OGH Reports 2018; 7(1): 25-34
Peer Reviewed Journal in Oncology, Gastroenterology and Hepatology
www.oghreports.org | www.journalonweb.com/ogh

Original Article

To Assess the Efficacy and Safety of Various Anti-heliminthics against Ascariasis Lumbricoides among a Study Population in North India

Zaffar Kawoosa, Gul Javid, Ghulam Nabi Yattoo, Ghulam Mohamad Gulzar, Jaswinder Singh Sodhi, Altaf Hussain Shah, Mushtaq Khan, Sajad Hamid

ABSTRACT

Introduction: More than 24% of the world's population, are infected with soil-transmitted helminth infection. **Aim**: To assess the helminthic load & efficacy and safety of various anti-heliminthics. **Methods:** A total of 400 patients who met the inclusion criteria were recruited after proper consent. Subjects were divided into Four groups (100 each) randomly & receive different anti- helminthic drugs. Cure rate and egg reduction rate was used as a primary outcome measure. Three weeks later two more stool samples were analyzed by two methods 1) Direct Smear method & 2) Concentration method. On follow-up, each group were randomly assigned a single dose of albendazole (single 400 mg dose), mebendazole (100 mg, BD×3 days), pyrantel pamoate (11 mg/kg orally once) and ivermectin (0.2 mg/kg orally once) using a randomization procedure.The data was statistically analysed. **Observations:** Among 400 patients, 63% were 5-19 years of age, 68% were male, 73.5% were from rural areas, 71% were literate, 62% were in the low income group, 58% reported closed sanitation, 6.75% were having low BMI, 26.25% were having High Absolute Eosinophilic Count before treatment, 77.5% were non-anaemic. 92.5% did not have icterus. In the present study it was seen that the difference among the four drugs was statistically significant as per demographic variables. Significant decrease of worm load after treatment were comparable with each other. However, Presence of Worm across papillae seen after upper GI endoscopy and persistent biliary ascariasis was comparable in all the four drug groups. Overall, the efficacy of anthelmintic drugs was excellent and statistically significant ($p<0.001$). **Conclusion:** Albendazole and mebendazole having cure rates of 90% and also reducing the mean egg count by 90%. Also treatment of school children every 4 monthly may be necessary in high endemic areas, like ours. All these drugs which we used in our study are safe and no significant side effects were observed.

Key words: Helminth, Prevalence, Infestation, Sanitation, Parasite.

Zaffar Kawoosa, Gul Javid, Ghulam Nabi Yattoo, Ghulam Mohamad Gulzar, Jaswinder Singh Sodhi, Altaf Hussain Shah, Mushtaq Khan, Sajad Hamid

Department of Gastroenterology, SKIMS, Soura, Jammu and Kashmir, INDIA.

Correspondence

Dr. Zaffar Kawoosa
Post DM senior resident, Department of Gastroenterology, SKIMS,Soura, Jammu and Kashmir, INDIA.

Phone: 9419070488
Email: medicalacademy@rediffmail.com

History
- Submission Date: 29-06-2017;
- Review completed: 16-07-2017;
- Accepted Date: 28-07-2017.

DOI : 10.5530/ogh.2018.7.1.5

Article Available online
http://www.oghreports.org

INTRODUCTION

Worms or helminths have historically infected more than half the world's population, but were largely neglected by medical science and public health interventions because they were considered non-fatal and of minimal clinical significance. During the 1980s, several oral drugs that were originally developed for veterinary use were discovered to cure, in a single dose, most human helminth infections. This allowed the first systematic population-based studies of the morbid sequelae of chronic worm infection and their potential reversibility after treatment.[1]

Infections with the three common soil-transmitted helminthes (STHs), *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm (*Ancylostoma duodenale* and *Necator americanus*), are a global public health concern, particularly in areas where poor sanitation prevails.[2,3] *Taenia* spp. infections are also widespread.[4,5] STHs and taeniasis/cysticercosis belong to the neglected tropical diseases (NTDs) and are responsible for mainly chronic and often inconspicuous morbidity.[6,7] More than a billion people are currently infected with one or several STH species, even though growing efforts are underway to control these parasitic worm infections.[8]

A. lumbricoides, an intestinal roundworm, is one of the most common helminthic human infections worldwide. Highest prevalence has been reported from tropical and subtropical regions, and areas with inadequate sanitation. It is the largest intestinal nematode of man. The female worms are larger than the males and can measure 40 cm in length and 6 mm in diameter.[9] Infections of *A. lumbricoides* are largely asymptomatic, and hence a large population of people carrying this worm remains undetected for years until they develop some symptoms. Due to a large group of asymptomatic individuals with intestinal

Cite this article: Kawoosa Z, Javid G, Yattoo GN, Gulzar GM, Sodhi JS, Shah AH, Khan M, Hamid S. To Assess the Efficacy and Safety of Various Anti-heliminthics against Ascariasis Lumbricoides among a Study Population in North India. OGH Reports. 2018;7(1):25-34.

ascariasis, these worms are occasionally and unexpectedly identified during routine endoscopic procedures.[10]

It is estimated that more than 1.4 billion people are infected with *A. lumbricoides,* representing 25% of the world population. A number of features account for its high prevalence including a ubiquitous distribution, the durability of eggs under a variety of environmental conditions, the high number of eggs produced per parasite and poor socioeconomic conditions that facilitate its spread. [11] Although ascariasis occurs at all ages, it is most common in children 2 to 10 years old, and prevalence decreases over the age of 15 years. Infections tend to cluster in families, and worm burden correlates with the number of people living in a home.[12] The highest prevalence of ascariasis occurs in tropical countries where warm, wet climates provide environmental conditions that favour year-round transmission of infection. This contrasts to the situation in dry areas where transmission is seasonal, occurring predominantly during the rainy months.[13] The prevalence is also greatest in areas where suboptimal sanitation practices lead to increased contamination of soil and water. The majority of people with ascariasis live in Asia (73%), Africa (12%) and South America (8%), where some populations have infection rates as high as 95%.[14,15]

Transmission occurs mainly via ingestion of water or food (raw vegetables or fruit in particular) contaminated with *A lumbricoides* eggs and occasionally via inhalation of contaminated dust. Children playing in contaminated soil may acquire the parasite from their hands. Transplacental migration of larvae has also occasionally been reported.[16] Coinfection with other parasitic diseases occurs with some regularity because of similar predisposing factors for transmission.[17,18] Adult worms inhabit the lumen of the small intestine, usually in the jejunum or ileum. They have a life span of 10 months to 2 years and then are passed in the stool. When both female and male worms are present in the intestine, each female worm produces approximately 200,000 fertilized ova per day. When infections with only female worms occur, infertile eggs that do not develop into the infectious stage are produced. With male-only worm infections, no eggs are formed.[15] Ascaris infection is acquired by the ingestion of the embryonated eggs. The larvae, while passing through the pulmonary migration phase for maturation, cause ascaris pneumonia. Intestinal ascaris is usually detected as an incidental finding. Ascaris-induced intestinal obstruction is a frequent complication in children with heavy worm loads. It can be complicated by intussusception, perforation, and gangrene of the bowel. Acute appendicitis and appendicular perforation can occur as a result of worms entering the appendix. Hepatobiliary Pancreatic Ascariasis (HPA) is a frequent cause of biliary and pancreatic disease in endemic areas. It occurs in all age groups and can cause biliary colic, acute cholecystitis, acute cholangitis, acute pancreatitis, and hepatic abscess. Recurrent Pyogenic Cholangitis (RPC) causing hepatic duct calculi is possibly an aftermath of recurrent biliary invasion in such areas.[9]

