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REVIEW ARTICLE ON CURRENT STATUS OF THE GUINEA WORM DISEASES, ERADICATION STRATEGIES AND CHALLENGES TO THE END OF THE GAME IN ETHIOPIA.

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ABSTRACT Guinea worm disease (GWD) is a painful, disabling caused by the parasite dracunculus medinensis. The implementation of the global GWD eradication campaign resulted in decrease of global burden of disease and several countries have been proclaimed free of the disease. At present only five countries (Angola, Chad, Ethiopia, Mali and South Sudan) reported with indigenous transmission of this disease: Though, Ethiopia has implemented the GWD eradication program since 1992, the disease remains endemic in some parts of the country especially in Gambella region. The purpose of this review is to explore the perceptions and experiences of the community of Ethiopia on Guinea worm disease (GWD) eradication, its current status, eradication Strategies and the raging challenges to eradicate the disease. Continuous health education targeting the community with clear objectives of helping to eradicate GWD was found to be limited in its coverage. Provision of water filters necessary for GWD eradication was inadequate. The community did not have clear understanding of the current status of GWD, its eradication strategy and overwhelming challenges. It is hoped that the findings of this review study would contribute significantly to the GWEP in Ethiopia.

KEYWORDS : Dracunculiasis, EDEP, Endgame, Eradication, Guinea worm and Strategies.

INTRODUCTION

Dracunculus medinensis is the only nematode worm to have been shown unequivocally to be transmitted through drinking water. The adult males remain small, about 4 cm in length and the adult female worm measures up to 1 m long and 2 mm in diameter. The head end of the worm is rounded with a triangular mouth. Most of the body of the worm is taken up with a double uterus. The worm resides in connective tissues where it does no harm until it migrates down (usually to the legs and feet). Here lytic secretions from glands in the head probably combined with irritant effect of the larvae cause a blister that eventually ruptures to expose the head of the worm. When the head is doused in water the uterus is extruded through the mouth of the worm and larvae are expelled into the water (Ruiz-Tiben & Hopkins, 2006).

Guinea worm disease (GWD) or dracunculiasis is a painful, disabling disease caused by the nematode parasite dracunculus medinensis (D medinensis). The disease has a low mortality rate but causes an enormous amount of morbidity and has a serious negative economic impact on affected villages. Persons become contaminated with D. medinensis by drinking water from stagnant sources such as ponds that have infected copepods (water fleas) with Guinea worm larvae that act as intermediate hosts for the parasite. At present, there is no effective drug to treat or vaccine to prevent dracunculiasis available. Infected person do not develop immunity (Hopkins et al., 2002).

The global campaign to eradicate dracunculiasis began as an initiative of the US CDC in 1980, under the auspices of the international Drinking Water Supply and Sanitation Decade (1981-1990). The fight against GWD represents one of the most successful international collaborations and is particularly interesting because the intervention is, at its heart, behavior change. Success depended on the campaign's ability to reach poor, isolated communities and convey essential messages about how to handle water and prevent the disease. This was possible because of the steady commitment of donors, technical supporters and National governments (Hopkins et al., 2000).

Ethiopian Dracunculiasis Eradication Program (EDEP) was established in 1992 and the elimination of the disease among humans seems to be to the end because no human cases reported since 2018; however, another challenging scenario has emerged with the occurrences of animal infection and it is increasing over time. Dogs, cats, and olive baboons were infected. Infection among olive baboons was the first to be reported in Ethiopia. Unlike the other regions, dogs value greater than other livestock's; because of wider forestation and community lives close to the wildlife. Dogs are serving as a guardian, farm keepers, and hunting assistances (Habtamu et al., 2017).

