The Role of Case Containment Centers in the Eradication of Dracunculiasis in Togo and Ghana

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Abstract. As part of the global effort to eradicate dracunculiasis (Guinea worm disease), several endemic countries established case containment centers to provide treatment and support to patients with emerging Guinea worms to keep them from contaminating water sources. To assess the functioning, effectiveness, and public perception of this intervention, we visited eight centers and conducted surveys in 32 villages in Togo and Ghana. In the areas served by these centers, incidence dropped by 71% in Togo and 42% in Ghana from 2003 to 2004. Among persons with emerging worms, admission to the centers was associated with younger age (P value = 0.04) after controlling for occupation and gender. Overall, the centers functioned well and were regarded favorably: 99% of the 152 center-attendees expressed satisfaction with their stay. Strategically-located case containment centers in conjunction with other interventions appear to play an important role in the final effort to eradicate dracunculiasis.

INTRODUCTION

Dracunculiasis or Guinea worm disease (GWD) is caused by the nematode Dracunculus medinensis. Persons acquire infection by drinking water containing copepods (water fleas), the intermediate hosts that harbor larvae of the parasite. After 10–14 months, the adult female worm emerges through a blister usually located on the infected individual’s lower leg. To ease the pain, persons with GWD often immerse the affected limb into water, at which time the worm releases larvae that are ingested by copepods. Human infection results in an average of eight weeks of disability and adverse socioeconomic consequences from decreased agricultural production, school attendance, and ability to care for self and family.1–4

Although there is no existing medication or vaccine, GWD is the target of a global eradication program.5 Since its inception in 1980, the Guinea worm eradication program (GWEP) has registered tremendous success in the 20 endemic countries.6,7 Between 1986 and December 2007, the annual number of cases decreased by greater than 99% from an estimated 3.5 million cases to a provisional total of 10,068 cases (Guinea worm wrap-up #178: www.cdc.gov/nceid/dpd/parasites/dracunculiasis/wrapupp178.pdf).5–10 Interventions have included preventing contamination of water sources by infected persons, filtration of drinking water, provision of potable water to communities, and application of temephos (Abate; BASF Corporation, Mount Olive, NJ) to bodies of water to kill copepods.11 Selection and application of these public health measures are not uniform within countries or between them. Such differences in public health measures (and environmental factors) clearly affect disease incidence.

To prevent infected persons from contaminating water, the GWEP also employs a “case containment” strategy similar to that which facilitated the eradication of smallpox.12 Through active community-based surveillance, village volunteers identify case patients within 24 hours of worm emergence, instruct the patient and family members on ways to prevent contamination of water sources, and report demographic information to the national GWEP.13,14 Implementation of this strategy, first in Pakistan and Cameroon in the early 1990s and later in other endemic countries, contributed to a major decline in numbers of cases and villages reporting cases.3,14–16 By the end of the decade, however, progress towards the goal of global eradication had slowed. Reports of a yearly average of 10 cases of GWD per village in endemic areas suggested the need for intensified case containment (E. Ruiz-Tiben, unpublished data).

The concept of case containment centers arose as a strategy for encouraging persons with emerging worms not to enter sources of drinking water. To enhance effectiveness, GWEPs were encouraged to establish ad hoc case containment centers in endemic areas with the highest annual case loads (based on cases reported in the preceding year), and where possible to make use of existing public health clinics or posts. For persons with GWD, the centers provide free treatment, lodging, meals or money to purchase food, and in some instances, a stipend to compensate for wages lost during confinement in the center. Many centers use controlled immersion; infected limbs are immersed in a bucket of cold water to trigger the expulsion of larvae. The centers opened first in Ethiopia in 1999, and later in Togo (2001) and Ghana (2002). By 2006, 27 centers were operational in six countries.

To understand the effectiveness of case containment centers, we undertook an evaluation of their operation, cost, perception by the public, and utility in preventing new cases of GWD. We selected Togo and Ghana for our survey as examples of countries in which the 2004 incidence of GWD was decreasing dramatically (Togo), and one in which the number of cases was increasing (Ghana).9

METHODS

Selection of survey sites. The evaluation took place in May and June 2004. Within each country, case containment centers were eligible for study if during 2003 they had been in operation for at least nine months, had a functioning reporting system (i.e., the GWD national program manager received reports of case numbers), and were active (i.e., had reported one or more cases to the GWD national program manager). Four case containment centers (each in a different district) were selected for each country. Because of the small number

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of cases in Togo, we selected the four centers that had the greatest number of case patients in 2003, whereas in Ghana we drew lots to randomly select the centers from among those that were accessible.

