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A Rapid Appraisal of the Efficacy of Sodium Carbonate in the Management of *Tunga penetrans* Infestation at Uuna Primary School in Karemo Division, Siaya District, Kenya

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Abstract

The study assessed the efficacy of Sodium carbonate in removing jiggers. The 2007 study purposively sampled 27 pupils in class five to eight out of 68 jigger victims at Uuna primary school that had an upper primary pupil population of 275. The upper primary section was purposively selected because the school offered holiday teaching for these pupils. The whole school had 762 pupils. Structured questionnaires were administered to the purposively sampled pupils. Frequencies and percentages were calculated. Approximately 68 (8.9%) of the total student population at the school were jigger infested for 2 weeks to 4 months. Infestation was higher in class five (11%) reducing to 1% in class eight with twenty two percent children not wearing shoes. On dissolving 50 gm/litre of Sodium carbonate in warm water and applying it to the infested feet, 19 (70%) pupils had 100% jigger extraction, within 15 to 20 minutes. This was the first study showing Sodium carbonate as an effective local chemical alternative in removing jiggers.

Keywords: Primary school pupils; 50 gm/litre; Sodium carbonate; Warm water; Jiggers; Kenya

Introduction

Media reports indicate that infestation by gravid *Tunga penetrans* (L. 1758) or jiggers, the sand flea among the tropical 3 world's poor is rapidly becoming a major public health concern among the impoverished rural populations. The parasite affects resource poor communities in the Carribbeans, South America and Africa South of the Sahara [1] where it is endemic [2] and is one of the tropical diseases that is neglected by health professionals and governments, with no specific drug developed to treat it. In addition, victims of this parasite are often stigmatized [3] by their communities.

A study by Ariza et al. [4] among 545 Nigerian children showed an infestation rate of 24.4% with a higher number of boys affected. It is estimated that a total of six million Ugandans are risk of contracting jiggers while two million are already victims of the parasite. A news article in the Monitor newspaper in Uganda (2014) reported that 41% of the schools and communities in Busoga district were affected by jiggers demonstrating the magnitude of the problem in just one region of the country [5].

Tungiasis has of late been gaining importance in Kenya's rural setups although there is no plausible explanation for the increase in cases. The Ministry of Public Health and sanitation records show that about 1.6 million Kenyans have over the last five years (2005-2010) [6] been affected by Tungiasis, and the government is currently increasing its efforts to control the spread of the problem. AHADI Kenya, an Non-Government Organisation (NGO) that has been at the forefront of fighting the jigger menace puts the figures at 2.6 million. Jigger infestation is widespread in many parts of Kenya including the Coast, Central, Western, Nyanza and parts of Rift valley regions.

Jiggers affect people across all groups with higher prevalence among the young aged 20 and older people above 50 years.

Jigger infestations are associated with poverty [7-9], poor hygiene and dirty surroundings and possibly poor nutrition as depicted by few fatalities [9] and stunting in victims since they cannot wander far to forage. A death was reported in Kisii District in July of the year 2009 although there have also been unconfirmed reports of mortality from the jigger problem in other parts of the country. Affected people lack self esteem and are stigmatized, the jiggers deform their limbs and in extreme cases, limbs of the victims may develop secondary infection or may even be amputated as the result of gangrene in which case they have had to be rehabilitated. Cases of infestation of peri-anal and reproductive parts are also being observed (personnal observation).

Tunga penetrans infestations have been classified into four categories based on the Fortaleza Classification developed in Brazil [10].

The diagnosis of tungiasis is made clinically [2], however even the untrained person can diagnose the ectoparasitosis from the typical topographic lesions and the natural history of the disease. The patient typically complains about local itching, pain and the tingling sensation of a foreign body. Patients commonly report having walked in infested places such as beaches and farms. In Kenya, crowded jigger infested-places such as funeral gatherings are the commonest sources of fresh attacks.

Infestation with *Tunga penetrans* is usually a mild and self-limiting infection. However, severe cases of multiple infections do frequently occur, especiallyn among underprivileged communities [11,12]. Mazigo, et al. [13] reported parasite load counts between 60 jiggers in the hands and 810 in the feet of a mentally challenged epileptic male. Bacterial super infection by a variety of highly pathogenic microorganisms and (Heukelbach, et al. [13]) may lead to pustule

formation, ulceration, lymphangitis, gas gangrene, tetanus and sepsis. The role of tungiasis in the development of tetanus is often underestimated, since fifty percent of tetanus cases in endemic areas probably to result from secondary infection after infestation with *Tunga penetrans* [14,15] although the role of the jiggers in this process is often underestimated. Fatalities from lethal tetanus caused by jigger infestations have been recorded [15,16]. Although the jigger lesion has a characteristic appearance, dermascopy at 20-fold magnification can help to rapidly confirm the diagnosis.

Complications may arise out of jigger infestation and these include deep ulceration, tissue necrosis and denudation of bone and auto amputation of digits leading to inability to use limbs for work and movement as cited in older works (Gordon, 1914), Jolly (1926).