The social and economic effects of the disease are attributed mainly to the temporary disability suffered by infected persons. More than half of patients are unable to leave their beds for about a month, which generally coincides with the peak season of agricultural activities, when labor is in maximum demand. This can lead to malnutrition among children in households whose able members are affected. For this reason, in Mali the disease is called "the disease of the empty granary". Children miss school when they have guinea-worm and when they substitute for sick members of their households (Ruiz-Tiben & Hopkins, 2006). Therefore, this paper reviews the current status of the global Guinea worm eradication in Ethiopia and intervention strategies such as surveillance activities, case containment, provision of safe water, awareness creation to the community.

Statement of the Problem: Guinea Worm Disease (GWD) is one of the Neglected Tropical Diseases (NTDs) characterized by painful skin blister which may ultimately break forming an ulcer. Though rarely fatal, it may cause permanent disability and may result in loss of family income and school absenteeism. Neither anti helminthic medication nor a vaccine is available to treat or prevent Guinea Worm Disease. The disease mainly affects people in rural areas, deprived and isolated communities who depend on open surface water sources such as ponds for drinking. Guinea Worm Disease is transmitted when people in endemic area drink water containing copepods harboring infective larvae. In Ethiopia, Dracunculiasis Disease Eradication Program (EDEP) which was established in 1993 has made remarkable move towards interruption of disease transmission and now the endgame is

fast approaching. Hence this Review is focused on Current Status of the Guinea Worm Diseases, Eradication Strategies and Challenges in Ethiopia.

Significance of the study: The purpose of this study is to explore and understand the perception of the community and implementation failures in Guinea worm eradication program (GWEP) in Ethiopia. This study will analyse and describe conditions that delayed interruption of indigenous transmission of GWD in Ethiopia. This review will also focus on the current status of the global Guinea worm eradication in Ethiopia and intervention strategies such as surveillance activities, case containment, provision of safe water, awareness creation on GW/cash reward. The challenges and/or gaps in intervention strategies and implications of animal hosts for the eradication efforts is also discussed in brief. This review will explore and understand the perceptions and experiences of people and also understand the current status, eradication strategies and setback to the end of the Game in Ethiopia.

Current Status, Eradication Strategies and Challenges of Guinea Worm Diseases

Current Status

Global Occurrence of Guinea Worm Diseases: In 1980, the Centre for Disease Control and Prevention (CDC) in Atlanta, United States of America, initiated the global GWD eradication campaign. It was adopted as a sub-goal of the International Drinking Water Supply and Sanitation Decade, 1981-1990. In 1986, the World Health Assembly (WHA) called for the eradication of dracunculiasis (GWD) at a time when an estimated 3.5 million cases occurred annually in 20 countries in Africa and Asia and 120 million persons were at risk for the disease. Because of slow mobilization in countries with endemic disease, the global dracunculiasis eradication program did not achieve the 1995 target date for eradicating dracunculiasis set by WHA in 1991(Hopkins et al., 2008).

In 2004, the WHA set a new target for 2009. However, despite considerable progress towards global eradication, that target was also not met (Maguire et al., 2005). Despite the absence of a drug or vaccine and the only diagnostic being a painful emergent worm, the transmission of GWD has been eliminated in Asia and is presently only in Mali, Ghana, Sudan, and Ethiopia. Several African countries have reported no cases for over a year and await the formal certification of the absence of transmission (WHO 2008) formally certified Benin, Guinea, Mauritania, and Uganda free of transmission recently. This progress reveals the effectiveness of case containment and copepod control using temephos larvicide and water filtration, backed up by health education, community commitment, and regular surveillance and reporting from endemic villages. The implementation of the global GWD eradication campaign resulted in a decrease of global burden of disease and several countries have been proclaimed free of the disease (MMWR, 2010).