In endemic countries such as India, ascariasis has been found to cause up to one-third of biliary and pancreatic disease.[19,20] Complications associated with *A. lumbricoides* infections are fatal in up to 5% of cases. It is estimated that 20,000 deaths from ascariasis occur annually, primarily as a consequence of intestinal obstruction.[21] In terms of their estimated global burden, hookworm is the most important among the STHs, perhaps responsible for more than 20 million disability-adjusted life years among the estimated 600 million infected people worldwide.[2,22] Another study estimated 5.3 billion people worldwide, including 1.0 billion school-aged children, living in areas of stable transmission for at least one STH species.[23] Chronic hookworm infection cause intestinal blood loss and result in poor iron status and iron deficiency anemia, particularly in children, and women in reproductive age.[2,24] As a consequence, permanent impairment, including delayed physical and cognitive development, has been described.[25] *Taenia solium* cysticercosis is a major cause of epilepsy and other neurological disorders in developing countries.[26]

Almost all infected children and many adults, particularly pregnant and lactating women, suffer adverse effects from worms, including growth stunting, anemia, decreased cognitive development, and poor birth outcomes as well as poor school and work performance. Worm-infected people also respond less well to vaccinations and are more susceptible to several co-conditions such as HIV and cirrhosis. Based on these findings, several vertically organized national control programs were initiated in developing countries against schistosomiasis and the soil-transmitted helminths (hookworm, ascariasis, and whipworm). In 2005, the impact of helminth infections was redefined in terms of disability-adjusted life years. All worm infections amenable to population-based mass chemotherapy are thought today to cause 30 million disability-adjusted life years worldwide or very close to the worldwide impact of tuberculosis or malaria. In addition, almost all worm-induced disability-adjusted life years are potentially reversible or preventable with periodic treatment. In 2001, the World Health Assembly advocated for mass deworming to reach 75% of the at-risk school-aged children of the world, but by 2011 only 13% had been reached. The large donations of anti-helminth drugs by major pharmaceutical companies linked to the inclusion of the "neglected tropical diseases" into current priorities for AIDS/TB and malaria now represent the best hope for closing this gap.[1]

The current strategy for STH control in highly endemic areas focuses on morbidity control through large-scale administration of single-dose anthelminthics to at-risk populations, particularly school-aged children.[7,27] Due to the zoonotic nature of taeniasis/cysticercosis, its control must also include the veterinary sector.[4,28]

At present, only four drugs are recommended by the World Health Organization (WHO) for treating STH infections.[27] The global STH control relies on two of them–albendazole and mebendazole – both benzimidazole carbamates. Albendazole and mebendazole display a broad spectrum of activity and are administered orally, usually at a single dose of 400 mg and 500 mg, respectively.[29] Children below the age of 1 year and pregnant women in the first trimester of pregnancy are not eligible for treatment.[27] Albendazole and mebendazole have been extensively used worldwide for more than 30 years, both as stand-alone treatments and, more recently, in combination with other drugs, *e.g.*, praziquantel (against schistosomiasis and food-borne trematodiasis) or ivermectin (against lymphatic filariasis).[7,30] Availability, cost, drug donation programs, and policy instead of the local parasite spectra and evidence determine the choice of which anthelminthic drug is deployed. Justification for the indiscriminate use of either drug is derived from high egg reduction rates (ERRs) achieved with both albendazole and mebendazole, and the assumption that morbidity is a function of infection intensity.[31]

Albendazole is a broad spectrum antihelmintic, effective against round worms, tapeworms, and flukes of domestic animals and humans. It is used against giardiasis, to treat lymphatic filariasis as part of efforts to stop transmission of the disease, it is used in conjunction with ivermectin and in combination with diethylcarbamazine. Albendazole may cause abdominal pain, dizziness, headache, fever, nausea, vomiting, or temporary hair loss when used for longer periods.

Mebendazole is a highly effective, broad spectrum antihelmintic indicated for the treatment of nematode infestations, including roundworm, whipworm, threadworm, and hookworm. It is poorly absorbed and has no systemic effects. Mebendazole is relatively free of toxic side effects or adverse reactions, although patients may complain of transient abdominal pain, heart pain, diarrhea, slight headache, fever, dizziness, exanthema, urticaria and angiodema.

Ivermectin is a broad-spectrum antiparasitic agent. It is traditionally used against worms. It is mainly used in humans in the treatment of onchocerciasis, but is also effective against other worm infestations (such as strongyloidiasis, ascariasis, trichuriasis, filariasis, enterobiasis) and some epidermal parasitic skin diseases, including scabies. Ivermectin is contraindicated in children under the age of five, or those who weigh less than 15 kg (33 lb) and those who are breastfeeding, and have a hepatic or renal disease.

Pyrantel pamoate is used as a deworming agent in the treatment of hookworms (all species) and roundworms (*Ascaris lumbricoides*) in domesticated animals such as horses, cattle, sheep, pigs, cats, dogs, and many other species. It is a combination of pyrantel and pamoic acid. Some drug companies pair pyrantel pamoate with praziquantel for tapeworms, and sometimes febantel for whipworms in order to provide more complete treatment for intestinal parasites in one dose. It is also used for pinworm treatment for humans. Nausea, vomiting, diarrhea, stomach/abdominal cramps, headache, drowsiness, dizziness, trouble sleeping, or loss of appetite may occur.

A recent meta-analysis of randomized placebo controlled single-dose drug efficacy trials pointed to a marked superiority of albendazole over mebendazole against hookworm, high efficacy [in terms of cure rate (CR)] of both drugs against *A. lumbricoides*, and disappointing efficacy of either drug against *T. trichiura*. Few data are available regarding (Egg Reduction Rate) ERR.[29] However, reinfection commonly occurs due to the inability of the human host to mount protective immunity to reinfection by intestinal helminths, combined with inadequate hygiene and sanitation to restrict or eliminate re-exposure in environments continuously contaminated with the egg or larval free-living transmission stages of these parasitic worms.[32]

Following treatment, average worm loads in the population return to their pre-treatment equilibrium in a monotonic manner. The exact dynamics will depend on a number of density-dependent processes that influence parasite reproduction, infection and mortality (in part related to the build-up of a degree of acquired immunity), plus the relatively long life expectancies of established worms in the human host (measured in years). It will also depend on the proportion of worms in the entire human community in a defined location which are exposed to treatment in a particular control programme.[33]

Following therapy, patients should be reevaluated at two to three months to ensure that no eggs are detectable, either because of inadequate elimination of adult worms or because of reinfection. Reinfection occurs frequently; more than 80 percent of individuals in some endemic areas become reinfected within six months.[9] Evaluation of other family members should be entertained whenever the diagnosis is made because of the propensity of the infection to cluster in families.[16,18]

Deworming programmes for the STHs are often centered on school delivery because of the large burden of morbidity and concomitant developmental consequences for these children, as well as relative ease of access to children in poor rural areas through schools and the cost-effectiveness of school-based deworming.[34]

School-based approaches to deworming children have many advantages in terms of ease of access in urban and rural regions and the ability to link with other nutritional, health and education initiatives in order to try and minimize delivery and logistic costs. Advocacy for this approach to the control of STHs and the morbidity they induce has been made by many over the past decade.[35]

Ultrasonography can detect worms in the biliary tract and pancreas and is a useful noninvasive technique for diagnosis and follow-up of such patients. ERCP can help diagnose biliary and pancreatic ascariasis, including ascaris in the duodenum. Also, ERCP can be used to extract worms from the biliary and pancreatic ducts when indicated. Pyrantel pamoate, mebendazole, albendazole, and levamisole are effective drugs and can be used for mass therapy to control ascariasis in endemic areas.[9]

The present randomized single blinded study was undertaken to assess the efficacy and safety of various anti-heliminthics *i.e.* albendzole, mebendazole, pyrantel pamoate and ivermectin on patients diagnosed as cases of symptomatic or asymptomatic ascariasis presenting in the Department of Gastroenterology, SKIMS, Soura, Srinagar (Kashmir). The study also assessed the recurrence and need for repeat deworming therapy in these subjects.

