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Abate application practices in the Guinea worm endemic region of Gambella, Ethiopia: identification of elimination gaps

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Abstract

Introduction: Guinea worm disease is caused by *Dracunculus medinensis*. Transmission of the disease depends on vectors (copepods). Abate applications in targeted water sources to control copepod is the main intervention. The aim of this study was to assess vector control practice in the guinea worm endemic region of Gambela, Ethiopia and to identify elimination gaps.

Methodology: Retrospective analysis of routine program data recorded from 2016 to 2020 was performed. Pre-and post-copepod test is conducted on water ponds to determine the density of copepods. Based on the copepod density, the chemical is applied accordingly. The five years data was obtained from Ethiopian public health institute electronic database with permission.

Results: A total of 22,131 water ponds were treated during the past five years. Out of the total treated in 2020, 4,669/7,266 (64%) were found with > 9 Copepods during pre-copepod test. 130/7,266 (1.79%) of water ponds which were post-tested after Abate application failed the requirement of scoring ≤ 9 copepods. Of the 130 water ponds, 115 (88.5%) were observed during the transmission season (April to November). Abate application trend had increased by 28.9% during the 5 years period. According to the database, some of the largest water sources found in infection reporting villages missed their 28 days regular treatment schedule.

Conclusions: A single water source that has not been treated effectively could be a source of infection for both humans and animals. The practice of Abate application should be enhanced and monitored regularly. The documenting system should be improved for quality, timely information and action.

Key words: SORT-IT; Abate chemical; operational research; elimination; Guinea worm; Ethiopia.

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Introduction

Guinea Worm Disease (GWD) is caused by the nematode parasite *Dracunculus medinensis*, and it is transmitted to humans through drinking water from contaminated sources containing copepods (vectors) that harbor infective larvae of the parasite [1]. In 1986, an estimated 3.5 million people were affected globally [2]. The disease has been eliminated from 17 countries so far [3]. As at the end of 2020, only 27 human cases of the disease were reported in Chad, South Sudan, Ethiopia, Angola and Mali [4].

The Ethiopian Dracunculiasis Eradication Program (EDEP) was established in 1993 [5]. By the year 1994, Ethiopia had reported the highest guinea worm cases (1,252) from 99 endemic villages of Gambella and South Nation Nationalities and People Region

(SNNPR). Due to the program effort, currently only two districts (Gog and Abobo) of Gambella region are endemic. In 2020, EDEP reported 11 human cases and 15 animal infections [6].

The program is implementing four main strategic interventions; surveillance, health education and behavioral change communications (BCC), provision of safe drinking-water points and vector control [7]. Of these strategies, vector control is the core approach to interrupt the transmission cycle of the disease due to contaminated water ponds are the main source of infection in humans and animals. Applying Abate chemical (larvicide) in targeted water sources to reduce vectors of the guinea worm larvae is the main practice of the strategy [8].

The presence of large number of water ponds during rainy season, unhindered movements of wild animals, and the difficult topography of the area/ villages under Abate applications are the main factors affecting effectiveness of the chemical applications in the water ponds. A single water source that has not been treated effectively could be a source of infection for both humans and animals [9].

In the guinea worm eradication program, all the possible water sources should be mapped and targeted for treatment. Additionally, understanding the trend in Abating expansion as well as identifying gaps in the documentation system of Abating data is critical. Therefore, the aim of this study was to assess vector control practice in the guinea worm endemic district of Gambella region, Ethiopia and support the eradication program through evidence-based practices.

Methodology

Study design

Retrospective analysis of routine program data recorded during 2016 to 2020 was performed.

General setting

Ethiopia is the second most populous country in Africa. It shares borders with Eritrea in the north and north east, Djibouti and Somalia in the east, Sudan and South Sudan to the west, and Kenya to the south [10].

Specific setting

Gambella Region is found 768 Km from Addis Ababa in the western parts of the country. The two endemic districts for GWD are Gog and Abobo. Among the two endemic districts, Gog district is currently reporting both guinea worm animal infections and human cases. Abobo district reported three human cases before, while animal infections were reported recently. Hence, Abating is being implemented routinely in both districts.

The practice of Abate applications includes; clearing of water ponds and its surroundings in order not to reduce effectiveness of the chemical to be applied, measuring of the volume of the water ponds then conducting pre-copepod test to determine the number of copepod density in pond waters. According to Abate treatment guideline, if the number of copepods in targeted pond water is found to be above nine, it should be treated immediately and re-checked again after three days (72 hours) of chemical treatment to be sure whether the copepod density is reduced to (equal or below) nine. This is the level considered no transmission will occur in humans or animals. If the

level of copepods were found to be above nine within 72 hours after treatment, another round of Abate application should be implemented [11,12].