Global Guinea worm eradication status: The conception of the Guinea worm eradication program in the 1980s, significant progress has been made in reducing the number of cases from 3.5 million (in 1980s) to only 126 cases in 2014 and as few as 22 cases by the end of 2015. In 2016, 25 confirmed human GWD cases were reported globally from the 3 remaining endemic countries. Similarly, the number of villages reporting cases had been reduced from 23,735 (in 1993) from 21 endemic countries to 30 villages in 2014 and to only 20 by the end of 2015 confined to only four countries, namely Chad, Ethiopia, Mali, and South Sudan (16). Sixteen out of 20 previously endemic countries had now achieved transmission interruption with Ghana being lately certified as free of Dracunculiasis by 5 the International Commission for the Certification of Dracunculiasis Eradication (ICCDE) in January, 2015. Sudan and Kenya are in the pre-certification stage. Angola and the Democratic Republic of Congo do not have recent history of the diseases. Case importation across countries has also been minimized significantly (WHO, 2016).

The disease is now brought to the verge of global eradication. However, challenges remain to overcome in the remaining endemic countries in order to realize the end of this painful disease. The risk of case importation, continued low intensity transmission, inaccessibility to endemic localities, emerging infections in dogs and baboons (as in Ethiopia), as well as the changing transmission dynamics with a rising number of dog infections in Chad, insecurities in South Sudan are among other threats to the eradication campaign. The remaining challenges and/or gaps in intervention strategies and implications of animal hosts for the eradication an effort is also discussed in brief (Gebre Alamerew & Tesfaye Gebya, 2006).

Eradication status in Ethiopia: In August 1990, the Ethiopian Ministry of Health organized a national steering committee for the eradication of dracunculiasis with the primary responsibility of determining the extent of the disease Nationwide. The steering committee designed two approaches: a passive surveillance approach, whereby all regional health departments were requested to collect morbidity data on dracunculiasis from all health facilities within their respective regions on a monthly basis, and an active case search approach in selected highly suspected regions of the country based on the available suggestive statistical data. The Ethiopian GWD eradication program was introduced in 1992 and a case search was conducted throughout the country in 1993. The then administrative regions selected for the National active case search were West Gojjam, Metekel, Assossa (including Kamashi), South Wollo (including Afar), West Shoa, North Omo, South Omo, Keffa and Gambella. The survey confirmed that the disease is endemic in six districts of Gambella Regional State, namely Abobo, Akobo, Gambella, Gog, Itang and Jikow. The survey also indicated that one district of the Southern Nations Nationalities Peoples' Region (SNNPR), namely Kuraz (recently named as Nyangatom), in South Omo Zone was also endemic for GWD. In 1994, a number of interventions were initiated in endemic areas. These included case control; vector control; provision of safe water; health education; provision of filters; training of village-based volunteers (VBVs), and monthly reporting. These efforts achieved considerable success in the eradication process (Gebre Alamerew, 2006).

In 1995, one hundred and thirty-three (133) GWD cases were reported from 47 endemic villages in the six districts, which represented a reduction of 84.3% from 1994. The number of cases has been reduced by more than 98% between 1994 and 2010. Indigenous transmission has been interrupted from South Omo since 2001and zero indigenous case report is maintained so far. However, GWD continues to be reported from Gambella region. In the preceding 5 years (2006 to 2010), Ethiopia reported 83 GWD cases, in which one indigenous case in 2006, zero indigenous case in 2007 and 38, 24, and 20 indigenous GWD cases in 2008, 2009 and 2010 respectively from Gambella region. The annual incidence of GWD cases in Gambella region has decreased significantly since 1994 but the main goal of the program, namely interruption of indigenous transmission was not achieved (FMoH, 2010).

Current status around the globe: Endemic countries must show and document evidence of absence of indigenous transmission of guinea worm disease for at least three consecutive years to be eligible for consideration by the International Commission for the Certification of Dracunculiasis Eradication (ICCDE). The ICCDE decides, after satisfactory deliberation, whether or not to recommend the country for

certification by the World Health Organization as free of guinea worm transmission. Currently (2020) they are only five countries with indigenous transmission of the disease: Angola, Chad, Ethiopia, Mali and South Sudan. Each country has its own national Guinea Worm Eradication Program (CDC, 2010).