MATERIAL AND METHODOLOGY

This study was conducted in the Department of Gastroenterology, SKIMS, Soura in collaboration with the Department of Microbiology, SKIMS Soura Srinagar and included all age groups except pregnant females and children <5 years of age. The research protocol was approved by Ethical Committee of SKIMS, Soura.

STUDY DESIGN

Inclusion criteria:

- All subjects who had symptomatic or asymptomatic ascariasis.

Exclusion criteria:

- Pregnant females.
- Females who were breast feeding.
- Children <5 years of age.
- Patients who had terminal illness or who were sick because of other comorbidities.
- History of hypersensitivity to albendazole, mebendazole, pyrantel pamoate or ivermectin.

The present study was a randomized single blinded trial. A total of 400 patients including children, adolescents and elderly, who were infected with *Ascaris lumbricoides* and met the inclusion criteria were recruited. Four groups each comprising of 100 patients were randomly allocated to receive albendazole, mebendazole, pyrantel pamoate and ivermectin. Cure rate (CR) which means the percentage of patients who became egg- negative after treatment and egg reduction rate (ERR) which indicated reduction in the geometric mean fecal egg count on follow-up compared to base line at 21-23 days post-treatment was used as a primary outcome measure. Adverse events were monitored 3 hours post treatment. From each patient, two stool samples were examined for the presence and number of *A. lumbricoides eggs*. The patients were randomly assigned to albendazole, mebendazole, pyrantel pamoate and ivermectin. Three weeks later two more stool samples were analyzed for *A. lumbricoides* eggs. The stool was examined for ova of Ascariasis. Stool examination for ova of *A. lumbricoides* was done by two methods:

1. Direct Smear method
2. Concentration method

1. Direct smear method

A simple microscopical examination of a stool smear was made directly from the sample and viewed under low power microscope. This method was helpful in finding the eggs when they were present in overwhelming numbers. Concentration Method

This procedure was adapted for the concentration of *A. lumbricoides* eggs and was carried out either by Floatation or Sedimentation technique. A) Floatation Technique

In this method, the fecal material was dissolved in a solution of a higher density than that of the eggs. In this case, the fertilized eggs of *A. lumbricoides* float in the superficial portion of the fluid. Technique One millilitre of faeces was taken in the container and a few drops of salt solution were added. It was then stirred with a glass rod so as to make an even emulsion. After this more salt solution (15-20 ml) was added till the container was nearly full and stirring being continued throughout the process. Any coarse matter which floated was removed without fear of removing any eggs as the eggs took a long time (20-30 minutes) to come to the surface of the fluid. The final filling of the container was carried out by means of a dropper, until a convex meniscus was formed. A glass slide (3″×2″ size) was carefully laid on the top of the container so that its center was in contact with the fluid. The preparation was allowed to stand for 20-30 minutes, after which the glass slide was quickly lifted, turned over smoothly so as to avoid spilling of the liquid and examined under the microscope.

B) Sedimentation Method:

In this method, the fecal material was dissolved in water or solution of a density below that of eggs so that eggs get concentrated at the bottom. Although, the sedimentation technique is of two types viz; simple sedimentation and Formal Ether concentration method, the method which we followed was Formal Ether concentration method. In this method, one gram of faeces was emulsified in 7 ml of 10% formal saline and kept for 10 minutes for fixation. It was then strained through a wire guage (40 meshed/inch) and the filtrate was collected in a centrifuge tube. To it, 3 ml ether was added and the mixture was shaken vigorously for one minute. It was centrifuged at 2000 rpm for 2 minutes. The debris was loosened with a glass rod. The upper part of the test tube was cleared of fatty debris and the supernatant fluid was decanted, leaving 1 or 2 drops. The deposit after shaking was poured on a glass slide. A cover slip was placed over it and the specimen was examined under the microscope *(Ref: Clinical Parasitology; Paul Chester, Rodney Clifton, Eddie Wayne).* Worm Load :Stool for worm load was done by *Stoll's Egg- Counting Technique*. In this method, four grams of faeces was mixed with 56 ml of N/10 NaOH in a thick glass tube and thoroughly mixed to make a uniform suspension. This was facilitated by adding few glass beads and closing the mouth with a rubber stopper and then shaking vigorously. Exactly 0.15 ml of the emulsion was removed by a measuring pipette and placed on a large slide (3″ × 2″ size). A cover slip was place over it. With the help of a mechanical stage, all the eggs in the preparation were counted. The number of eggs per gram of faeces was obtained by multiplying the count of two such preparation by 100,

In our study, the subjects were recruited from outpatient, inpatient, schools, villages and far-flung areas. Potential risks and benefits were explained to all subjects. An informed consent form was distributed to all subjects and their consent was sought.In addition a questionnaire was administered to each participating subject for obtaining socio-demographic data including sex, age, residence, level of education, occupation, ethnic group, sanitation infrastructure and behavioral data (wearing of shoes, source of drinking water, food consumption and personal hygiene). Patients were grouped as per the socio-economic status into high, middle and low income groups. This classification was based on modified B. G Prasad's classification (2013) as under:

S. No	Socio-economic Status (Class)	Income per capita (Rs)
1	I	5156 & above
2	II	2578 -5155
3	III	1547 - 2577
4	IV	773-1546
5	V	Below Rs 773

Patients which were falling in the class I and II as per B G Prasad's classification were taken as High income families. Those falling in III and IV class as middle income group whereas class V were taken as low income group.

The patients were also grouped as per their education status as literate and illiterate. A person aged 7 years & above was deemed as literate if he or she can read and write with understanding in any language and an illiterate was defined as a person who is not literate *(Ref: K. Park 22nd Edn Page 447).* Patients were also grouped as per the use of sanitation into open, closed and both types of sanitation.

The closed type of sanitation *(sanitary latrine)* was defined as a latrine which fulfills the criteria of sanitation barrier and an open type of sanitation *(Insanitary latrine)* was defined as a latrine which does not fulfill the criteria of sanitation barrier*(Ref: K. Park 22nd Edn Page 702).*

At enrolment a clinical examination of all the subjects was done which included measurement of height, weight, axillary temperature and anemia. We assessed all the subjects and full medical history was taken. Subjects were excluded if they had fever or showed signs of severe malnutrition.

On follow-up, 21-23 days after drug administration, two stool samples were collected from each subject and were transferred to microbiology laboratory. Each stool specimen collected at follow-up was subjected to the same procedure as during the baseline survey. Microbiologist was blinded in treatment allocation.

