Worm Infestations in Children

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ABSTRACT
Worm infestations in children caused by roundworms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*) and hookworms (*Ancylostoma duodenale* and *Necator americanus*) are common, largely asymptomatic and responsible for considerable morbidity and occasional mortalities. The majority of South African children remain untreated for these and other helminthic infections. Untreated infections result in adverse effects on growth, nutrition, micronutrient deficiencies, anaemia and a number of cognitive developmental areas. Treatment of more of these infections would significantly improve many aspects of child health. The interaction of worm infections with HIV/AIDS is also of interest. More comprehensive deworming programs, as employed in many other countries, have the potential to provide important improvements to the health of our children at remarkably low cost.

Preamble
It was with some trepidation that I, as a hospital-based paediatrician in Johannesburg, set out to write this article with an instruction to 'tell nurses what they need to know'. The reason for my trepidation stems from the reality that the majority of children infected with worms are either:

- Asymptomatic, in which case they will not seek medical help for their worms; or
- Mildly symptomatic, in which case they will be treated as out-patients – by either nurses or junior doctors.

As such, they are quite unlikely to present to a hospital-based paediatrician, unless they experience one of the rare or severe complications related to their worm infections.

The approach typically taken in most overviews of these diseases is to discuss their life-cycles, clinical manifestations, complications, treatment etc. I have no problem with these sorts of reviews; they are freely available and contain important information. I have instead decided to take a slightly different approach. If you require these cold, hard facts they can be obtained in most credible medical or nursing textbooks and a brief overview can be found in the Standard Treatment Guidelines and Essential Drugs List recently (2006) updated by the national Department of Health.[1]

The approach I will be taking is to look at the impact of worm infections on a variety of child health issues and attempt to give a broader overview of their importance. A quick word on terminology; previously we spoke of non-invasive involvement by these worms as *infestations*, and as *infections* if tissue invasion occurred. Today, *infection* includes both of these.

Introduction

How important are worm infections as a public health concern?
It has been estimated that worldwide more than 1.2 billion people are infected with roundworms (*Ascaris lumbricoides*), almost 800 million with whipworms (*Trichuris trichiura*) and more than 700 million with hookworms (*Necator americanus* and *Ancylostoma duodenale*).[2] Many people are obviously affected by more than one worm as they share common risk factors. Of even more concern is that, it is thought that the prevalence of all three of these infections in Sub-Saharan Africa have increased between 1994 and 2003,[2] compared to most other regions, were they decreased over the same time period.[2] It was further estimated that 44 000 Disability-Adjusted Life Years (DALYs) were lost to these three diseases in South Africa in 2002.[3] These figures help to demonstrate the prevalence of these worm infections in our patients. It should, however, be borne in mind that they do not even take into account other worms, causing both intra- and extraintestinal pathology. A list of the more common worm infections can be found in Table 1. Many of these are not considered health problems in South Africa, but are included here to provide a clearer picture of the potential pathogens involved.

What proportion of those people infected, receive treatment?
This is a difficult question to answer, but since it is thought that in 2004 only 6% of pre-school children received either albendazole or mebendazole,[4] clearly we are not doing as well as we could.

Who are these billions of people infected worldwide?
Part of the problem with diagnosing and treating infected individuals is that they are largely found in the least accessible and poorest areas of affected countries; the reason for this is obvious as these diseases rely, predominantly, on the absence of access to good sanitation and clean water for their transmission. Long-term control inevitably needs to address these as well as simply considering access to medical treatment. A

Table I: Classification of worms of human importance

Platyhelminths
- Cestodes
  - *Intestinal*
    - *Taenia* species (beef and pork tapeworms)
    - *Hymenolepis* sp.(rat and dwarf tapeworms)
    - *Dipylidium* sp.(dog and cat tapeworms)
    - *Diphyllobothrium* sp.(fish tapeworm)
  - *Tissue*
    - *Taenia* sp.(pork tapeworm - cysticercosis)
    - *Echinococcus* sp.(Hydatid disease)
    - *Multiceps* sp.(dog tapeworm - coenurosis)
    - *Spirometra* sp.(sparganosis)
- Trematodes
  - *GIT*
    - *Fasciola* sp.
    - *Clonorchis* sp.
    - *Fasciolopsis* sp.
    - *Heterophyes* sp.
  - *Blood/tissue*
    - *Schistosoma* sp. (bilharzia)
    - *Paragonimus* sp.