Current status in Ethiopia and study area: Between 2 and 8 April 2020, six suspected human cases of dracunculiasis in Duli village, Gog district, Gambella region, Ethiopia, were reported to WHO. As of 27 April 2020, the Ethiopian Dracunculiasis Eradication Program (EDEP) had detected one additional person with an emerged worm, morphologically consistent with human guinea worm, bringing the total to seven suspected cases. This report comes after more than two consecutive years of zero reporting, as the last cases were reported in December 2017. Since its establishment in 1992, the EDEP has made remarkable progress towards interruption of disease transmission in humans despite the existence of low-level transmission of the parasite in non-human hosts such as dogs and peri domestic baboons. The seven suspected cases; five were detected from the Angota side of Duli village and two suspected cases from Metaget Dipach and Wadmaro villages in Gog Dipach Kebele (smallest admirative unit). All the infected people used unsafe drinking water from farm ponds. These water sources 7 were reported to be associated with the baboon infection in June 2019 in the same (Withers & Maguire, 2005).

Eradication Strategies

Health education and community mobilization: Health education and community mobilization should be emphasized as a priority because they are the least costly strategies available, and are a necessary base for the other strategies The goal of health education and community mobilization is to get the same basic messages to endemic populations repeatedly, using all appropriate channels. The three essential messages are drinking contaminated water is the only source for GWD infection, Prevent persons with emerging worms or blisters from entering ponds and it is important to filter or boil drinking water from ponds, and drinking water from safe sources (WHO,2016).

The VBVs are an important resource for the health education messages but need to be reinforced by influential community members such as traditional, political and religious leaders. Teachers, church, youth and women's associations would also contribute significantly if proper training were provided. The mass media such as radio and printed materials, including posters and brochures, need to be developed in the local languages. Only brochures and posters are translated into local languages, Nuer and Anyuak. These activities should also focus on improved supply and proper use of cloth filters, early case detection and reporting of suspected cases, and community participation (Ruiz &Tiben, 1991).

Provision of safe water: The provision of a safe source of drinking water, such as a borehole and properly constructed hand-dug well, is the most desirable Strategy. It gives many other important benefits but this is most expensive of the strategies. The overall goal of the eradication program should be to try to get safe wells provided or rehabilitated in as many of the identified endemic villages as possible and as quickly as possible, especially in the most highly-endemic, densely-populated areas. Among priority areas with the latter characteristics, the highest priority should be given to localities with the greatest agricultural potential (Cairncross et al., 2002).

The provision of safe water supply has been widely implemented in both endemic regions of the country. A wide range of safe water supply options were explored. Hydro-geological surveys were conducted to determine the appropriate technology for the provision of safe water supplies. Hand-dug wells were provided for most of the accessible endemic villages where the hydro-geological formation permitted its implementation. Other options employed for the improvement of safe water 8 provisions include: pond protection (fencing ponds and assigning guards), infiltration systems, machine-drilled boreholes, hand drilled tube wells, community sand filters, roof rain catchments, and ground rain catchments. Seasonal migration of the endemic communities to and from riverbanks posed a lot of challenges in planning and implementing various water supply schemes. In addition, large numbers of pipe filters (straw filters) were provided to mobile population groups like shepherds, hunters, and travelers. The provision of individual household monofilament cloth filters, at least twice a year, has been in place in all endemic and at-risk villages since 1994 (Gebre et al., 2006)

Filtration of drinking water: The adult cyclopoid is more than 1 mm long and can easily be filtered using an ordinary cloth. Filtration of drinking water is easy, but that does not mean people do it. The disease is found in remote areas where millions of poor and mostly illiterate villagers live. These villages are remote and often inaccessible communities. This makes it difficult for the villagers to access health care. Two types of filters were supplied by the program, the monofilament cloth filters that can be used for households and straw filters (a piece of 10 to 20 mm diameter plastic pipe, 100 to 200 mm long having a material fixed in one tip) to be used individually during a journey or to the fields. Regular health education should be provided to community members on proper handling of the filters during washing otherwise it can easily be damaged (CDC, 2005).

