CONTINUING MEDICAL EDUCATION

Intestinal Parasitic Infections in Man: A Review

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Summary

Intestinal parasites of importance to man are *Enterobius vermicularis*, the soil-transmitted helminthes (STH) - *Ascaris lumbricoides*, *Trichuris trichiura*, *hookworms (Necator americanus/Ancylostoma duodenale)* and *Strongyloides stercoralis* and the protozoa *Entamoeba histolytica and Giardia duodenalis*. Other protozoa such as *Cryptosporidium* sp. and *Isospora* sp. are becoming important in causing prolonged diarrhea in immunocompromised patients. It is estimated that almost 1 billion, 500 million and 900 million people worldwide are infected by the major nematode species – *A.lumbricoides*, *T. trichiura* and hookworms respectively. Most of the infections are endemic and widely distributed throughout poor and socio-economically deprived communities in the tropics and subtropics. Environmental, socio-economic, demographic and health-related behavior is known to influence the transmission and distribution of these infections. In giardiasis, one study indicates that age $\leq$ 12 years and the presence of family members infected with *Giardia* were risk factors for infection. Most of the infections occur in children and both genders are equally affected. Epidemiological studies of STH infections have shown that the prevalence and intensity of infection are highest among children 4-15 years of age. The frequency of distribution of STH infections is over-dispersed and highly aggregated. Predisposition to reinfection following treatment has been reported in these infections. In highly endemic areas reinfection can occur as early as 2 months post-treatment, and by 4 months, almost half of the population treated become reinfected. By 6 months the intensity of infection was similar to pretreatment level.

Key Words: Intestinal Parasitic Infections

Introduction

Intestinal parasitic infections are distributed throughout the world, with high prevalence in poor and socio-economically deprived communities in the tropics and subtropics. Amebiasis, ascariasis, hookworm infection and trichuriasis are among the top ten most common infections in the world[1]. These infections continue to be a global health problems, particularly among children in poor communities in developing countries[2]. If AIDS is synonymous with promiscuity, intestinal parasitic infections are synonymous with poverty. Epidemiological assessments of these infections have traditionally focused on estimating the number of infections (prevalence), which occur worldwide. This is

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because the clinical consequences of these infections are very mild.

The Global Burden of Intestinal Parasitic Infections

Intestinal Helminthic Infections

Intestinal helminths of importance to man are E. *vermicularis* (pinworm), soil-transmitted helminths (STH) - *A. lumbricoides* (round worm), *T. trichiura* (whip worm), *N. americanus* and *A. duodenale* (hookworm) and *S. stercoralis* (threadworm). The other intestinal nematodes (*Anisakis sp., Capillaria philippinensis*), trematodes and cestodes are less widespread in man. Their distribution is limited to certain areas in the world and the infections are usually confined to certain communities.

It is estimated that 25% of the world population are infected by *A. lumbricoides* and this causes up to a million cases of disease annually[3-4]; 500-600 million people worldwide are infected by *T. trichiura*[5] and about 500 million by hookworm[6]. The distribution of *S. stercoralis* infection usually follows that of hookworm. It is estimated that 50-100 million of the world's population are infected by *S. stercoralis*. The worldwide infection by *Enterobius vermicularis* is about 200 million and it is the commonest helminthic infection in the United States (40 million). In contrast to soil-transmitted helminthiasis, enterobiasis is prevalent in both developed and developing countries[7,8]. Intestinal helminthic infections are endemic and widely distributed throughout poor and socio-economically deprived communities in the tropics and subtropics; where poverty, overcrowding, poor environmental sanitation and low level of education are more apparent problems than intestinal helminthic infections (Table I).