**Center inspection and interview of manager.** During visits by the study team, each center was inspected (by NH or JF) and evaluated descriptively with respect to cleanliness, adequacy of documentation (e.g., patient names and duration of treatment), and associated costs. We assessed whether there were sufficient medical supplies, educational materials, and basic provisions such as bedding and water. Managers or staff present during the site visit were interviewed about practices for case containment, treatment, education, and other activities.

**Selection of persons for interviews: Cases.** We interviewed equal numbers of GWD “case” patients who went to the case containment centers during their illness, and those who did not go to the centers. To find cases, we selected villages within the catchment area of each center that had reported at least one case of GWD in 2003 (Ghana) or January 2003–April 2004 (Togo); the number of villages chosen varied depending on the number of case patients per village. Village volunteers confirmed cases using GWD registries. If no GWD patients were available for interview in the selected village, we went to the nearest accessible endemic village.

**Uninfected persons.** To assess whether the general population was aware of the centers, we interviewed uninfected persons. For every case patient who participated in each village, we selected two persons who had no recent history of GWD and who would not have attended a center had they ever been infected with GWD. Because the Ghanaian centers opened in 2003 and the Togolese in 2002, we sought persons who did not have GWD during the previous 12 (Ghana) or 16 months (Togo). We selected these uninfected participants by starting in the center of the village and visiting houses in one direction. We invited members of every 4th or 5th household (defined as all persons sharing the same cooking pot) to participate in the survey. Children who were exclusively breastfed (and therefore not at risk for infection) were not eligible to take part in the survey. Informed consent was obtained from all adult participants and from the parents or legal guardians of minors. Because this was a program evaluation, participating institutions’ Institutional Review Board approval was waived.

**Survey team and instrument.** The survey team (whose members varied by district) consisted of one outside consultant (NH or JF) and at least two of the following persons: GWEP technical advisor or coordinator (from the national, regional, or district level) and case containment center personnel. Village volunteers, GWEP drivers, and villagers acted as guides and translated when necessary.

One standardized questionnaire was used in interviews of center managers and staff to address the functioning of the center, costs, and logistical issues. Case patients and uninfected persons were interviewed using different standardized questionnaires that focused on knowledge, attitudes, and practices about GWD and case containment centers. Information was collected from center attendees on the estimated time required to travel to the centers.

**Case numbers and cost.** On a monthly basis, national GWEP coordinators provided information to the Carter Center on the number of cases. These reports were derived from village volunteer and case containment center patient lists. Data on cost for 2003 from all case containment centers that had sufficient records were obtained from the country GWEP coordinator.

**Determination of sample size and statistical analysis.** Sample size was calculated to determine a 25% absolute difference in characteristics among the three groups (case patients who went to centers, case patients who did not go to the centers, and uninfected persons). Calculations were based on an estimated 50% prevalence of each outcome, a clustering effect of 25%, and a non-response rate of 20%. A Bonferroni correction was applied. Because of logistic constraints and the limitations of ecologic studies, the study was not designed or powered to make comparisons between Togo and Ghana.

Data were entered using Epi Info 6 and analyzed using SAS versions 8.2 and 9.0 (SAS Institute Inc., Cary, NC). A two-tailed Fishers exact test was used for binary variables. The Wilcoxon rank-sum test was used for comparison of medians. A logistic regression model assessed the association between independent variables (age, occupation, and gender) and whether a patient attended the case containment center. Occupation was categorized as student (versus all other professions), and age was categorized by decade. The Hosmer and Lemeshow goodness-of-fit test produced a P value of 0.80.

**RESULTS**

Six centers (in six different districts) in Togo and 15 centers (in eight districts) in Ghana met the criteria for inclusion. Four centers were selected in each country: Agou-Ave (Ave district), Est Mono (Est Mono district), Ogou (Ogou district), and Haho (Haho district) in Togo, and Sang (Yendi district), Datoyili (Tamale district), Gbandi (Zabzugu-Tatale district), and Dashei (East Gonja district) in Ghana. A total of 822 persons were surveyed in 32 villages (18 in Togo, 14 in Ghana). Of these, 542 persons (66%) were uninfected persons (241 in Ghana, 302 in Togo), and 280 (34%) were GWD patients. Of those with GWD, 152 (54%) had gone to the centers (61 in Ghana, 91 in Togo), and 127 (46%) had not (65 in Ghana, 62 in Togo).