Early case detection and management: Critical examination of the case containment activities in early 1999 revealed shortcomings such as socio-cultural limitations in some localities, and inaccessibility of some remote villages during the heavy rains. This led to poor compliance with case containment standards. International case containment standard calls for prompt detection of each and every case before or within 24 hours of worm emergence. It further requires putting in place immediate and complete containment measures so that there is no possibility of transmission to other persons. This challenge prompted the Ethiopian program to take a critical step in refining the case containment strategy. In order to effectively prevent individuals with emergent Guinea worms from transmitting the disease to others, the EDEP began treating these individuals as "inpatients", for the first time in South Omo in 1999. This approach emphasized the use of case containment centers (houses) for the treatment of all suspected and confirmed cases of dracunculiasis, and provided food, water, shelter, and in-kind incentives such as blankets and 9 bed sheets, particularly, for those individuals willing to stay in the containment centers until the Guinea worm was manually extracted (FMoH, 2010).

Treatment of ponds using Abate chemical: The application of the Abate chemical (temephos) to surface sources of drinking water, mainly ponds, kills Cyclops and is an effective measure to prevent transmission. Treatment of drinking water sources should be carried out monthly throughout the transmission season (WHO, 2008).

Disease trend

Following the establishment of an EDEP in 1992 and its implementation in 1994, there has been a steady decrease of the disease in Ethiopia. Indigenous GWD transmission has been interrupted in South Omo zone since 2001 but Gambella region remains endemic for the disease (FMoH, Ethiopia 2010:1). This report comes after more than two consecutive years of zero reporting, as the last cases were reported in December 2017. Some cases emerged in 2020. The zero report

achieved in 2017 might have been due to missed cases as a consequence of poor surveillance, contamination of ponds, and imported cases from neighboring countries (Cairncross et al., 2002).

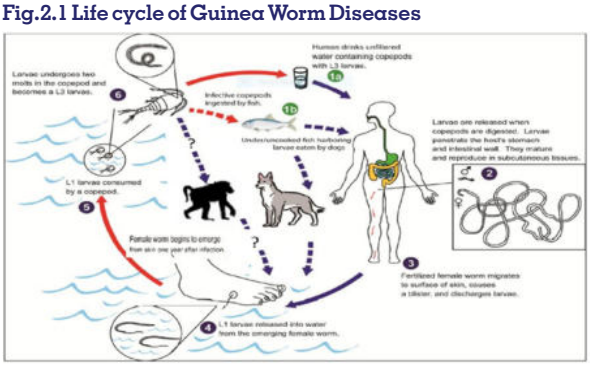
Challenges

Guinea worm transmission is limited to only two districts (Gog and Abobo of Gambella region) in Ethiopia, the presence of hard to reach communities and lack of safe water sources in remote non-village areas, the result of the mass regular cross-border population movement between Ethiopia and South Sudan, due to insecurity in South Sudan and activities of nomadic pastoralists, simply a large refugee influx, and animal infections with an unknown role in transmission of dracunculiasis, remain significant challenges for guinea worm disease elimination in Ethiopia. Within the context of the COVID-19 pandemic, health systems are strained worldwide due to the rapidly increasing demand of services for the management of this disease and other existing ones. This also becomes setback to end the Game in Ethiopia. Even though support from The Carter Center and WHO has reinforced active surveillance in all the communities of Gog and Abobo districts including those living in cross-border areas, particularly in and around refugee camps, to prevent any spread of the disease to South Sudan, still there is low enforcement of disease prevention strategies (FMoH, 2010).