Nematodes
- *Intestinal*
  - *Ascaris* sp.(roundworm)
  - *Enterobius* sp.(pinworm)
  - *Ancylostoma* sp.(hookworm)
  - *Necator* sp.(hookworm)
  - *Strongyloides* sp.(threadworm)
  - *Trichuris* sp.(whipworm)
- *Blood/tissue*
  - *Trichinella* sp.
  - *Toxocara* sp.
  - *Dracunculus* sp.
  - *Wuchereria* sp.
  - *Brugia* sp.
  - *Loa* sp.
  - *Onchocerca* sp.
  - *Mansonella* sp.
  - *Dirofilaria* sp.

disproportionately large proportion of those affected are young children. The main burden of most of these diseases is in pre-school children. The implication of this is that untreated infection potentially affects these individuals for the rest of their lives and tends to occur at times when there is active organ development, particularly of the brain.[5] Consider the issue of anaemia. This is often a significant, but infrequently clinically noticed, effect of intestinal worm infection (particularly related to hookworm infection) and a recent review has demonstrated the significant increase in haemoglobin levels following treatment for intestinal worms.[6]

The effects on childhood growth, intellectual, cognitive and educational development

It is known that intestinal worm infections are associated with childhood malnutrition, growth stunting, adverse intellectual growth, as well as cognitive and educational deficits.[7] Furthermore, there is increasing evidence that treatment, and particularly regular deworming of pre-school and school children is able to reverse these effects to a significant extent.[7] However, a causative link between intestinal worm infestations and adverse cognitive outcomes has been questioned;[8] alternative viewpoints include the suggestion that weaning and subsequent malnutrition are able to explain both the cognitive effects and the increase in helminth infections simultaneously.[8] causative link is, nevertheless, being increasingly favoured.

It is interesting to consider how intestinal worm infections are able to interfere with these crucial areas of a child's development. Iron deficiency and the concomitant anaemia are able to explain part of the deficit by interfering with concentration, motivation and energy levels.[8] An additional factor, particularly in school-going children, is that of school absenteeism related to intestinal worm infections – either as a result of direct symptoms or indirectly, for example, through malnutrition associated illnesses.[8] A further factor is that of associated micronutrient deficiencies and there are good reasons to consider supplementation with iron and vitamin A as part of deworming therapy.[9] The thinking around this being that if the adverse effects of worm infections include them predisposing to micronutrient deficiency, then killing the worms will prevent further losses but existing deficiencies will remain.[9] Whether these consequences of worm infections are attributable to the factors mentioned is still an area of debate and active research.[10]

What is the link between HIV/AIDS and worm infections?

Almost all 2007 South African medical literature include some reference to HIV/AIDS and worm infections. Unfortunately, this article is no exception. So what is the link between these apparently unrelated illnesses? Apart from the obvious association with lower socioeconomic conditions, poorer living conditions, poverty, etc. there are other aspects worthy of consideration. Both HIV and worm infections adversely impact on nutritional status and cognitive development. So with both being common we can expect their effects to be at least additive resulting in ever larger numbers of affected individuals unless we are able to effectively combat both. It does not seem that worm infections (with the possible exception of *Strongyloides stercoralis*) are, in general, more common or more severe because of HIV/AIDS-related immunosuppression. It has however been suggested that there may be some interaction between them on an immunological level. A theory expressed is that the chronic immune activation against the tissue stages of worms results in a shift towards a predominantly Th2 response which is thought to increase the risk of HIV acquisition, enhance HIV-progression to AIDS, potentially increase mother-to-child-transmission and possibly could interfere with response to any future HIV-vaccines.[11] Conceivably, adequate anthelmintic treatment could reverse these effects.