**Center organization and functioning.** Inspection of the centers in both countries demonstrated that most facilities and lodging areas were reasonably clean (e.g., the interior was protected from rain and the latrine was relatively hygienic). Educational materials were present, but several centers were missing treatment supplies and documentation forms. In Ghana, more so than in Togo, the definition of “case containment” was variable, so that not all “contained” cases had arrived at the center within 24 hours of worm emergence. Furthermore, the GWEPs in Ghana did not have a standard policy for dealing with water sources that may have been contaminated by patients en route to the case containment centers. Last, centers in Togo were open year-round as they are part of an existing health facility; those in Ghana were open only during the peak transmission season and may have missed cases that occurred at other times.

Treatment also differed between the two countries. More center personnel in Togo than in Ghana used antibiotic cream for treatment of GWD (¼ centers versus ¼) and provided oral pain relief (¼ versus ¼). Centers in Togo were also more likely than those in Ghana (¼ versus ¼) to perform con-
trolled immersion. Furthermore, in Togo, if patients had other concomitant diseases (e.g., diarrhea or malaria), these were treated for free; this was not the case in Ghana.

**Case reduction.** From 2003 to 2004, the percentage of GWD patients admitted to all of Togo’s case containment centers increased from 48% to 63%, whereas in Ghana, admissions decreased from 50% to 27%. In 2003, the utilization at the four selected centers averaged 58% (range 46–75%) in Togo and 65% (range 57–73%) in Ghana. In 2004, utilization was 70% (range 50–86%) in Togo, but 32% (range 17–70%) in Ghana; utilization at three out of the four Ghanaian centers surveyed was less than 25% in 2004. From 2003 to 2004 in the corresponding districts, there was a 70% decrease (from 283 to 86) in reported cases in Togo and a 42% decrease (from 1,572 to 913) in Ghana (Figures 1 and 2). Countrywide from 2003 to 2004, numbers of reported cases declined in both Ghana and Togo, but more so in Togo (58% decline) than in Ghana (12%; Figure 3).

**Awareness about case containment centers.** Most persons knew that the centers existed. Ninety-three percent of case patients who did not attend the centers were aware of them, and 95% of uninfected persons were as well. The largest proportion of persons in all groups had learned of the centers from the village volunteers. District supervisors from the GWEP, family members, and friends were other common sources of information.

**Attitudes toward centers.** Of those who went to the centers, 99% reported that they would go to the centers again if they were re-infected with GWD, and 95% would advise a friend with GWD to go. In both countries combined, 99% described their stay as either good or very good (Table 1). Reports were generally positive regarding food, lodging, staff, and the cash stipend.

Of those who had GWD and did not go to the center, there were two primary reasons: 20% stated they did not know at the time of infection that the center existed (although all knew about them at the time of the survey), and 11% referred to a lack of transportation or money for transportation (Table 2). The difficulty of leaving their families was also cited as a disincentive in both countries (9%). Overall, 14% of respondents believed incorrectly that they would have to pay for treatment. Only 2 (2%) stated that the centers were too far away; attendees in Togo reported that it took an average of 2.2 hours to get to the center, whereas in Ghana it took only half an hour.

**Length of stay and illness.** Those who attended the centers stayed for a median of 14 days (range 0–90 days), although it is not known if these people returned to work or school immediately afterwards. Case patients who stayed home missed a median of 30 days of work/school (range 1–365 days), and 5 (4%) contaminated water. In comparison, 2/152 (1%) of those who went to the centers contaminated water; the difference was not statistically significant.

**Demographics.** By univariate analysis, there were associations between admission to a center and younger age ($P = 0.05$) and being a student ($P = 0.05$; Table 3); association with gender was not statistically significant. In the logistic regression model that included age, gender, and student occupation, only younger age was significantly associated with attendance ($P = 0.04$). Previous infection with GWD and the number of years living in the village were not associated with attendance (data not shown).

**Differences between Togo and Ghana.** Center-attendees in Ghana were significantly younger than those in Togo ($P = 0.03$). Among attendees, food, lodging, treatment, and the cash stipend were all viewed significantly more favorably in Togo than in Ghana (Table 1). Among uninfected persons, awareness of the centers was higher in Togo (92%) than in Ghana (92%; $P$ value = 0.02).

**Cost.** Start-up costs averaged US$83 in Togo where the centers were established within existing health facilities, and...
US$2174 in Ghana where they were built de novo. Average operational costs per case contained were US$34 in Togo and US$10 in Ghana.