In Kenya however not much attention was given to jiggers since initially the people affected do not seek medical help a development has resulted in little awareness on the impact of the parasite on affected people who end up not seeking for treatment and possibly part of the reason for the neglect of this public health problem by the profession. The reporting of the cases increased over the last four years after activists such as AHADI KENYA highlighted the scourge through the media campaigns and jigger removal remedies.

The age old method of treating jigger infestations is by mechanically picking them out of the lesion with a thorn, sterile needle or pin and disinfection of the wound with disinfectants such as organophosphate powders. The flea has to be totally extricated out of the lesion or else the wound would take long to heal. The open wound is exposed to secondary infection which may complicate healing. Natural extrusion of the egg sac or removal of the jigger with a dirty pin or needle leaves a tiny pit in the skin which may develop into a sore or worse still a septic ulcer. Nyagero, et al. [17] reported that 91% of the respondents in the Muranga study used needles to remove jiggers while 39% used thorns. The use of these sharp contaminated objects posed the danger of cross infection especially if they were shared and also Tetanus since the deep lesions left after extraction are suitable habitats for growth of Clostridium tetani bacteria in addition to HIV/AIDs infection.

The clinical treatment of tungiasis involves local excision or sterile curettage. The extraction of fleas with needles and pins which are mostly shared poses a number of challenges as shown by Ariza et al. [4] in a study on the Nigerian children where 62% of the jiggers were removed using needles and thorns. Heukelbach et al. [18] got promising results when Tungiasis was treated using topical applications such as Thiabendzole ointment and lotion, Metrifonate lotion and Ivermectin on 125 jigger victims with multiple lesions. However each of the mentioned medications has side effects. Prophylaxis is provided by the wearing of shoes, although this does not guarantee prevention of infection. Sweeping floors and application of Malathion to infested sandy areas has significantly reduced the incidence of infection by over 80%.

The upsurge of the Non–communicable disease has slowed down research on infectious diseases placing conditions such as tungiasis on the lower scale and affected communities are left to guess on effective remedies.

Compounds such as the antischisostomal drug Nirisadole were withdrawn from the market due to severe side effects; Ivermectin started showing effectiveness after 7 days, Thiabendazole has to be given for 10-18 days orally before its effects can be seen, while the topical application starts effect after 3 days. Oral Metrifonate (Trichlorfon at doses above 10 mg/kg) is known to inhibit Acetylcholine in both the schisostome and man [19] and has been used successfully as a foot bath for dogs that are heavily infested with jiggers (Rietschel 1989). Ivermectin is used as an oral antihelminthic drench in camels and has shown promise against Tungiasis at an oral dose of 200 mg/kg for man. The high effective doses that are administered to man in managing Tungiasis are toxic and therefore a health hazard to man.

These drugs maybe effective but too costly for the poor in developing countries where the drugs may not be found altogether. The time taken to destroy the jiggers is also long making the treatments costly. Effective cheaper, nontoxic, convenient to use alternative drugs that also greatly reduce exposure to the HIV/AIDs virus and lower the chances of secondary infection therefore need to be introduced.

One such alternative is a home remedy that has been in limited use is Sodium carbonate generally referred to as Magadi or Magadi soda by local communities. The chemical combined with personal hygiene and good environmental practice has the potential for reducing jigger infestations drastically in Kenya. This naturally available chemical has been used in the manufacturing industry including the manufacture of glass, glazing of cakes, an anti-caking agent for pastries, and forms part of the chemical detergents applied variously in homes. Kenyan communities use Sodium carbonate or Magadi as it is aptly called to soften green vegetables and even applied as an anti odour chemical for toilet hygiene besides unclogging blocked household pipes. www.tatachemicals.com › home › product. Fluoride contaminated Sodium carbonate which is used to tenderize meat in Tanzania has been recorded to cause fluorosis in human teeth Mabelya et al. [20]. The Trona the raw chemical mined in Kenya and which is purified to produce Magadi soda is not contaminated by fluoride and is almost pure Sodium carbonate www.tatachemicals.com › home › product. Other Trona reserves are found in Asia and parts of the USA [21].

To ensure non recurrence of jiggers, hygiene of the environment and individual has to be maintained. Regular cleaning of clothing and bedding alter the dirty air conditions and remove the accompanying stench that is conducive to the survival of the jigger. It is a tradition among rural communities to repair and maintain houses every so often by cleaning the house daily by sprinkling water to settle the dust before sweeping, and smoothening the walls using either mud, or a mixture of cow dung and mud. The latter activity blocks any openings where fleas and their eggs can hide besides drowning the eggs in the cow dung and mud mix.

Nutrition is important in disease prevention so provision of nutritious food is essential for normal growth and repair of body tissues, and antibody production. Other effective preventive measures include frequent bathing and change of attire which provide clean environments that inhibit conducive climates for the jigger fleas.