Sample Size:

Proportion in group Albendazole: 84%
Proportion in group Mebendazole:67%
Power of the study:80%
Level of Significance:5%
Sample size for group Albendazole: 99
Sample size for group Mebendazole: 99

Proportion in group Albendazole: 84%
Proportion in group Ivermectin: 60%
Power of the study: 80%
Level of Significance: 5%
Sample size for group Albendazole: 55
Sample size for group Ivermectin: 55

Proportion in group Albendazole: 84%
Proportion in group Pyrantel Pamoate: 66%
Power of the study: 80%
Level of Significance: 5%
Sample size for group Albendazole: 90
Sample size for group Pyrantel Pamoate: 90

To be on safer side we took 100 samples from each group

RANDOMIZATION

Hundred subjects each were randomly assigned to a single dose of albendazole (single 400 mg dose), mebendazole (100 mg, BD×3 days), pyrantel pamoate (11 mg/kg orally once) and ivermectin (0.2 mg/kg orally once) using a randomization procedure. Randomization was done by *Computer Generator Method with the help of software Mini Table 14.*

DRUG AND ADVERSE EVENTS

On treatment day all subjects received drugs under direct medical supervision. Subjects were asked to report for any drug related adverse events. Infection with *A. lumbricoides* was grouped into light, moderate and heavy infection following the WHO Guidelines [for soil transmitted helminth (STH) infections] and cut-offs put forward by Maleewong and colleagues.*A. lumbricoides* infection intensity according to WHO classification is as follows:

1. 4,999 eggs / gram of stool = Light
2. 5,000-49999 eggs / gram of stool = Moderate
3. 50,000 eggs / gram of stool = Heavy

Primary outcome measures were cure rate (CR) and Egg Reduction Rate (ERR). The latter defined as the positive group reduction of geometric mean (GM) fecal egg count at post-treatment divided by the GM fecal egg count at pre-treatment, multiplied by 100.

Statistical Analysis

All the categorical variables of the study were shown in terms of the frequency and percentages. The categorical variables of the study were analyzed with the help of chi-square test. Also the standard statistical test *i.e.* Staurt-Maxwell test was used to see the change before and after treatment. Also the odds ratio and 95% confidence interval was used at appropriate place of analysis. All the results so obtained were discussed on 5% level of significance *i.e.* p-value less than 0.05 (considered significant).

OBSERVATION AND RESULTS

In the current study, the observations with regard to different parameters of patients are given in Table 1

DISCUSSION

Intestinal nematode infections affect one-fourth to one-third of the world's population. Of these, the intestinal roundworm *Ascaris lumbricoides* is the most common. While the vast majority of these cases are asymptomatic, infected persons may present with pulmonary or potentially severe

Table 1: Parameter wise distribution of patients (N=400)

Characteristics	Mean/Percentage
Age (Mean ± SE)	22.92 ± 9.37
Sex (M:F)	2.13:1
Residence (R:U) Percentage	73.5:26.5 (%)
Education (Lit/Illiterate) Percentage	71/29(%)
Income (High: Middle: low) Percentage	10:28:62 (%)
Sanitation (Closed: Open: Both) Percentage	58:22:20(%)
Anaemia Percentage	22.5(%)
Icterus Percentage	7.5(%)

Table 2: Distribution of Patients on the basis of their low Hemoglobin levels

Hemoglobin (g/dl)	No. of Patients (n=90)	Percentage
< 7.9 (severe)	16	17.77
8-10.9 (moderate)	26	28.88
11-12.9 (mild)	48	53.33

Table 3: Group wise distribution of patients on the basis of low Hemoglobin levels (N=400)

Group	Number of Patients with Anaemia	Percentage
Albendazole (N=100)	24	24
Mebendazole (N=100)	22	22
Pyrantel Pamoate (N=100)	23	23
Ivermectin (N=100)	21	21

Table 4: Distribution of Patients on the basis of their BMI (low) before treatment (N=400)

Group	No. of Patients with Low BMI	Percentage
Albendazole (N=100)	8	8
Mebendazole (N=100)	6	6
Pyrantel Pamoate (N=100)	6	6
Ivermectin (N=100)	7	7

Table 5: Distribution of Patients on the basis of their High Absolute Eosinophilic Count before treatment (N=400)

Group	No. of patients with High Absolute Eosinophilic Count	Percentage
Albendazole (N=100)	28	28
Mebendazole (N=100)	26	26
Pyrantel Pamoate (N=100)	25	25
Ivermectin (N=100)	26	26

Table 6: Distribution of Patients on the basis of decrease in their High Absolute Eosinophilic Count after 3 weeks of treatment (N=105)

Group	No. of patient with High Absolute Eosinophilic Count after 3 weeks of treatment
Albendazole (N=28)	17
Mebendazole (N=26)	13
Pyrantel Pamoate (N=25)	11
Ivermectin (N=26)	10

Table 7: Age distribution of subjects

Variable		Number of Patients	Percentage
Age	5-19 years	252	63.0
	20-45 years	84	21.0
	>45 years	64	16.0

Table 8: Sex distribution of subjects

Variable		Number of Patients	Percentage
Sex	Male	272	68.0
	Female	128	32.0

Table 9: Distribution of subjects according to place of residence

Variable		Number of Patients	Percentage
Residence	Urban	106	26.5
	Rural	294	73.5

Table 10: Distribution of subjects according to education

Variable		Number of Patients	Percentage
Education	Literate	284	71.0
	Illiterate	116	29.0

Table 11: Distribution of subjects according to their income

Variable		Number of Patients	Percentage
Income	Low	248	62.0
	Middle	112	28.0
	High	40	10.0

Table 12: Distribution of subjects according to the sanitation type

Variable		Number of Patients	Percentage
Sanitation	Open	88	22.0
	Closed	232	58.0
	Both	80	20.0

Table 13: Distribution of subjects according to presence of anaemia

Variable		Number of Patients	Percentage
Anemia	Yes	90	22.5
	No	310	77.5

Table 14: Distribution of subjects according to presence of icterus

Variable		Number of Patients	Percentage
Icterus	Yes	30	7.5
	No	370	92.5

Table 15: Comparison of anthelminthic drugs given as per demographic variables

Variable		Drugs Given				p-value
		Albendazole	Mebendazole	Pyrantel Pamoate	Ivermectin	
Age	5-19 years	70 (27.8)	60 (23.8)	64 (24.5)	58 (23.0)	0.156
	ears	18 (21.4)	28 (33.3)	16 (19.0)	22 (26.2)	
	>45 years	12 (18.8)	12 (18.8)	20 (31.2)	20 (31.2)	
Sex	Male	72 (28.5)	64 (23.5)	72 (26.5)	64 (23.5)	0.401
	Female	28 (21.9)	36 (28.1)	28 (21.9)	36 (28.1)	
Residence	Urban	32 (30.2)	28 (26.4)	20 (18.86)	26 (24.52)	0.278
	Rural	68 (23.1)	72 (24.5)	80 (27.21)	74 (25.17)	
Education	Literate	72 (25.4)	68 (23.9)	70 (24.6)	74 (26.1)	0.808
	Illiterate	28 (24.1)	32 (27.6)	30 (25.9)	26 (22.4)	
Income	Low	58 (23.38)	64 (25.8)	60 (24.2)	66 (26.61)	0.644
	Middle	34 (30.35)	24 (21.4)	28 (25.0)	26 (23.21)	
	High	8 (20.0)	12 (30.0)	12 (30.0)	8 (20.0)	
Sanitation	Open	24 (27.3)	24 (27.3)	20 (22.7)	20 (22.7)	0.716
	Closed	52 (22.4)	54 (24.1)	66 (27.6)	60 (25.9)	
	Both	24 (30.0)	20 (25.0)	16 (20.0)	20 (25.0)	
Anemia	Yes	24 (26.7)	26 (28.9)	28 (31.1)	12 (13.3)	0.31
	No	76 (24.5)	74 (23.9)	72 (23.2)	88 (28.4)	
Icterus	Yes	10 (33.3)	8 (26.7)	5 (16.7)	7 (23.3)	0.599
	No	90 (24.3)	92 (24.9)	95 (25.7)	93 (25.1)	

gastrointestinal complaints. Ascariasis predominates in areas of poor sanitation and is associated with malnutrition, iron-deficiency anaemia and impairment of growth and cognition.