Operational Definitions

- Copepods: Are vectors of the guinea worm larvae, where 1st stage larvae of the worm mature and transform to infective 3rd stage larvae.
- Abate (Temephos): A chemical used to apply in water ponds to control copepods.
- Abate catalogue: a document/ file to record all identified water sources and to target them for chemical treatment based on their eligibility for treatment.
- Pre-copepod test: It is a practical test. It's usually performed before application of chemical to targeted water sources to check for density of copepods.
- Post-copepod test: After application of Abate chemical in targeted water sources, the effectiveness is checked/confirmed after three days. In this case, the indication for the chemical effectiveness is the reduction in copepod density to below nine or equal to nine.
- Abating: Is the process of applying Abate chemical in targeted water sources for treatment.
- Re-abating: In some water ponds, even after Abate application, the density of copepods does not reduce to less than nine, due to different reasons. In such cases, a repeat Abate application is performed in those water ponds.
- 1+villages: Endemic villages, which has reported at least one or more than one human cases or animal infections recently.

Study subject

All treated water ponds in Gog district of Gambella region were the study subjects.

Data variables and sources of data

Data variables included in this study are; number and proportion of water ponds treated by Abate chemical during 2016 to 2020, level of copepods in number and proportion in the five years (2016 to 2020) period. The data was obtained from EPHI-EDEP electronic database.

Data collection and validation

Data for this study was extracted from EDEP database on Abating and was entered to MS-excel 2016 excel sheet for analysis. The data was double entered in

excel sheet. The two files were then compared and discordances was resolved by referring to the original data source.

Data analysis and statistics

Data was analysed using MS-excel 2016 excel sheet. Proportions were calculated to describe the outcome of interest. The results were presented using figures and tables.

Ethics considerations

Ethical approval was obtained from EPHI Institutional Review Board (IRB) and the Ethics Advisory Committee of the International Union against TB and Lung Disease, Paris, France. As this study involves routine program data, a waiver for informed consent was also requested and granted.

The data was stored in password protected computer and only the PI can access it and used for intended research purposes only.

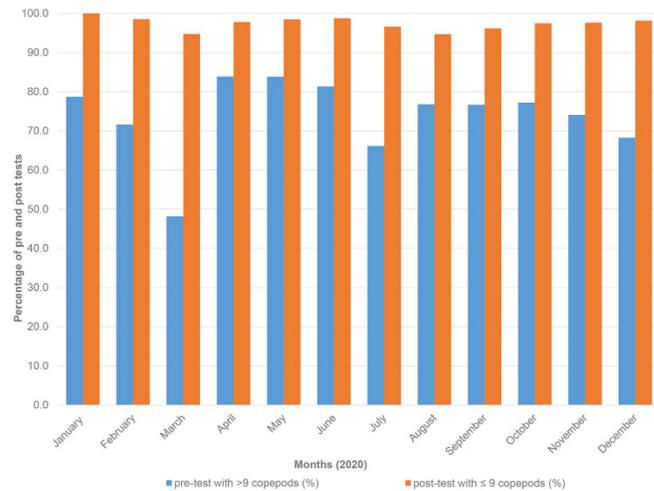
Results

Comparing the pre- and post- copepod test outcomes

The total number of water ponds treated in 2020 were 7,254. Out of these, 4,669 (64.3%) of water ponds were found with > 9 copepods during the pre-copepod test. On the other hand, 130 (1.79%) of water ponds which were post-tested after treatment failed the requirement of scoring ≤ 9 copepods. Of the 130 that failed post copepod treatment, 115 (88.5%) were observed during the high transmission season, coinciding with the rainy season (April to November 2020). During post-test, we observed a reduction in copepods density by more than 95%. However, there are no water ponds found with 100% reduction to less than nine copepods after chemical treatment (Figure 1).

In the five years period, the density of copepods in the pre and post copepod test was determined. And the five years trend in copepod density revealed increment. For example, out of the total of 22,131 tested water ponds, in pre-copepod test, a total of 2,197 (9.9%) of water ponds were found with more than 50 copepods, while during the post-copepod test, 900 (4.1%) of water

Figure 1. Comparison of pre- and post-copepod tests in treated water ponds of Gog district, Gambela region, Ethiopia.



ponds were found with more than 20 copepods. The highest proportion of copepods during the pre-test was observed in 2020, 896/7,254 (12.4%), while during post-test, the highest copepod density was observed in 2020, 873/7,254 (12%) (Table 1).