Statement problem

Tunga penetrans in Kenya affects approximately 1.4 to 2.6 million people according the Ministry of Public health and Sanitation Records in 2005-2010 [22] and AHADI Kenya respectively. Monthly health records at Kogelo Dispensary in Karemo Division, showed a high jigger infestation within the area with the number of cases rising from 1,300 in May to 1,354 in June 2007. Interviews with Community Health Workers from the area indicated that primary school children were most affected. Most people apply crude unhygienic means to remove the jiggers thus exposing themselves to cross infection and other health impacts like reduced mobility, pain and even limb

amputation. The extricated jigger eggs thrive in the dirty areas resulting in further spread of jiggers.

Justification

Infestation by jiggers if not managed properly can result in many health and socio economic effects. Jiggers can affect any part of the body resulting in deformity, amputations, gangrene and secondary infection and death in some instances.

The conventional method of removing jiggers using contaminated or shared objects is painful and takes time besides scarring the extraction sites when pins, thorns and other sharp contaminated objects are used. The contamination of the equipment poses a risk of bacterial and viral cross infection including Hepatitis B and HIV/AIDs. Chemicals that are used are either potentially poisonous or too expensive for the common man. In case of secondary infection after removal, antibiotics and anti tetanus toxoids have to be applied meaning additional expenses for the poor patients.

Research Question

Is Sodium carbonate an effective, safe, cheap, fast and readily available chemical alternative for the management of jigger infestations in human beings?

Broad Objective

To determine the efficacy of Sodium carbonate in the management of jiggers.

Specific Objective

The study objective was to assess the efficacy of Sodium carbonate in managing jiggers in human beings.

Assumptions

1 Pupils of Uuna primary school are not infested with jiggers.

2 A 5% Sodium carbonate solution is not an effective, fast, safe, readily available and cost-effective alternative means of managing jigger infestations in humans.

Methods

Study design

Across sectional experimental study was conducted to determine the effectiveness of Sodium carbonate in the management of jiggers in primary school children in Uuna Primary School in Siaya District.

Study area

The study was done in Siaya District which is divided into seven administrative divisions; Yala, Wagai, Karemo, Ugunja, Boro, Uranga and Ukwala. The largest of these is Ukwala, Boro being the smallest. Kogelo village, where this study was carried out, is in Karemo Division.

In 2007, it was estimated that Karemo Division in Siaya district had a population of 80,356 with 47,912 females and 32,444 males. There are eleven primary schools, three health centres: Nyang'oma Health centre and Ng'iya Health Centre and Kogelo Dispensary.

Uuna Primary School located in Kogelo Location in Karemo Subdivision was purposively selected for the study because health centre records showed increased jigger infestations among pupils attending the school.

Study population

The total pupil population at Uuna Primary School was 672 pupils with 275 pupils in upper primary (classes 5-8). The study focused on the 275 upper primary pupils (in classes 5-8) who were attending holiday school during the jigger campaign.

Target population

A sample of 27 jigger infested pupils out of the 275 pupils in upper primary classes who were having remedial classes and were infested by various stages of jiggers were conveniently recruited into the study.

Sampling technique

Convenient sampling was used to select the study area due to the high prevalence of jigger infestation in pupils attending Uuna Primary school. The upper primary section was purposively selected because the school offered holiday teaching for these pupils and it was also easy to recruit jigger victims. The affected students were recruited by Community Health Workers (CHWs). One of the roles of the CHW is to maintain and monitor disease at the grass root level and mobilize the community for health related activities. The CHWs approached the parents on behalf of the researcher and asked for consent to treat the children. Qualified hospital staff were among the treatment team and supervised the whole operation.

Inclusion criteria

The study included Upper Primary pupils of Uuna Primary School who were at the time suffering from jigger infestation, regardless of the degree of infestation, were willing, of sound mind and available to participate in the study.

Study Limitation

Since schools were in recess at the time, pupils in lower primary classes were not in school thus could not take part in the study. Limited funds were available thus the study could not be carried out exhaustively. Time allocated for the elective study was short and there was a limited supply of Sodium carbonate for the trial.

Data collection

Prevalence data was collected through observation of the subjects forjigger infestation and health centre records. Efficacy of Sodium carbonate was assessed by dissolving and applying 50 gm/litre weight by volume warm solution solution to the 27 jigger infested pupils.

Apparatus

The tools used for the trial included 50 gm of Sodium carbonate per litre of warm water in a deep basin that could immerse the affected part well, soap for cleaning the affected area a pumice stone for scrubbing and defoliating the affected area for ease of penetration of the Sodium carbonate solution and gloves for handling the affected part as a protective measure against jigger infestation.

Procedure

There was a health talk on jigger management and prevention to the whole of the upper primary classes before the start of treatment. The talk was given by the researcher who also clarified issues the audience did not understand.