Life Cycle

GWD is characterized by the emergence of a female worm (60-100 cm long) from a blister usually, but not solely, located on the lower leg. The pain from the blister becomes so excruciating that the leg feels as if it is on fire, compelling the infected person to plunge it into cold water to relieve the burning sensation. This action ruptures the blister, causing the worm to release thousands of larvae. The larvae reach an infective stage after being ingested by tiny crustaceans or copepods, also called water flea. People swallow the infected water flea when drinking contaminated water. This action kills the water flea but liberates the infective larvae, which penetrate the wall of the intestine and migrate throughout the body as they mature and reproduce fertilized female worms, migrate under the skin tissue until they reach the lower limbs, forming a blister or swelling from which they eventually emerge to pierce the skin. The migration and emergence of the worm may take 10 to 14 months after infection (Habtamu et al., 2017).

Fig.2.1 Life cycle of Guinea Worm Diseases



Clinical Features

The first clinical feature in most cases is the appearance of the blister, which measures about 3 cm diameter within a few days. The site of the blister is usually preceded by burning, intense itching and urticaria. The blister then ruptures and the worm extrudes, about 1 cm per day. Left to itself and assuming the site does not become secondarily infected, the worm track will resolve within about 6 months. Secondary infection is frequent, however, affecting more than 50% of cases and this can cause severe pain and disability, and rarely death. If the worm breaks before complete removal, the remnant can cause severe inflammation and scarring. Dracunculiasis is rarely fatal, though it can be severely disabling (Hochberg et al., 2008).

Diagnosis

The absence of obvious symptoms even if D. medinensis parasites (guinea worms) are present in the body is a problem for the early diagnosis of GWD. The long asymptomatic period is a characteristic of the disease, and demands the development of immunodiagnostic methods for the early detection of the disease. The first noticeable symptom of the disease is the appearance of a red, itchy papule that rapidly transforms into a blister. Patients who have had previous infections become aware of the worm and can already predict the expected days of the parasite's emergence. Obtaining samples of juveniles for study can only be done after the blister has ruptured. The procedure is done by placing cold water directly on the wound; this stimulates the release of juveniles from the uterus of adult female worms. Then the juveniles are mounted on a slide, and can be seen actively moving under a low-power microscope. The diagnosis of dracunculiasis becomes simple when a part of the worm emerges from the wound. In order to recognize the morphology of the parasite, however, it is important that the worm does not dry out and disintegrate. An intermittent sparganum may be diagnosed (WHO, 2008 and Hopkins et al., 2002).

Treatment

As the guinea worm emerges through the dermal lesion, the affected person pulls it out slowly and carefully (to minimize inflammation and pain) by winding a few centimeters of the worm each day onto a stick. This painful process may take several weeks, as the worm may be up to 1 m long. The pain can be relieved with wet compresses on the lesion and the use of an oral analgesic. The risk of bacterial super-infection can be reduced with the use of topical antiseptics or antibiotic ointment. In one study the mean duration of disability from GWD was 50% shorter among patients who had been given antibiotics as well as instructions and supplies to clean and dress their wounds than among those who did not receive any intervention. No anti-helminthic medication is effective against the disease, and there is no vaccine. Prevention is the only effective intervention to reduce the incidence of GWD (Nelson, 2012).

CONCLUSION

Guinea worm is a water-borne disease that can be vectored from place to place by humans who are the definitive hosts of the parasite Dracunculus medinensis. Humans move about a lot and with the porous nature of Ethiopia boarders, particularly in the southwestern part, infected persons can transport the disease back to Ethiopia. It is imperative that continuous surveillance by the Federal Ministry of Health and the Security Agencies at the boarders be strengthened or put in place to check emigrants and refugee for guinea worm so as to maintain the guinea worm free status permanently. The perceptions and experiences of communities and GWEP providers is vital to devise acceptable educational messages and provides the basis to bridge conceptual and attitudinal differences and gap between the community and GWEP implementers. The review of this study indicated the necessity of and need for community education on safe drinking water, and priority setting in the application of interventions, mainly filtering drinking water depending on the availability as this is the choice of the community and feasible than other strategies.