Figure 2. Yearly trend (2016 to 2020) in number of water ponds treatment by Abate chemical, Gog district, Gambela region, Ethiopia.

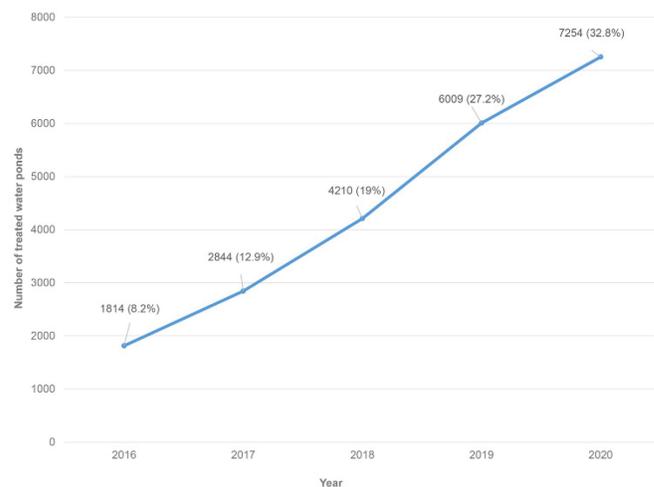


Table 1. Copepods density in water ponds during the pre- and post- copepod test in the five years (2016-2020) period, Gog district, Gambela region, Ethiopia.

Year	Total water ponds treated	20+ copepod in post-test		50+ copepod in pre-test	
		n	%	n	%
2016	1,814	7	0.4	277	15.3
2017	2,844	1	0.0	36	1.3
2018	4,210	3	0.1	403	9.6
2019	6,009	16	0.3	585	9.7
2020	7,254	873	12.0	896	12.4
Total	22,131	900	4.1	2,197	9.9

Table 2. Gaps in completeness of abating data during the five years period (2016-2020), Gog district, Gambela region, Ethiopia.

Year	Total water ponds treated	Copepod density not recorded in pre-test	Copepod density not recorded in post-test	Next treatment date unknown	Volume of water source not recorded	Incorrect volume of ABATE chemical recorded
2016	1,814	16	6	-	-	4
2017	2,844	69	52	-	1	-
2018	4,210	325	63	2	3	338
2019	6,009	3	57	9	-	-
2020	7,254	-	40	3	-	-
Total	22,131	413	218	14	4	342

Five years Abate expansion trend from 2016 to 2020

Abate applications trend showed an increment from year to year (Figure 2). In 2017, 2018, 2019 and 2020, the trend has increased (yearly) by 36.2%, 32.4%, 29.9%, and 17.2% respectively. These figures were obtained using the following way: first obtain the difference of treated water ponds among the two consecutive years (subtract treated ponds in 2016 from treated ponds in 2017) then divide the difference to treated water ponds of the following year (2017) then convert the result to percentage (same procedure to the remaining years). Hence, the Abate expansion trend had increased on average by 28.9% during the five years period. Additionally, a total of 532 new water sources were added to Abate catalogue.

Identified gaps in Abating data for 1+ villages (2016-2020)

In the five years period, a total of 22,131 water ponds were treated. Among these, in 413 (1.86%) water ponds, the density of copepods in pre-copepod test was not recorded. Similarly, in 218 (0.98%) water ponds the density of copepods during post-copepod test was not recorded. In 342 (1.54%) water ponds incorrect volume of Abate chemical was recorded/ calculated against established guidelines or standard operation procedures (Table 2).

In 2020, the total number of 1+ villages were 16. Among treated water ponds in 1+ villages, 28 days Abate cycle schedule was missed (not recorded) in 64 water ponds in 2020 (Table 3).

Discussion

The total number of water ponds treated in 2020 were 7,254. Out of this, 130 (1.79%) of water ponds which were post-tested after treatment failed the requirement of scoring ≤ 9 copepods. The five years trend in copepod density has been increased in water ponds examined for chemical treatment and after treatment. Regarding to trend of Abate applications, it showed improvement in coverage from year to year with the average rate of increment 28.9%. In the five years Abate application database we found lots of data quality issues which needs much improvement.