Intestinal Protozoal Infections

Intestinal protozoa of importance to man are *Entamoeba histolytica* and *Giardia duodenalis*. Currently *Blastocystis hominis* and opportunistic protozoa such as *Cryptosporidium* sp. and *Isospora* sp. have been identified as the causes of diarrhea in children and immunocompromised patients. Other protozoal intestinal infections have restricted distribution *(Balantidium coli)* or are widely distributed but not pathogenic *(Entamoeba coli, Dientamoeba fragilis, Trichomonas hominis).*

E. histolytica affects about 10% of the world's population or 480 million people9, however this infection can be as high as 25% in certain areas of underdeveloped tropical countries. About 36 million develop clinical amebiasis and about 40,000 die annually9 (Table I). *G. duodenalis* is the most common intestinal protozoal infection and it is found throughout temperate and tropical regions10,11. Their prevalence varies between 2% -5% in developed countries and 20%-30% in developing countries. In USA and UK, giardiasis is the most commonly reported intestinal parasitic infection of man. It is estimated that about 200 million infections occur each year in Africa, Asia and Latin America.

Human cases of *Cryptosporidium* sp. have been reported in various parts of the world and the prevalence appears to be highest in the tropics. This infection has been reported in 13% of diarrhea children in India and 7.3% in Thailand[12,13]. In temperate countries the prevalence in children varies from 1.1% in Spain[14] to 1.4% in United Kingdom[15] and 2.1% in France[16]. The majority of the infection in man is by *Cryptosporidium parvum.*

Intestinal Parasitic Infections in Malaysia

The common intestinal parasites in man in Malaysia are mainly the helminths, especially *E. vermicularis* and the STH *(A. lumbricoides, T. trichiura and N. americanus)* and the protozoans, *E. histolytica* and *G. duodenalis.*

Several studies have demonstrated a high prevalence of *A. lumbricoides, T. trichiura* and *N. americanus* infections in underprivileged

community such as Orang Asli children[17-21], in estates[22-25], squatter areas[26-29] and poor Malay villages[18,30-32] (Table II). *S. stercoralis* infection is not endemic in Malaysia. It usually occurs as sporadic cases. Infections with trematodes and tapeworms *(Hymenolepis nana and Hymenolepis diminuta)* are only reported occasionally. The prevalence of enterobiasis both in rural and urban communities in Malaysia is high[33-36]. The overall prevalence is between 40.4-57.8%.

The prevalence of amebiasis also varies from 1% - 14% [17,22,21,37-44] (Table III). The prevalence of *giardiasis* varies between 2% - 19.4%, depending on the areas studied and methods used in the detection of the protozoa [17,22,21,37,38,40,42,43,45-47] (Table IV). In Malaysia, 4.3% of children with diarrhea were found to be positive for *Cryptosporidium* sp.[48]. High prevalence of cryptosporidiosis in asymptomatic carriers among HIV-positive intravenous drug users was also reported in Malaysia [49].

Risk Factors of Intestinal Parasitic Infections

With the exception of *E. vermicularis*, intestinal trematodes and cestodes, most of the common intestinal parasitic infections of man are fecal-borne infections and the transmission occurs either directly hand-to-mouth or indirectly through food and water. For protozoal infections person-to-person transmission can occur. The source of infection is mainly human (carrier or patient). Two principal factors in maintaining endemicity of intestinal parasitic infections are favorable qualities of the soil and frequent contamination of the environment by human faeces. Their transmission within the community is predominantly related to human habits with regards to eating, defecation, personal hygiene, cleanliness and level of education. Its prevalence in the community can be used as an indicator of the conditions of living, environmental sanitation as well as the socio-economic status of the community.

Environmental factors, such as water supply for domestic and personal hygiene, sanitation and housing condition[50-53] and other factors such as socio-economic[51-54], demographic[51,53] and health related behavior[51,52,54] are known to influence this infection. In giardiasis, one study indicates that age and the presence of infected family members were the risk factors of infection[47].