The person to apply the Sodium carbonate put on a pair of gloves and cleaned the patients feet or other part of the body with soap and preferably warm water. Each patient brought a clean basin, bathing soap and a 5 litre jerry can of warm water to the health centre.

A pumice stone was then used to scrub the hardened or keratinized parts of the lesions in order to remove clogged dirt. The lesions were later rinsed with potable water.

The area was left to dry for a few minutes.

Meanwhile 50 gm of Sodium carbonate was dissolved in a litre of warm potable water which was poured into a deep basin to allow for immersion of the affected parts.

Other concentrations of Sodium carbonate were 2% w/v and 7.0% w/v each dissolved in warm water.

Affected parts were soaked in the solution for 15 to 20 minutes.

Observations were made on the affected areas and patients were asked to report any thing felt for example pain.

There was a trained health centre official on standby in case of emergency.

Aseptic techniques were observed throughout and included disposal of the used water, tissue papers and the extracted jigger eggs and 'cysts'/'egg casings 'into a pit latrine. The basins used to wash the feet were cleaned and the water disposed of appropriately and finally disinfected before use next time.

Findings

According to records obtained from Mr. Osanya, the Community Health Extension Worker in charge of Kogelo Dispensary, jigger prevalence rate at the Uuna Primary School was 68 (10%) of 762 pupils; of these 41(60%) pupils were in lower primary while 27 (40%) were in upper primary section respectively.

The school compound had a lot of sand and soil, which could easily contribute to jigger infestation. Environmental sanitation at the school was properly observed. The cemented classrooms were swept daily and washed with soap and water every two days.

Upon observation, 27 pupils were found to have the black spots enclosed within white halos indicative of various stages of jigger infestation. 100% of the pupils preferred r self-medication; none of the pupils sought for professional assistance from the three nearby health facilities. AT home, conventional treatment by use of sharps including pins, thorns and needles t was provided by the parents or caregivers with varying degrees of success.

The results reported in Figure 1 showed that infestation by jiggers affected pupils in all classes. The results further showed that jigger infestation declined from Class 5-8.

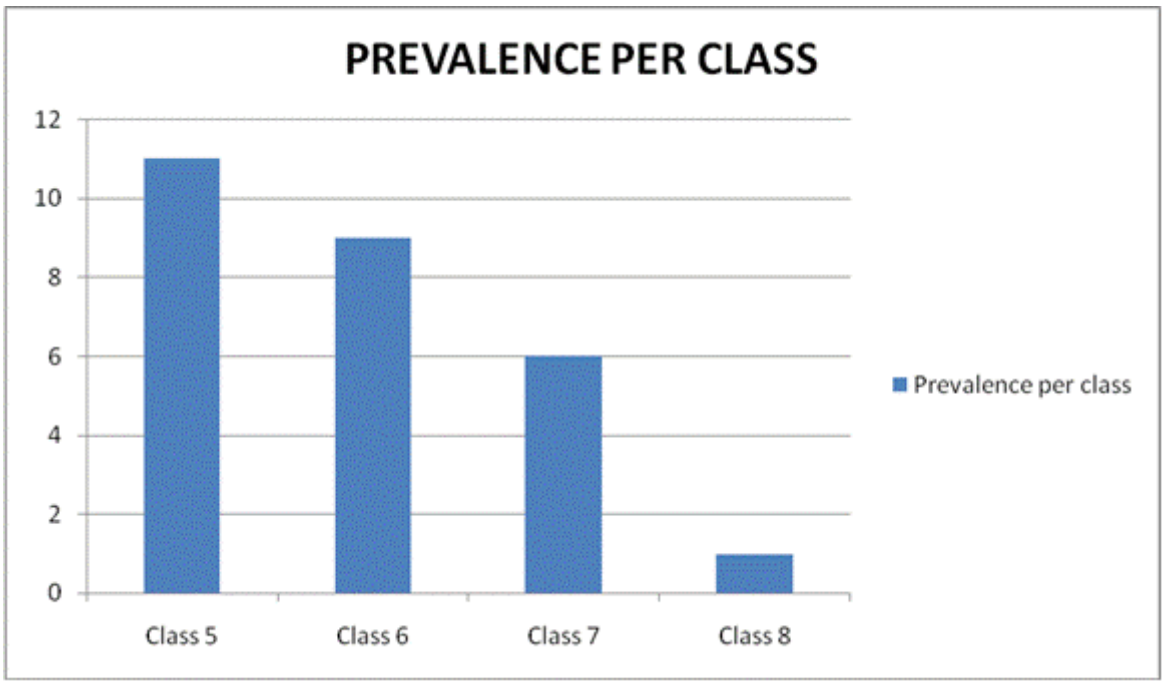

Figure 1: Prevalence of jigger infestation among pupils in the various classes.

The results in Figure 2 showed that most pupils had been affected by jiggers for between 2 weeks and two months but hardly sought medical attention.