A. lumbricoides is the largest of the intestinal nematodes affecting humans, measuring 15-35 cm in length in adulthood. Infection begins with the ingestion of embryonated (infective) eggs in feces contaminated soil or foodstuffs. Once ingested, eggs hatch usually in the small intestine, releasing small larvae that penetrate the intestinal wall. Larvae migrate to the pulmonary vascular beds and then to the alveoli via the portal veins usually 1-2 weeks after infection, during this time they may cause pulmonary symptoms (*e.g*., cough, wheezing etc). During the time frame of pulmonary symptoms, eggs are not being shed and thus diagnosis via stool ova and parasites is not possible. Eggs are not shed in stool until roughly 40 days after the development of pulmonary symptoms.

After migrating up the respiratory tract and being swallowed, they mature, copulate and lay eggs in the intestine. Adult worms may live in the gut for 6-24 months, where they can cause partial or complete bowel obstruction in large numbers, or they can migrate into the appendix, hepatobiliary system or pancreatic ducts and rarely other organs such as kidney or brain. From egg ingestion to new egg passage takes approximately 9 weeks, with an additional 3 weeks needed for egg molting before they are capable of infecting a new host.

Worldwide, 1.4 billion people are infected with *A. lumbricoides*, with prevalence among developing countries as low as 4% in Mafia Island, Zanzibar, to as high as 90% in some areas of Indonesia.[36]

Rate of complications secondary to Ascariasis range from 11-67% with intestinal and biliary obstruction representing the most common serious sequelae. Although infection with *A. lumbricoides* is rarely fatal, it is responsible for an estimated 8,000-100,000 deaths annually, mainly in children, usually from bowel obstruction or perforation in case of high parasite burden. Male children are thought to be infected more frequently, owing to greater propensity to eat soil; as seen in our study children,

Table 16: Comparison of anthelmintic drugs according to primary outcome

Variable		Drugs Given				P Value	OR (95% C.I) (Reference Albendazole)
		Albendazole	Mebendazole	Pyrantel Pamoate	Ivermectin		
Stool examination for presence of ova/eggs after 3 weeks of treatment	Yes	8 (8)	12(12)	16 (16)	24 (24)		
						0.3458	0.637 (0.215-1.794)
	No	92 (92)	88 (88)	84 (84)	76 (76)	0.0817	0.456 (0.161-1.205)
						0.002	0.275 (0.101-0.682)
Stool examination for worm load before treatment	Light	56 (56)	48 (48)	44 (44)	48 (48)		-
	Moderate	24 (24)	28 (28)	32 (32)	28 (28)		-
	Heavy	20 (20)	24 (24)	24 (24)	24 (24)	0.781	-
Stool examination for worm load after treatment	Light	8 (8)	12 (12)	16 (16)	24(24)		
						0.3458	0.637 (0.215-1.794)
	Nil	92 (92)	88 (88)	84 (84)	76 (76)	0.0817	0.456 (0.161-1.205)
						0.002	0.275 (0.101-0.682)
Presence biliary ascariasis	Yes	9 (9)	8 (8)	10 (10)	8 (8)	0.951	
	No	91 (91)	92 (92)	90 (90)	92 (92)		-
Upper GI endoscopy for worm across papillae	Yes	4 (4)	5 (5)	2 (2)	2 (2)		-
	No	96 (96)	95 (95)	98 (98)	98 (98)	0.543	-
ERCP for persistent biliary ascariasis	Yes	2 (2)	2 (2)	2 (2)	0 (0)		-
	No	98 (98)	98 (98)	98 (98)	100 (100)	0.566	-

Table 17: Comparison of worm load before and after treatment in all the subjects

Variable		Worm Load after Treatment		Total	p-value
		Light	Nil		
Worm Load before Treatment	Light (196)*	0 (0%)	196 (100%)	196	< 0.001
	Moderate (112)*	0 (0%)	112 (100%)	112	
	Heavy (92)*	60 (65.2%)	32 (34.8%)	92	

**Figures in parenthesis indicate total number of patients*

Figures in parenthesis without astrics indicate percentage within rows

because of their habits (*e.g.*, directly or indirectly consuming soil), are more commonly and more heavily infected than adults.

Frequently, families may be infected and reinfected in groups fashion due to shared food and water sources as well as hygiene practices. Ascaris related clinical disease is restricted to subjects with heavy worm load and an estimated 1.2-2 million such cases, with 20,000 deaths, occurred in endemic areas per year.[9]

Due to a large group of asymptomatic individuals with intestinal ascariasis, these worms are occasionally and unexpectedly identified during routine endoscope procedures.[10]

Hepatobiliary pancreatic Ascariasis (HPA) is a frequent cause of biliary and pancreatic disease in endemic areas. It occurs in all age groups and can cause biliary colic, acute cholecystitis, acute cholangitis, acute pancreatitis and hepatic abscesses. Recurrent pyogenic cholangitis or oriental cholangiohepatitis (OCH) or hepatolithiasis is possibly an after math of recurrent biliary invasion in such areas.[9] Chronic worm infestation have been linked with delayed physical and cognitive development.[25]

Our study was conducted in the Department of Gastroenterology SKIMS Srinagar (Kashmir), India in collaboration with Department of Microbiology SKIMS Srinagar. Most common age group we observed was between 5 to 19 years. This is in concordance with the studies which focused on morbidity control through large scale administration of single dose antihelminthics to at risk populations, particularly school-aged children.[7,27] In our study, males (68%) were most commonly affected as compared to females (32%). This was in concordance with the study done by Sacko *et al*,[37] who compared the efficacy of mebandazole, albendazole and pyrantel pamoate in treatment of human hookworm infections in the southern region of Mali, West Africa. Most of our

Table 18: Comparison of worm load before and after treatment with respective antihelmintic drugs

Drug Given	Variables		Worm Load after Treatment		Total	p-value
			Light	Nil		
Albendazole	Worm Load before Treatment	Light (56)*	0 (0%)	56 (100%)	56	< 0.001
		Moderate (24)*	0 (0%)	24 (100%)	24	
		Heavy (20)*	8 (40%)	12 (60%)	20	
Mebendazole	Worm Load before Treatment	Light (48)*	0 (0%)	48(100%)	48	< 0.001
		Moderate (28)*	0 (0%)	28 (100%)	28	
		Heavy (24)*	12 (50%)	12 (50%)	24	
Pyrantel Pamoate	Worm Load before Treatment	Light (44)*	0 (0%)	44 (100%)	44	< 0.001
		Moderate (32)*	0 (0%)	32 (100%)	32	
		Heavy (24)*	16 (66.7%)	8 (33.3%)	24	
Ivermectin	Worm Load before Treatment	Light (48)*	0 (0%)	48(100%)	48	< 0.001
		Moderate (28)*	0 (0%)	28 (100%)	28	
		Heavy (24)*	24 (100%)	0 (0%)	24	