Previous studies on enterobiasis indicate that it is more prevalent in over-crowded areas or families with many members [8,34]. Two other social factors that are often believed to be related to the transmission of *E. vermicularis* are socio-economic status and level of education although the findings are controversial [7,34,36,56]. It can be surmised that the transmission of *E. vermicularis* is determined by the cleanliness of the house and personal hygiene and not by the size of the family and socio-economic background.

Public Health Significance of Intestinal Parasitic Infections

The amount of harm caused by intestinal parasites to the health of communities depends on several factors such as species, prevalence and/or intensity of infection, the interaction between the parasites and concurrent infections, the nutritional and immunological status of the population and numerous socio-economic factors. Their significance is extremely difficult to assess because most of these infections are asymptomatic with very low morbidity and mortality. Therefore the public health significance is always measured by the prevalence, intensity of the infection and association of these infections with human nutrition, growth and development of children and work productivity in adults.

The impact of intestinal parasitic infections on nutrition, growth and development of children has been studied since the seventies. The findings however, have remained controversial. Evidence from community studies indicate that ascariasis is associated with growth impairment[57–60], impaired

lactose digestion, decreased food consumption and lower plasma vitamin A[61]. The role of hookworm infection in causing iron deficiency anemia has been confirmed by several studies[62]. Chronic giardiasis can interfere with the growth of children by impaired nutrient digestion (fat and vitamin) and lactose intolerance. Recently, it has been shown that trichuriasis and ascariasis impair school performance and cognitive functions of children[63-64].

Epidemiological studies of soil-transmitted helminthiases have shown that the prevalence and intensity of infection are highest among children 4-15 years of age and significantly associated with age[20,27]. Infection occurs at a very young age (1-2 years) and the prevalence and intensity of infection rise with age, reaching maximum values at approximately 5-7 years of age and remaining constant thereafter[20,27]. The frequency distribution of STH infections is overdispersed and highly aggregated[20,27,65], which means that a large proportion of the populations are not or mildly infected and only a small proportion of them are heavily infected. Predisposition to reinfection following treatment has been reported in these infections [29,66-69]. In highly endemic areas reinfection can occur as early as 2 months post-treatment, and by 4 months almost half of the population treated become reinfected[20,70]. By 6 months the intensity of infection was similar to pretreatment level [65,71].

The recent developments and findings in epidemiological research have led to the understanding of epidemiology and population dynamics of the intestinal parasites. Mathematical models for several infections have been developed based on these findings (age-related prevalence and intensity of infection for helminthiases and age-related incidence rate for protozoal infections). These models are used for devising control strategies and planning the timing and form of intervention (chemotherapy). For example in the intervention of STH infections, periodic 4-6 monthly, targeted chemotherapy is suggested as one of the strategies.

Clinical Significance of Intestinal Parasitic Infections

Although the prevalence of intestinal parasitic infections is high, the morbidity and mortality caused by these infections is very low. They are usually considered an unimportant problem. Besides that, the statistics for hospital admissions due to intestinal parasitic infections are also scarce, although the WHO estimates suggest that there may be some 3.5 million cases admitted annually with clinical disease associated with nematode infections. Intestinal parasitic infections associated with clinical disease are well documented. Ascariasis can result in often-fatal intestinal obstruction; hookworm infection can cause iron deficiency anemia; trichuriasis is associated with chronic dysentery and rectal prolapse. Amebiasis can result in dysentery and extraintestinal complications; giardiasis is associated with acute diarrhea, steatorrhea and lactose intolerance. *Cryptosporidium parvum* and *Blastocystis hominis* have been documented as the commonest opportunistic parasites causing severe enteritis and chronic diarrhea in immunocompromised people. *Cryptosporidium parvum* has also been increasingly recognised as a cause of diarrheal illness in both immunocompetent and immunocompromised people. Ascariasis was the cause of intestinal obstruction in 5-35% of all paediatric cases in a comparison of studies conducted throughout the tropics[72]. Rectal prolapse due to trichuriasis occurred in nearly 4% of children studied in the West Indies[73].