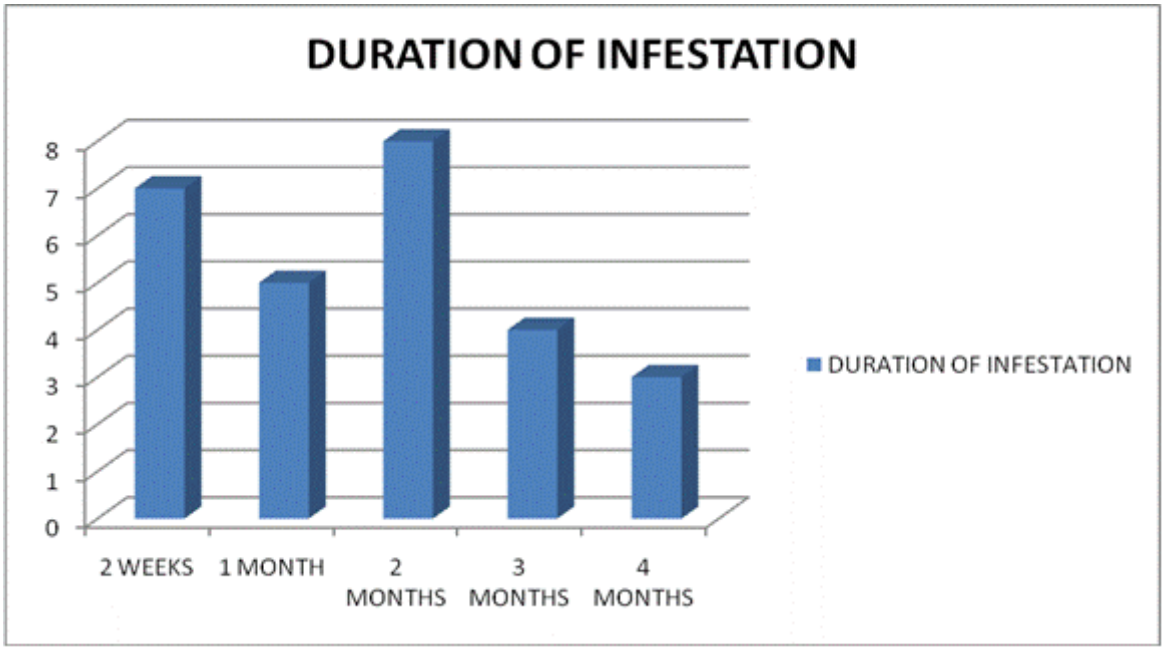

Figure 2: Bar graph showing duration of jigger infestation among the pupils.

Most of the pupils (81.5%) of the pupils did not have shoes on (Figure 3).

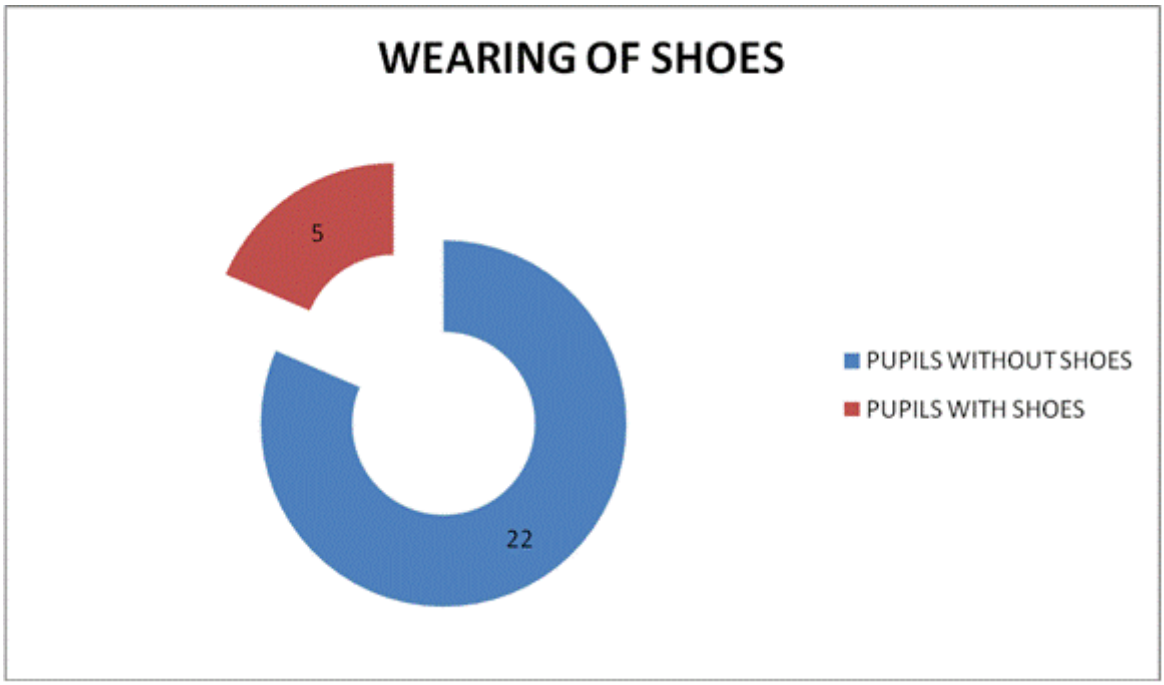

Figure 3: Ratio of jigger-infested pupils that had shoes on.

