers a cash reward equivalent to US\$100 for reporting a case of dracunculiasis. Among 1,021 persons surveyed in Gog district in January–June 2016, 95% were aware of the reward for reporting an infected person; 51% of 1,068 surveyed knew of the reward for reporting an infected animal.

Mali. In 2015, Mali reported five cases of dracunculiasis (three contained) in three villages, located in Ansongo district of Gao Region (Tanzikratene, three cases), Tominian district of Segou Region (Parasilame, one case) and Gourma Rharous district of Timbuktu Region (Ngariatane, one case). This represented an 88% reduction from the 40 cases (35 [88%] contained) reported in 2014. Tanzikratene had reported 29 (73%) of Mali's cases in 2014; the other two villages with cases had not previously reported a case. Mali reported no cases during January–June 2015 or January–June 2016. However, Mali reported one infected dog in Tominian district in 2015 for the first time since the program began and one infected dog in the first half of 2016. Tanzikratene received a rehabilitated source of safe drinking water in 2015. There are 698 villages under active surveillance. Mali offers a cash reward equivalent to US\$100 for reporting a case of dracunculiasis and US\$20 for reporting and tethering an infected dog. In areas under active surveillance, 89% of 974 persons surveyed in June 2016 knew of the reward for reporting a case of dracunculiasis, and 61% of 461 surveyed knew of the reward for reporting an infected dog. In a sign of increased political support, in June 2016, the minister of health visited the area of Segou Region where dracunculiasis is endemic.

South Sudan. South Sudan reported five cases of dracunculiasis (two contained) in five villages in 2015, representing a 93% reduction from the 70 cases reported in 2014. It also reported the country's only known infected dog in 2015, which belonged to the household of one of the human patients. During January–June 2016, South Sudan reported four cases in June (three contained) in Tonj East County of Warrap State and Jur River County of Western Bahr Al Ghazal State, compared with only one case reported during January–June 2015. South Sudan has reported zero cases of dracunculiasis for 10 of the 18 months under review. South Sudan had 2,610 villages under active surveillance in 2015. Coverage with interventions in villages with endemic disease remains high, except for providing safe sources of drinking water (Table 2). In early July 2016, increased insecurity forced evacuation of all expatriate staff members assisting the South Sudan Guinea Worm Eradication Program. South Sudan began offering a

Summary

What is already known about this topic?

The number of new cases of dracunculiasis (Guinea worm disease) occurring worldwide has decreased each year since 1986, when the World Health Assembly declared global elimination as a goal, from an estimated 3.5 million in 1986 to 22 in 2015.

What is added by this report?

The number of dracunculiasis cases reported worldwide during 2015 declined by 83% compared with 2014, but increased by 25% in January–June 2016 compared with January–June 2015. Despite missing earlier target dates for global dracunculiasis eradication, progress in eradicating human disease accelerated in 2015, although the rate of decline has been modest so far in 2016. Transmission is ongoing in four countries: Chad, Ethiopia, Mali, and South Sudan. The emergence of *Dracunculus* infections in domestic dogs in Chad and program disruptions caused by civil unrest and insecurity in Mali and South Sudan are now the greatest challenges to interrupting transmission.

What are the implications for public health practice?

Although earlier target dates for global dracunculiasis eradication were missed, progress has accelerated, and eradication is likely within the next year or two if disruption of program operations caused by insecurity in Mali can be minimized. However, rigorous implementation of all interventions (including recent interventions to prevent transmission to and from dogs) must continue to be maintained in Chad to ensure impact becomes manifest during 2016 and beyond.

cash reward equivalent to about US\$125 for reporting a case of dracunculiasis in April 2014; in 2015, approximately 72% of 4,125 persons surveyed in areas under active surveillance knew of the reward (10).

Discussion

Led by sharp reductions in Mali and South Sudan, the unprecedented 83% reduction in total reported cases of dracunculiasis from 2014 to 2015 included 3 months (January, September, and December 2015) with zero cases worldwide. The 10 cases reported during January–June 2016 represent a 25% increase over the eight reported during January–June 2015, although zero cases were reported worldwide for the months of January and March 2016.

Political support for Guinea worm eradication remains very strong in South Sudan and has improved recently in Ethiopia and Mali, although civil unrest and associated insecurity remain major challenges to completing the eradication campaign, especially in Mali and South Sudan. The health ministers of all four countries attended or were represented at the annual informal meeting of countries with current or former endemic dracunculiasis during the World Health Assembly in Geneva,

Switzerland, in May 2016 and at the International Review Meeting for Guinea Worm Eradication Program Managers held at the Carter Center in March 2016. The continued increase in infections of dogs in Chad and a lesser increase in Ethiopia in 2015 present a substantial challenge as the global program negotiates its final phase. Specific interventions and vigorous research to address these challenges could reduce infections in humans and dogs in Chad before the end of 2016.

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