In Malaysia, studies on the prevalence and clinical manifestations of intestinal parasitic infections in hospitalised patients have been carried out since the sixties. Clinical features of severe trichuriasis have been described in a few studies carried out in Hospital Kuala Lumpur. These studies indicate that rectal prolapse occurred in 50% of children with severe trichuriasis [74-76]. Ascariasis was responsible for 42% and 41% of all acute abdominal emergencies and intestinal obstruction respectively in children 7 years and below admitted to hospital in Kuala Lumpur[77]. Ascariasis

causing acute pancreatitis and acute cholecystitis has also been reported recently in patients admitted to UMMC[78]. The prevalence of intestinal parasitic infections in hospitalised patients is between 21.3-43.3% [40,79-82]. A recent study in HUKM reported a prevalence of 5.3% [83].

Control and Prevention of Intestinal Parasitic Infections

The most effective control program of intestinal parasitic infections is an integrated approach with community participation. The long-term objective is to reduce the prevalence, intensity of infection and severity of intestinal parasitic infections to levels at which they cease to be of public health significance. Theoretically, the infections can be controlled and prevented by improvement in environmental sanitation such as safe methods of faeces and waste disposal and provision of safe water supplies and health education on health promotion of personal and food hygiene. Such measures are usually slow to take effect, require considerable investment and need to be accompanied by social, economic and educational development. Due to constraints at the national and individual levels, control of infection using the above methods have become unrealistic besides taking a long time.

In recent years the availability of single-dose broad-spectrum anthelminthics has helped in reducing the worm burden in endemic communities. Studies have shown that periodic chemotherapy strategy has successfully lowered the intensity of *Ascaris* and hookworm infections[69,86,87].

In Malaysia efforts made towards the control of STH / intestinal parasitic infections are minimal compared to other health activities. There is no national policy for the prevention and control of these infections. Instead their control is integrated in the National Environmental Sanitation Program. The objectives of this program are to educate and to increase public awareness on personal hygiene and environmental sanitation and to give anthelminthic treatment to children. The effectiveness of this program in controlling STH and other intestinal parasitic infections is still questionable.

New Challenges in Intestinal Parasitic Infections

1. Intestinal parasitic infections are still a public health concern in Malaysia. Studies from the sixties until the nineties indicate that the prevalence and intensity of these infections are still high. They also interfere with nutrition, growth and development of children. However severe clinical consequences associated with these infections are very low. To achieve optimum quality of life do we need to consider adopting a national policy for their prevention and control as what is done for malaria and filariasis?
2. Most of the epidemiological data of these infections were acquired from sporadic studies carried out in academic and research institutions. Currently there is no database on these infections at the national level. Should we include intestinal parasitic infections as one of the parameters in our National Health and Morbidity Surveys?
3. What are the implications on medical education and training of health professionals?
4. How about intestinal parasitic infections among migrants in Malaysia. Is it a problem? If so, of what magnitude?

Above are some of the questions which pose new challenges for parasitologist of the new millennium in Malaysia.

Table I : Estimated Prevalence of Major Intestinal Parasitic Infections Worldwide

Intestinal Parasitic Infections	Estimated Prevalence (million)
Ascariasis	1000
Hookworm infection	900
Trichuriasis	500-600
Strongyloidiasis	50-100
Enterobiasis	200
Amebiasis	480

Table II: Intestinal Helminthiases in Malaysia

Author & Year / Area	Prevalence (%) of Infection		
	Ascaris	Trichuris	Hookworm
Orang Asli	(17-63)	(29-92)	(24-92)
Bisseru & Aziz (1970)	48	81	95
Che Ghani & Oothuman (1991)	43	59	26
Norhayati et al., (1997)	63	92	29
Noor Hayati et al., (1998)	17	29	24
Estates	(14-73)	(36-93)	(16-55)
Sinniah et al., (1978)	34	36	16
Zahedi et al., (1980)	52	65	28
Kan (1982)	73	55	23
Kan (1989)	34	36	16
Squatters	(23-50)	(44-62)	(4-11)
Kan (1982)	23-39	44-56	5-11
Kan & Poon (1987)	47	61	4
Bundy et al., (1988)	50	62	5
Chan et al., (1992)	47	61	4
Traditional villages	(4-75)	(13-99)	(2-26)
Khairul Anuar et al., (1978)	67	55	12
Li (1990)	68-75	67-99	6-22
Che Ghani & Oothuman, (1991)	41-43	33-59	11-26
Norhayati et al., (1995)	4	13	2