All the pupils recruited into the trial resided in mud-walled homes. Only 38% of the pupils houses were maintained using cow dung. A proportion of fresh cow dung (approximately 5 kg) was collected very early in the morning either from the home or neighbours who reared cattle. It was then mixed with mud and a little water to form a sticky paste which was smeared on to the walls and the floor using the flat

side of the palm. The purpose of using the palm was to create a smooth surface after application (Figure 4).

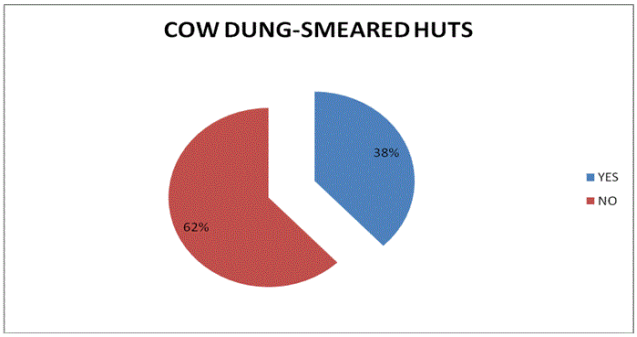

Figure 4: Percent houses smeared with cow dung.

Figure 5 shows the response of jiggers to treatment with Sodium carbonate. When 5% Sodium carbonate was administered, 70% of the pupils had all the jiggers extricated from the lesions within 10 to 15 minutes of application. The extricated jiggers were either scraped off using a tooth pick or they burst forming a string of eggs in the solution The dead jiggers and their eggs were disposed off to pit latrine. There was no increase in jigger removal rate when the concentration of the chemical was increased above 5% wv. No jiggers were expelled when concentrations at 2%, or 7% w/v respectively were applied to jigger lesions, suggesting that 5% was the optimal concentration.

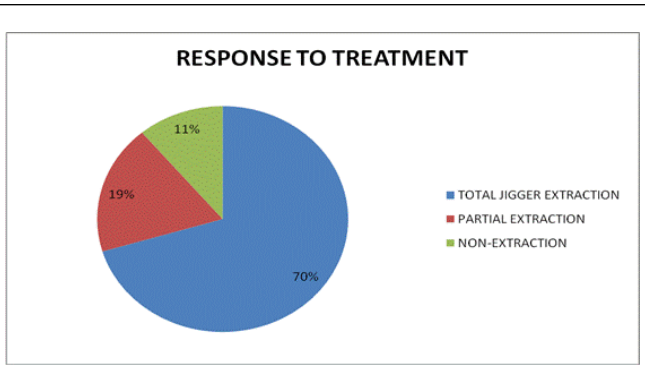

Figure 5: Response by infested pupils to jigger treatment with Magadi soda.

After treatment with the 5% solution, total jigger extraction was observed in 19 of the pupils representing 70.3% of all the sampled pupils. Five (18.5%) pupils, had partial removal of the flea and its eggs or larvae. Extraction was not observed at all in 3 (11.2%) of the pupils. Even increasing the concentration of the solution to 10%, these pupils still did not show positive response to treatment. The least favourable response to treatment was found among those who had been suffering from infestation for 3 months and over. The 3 who did not respond at all to treatment had had chronic infestation over 4 months. During treatment, the pupils said they felt varying levels of itching though neither great discomfort nor pain was reported. Of the 5 pupils who experienced partial jigger removal, least response to treatment was observed on the sides of the feet.

Discussion

Jigger prevalence at Uuna primary school was low compared to other studies where up to 19% of communities get affected as demonstrated by Kimani et al. [17] during a knowledge, attitude and practice study in Muranga district in Kenya. The high infestation rate by jiggers at the school showed that jiggers were a public health concern that required an immediate address. The community did not seem to think the problem was serious because jiggers are not considered a serious health problem. The community, perceived Tungiasis as a problem that run within family circles or was associated with mentally affected people who hardly get adequate medical care [23]. Makena [24] in a study of 11 schools in Gatundu district recorded that jiggers affected pupil education through poor attendance, poor performance, and the need for community sensitization about the treatment and prevention of jiggers. This observation calls for an emphasis on Public health education among infested people so the myths and misconceptions about the problem can be eradicated.