Pregnant women

The next issue to consider is that of treating pregnant women. While this article is focussing on children, it does seem that treating women during pregnancy has beneficial effects on their children. Treating pregnant women reduces the rate of maternal anaemia and has been associated with reductions in stillbirth rate, perinatal mortality and low-birth-weight rates.[12] Furthermore, mebendazole has been shown to be safe after the first trimester in pregnancy.[12]

What is being done on a global scale to address the issues around worm infestations?

In 2001, the 54th World Health Assembly set a target that by 2010, at least 75% of the all school age children at risk for schistosomiasis and soil-transmitted helminth infections would receive regular deworming therapy[7] – clearly, we are a

long way from achieving this goal locally. A group, Partners for Parasite Control, was formed in 2001 to address the issue of parasite control globally. This initiative aims to deliver anthelmintic therapy to those groups at highest risk. This is achieved by regular deworming of children at risk (from as young as 12 months of age), as well as pregnant and lactating women.[7] In many countries this is linked to Vitamin A distribution and immunisation programmes, thus achieving higher coverage rates and taking advantage of existing public health structures.[7] Deworming is also considered an important component in achieving a number of the Millennium Development Goals:[13]

- **MDG 1** – Eradicate extreme poverty and hunger
  - Deworming contributes to improving malnutrition and its effects on cognitive development allow children to potentially go on to earn better remuneration and alleviate poverty.

- **MDG 2** – Achieve universal primary education
  - Deworming decreases school absenteeism improving access to education.

- **MDG 3** – Promote gender equality and empower women
  - Deworming female schoolchildren and pregnant women improves their health status indirectly empowering them.

- **MDG 4** – Reduce child mortality
  - Improvements in nutrition and reduction of anaemia following deworming can contribute towards this goal.

- **MDG 5** – Improve maternal health
  - Similar effects can be expected by deworming pregnant and lactating women.

- **MDG 6** – Combat HIV/AIDS, malaria and other diseases
  - Worm infections make up part of the 'other diseases'.

- **MDG 8** – Develop a global partnership for development
  - Deworming programs allow for development of partnerships, particularly with pharmaceutical companies.

One of the concerns expressed about the consequences of greater use of anthelmintics, is the potential for development of drug resistance to commonly used agents (mebendazaole, albendazole, levamisole and pyrantel palmoate). At the moment this is largely a theoretical concern, but it has been documented in animal helminths,[14] and will warrant close monitoring once a more comprehensive treatment program is in place.

Space constraints do not allow further consideration of two other important South African helminthic pathogens. Suffice to say that cysticercosis, particularly neurocysticercosis (caused by *Taenia solium*) and schistosomiasis (*S. haematobium* and *S. mansoni*) are also of public health concern in South African children and their medical management involves many of the same principles as that of the intestinal helminths.

Conclusion

In conclusion, this brief overview has hopefully demonstrated the importance of worm infestations to the health of our country's children. They impact on multiple areas and untreated have long-lasting adverse effects on our children's outcomes. It seems inevitable that more formal deworming programs will be important developments in our primary health facilities, hopefully, in the not too distant future. Regular deworming can be linked to existing public health programs and the cost is likely to be lower than that currently incurred by the targeted investigation and treatment of symptomatic individuals because the costs of investigations and repeat clinic visits are saved. The exact nature of a more comprehensive deworming program still needs to be decided, but it will probably include the regular treatment of school children (in all likelihood at school by their teachers), pregnant women and possibly pre-school children.

The loose poster in this issue is a South African worm information poster, downloaded from WHO website: *http://www.who.int/wormcontrol/education_materials/south_africa/en/Poster.pdf <http://www.who.int/wormcontrol/education_materials/south_africa/en/Poster.pdf>*. This poster demonstrates, pictorially, some useful information about worm infestations that we could communicate to our patients.

Conflict of interest: None to declare.