Table III: Amebiasis in Malaysia

Author & Year	Prevalence (%) of Infection
Bisseru & Aziz (1970)	1.5
Dunn (1972)	5.1
Dissanaike et al., (1977)	8.7
Sinniah et al., (1978)	1.3
Nawalinski & Roundy (1978)	1.2
Hamimah et al., (1982)	2.3
Thomas & Sinniah (1982)	8.3
Sinniah (1984)	4.4
Che Ghani et al., (1987)	14.4
Noor Hayati et al., (1998)	11.5

Table IV: Giardiasis in Malaysia

Author & Year	Prevalence (%) of Infection
Bisseru & Aziz (1970)	5.6
Dunn (1972)	10.8
Dissanaike et al., (1977)	4.8
Sinniah et al., (1978)	11.3
Nawalinski & Roundy (1978)	6.0
Hamimah et al., (1982)	2.6
Sinniah (1984)	8.5
Che Ghani et al., (1987)	9.5
Noor Hayati et al., (1998)	19.4
Norhayati et al., (1998)	19.2

Table V: Changes in the prevalence of intestinal parasitic infections in patients admitted to hospital in 1981 and 2001

	Year of Study / %	
Intestinal Parasites	1981(n=198)	2001(n=300)
E. histolytica	3.4	2.7
G. duodenalis	2.8	0.7
Cryptosporidium sp	-	0.3
B. hominis	-	0.3
A. lumbricoides	16.2	0.7
T. trichiura	15.1	1.4
Hookworm	-	0.3

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Intestinal Parasitic Infections In Man: A Review

Questions

1. The following intestinal parasitic infections are endemic in Malaysia:
A. Trichuriasis
B. Giardiasis
C. Strongyloidiasis
D. Amebiasis
E. Fasciolopsiasis

2. Presenting symptoms of intestinal parasitic infections include
A. diarrhea / dysentery
B. respiratory symptoms
C. dermatitis
D. failure to thrive
E. joint pain

3. Infection with the following intestinal parasites should be ruled out in AIDS patients who present with prolonged diarrhea:
A. Cryptosporidium parvum
B. Strongyloides stercoralis
C. Microsporidia
D. Ascaris lumbricoides
E. Isospora belli

4. The following statements are true of intestinal protozoal infections:
A. They are feco-oral infections.
B. A few species of protozoa can cause malabsorption syndrome.
C. They do not cause extra-intestinal lesions.
D. Intestinal biopsy can be used in the diagnosis.
E. Most antiprotozoals are effective in their treatment.

5. The following statements are true of soil-transmitted helminthiases:
A. Enterobiasis is an example.
B. They are zoonotic infections.
C. Most infections are asymptomatic.
D. They are easily diagnosed by fecal smear examination.
E. Only severe infections need treatment.

Intestinal parasites are currently diagnosed by morphological identification of trophozoites, cysts, oocysts, eggs, or adult worms in feces, whereas tissue parasites are generally diagnosed by immunological methods. From: Encyclopedia of Food Sciences and Nutrition (Second Edition), 2003. Related termsÂ â€¢ The carriage of intestinal parasites may alter the course of other important infections. For example, large helminthic burdens may impair cellular immune responses to both Mycobacterium tuberculosis and the human immunodeficiency virus through chronic immune-system activation characterized by an exaggerated helper T-cell subset 2 response.