The study demonstrated that Sodium carbonate was an options available for managing jiggers in addition to the surgical removal by pins and needles and scalpels and the disinfectants. The 5% Sodium carbonate solution caused less pain, was not as deeply invasive compared to other chemicals. It was also a non-toxic, environmentally friendly option that was easily available, cheap and uneasy to use which killed and totally destroyed the jigger egg as demonstrated by the macerated eggs seen at a x10 magnification under the light microscope. It was observed that removal was more efficient in the acute lesions, compared to the heavily keratinized chronic lesions-cases. This could be due to encrustation that resulted in hardening of these parts making it difficult for the solution to penetrate into the inner parts of the feet where the flea is found. A solution to this may be abrasion using a pumice stone that would result in thinning of the skin where crusts are seen to have formed.

The mode of action of was Sodium carbonate solution was most likely by osmolarity with the salt moving into the body of the flea through diffusion of the chemical from a higher concentration into the flea's body via the exposed posterior pore and the softening of the connective tissues around the parasite enabling it bulge and thus to push its way backwards out of the lesion since it anchors into the host's tissues with its head anteriorly.

There was also no secondary infection after the treatment implying the Sodium carbonate had antiseptic properties which lowered the risk bacterial infection into the lesions. The presence of encrustations reduced permeability of the lesions to the compound thus making the compound ineffective however, the fleas died even without repeated treatments. In very stubborn cases treatment was repeated twice or thrice.

Lack of wearing shoes could be related to the high poverty levels in the area thus inability to acquire them as also stated by Cestari [25]. Although the wearing of shoes was advocated for, affordability and sustained use of the shoes was a challenge arising from the poverty state of the community from which the pupils came. Reliance on donors may not be answer either because after the publicity of distribution of a single pair of shoes dies down, the vulnerable individual is left without a second pair to put on when the donated pair is soiled thus creating a potential environment for re-infestation. There are allegations of the shoes being sold for profit after prevention campaigns in some areas. Personal hygiene and environmental hygiene

have to be religiously maintained in controlling and preventing jigger infestations

The practice of maintaining houses using cow dung aided the management of the jiggers by blocking the dark crevices that provided shelter to the fleas and their eggs.

The practice of frequent smearing walls and floors with cow dung reduced accumulation of dust, and sealed cracks where the flea could hide and breed in addition to drowning the eggs thus their death when they became wet. The fresh dung also had a refreshing effect in the house. There is a school of thought that the gases produced by the decomposing cow dung repelled the jiggers from the confines of the huts. Sprinkling water on the floor which is an age old practice among the Uuna community is believed to help in settling the dust and it may be inferred that the increased atmospheric moisture inhibits the hatching of the flea eggs.

The ability of the 05% Sodium carbonate to kill jiggers within 15 to 20 minutes demonstrated that the compound had great potential in the management of jiggers. The compound is naturally available therefore environmentally friendly, was found in most houses where it has other uses including general cleaning among others. This was further strengthened by the observation that despite the slight tingling discomfort in some cases; no pin was used sparing the victims the discomfort, pain and risk of secondary infection and HIV/AIDS among other potentially harmful diseases. The victims could also be able to apply the compound by themselves at any time of the day once the affected parts had been cleaned. The almost instant results boosted the victim's self esteem within a short time. This was demonstrated by the cheers that met the trial team immediately they literally saw whole jiggers extricated within ten minutes of application of the chemical. The jiggers that were extricated were teased off using clean toothpicks wrapped in tissue paper then disposed of in a pit latrine which prevented further spread of the problem. It should however be noted that microscopic observation showed a strucreless mass of denatured eggs implying that the treatment also kills the egg stage and adult it gets in contact and therefore destroys potential life stages of the flea.

Conclusion and Recommendations

The study confirmed that a warm solution of 5% w/v Sodium carbonate was a potential alternative to the management of jiggers among infested pupils since it was naturally available, cheap, readily available and showed 70% Tungicidal property within 15 to 20 minutes of its application. It also had the double advantage of having antiseptic properties so no additional antibiotics or antiseptics had to be applied to the extracted jigger lesions. Since this was a natural product it was environmentally friendly and therefore a better option to the synthetic compounds than the contaminated needles and thorns that posed public health problems through cross infection and transmission of communicable diseases. Sodium carbonate extracted from Trona in Tanzania shows high levels of Fluoride which maybe a risk especially to growing children. Kenyan Trona is among the purest since it contains no traces of Fluoride and this allays fear of Fluoride poisoning after topical application. The study recommended that more research be done on Sodium carbonate as an alternative tungicide.

The study concluded that 9% of the pupils were infested by jiggers and that they did not seek medical attention and did not consider Tungiasis a major public health problem. The preventive measures should include promotion of health through Health education about jiggers and their impact on health. Although most of the pupils had houses that were regularly maintained through smearing of dung on the walls and the floor, there were some houses that were not regularly maintained and these posed a risk for jigger infestation in addition to lack of wearing shoes.

Schools are important sources of empowering communities and they should be used as avenues for sensitizing pupils on the importance and maintenance of general hygiene as individuals and in the community they live in. This can be achieved through practical subjects like home science which essentially advocates foe behavior change with regards to an individual.