DISCUSSION

As the number of GWD cases decreases, resources need to be allocated to maximize the chance of eradication. As has been documented in other disease eradication or elimination programs, new strategies and increased resources are necessary in the “final push” to prevent even a small number of new cases. The numbers of GWD cases dropped dramatically in Togo and Ghana after the introduction of case containment centers, reversing the trend of increasing case numbers during the previous 2–3 years. Some of the decline may have been environmental (e.g., from a change in rainfall or temperature) or resulted from the simultaneous intensification of other interventions (e.g., water treatment with Abate, provision of water filters, and health education among others). The impact of case containment centers may vary depending on disease incidence and other mitigating factors. That being said, data for both countries indicate that case containment potentially prevented a large number of persons from contaminating water sources. The cost of implementing the centers is well justified,

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Ghana (N = 61)</th>
<th>Togo (N = 91)</th>
<th>Total (N = 152)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%) reporting experience as good or very good</td>
<td>55 (98.2%)</td>
<td>90 (98.9%)</td>
<td>145 (98.6%)</td>
</tr>
<tr>
<td>Food*</td>
<td>40 (85.1%)</td>
<td>85 (97.7%)</td>
<td>125 (93.3%)</td>
</tr>
<tr>
<td>Lodging†</td>
<td>46 (85.2%)</td>
<td>88 (96.7%)</td>
<td>134 (92.4%)</td>
</tr>
<tr>
<td>Staff</td>
<td>57 (100%)</td>
<td>88 (97.8%)</td>
<td>145 (98.6%)</td>
</tr>
<tr>
<td>Treatment‡</td>
<td>34 (60.7%)</td>
<td>87 (95.6%)</td>
<td>121 (82.3%)</td>
</tr>
<tr>
<td>Incentive*</td>
<td>42 (87.5%)</td>
<td>85 (98.8%)</td>
<td>127 (94.8%)</td>
</tr>
<tr>
<td>Reason for going to center§</td>
<td>45 (73.8%)</td>
<td>39 (42.9%)</td>
<td>84 (55.3%)</td>
</tr>
<tr>
<td>Heal faster‡</td>
<td>8 (13.1%)</td>
<td>35 (38.5%)</td>
<td>43 (28.3%)</td>
</tr>
<tr>
<td>Treat GWD†</td>
<td>14 (23.0%)</td>
<td>18 (19.8%)</td>
<td>32 (21.1%)</td>
</tr>
<tr>
<td>Help with pain‡</td>
<td>20 (32.8%)</td>
<td>5 (5.5%)</td>
<td>25 (16.5%)</td>
</tr>
<tr>
<td>Prevent transmission¶</td>
<td>8 (13.1%)</td>
<td>3 (3.3%)</td>
<td>11 (7.2%)</td>
</tr>
<tr>
<td>Stipend¶</td>
<td>6 (9.8%)</td>
<td>2 (2.2%)</td>
<td>8 (5.3%)</td>
</tr>
<tr>
<td>Get lodging/food</td>
<td>4 (6.6%)</td>
<td>8 (8.8%)</td>
<td>12 (7.9%)</td>
</tr>
<tr>
<td>Other</td>
<td>60 (98.4%)</td>
<td>91 (100%)</td>
<td>151 (99.3%)</td>
</tr>
<tr>
<td>No. (%) would go again</td>
<td>57 (93.4%)</td>
<td>88 (96.7%)</td>
<td>145 (95.4%)</td>
</tr>
</tbody>
</table>

* P value = 0.009.
† P value = 0.02.
‡ P value < 0.001.
§ Persons were allowed to cite multiple reasons.
¶ P value = 0.03.
GWD = Guinea worm disease.
not only because of the contribution towards the goal of elimination, but also the potential decrease in suffering and shortened recovery times of persons with emerging guinea worms. Once established, the yearly operational costs are modest, especially if the centers are integrated into the existing health care system.

Our study confirmed that the case containment centers attracted patients because of improved analgesia, wound care, and prevention of infection. Indeed, center attendees cited better pain control as a major reason for going to the center. Previous studies found that 10–55% of untreated persons with GWD develop secondary bacterial infections, including cellulitis, abscesses, and tetanus.17–19 We did not specifically ask about secondary infections, but those who went to the centers said that “better treatment” was a motivation for seeking care at the center. Provision of food, lodging, medical treatment of other health problems, and stipends to cover lost wages also undoubtedly contributed to the appeal and overall success of the centers.