Abate chemical applications in water ponds of the endemic localities in Gambela region is the main vector control intervention to interrupt local transmission of guinea worm disease. One of the important activities to look for the effectiveness of the chemical applied to water ponds is through evaluating the density of copepods before and after chemical applications, which is the pre- and the post-copepod test.

According to guidelines for chemical control of copepods populations [13], before Abate chemical applications in water ponds, the density baseline is normally expected to be more than nine copepods per a pond. But, after three days of the chemical application, the expected reduction in copepod population is less than nine. This is for the reason that a single water source can be a source of Guinea worm infection for both humans and animals if not treated effectively [14].

In this study, as of 2020, a total of 130 water ponds were found with the copepod density of above nine, all of them were located in infection reporting villages.

Table 3. 28 days Abate cycle schedule missing in 1+ villages by month, Gog district, Gambela region, Ethiopia.

Variables	Year 2020												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1. Number of 1+ villages	16	16	16	16	16	16	16	16	16	16	16	16	192
2. Total water ponds treated (in all villages)	398	301	402	525	830	755	803	907	762	905	668	10	7,266
3. Total water ponds treated in 1+ villages	42	33	49	101	153	124	166	157	139	158	105	76	1,303
4. 28 days ABATE cycle schedule missed in 1+ villages (number of water ponds)	7	6	6	6	5	5	5	5	4	4	4	7	7

Even in the pre-test, before the chemical applications, most of the water ponds recorded high number of copepods, despite the water ponds being under regular treatment.

Even though, quality of Abating depends on many factors, copepod density comparison still remains the main indicator of chemical application effectiveness in the eradication program. The persistent report of infections from the villages where water ponds are under regular chemical treatment could be one reason to question the Abating practice and its effectiveness in interrupting local GWD transmission while making the water ponds safe.

The Abate expansion showed an increasing trend from year to year in the period of 2016 to 2020. On top of this, a total of 532 new water sources were added to Abate catalogue for treatment. In those villages where the Abate expansion activity is undergoing, there are still reports of animal infections and human cases of Guinea worm. For instance, in 2020, a total of 11 human cases and 15 animal infections were reported in endemic localities of Gog district, where chemical applications in water ponds were intensively conducted. In retrospect, cases and infection reports from these villages in the years before 2020, show a persistent Guinea worm presence even in those with an active Abate expansion trend complimented by mapping and treatment of new water sources.

In 2020, the total number of 1+ villages were 16. In these villages, 1,303 water ponds were treated by Abate chemical. Among these treated water ponds, 28 days Abating cycle schedule was missed (not recorded) for 64 water ponds. For instance, one of the water pond called “Lel Bonge”, which is found in Duli village missed its monthly Abating schedule for the months of February, May and June. The reason for missing the schedule was not indicated in the database. It is important to note that, in 2020, Duli village reported human cases and baboon guinea worm infection and in 2021 the human case detected in the neighboring village called “Wademaro” is likely to be associated.

“Wichini” is one of the 1+ village found in Atheti kebele where recurrent human cases and animal infections (dog infections in 2020) have been reported [15]. In this village, the water pond called “Tanchi 1” is located, this is a very large source of water, which is considered as a permanent pond throughout the year, but it failed to follow the 28 days Abating schedule in some months of the year.

Re-abating status of water ponds from the year 2016 to 2019 was not clearly stated, but the practice was started in the year 2020 by recording the re-abating

status of water ponds under the remark section of the database. Even though, re-abating status of water ponds was started recently, copepod density was not described in all of the water ponds after the re-abating.

As a strength, the study is believed to support the Ethiopian dracunculiasis eradication program through evidences it generated, especially improving the documentation system of Abate application database. Hence, as a strength, this study is regarded as a basic type of research, hence it will contribute knowledge and experience to the scientific community and to the program. As a limitation, we relied on secondary program data, hence, we didn't conduct practical tests for examining copepod density, which is a more reliable way of obtaining relevant data for the study.

Conclusions

Even though, density of copepods in most of the water ponds were reduced after the chemical applications, still there are significant number of ponds located in guinea worm case/ infection reporting villages where after treatment, the number of copepods were found to be very high.

Despite the increased trend in coverage of Abate applications, abating quality still face challenges as evidenced by the reports of human cases and animal infections. Data quality issues in abating database was the other major gap of the vector control practice. Therefore, proper documentation system is expected from the program.

Based on these findings, the effectiveness of the Abating practice in the affected endemic villages remains inadequate to meet the EDEP objectives. Hence, the practice of Abate application should be enhanced and monitored regularly.

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