**Figures in parenthesis indicate total number of patientFigures in parenthesis indicate without astrics mark percentage within row*

patients were from rural areas (73.5%), where they are easily exposed to the helminthic infections. It has been seen in various studies that worm infestation commonly involves developing areas and proper segments of the community.[38]

Most of our patients were from low income families (62%) followed by middle income (28%). This was also seen in study done by Lubis *et al.*[39] In our study, 58%, 22% and 20% of patients were using closed, open and both types of sanitation, respectively. This also shows that the use of open field defecation increases the risk of helminthic infestations as there is an increased risk of contact with the contaminated soil. Anaemia was seen in 22.5% patients in our study which is in concordance with the study done by Khuroo MS, Zargar SA.[9]

In our study, jaundice (icterus) was seen in 7.5% of patients. This was mostly because of hepatobiliary pancreatic ascariasis (HPA) giving rise to biliary colic, acute cholecystitis, acute cholangitis, acute pancreatitis and hepatic abscess.[9] In our study, we took only those patients whose stool sample was positive for ova of *A. lumbricoides*. In this study, four hundred patients were recruited which fulfilled the inclusion criteria.

A medical history was obtained from the subjects who met the inclusion criteria and each subject underwent a physical examination. Written informed consent was obtained from the patients, parents or guardians. The purpose and procedure of the study including potential benefits and risks were explained to the subjects. Before treatment, subjects were asked about clinical signs and symptoms and their weight and height was measured. Treatment efficacy was assessed at 21-23 days post treatment and adverse events were monitored 3 hours post treatment. The above procedures are inconsistent with the study done by Benjamin *et al.*[40]

The cure rate (CR) and egg reduction rate (ERR) which was our primary outcome measure was calculated as the percentage of the patients who became egg negative after treatment among those who had eggs in their stool at baseline. This was in accordance with the studies done by Benjamin *et al.*[40] Viravan *et al,*[41] Mism *et al.*[42] Stool examination for ova of *A. lumbricoides* and for worm load was done 3 weeks post treatment to check the efficacy of drugs used.

In albendazole group, stool examination for worm load was done prior to treatment– 56% of patients were falling in light, 24% in moderate and 20% in heavy worm load group. Similarly, we did stool examination for worm load prior to treatment for mebendazole, pyrantel pamoate and ivermectin groups which showed that 48% (light), 28% (moderate) and 24% (heavy) were in mebendzole group; 44% (light), 32% (moderate) and 24% (heavy) were in pyrantel pamoate group; and 48% (light), 28% (moderate) and 24% (heavy) were in ivermectin group as per WHO classification for worm load.

In albendazole group, out of the 20% patients who were having heavy worm load, 12% were treated completely while 8% of patients transformed from heavy to light worm load. This shows that 92% of cure rate was seen in albendazole group. This was consistent with the studies done by Bartoloni *et al.,*[43] Muchiri *et al.,*[44] Steinmann *et al.*[45]

In mebendazole group, 48% of patients were falling in light worm load, 28% moderate and 24% in heavy worm load group. Three weeks post treatment, out of the 24% patients which were in heavy worm load group, half were treated completely and half were transformed into light worm load. All patients who were having light and moderate worm load were treated completely. This showed that a cure rate of 88% was seen in mebendazole group and was in concordance with the study done by Muchiri *et al.*[44]

In a study, Pereira *et al.*[46] has shown that a 3 day regimen (100 mg BD) of a mebendazole dewormed 75% of the subjects and a 5 day regimen cured 95%. Another study done by Abadi[47] has shown that single dose mebendazole treatment appears to be relatively inexpensive, convenient and effective in mass treatment for the control of intestinal nematode infections, especially in highly infected communities.

A study done by Levecke *et al.*[48] showed that mebendazole efficacy was in comparison to that of albendazole, the result of which is in concordance with our study (CR for albendazole 92% and mebendazole 88%).

In pyrantel pamoate group, on the basis of stool examination, 44% of patients were having light worm load, 32% were with moderate worm load and 24% with heavy worm load. Among 24% patients who were having heavy worm, 8 were treated completely and 16 were transformed from heavy to light worm load. That means a cure rate of 84% was seen in pamoate group. In a recent study published in NEJM, it was reported that cure rate with oxantel pamoate-albendzole was 94.4% and monotheraphy with oxantel pamoate resulted in low cure and egg-reduction rates among children with *A. lumbricoides* infections.[40]

In ivermectin group, 48% of patients were light worm load, 28% moderate worm load and 24% heavy worm load as per their stool examination. A cure rate of 76% was seen among this group, while 24% of patients with heavy worm load infection got transformed into light worm load after their treatment. This showed that 24% of patients were not treated completely in this group. The results were in accordance with the studies done by Belizario *et al.*[49] Wen *et al.*[50]

From our study, it was observed that albendazole group had a total cure rate of 92%, mebendazole group had a total cure rate of 88%, pyrantel pamoate had a cure rate of 84% and ivermectin a cure rate of 76%.

This shows that a single dose of Albendazole had a cure rate of 92%, mebendazole (100 mg BD × 3days) a cure rate of 88%, pyrantel pamoate (11 mg/1kg orally once) cure rate of 84% and ivermectin (0.2 mg/kg orally once) a cure rate of 76%. This was in consistent with the studies done by Ismail *et al.*,[38] Muchiri *et al.*,[44]

Biliary ascariaris was seen in 8.75% of patients and was diagnosed by ultrasonographic study of hepatobiliary system in the present study. This was in consistent with the study done by Khuroo, Zargar SA.[9] This study showed that USG can detect worms in the biliary tract and pancreas and is a useful non-invasive technique for diagnosis and follow- up of these patients. Upper GI endoscopy showed worm across papilla in 3.25% of patients. The presentation of these patients was severe biliary colics which did not respond to routine analgesic medications.

A study done by Khuroo, Zargar SA[9] showed that hepatobiliary pancreatic ascariasis (HPA) is a frequent cause of biliary and pancreatic disease in endemic areas and can cause biliary colic, acute cholecystitis, acute cholangitis, acute pancreatits and hepatic abscess.

ERCP was done in 1.5% of patients with persistent biliary ascariasis and CBD was cleared in all these patients. Next day they were discharged from the hospital on regular deworming protocol and antibiotics for five days.

All the four drugs which were used in our study were safe and no significant side effects were observed. These drugs are easy to use, well tolerated and generally curative. This was consistent with the studies done by Jongsuksuntigul *et al.*,[51] Rey and Debonne.[52]

SUMMARY AND CONCLUSION

The present study was conducted in the Department of Gastroentrology SKIMS Soura in collaboration with the Department of Microbiology. A total of 400 cases were studied. Among 400 patients, 272 (38%) were males and 128 were females (32%). Most of our patients were in the age group of 5-19 years (63%). Stool for ova and worm load of A. lumbricoides was used for diagnosis in these patients.