Although we were unable to determine the precise duration of disability after leaving the case containment centers, an additional benefit may have been reduction of the time spent away from work. Previous studies have shown that persons not receiving medical care were more likely to be disabled for longer than nine weeks compared with those receiving medical care, and secondary infections can prolong the duration of disability for untreated persons.18,20 The average stay in our study lasted 14 days, which reportedly included the time until the worm was removed and any signs of infection resolved. By decreasing the duration of disability, the centers may mitigate the social and economic cost of GWD. Depending on the season and the crop, previous estimates of the lost income of farmers with GWD were estimated to be as high as US $20 million a year.2

Strategically situated centers might be especially beneficial in villages where other interventions have been difficult to implement.21–23 Centrally-located case containment centers in areas with a limited supply of clean water could benefit many surrounding villages. The cost of the centers is minor in comparison to that of bore holes and wells that serve single villages—as much as US $6000 to US $18,000 each, even excluding maintenance costs.23–25 The centers also compare favorably in price to the village volunteer system (estimated at US $48 per case in 1991).14 In the remaining endemic countries, which have varying rates of case containment, the case containment centers could complement the village volunteer system (Guinea worm wrap-up #177: www.cdc.gov/ncidod/dpd/parasites/dracunculiasis/wrapup/177.pdf). Combinations of strategies and interventions will be most effective in the final stages of GWD eradication.

Our study documented ways in which the centers could be more effective. A strict definition of case containment is critical; if patients do not arrive at the centers within 24 hours of worm emergence, they pose a greater risk for contaminating water. Addressing water contamination remains a high priority. Second, ensuring adequate supplies of medications and other materials is important for appropriate patient treatment and satisfaction. Third, in both countries, attendees were significantly younger than non-attendees. This difference likely stems from family and work obligations of older persons. Edu-
cation about the shorter duration of disability among attendees could improve turnout among older persons. Last, transportation cost was cited as a disincentive by many in the study; GWD patients should be made aware that this cost is covered by the GWEP in Togo and transportation assistance may be provided in Ghana.

Our data suggest that satisfaction with the case containment centers was greater in Togo than in Ghana. Togolese centers, unlike those in Ghana, are integrated into preexisting health care centers that offer treatment of other medical problems and perhaps provide better care for GWD. Togo’s facilities also have a more-established infrastructure to allow for better provision of daily needs (such as food and lodging). The lower rate of satisfaction with the centers in Ghana might explain the drop in usage in Ghana in 2004 despite relatively high usage in 2003.

Our study has several limitations. As is true of other ecologic studies, we could not prove causation between the declining incidence of cases and implementation of the centers, and comparisons between centers in the two countries are subject to confounding. Furthermore, bias may have been introduced, because sampling in Togo was convenience-based (as a result of small case numbers), and selection of villages in both countries depended in part on accessibility. Participants in the survey may have been biased because of the presence of village volunteers and other GWD staff at the time of the interview (especially in Togo where more local GWEP staff helped administer the survey). Nevertheless, the high number of favorable reports about the centers suggests that this general impression holds true. Last, there were likely other unrecorded factors that affected impressions and attendance in each country.

The apparent effect of case containment centers on reducing GWD case numbers and duration of disability strongly suggests that the strategy of case containment centers should be scaled up in the effort to eradicate GWD. Their success in Togo suggests that GWEPs can be incorporated into national health care programs—in line with other integrated interventions that use joint logistics to accomplish their individual goals. Integration could help defray the initial cost of establishing the centers and help with provision of medical care. The role of centers in decreasing infection, accelerating recovery, and increasing the well-being of affected individuals, as well as their undoubted contribution to interrupting transmission, indicate that wider implementation of case containment centers could provide the final push toward GWD eradication.

Received October 21, 2007. Accepted for publication July 12, 2008.

Acknowledgments: The authors thank the numerous persons who participated in this program evaluation; Etse Gilles and Jim Ting for their valuable assistance with administering the surveys; Daniel Abbott, Emily Howard, and the volunteers at the Carter Center for their help with data entry; and Donald Hopkins and Sharon Roy for reviewing the manuscript. We also thank Mr. Ignace Komi Amegbo and Dr. Andrew Seidu Korkor, National Guinea Worm Eradication Program Managers of Togo and Ghana, respectively, and the Togolese and Ghanaian Ministries of Health for their support.

Financial support: Funding for this project was provided by the Carter Center.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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