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References

1. National Department of Health. Standard treatment guidelines and essential drugs list (Hospital level paediatrics). Pretoria (South Africa): National De-partment of Health; 2006: p. 163-166
2. De Silva NR, Brooker S, Hotez PJ, Montresor A, Engels D, Savioli L. Soil-transmitted helminth infections: updating the global picture. Trends in Parasitology. 2003;19: 547-551
3. WHO. Death and DALY estimates for 2002 by cause for WHO Member States. *http://www.who.int/entity/healthinfo/statistics/bodgbddeathdalyestimates.xls* (accessed 10 July 2007)
4. WHO. Weekly Epidemiological Record (21 April 2006). Geneva, World Health Organization, 2006; 81: 145-164; *http://www.who.int/wormcontrol/wer8116.pdf* (accessed 30 July 2007).
5. Awashti S, Bundy D. Intestinal nematode infection and anaemia in developing countries [editorial]. BMJ. 2007; 334:1065-6
6. Gulani A, Nagpal J, Osmond C, Sachdev HPS. Effects of administration of intestinal anthelminthic drugs on haemoglobin: systematic review of randomised controlled trials. BMJ, doi: 10.1136/bmj.39150.510475AE (published 13 April 2007)
7. WHO. Report of the third global meeting of the partners for parasite control: deworming for health and development. Geneva 29-30 November 2004, Geneva, World Health Organization, 2005. Ref: WHO/CDS/CPE/PVC/2005.14.
8. Kvalsvig JD. Parasites, nutrition, child development and public policy. In: Crompton DWT, Montresor A, Nesheim MC, Savioloi L, editors. Controlling disease due to helminth infections. Geneva, World Health Organization, 2003. *http://www.who.int/wormcontrol/documents/en/Controlling%20Helminths.pdf* (accessed 10 July 2007)
9. Hall A. Micronutrient supplements for children after deworming. Lancet Infect Dis. 2007; 7: 297-302
10. Abidin SAN, Hadidjaja P. The effect of soil-transmitted helminth infection on the cognitive function of schoolchildren. In: Crompton DWT, Montresor A, Nesheim MC, Savioloi L, editors. Controlling disease due to helminth infections. Geneva, World Health Organization, 2003. *http://www.who.int/wormcontrol/documents/en/Controlling%20Helminths.pdf* (accessed 10 July 2007)
11. Fincham JE, Markus MB, Adams VJ. Could control of soil-transmitted helminthic infection influence the HIV/AIDS pandemic. Acta Tropica. 2003; 86: 315-333
12. Ismail MM, Atukorala TMS, Naotunne TS, de Silva NR, Hettiarachchi. Control of intestinal helminthiasis in pregnancy – the Sri Lankan experience. In: Crompton DWT, Montresor A, Nesheim MC, Savioloi L, editors. Controlling disease due to helminth infections. Geneva, World Health Organization, 2003. *http://www.who.int/wormcontrol/documents/en/Controlling%20Helminths.pdf* (accessed 10 July 2007)
13. WHO. The evidence is in: Deworming helps meet the Millennium Development Goals. Geneva, World Health Organization, 2005. Ref:WHO/CDS/CPE/PVC/2005.12. *http://whqlibdoc.who.int/hq/2005/WHO_CDS_CPE_PVC_2005.12.pdf* (accessed 10 July 2007)
14. Albonico M. Treatment of soil-transmitted helminth infection: prescribing information for disease control. In: Crompton DWT, Montresor A, Nesheim MC, Savioloi L, editors. Controlling disease due to helminth infections. Geneva, World Health Organization, 2003. *http://www.who.int/wormcontrol/documents/en/Controlling%20Hel minths.pdf* (accessed 10 July 2007)

WHAT DO YOU KNOW ABOUT WORMS?

Portion of intestine removed from a young child because of blockage by roundworm (Ascaris)

Cows or pigs swallow tapeworm eggs on grass and cysts form in their meat, which we eat

Faeces containing thousands or even millions of worm eggs mix with soil or get into water

Pinworm eggs are laid on the skin near the anus. They are sticky, cause itching and get onto fingers during scratching

Larvae penetrate skin of bare feet (and cause itching) to reach bloodstream

Worm eggs on dirty hands, under finger nails and in water polluted by faeces and urine

Worm eggs in dust blown by wind

Worm eggs in soil, dust and dirty water get onto vegetables, fruit and other food we eat

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