The results of the study are summarized as follows:

1. Proportion of male to female patients was 2.12 :1
2. Most of our patients (63%) were in the age group of 5-19 years.
3. Most of our patients were from rural areas (73.5%)
4. Among 400 patients, 71% were literate and 29% were illiterate
5. Most of our patients were from low income families.
6. Open type of sanitation was seen in 22% of patients.
7. Anaemia was seen in 22.5% of our patients.
8. Icterus was seen in 7.5% of patients.
9. Stool sample of all 400 patients was initially positive for ova of Ascariasis.
10. Stool examination for worm load was done prior to treatment and worm load was categorized into light, moderate and heavy as per WHO classification.
11. Prior to treatment, among 400 patients light worm load was seen in 49%, moderate worm load in 28% and heavy worm load was seen in 23%.
12. Three weeks after treatment; patients having light (49%) and moderate worm (28%) load were completely treated *i.e.*, worm load was nil after 3 weeks of treatment.
13. Among 92 patients who were having heavy worm load infestation, 60 patients were transformed into light worm load group and 32 patients were treated completely.
14. In albendazole group there was a cure rate of 92%, in mebendazole group a cure rate of 88%, in pyrantel pamoate group a cure rate of 84% and in ivermectin group a cure rate of 76% was seen.
15. Biliary Ascariasis was seen in 8.75% of patients.
16. UGI-Endoscopy revealed worm across papilla in 3.25% of patients.
17. ERCP was done in 1.5% patients, who were having persistent Biliary Ascariasis.

CONCLUSION

Helminthis infect 25-30% of world's population. Common intestinal helminthic infection presents important health problem in the school-age population. Of the infected children, majority had Ascariasis with worm load of light, moderate and heavy intensity. This finding has important implications for morbidity and transmission rates. The periodic administration of antihelmintic drugs to at-risk population is the global strategy for controlling morbidity due to soil-transmitted helminthic infection. The goal of control program is to eliminate childhood illness caused by soil-transmitted helminthic infection, *i.e.*, to decrease the prevalence of moderate and heavy infection intensity among school-age children to less than 1%. The population of the developing countries across the globe suffers not only as a direct result of these infections but also due to comorbidity such as anemia, malnutrition and reduced immunity status. It has been seen that well targeted drug delivery, particularly via community chemotherapy, can substantially decrease aggregate morbidity and mortality and also improve growth rates, physical fitness and activity, cognitive school performance, and social well being. Improvement in appetite is likely to be the single most important mechanism through which a variety of physiological improvement occurs.

As school age group in most vulnerable to soil-transmitted helminthic infections, therefore schools should be randomly assigned to the health education package, which include a cartoon video or to a control package, which involves only the display of a health-education poster.

Infection rates, knowledge about soil-transmitted helminthes and hand-washing behavior should be explained to every individual. It has been seen that incidence of infections with soil-transmitted helminths is 50% less in persons who wash their hands after using the toilet.

It has also been seen that the health education package increased the knowledge about soil-transmitted helminthes and led to a change in behavior and a reduced incidence of infection in school-age group children. It has been shown that the mass treatment with antihelmintics is an effective and safe means of reducing the prevalence of most of the parasitic disease prevalent in poor community.

Albendazole and mebendazole are very effective in eliminating *Ascaris lumbricoides* infection, with cure rates of 90% and also reducing the mean egg count by 90%.

Albendazole/mebendazole can be prescribed for patients with clinical evidence of helminthic infections even where stool examination is not possible as it covers almost the whole range of common helminthic infection.

As the rate of helminthic infection was most common in age group 5-19 years, the treatment of school children every 4 monthly may be necessary in high endemic areas, like ours. Deworming has an impact on the intensity of intestinal nematode infections sufficient to likely reduce morbidity.

As such all the above drugs are effective and can be used for mass therapy to control A. lumricoides in endemic areas. All these drugs which we used in our study are safe and no significant side effects were observed.

Lastly, to conclude, large scale treatment and control of helminthes and treatment of individual cases when diagnosed are now truly urgent.