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References

1. Hoeppli R (1963) Early references to the occurrence of Tunga penetrans in tropical Africa. Acta Trop 20: 143-153.
2. Heukelbach J, de Oliveira FA, Hesse G, Feldmeier H (2001) Tungiasis: a neglected health problem of poor communities. Trop Med Int Health 6: 267-272.
3. Feldmeier H, Sentongo E, Krantz I (2013) Tungiasis (sand flea disease): a parasitic disease with particular challenges for public health. Eur J Clin Microbiol Infect Dis 32: 19-26.
4. Ariza L, Ugbomoiko US, Heukelbach J (2010) Epidemiology of Tungiasis in Nigerian schoolchildren 10. Kongress für Infektionskrankheiten und Tropenmedizin (KIT 2010). Deutsche Gesellschaft für Infektiologie,Deutsche AIDS-Gesellschaft,Deutsche Gesellschaft für Tropenmedizin und Internationale Gesundheit,Paul-Ehrlich-Gesellschaft für Chemotherapie.
5. (2014) The Monitor.
6. District Strategic Plan 2005 – 2010 For Implementation Of The National Population Policy For Sustainable Development. Available onlie :http// www.ncapd-ke.org
7. Feldmeier H, Eisele M, Sabóia-Moura RC, Heukelbach J (2003) Severe tungiasis in underprivileged communities: case series from Brazil. Emerg Infect Dis 9: 949-955.
8. Veraldi S, Valsecchi M (2007) Imported tungiasis: a report of 19 cases and review of the literature. Int J Dermatol 46: 1061-1066.
9. Heukelbach J, Wilcke T, Harms G, Feldmeier H (2005) Seasonal variation of tungiasis in an endemic community. Am J Trop Med Hyg 72: 145-149.
10. Eisele M, Heukelbach J, Van Marck E, Mehlhorn H, Meckes O, et al. (2003) Investigations on the biology, epidemiology, pathology and control of Tunga penetrans in Brazil: I. Natural history of tungiasis in man. Parasitol Res 90: 87-99.
11. Muehlen M, Heukelbach J, Wilcke T, Winter B, Mehlhorn H, et al. (2003) Investigations on the biology, epidemiology, pathology and control of Tunga penetrans in Brazil. II. Prevalence, parasite load and topographic distribution of lesions in the population of a traditional fishing village. Parasitol Res 90: 449-455.
12. Wilcke T, Heukelbach J, César Sabóia Moura R, Regina Sansigolo Kerr-Pontes L, Feldmeier H (2002) High prevalence of tungiasis in a poor neighbourhood in Fortaleza, Northeast Brazil. Acta Trop 83: 255-258.

13. Feldmeier H, Heukelbach J, Eisele M, Sousa AQ, Barbosa LM, et al. (2002) Bacterial superinfection in human tungiasis. Trop Med Int Health 7: 559-564.
14. de Bruijn HP (1983) [Tunga penetrans: a tropical surprise in a Dutch toe]. Ned Tijdschr Geneeskd 127: 1292-1294.
15. Greco JB, Sacramento E, Tavares-Neto J (2001) Chronic ulcers and myasis as ports of entry for Clostridium tetani. Braz J Infect Dis 5: 319-323.
16. Litvoc J, Leite RM, Katz G (1991) [Epidemiology of tetanus in São Paulo State (Brazil)]. Rev Inst Med Trop Sao Paulo 33: 477-484.
17. Bernard Kimani, Josephat Nyagero, Lawrence Ikamari (2012) Knowledge, attitude and practices on jigger infestation among household members aged 18 to 60 years: case study of a rural location in Kenya.
18. Heukelbach J, Eisele M, Jackson A, Feldmeier H (2003) Topical treatment of tungiasis: a randomized, controlled trial. Ann Trop Med Parasitol 97: 743-749.
19. Feldmeier H, Doehring E (1987) Clinical experience with metrifonate. Review with emphasis on its use in endemic areas. Acta Trop 44: 357-368.
20. Mabelya L, van Palenstein Helderman WH, van't Hof MA, König KG (1997) Dental fluorosis and the use of a high fluoride-containing trona tenderizer (magadi). Community Dent Oral Epidemiol 25: 170-176.
21. www.wyomingmining.org/minerals/trona
22. Verosky SC, Todorov A (2010) Generalization of affective learning about faces to perceptually similar faces. Psychol Sci 21: 779-785.
23. Collins G, Konfor M, Nyamnshi L (2009) Tungiasis; A Neglected Public Health Problem in Rural Cameroon Vol 1 International Journal of Collaborative Research, Yaoundé.
24. Makena, Beatrice, Mwebia (2014) Relationship between Jigger Infestation and Children's Participation in School activities in Gatundu District, Kiambu County, Kenya. Eur J Clin Microbiol Infect Dis 32: 19-26.
25. Cestari TF, Pessato S, Ramos-e-Silva M (2007) Tungiasis and myiasis. Clin Dermatol 25: 158-164.