REFERENCES

1. Babies, E & Mouton, J. (2001). The practice of social research. Oxford: Oxford University Press.
2. Barry, M. (2006). Slaying little Dragon: lessons from the dracunculiasis eradication program. American Journal of Tropical Medicine and Hygiene 75:1-7.
3. Cairncross, S, Muller, R & Zagaria, N. (2002). Dracunculiasis (Guinea worm

disease) and the eradication initiative. Journal of Clinical Microbiology Reviews 15:223-246.
4. Carney, JH, Joiner, JF & ragou, H. (1997). Categorizing, coding, and manipulating qualitative data using the word perfect word processor, the qualitative report.
5. CDC sees centers for Disease Control and Prevention (2005). Centers for Disease Control and Prevention. Guinea Worm Wrap-Up No 150. Atlanta: CDC.
6. Centers for Disease Control and Prevention (2009). Guinea Worm disease w r ap-up no 186. Atlanta: CDC.
7. Centers for Disease Control and Prevention (2010). Guinea Worm disease wrap-up no 194:1-7.
8. Didsbury, Manchester M20 2RR, from: http://www.tandf.co.uk/journals,Pdf (accessed 12 April 2012).Burns, N & Grove, SK. 2009.
9. FMoH (2012). Presented during the 16th guinea worm program managers meeting, 25 to 30 March 2012, Addis Ababa, Ethiopia: p 4, unpublished.
10. Gebre, T, Alamerew, D & Tesfaye, G. (2006). Dracunculiasis, in Epidemiology and Ecology of Health and Disease in Ethiopia, edited by Y Birhane, D Hailemariam and H Kloos. Addis Ababa: Shama Books: 674-691.
11. Hopkins, DR & Ruiz-Tiben, E. (1991). Strategies for dracunculiasis eradication. Bulletin of the World health Organization 69(5):533-540.
12. Hopkins, DR, Ruiz-Tiben, E, Downs, P, Withers (Jr), PC & Maguire, JH. (2005). Dracunculiasis eradication: the final inch. American Journal of Tropical Medicine and Hygiene 73(4):669-675.
13. Hopkins, DR, Ruiz-Tiben, E, Downs, P, Withers (Jr), PC & Roy, S. (2008). Dracunculiasis eradication: neglected no longer. American Journal of Tropical Medicine and Hygiene 79(4):474-479.
14. Hopkins, DR, Ruiz-Tiben, Ruebush, TK, Diallo, N, Agle, A & Withers (Jr), PC. (2002). Dracunculiasis eradication: delayed, not denied. American. Journal of Tropical Medicine and Hygiene 62(2):163-168.
15. Louis: Mosby.Cairncross, S, Muller, R & Zagaria, N. (2002). The practice of nursing research: appraisal, synthesis, and generation of evidence. 6th edition. Dracunculiasis (Guinea worm disease) and the eradication initiative. Clinical Microbiology Reviews 15: 223-246.
16. Miri, ES, Hopkins, DR, Ruiz-Tiben, E, Keana, AS, Withers (Jr), PC, Anagbogu, IN, Sadiq, LK, Kale, OO, Edungbola, LD & Ityonzughul, C. (2010). Nigeria's triumph: Dracunculiasis eradicated. American Journal of Tropical Medicine and Hygiene 83(2):215-225.
17. Ruiz-Tiben, E & Hopkins, DR. 2006. Dracunculiasis (Guinea worm disease) eradication. Journal of Advances in Parasitology 61:275-283.
18. World Health Organization (2016). Field trials of health interventions in developing countries- a tool box. 2nd edition. Peter G. Smith and Richard H. Morrow, eds. UNDP/World Bank/WHO program for research and training in tropical diseases (TDR). Macmillan.