REFERENCES

1. Olds GR. Deworming the world. Trans Am Clin Climatol Assoc. 2013;124:265-74.
2. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, *et al.* Soil transmitted helminth infections: ascariasis, trichuriasis, and hookworm. Lancet. 2006;367(9521):1521-32.
3. Hotez PJ, Bottazzi ME, Franco-Paredes C, Ault SK, Periago MR. The neglected tropical diseases of Latin America and the Caribbean: a review of disease burden and distribution and a roadmap for control and elimination. PLoS Negl Trop Dis. 2008;2(9):e300.
4. Willingham AL, 3rd and Engels D. Control of *Taenia solium* cysticercosis/taeniosis. Adv Parasitol. 2006;61:509-66.
5. Craig P and I to A. Intestinal cestodes. Curr Opin Infect Dis. 2007;20:524-32.
6. Ezeamama AE, Friedman JF, Olveda RM, Acosta LP, Kurtis JD, *et al.* Functional significance of low-intensity polyparasite helminth infections in anemia. J Infect Dis. 2005;192(12):2160-70.
7. Hotez PJ, Molyneux DH, Fenwick A, Kumaresan J, Ehrlich Sachs S, *et al.* Control of neglected tropical diseases. N Engl J Med. 2007;357:1018-27.
8. WHO. Soil-transmitted helminthiasis. Number of children treated 2007-2008: update on the 2010 global target. Wkly Epidemiol Rec. 2010;85:141-8.
9. Khuroo MS. Ascariasis. Gastroenterol Clin North Am. 1996;25(3):553-77.
10. Kanneganti K, Makker JS, Remy P. *Ascaris lumbricoides*: to expect the unexpected during a routine colonoscopy. Case Rep Med. 2013; doi: 10.1155/2013/579464.
11. Seltzer E. Ascariasis. In: *Tropical Infectious Diseases: Principles, Pathogens and Practice*. 1st ed., Guerrant RL, Weller PF (Eds), Philadelphia: Churchill Livingstone. 1999:553.
12. Haswell-Elkins M, Elkins D, Anderson RM. The influence of individual, social group and household factors on the distribution of *Ascaris lumbricoides* within a community and implications for control strategies. Parasitology. 1989;98(Pt 1):125.
13. Warren KS, Mahmoud AA. Algorithms in the diagnosis and management of exotic diseases. xxii. Ascariasis and toxocariasis. J Infect Dis. 1977;135(5):868.
14. Sarinas PS, Chitkara RK. Ascariasis and hookworm. Semin Respir Infect. 1997;12:130.
15. Reeder MM. The radiological and ultrasound evaluation of ascariasis of the gastrointestinal, biliary and respiratory tracts. *Semin Roentgenol* 1998; 33: 57.
16. Chu WG, Chen PM, Huang CC, Hsu CT. Neonatal ascariasis. *J Pediatr* 1972; 81: 783.
17. Bundy DA, Cooper ES, Thompson DE, *et al.* Epidemiology and population dynamics of *Ascaris lumbricoides* and *Trichuris trichiura* infection in the same community. Trans R Soc Trop Med Hyg. 1987;81(6):987.
18. Tietze PE, Tietze PH. The roundworm, *Ascaris lumbricoides*. Prim Care. 1991;18:25.
19. Khuroo MS, Zargar SA. Biliary ascariasis. A common cause of bilirary pancreatic disease in an endemic area. Gastroenterology. 1985;88:418.
20. Khuroo MS, Mahajan R, Zargar SA, *et al.* Prevalence of biliary tract disease in India: a sonographic study in adult population in Kashmir. Gut. 1989;30(2):201.
21. Pawlowski ZS. Morbidity and mortality in Ascariasis. In: *Ascariasis and Its Prevention and Control*. Crompton DWT, Pawlowski ZS (Eds). London: Taylor and Francis, 1989:45.
22. Hotez PJ, Bethony J, Bottazzi ME, Brooker S, Buss P. Hookworm: "the great infection of mankind". PLoS Med. 2005;2:e67.
23. Pullan RL, Brooker SJ. The global limits and population at risk of soil-transmitted helminth infections in 2010. Parasit Vectors. 2012;5(1):81.
24. Brooker S, Hotez PJ, Bundy DAP. Hookworm-related anaemia among pregnant women: a systematic review. PLoS Negl Trop Dis. 2008;2(9):e291.
25. WHO. Prevention and control of schistosomiasis and soil-transmitted helminthiasis: report of a WHO expert committee. WHO Tech Rep Ser. 2002;912:1-57.
26. Garcıa HH, Gonzalez AE, Evans CA, Gilman RH. Taenia solium cysticercosis. Lancet. 2003;362(9383):547-56.
27. WHO. Preventive chemotherapy in human helminthiasis. Coordinated use of anthelminthic drugs in control interventions: a manual for health professionals and programme managers. Geneva: World Health Organization. 2006;1-62.
28. Montresor A, Palmer K. Taeniasis/cysticercosis trend worldwide and rationale for control. Parasitol Int. 2006;55(Suppl.):S301-3.
29. Geary TG, Woo K, McCarthy JS, Mackenzie CD, Horton J, *et al.* Unresolved issues in anthelmintic pharmacology for helminthiases of humans. Int J Parasitol. 2010;40(1):1-13.
30. Olsen A. Efficacy and safety of drug combinations in the treatment of schistosomiasis, soil-transmitted helminthiasis, lymphatic filariasis and onchocerciasis. Trans R Soc Trop Med Hyg. 2007;101(8):747-58.
31. Albonico M, Allen H, Chitsulo L, Engels D, Gabrielli AF, *et al.* Controlling soil-transmitted helminthiasis in pre-school-age children through preventive chemotherapy. PLoS Negl Trop Dis. 2008;2(3):e126.
32. Jia TW, Melville S, Utzinger J, King CH, Zhou XN. Soil-transmitted helmintic reinfection after drug treatment: a systematic review and meta-analysis. PLoS Negl Trop Dis. 2012;6(5):e1621.
33. Anderson RM, May RM. Helminth infections of humans – mathematical models, population dynamics, and control. Adv Parasitol. 1985;24:1-101.
34. Horton J. Albendazole: a broad spectrum anthelminthic for treatment of individuals and populations. Curr Opin Infect Dis. 2002;15(6):599-608
35. WHO. Accelerating work to overcome the global impact of neglected tropical diseases –A roadmap for implementation. Geneva: World Health Organization 2012.
36. Albonico M, Ramsan M, Wright V, *et al.* Soil-transmitted nematode infections and mebendazole treatment in Mafia Island school children. Ann Trop Med Parasitol. 2002;96(7):717-26.
37. Sacko M, De Clercq D, Behnke JM, Gilbert FS, Dorny P, Vercruysse J. Comprison of the efficacy of mebendazole, albendazole and pyrantel in treatment of human hookworm infections in the Southern Region of Mali, West Africa. Trans Royal Soc Trop Med Hyg 1999;93(2):195-203.
38. Ismail MM, Premaratne UN, Suraweera MG. Comparative efficacy of single dose anthelmintics in relation to intensity of geohelminth infections. Ceylon Med J. 1991;36(4):162-7.
39. Lubis IN, Pasaribu S, Lubis CP. Current status of the efficacy and effectiveness of albendazole and mebendazole for the treatment of *Ascaris lumbricoides* in North-Western Indonesia. Asian Pac J Trop Med. 2012;5(8):605-9.
40. Speich B, Ame SM, Ali SM, Alles R, Huwyler J, Hattendorf J, *et al.* Oxantel pamoate-albendazole for *Trichuris trichiura* infection. N Engl J Med. 2014;370:610-20.
41. Viravan C, Migasena S, Bunnag D, Harinasuta T. Clinical trial of albendazole in hookworm infection. Southeast Asian J Trop Med Pub Health. 1982;13(4):654-7.
42. Mism PK, Pande NK, Jagota SC. Albendazole in the treatment of intestinal helminthiasis in children. Curr Med Res Opin. 1985;9(8):516-9.
43. Bartoloni A, Guglielmetti P, Cancrini G, Gamboa H, Roselli M, Nicoletti A, *et al.* Comparative efficacy of a single 400 mg dose of albendazole or mebendazole in the treatment of nematode infections in children. Trop Geogr Med. 1993;45(3):114-6.
44. Muchiri EM, Thiong's FW, Magnussen P, Onuma JH. A comparative study of different albendazole and mebendazole regimens for the treatment of intestinal infections in school children of Usigu Division, western Kenya. J Parasitol. 2001;87(2):413-8.
45. Steinmann P, Zhou XN, Du ZW, Jiang JY, Xiao SH, Wu ZX, *et al.* Tribendimidine and albendazole for treating soil-transmitted helminths, Strongyloides stercoralis and Taenia spp.: open-label randomized trial. PLoS Negl Trop Dis. 2008;2(10):e322.
46. Pereira JF, Ghosh HK, Concklin S, Ryan S. Mebendazole therapy of whipworm infestation: a clinical trial. Med J Aust. 1979;1(4):134-5.
47. Abadi K. Single dose mebendazole therapy for soil-transmitted nematodes. Am J Trop Med Hyg. 1985;34(1):129-33.
48. Levecke B, Montresor A, Albonico M, Ame SM, Behnke JM, Bethony JM, *et al.* Assessment of anthelmintic efficacy of mebendazole in school children in six countries where soil-transmitted helminthes are endemic. PLoS Negl Trop Dis. 2014;8(10):e3204.
49. Belizario VY, Amarillo ME, de Leon WU, de los Reyes AE, Bugayong MG, Macatangay BJC. A comparison of the efficacy of single doses of albendazole, ivermectin and diethylcarbamazine alone or in combinations against *Ascaris* and *Trichuris* spp. Bull World Health Organ. 2003;81(1):35-42.
50. Wen LY, Yan XL, Sun FH, Fang YY, Yang MJ, Lou LJ. A randomized, double-blind, multicenter clinical trial on the efficacy of ivermectin against intestinal nematode infections in China. Acta Tropica. 2008;106(3):190-4.
51. Jongsuksuntigul P, Jeradit C, Pornpattanakul S, Charanasri U. A comparative study on the efficacy of albendazole and mebendazole in the treatment of ascariasis, hookworm infection and trichuriasis. Southeast Asian J Trop Med Public Health. 1993;24(4):724-9.
52. Rey P, Debonne JM. Therapeutic alternatives in case of failure of first-line treatment of intestinal helminthiasis in adults. Med Trop (Mars). 2006;66(4):324-8.

Cite this article: Kawoosa Z, Javid G, Yattoo GN, Gulzar GM, Sodhi JS, Shah AH, Khan M, Hamid S. To Assess the Efficacy and Safety of Various Anti-heliminthics against Ascariasis Lumbricoides among a Study Population in North India. OGH Reports. 2018;7(1):25-34.