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Nematode infections in Slovak children hospitalised during 2008 – 2009

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Summary

A study involved 1800 hospitalised children (age: 9 months to 16 years) examined by ovoscopic analyses and confirmed the occurrence of *Ascaris lumbricoides* and *Trichuris trichiura* in 46 patients (2.55 %). Of these, 30 patients had *Ascaris* infection, 13 were positive for both nematodes and 3 patients had *Trichuris* infection. The mean count of *A. lumbricoides* eggs in positive cases was 1050 eggs per gramme (EPG) in range 150 – 4450 EPG. The mean count of *T. trichiura* eggs was 150 EPG (50 – 250 EPG). The highest intensities of *A. lumbricoides* and *T. trichiura* infections occurred in children 3 – 5 years of age living in poor hygienic conditions. Most common clinical conditions in all the patients included anaemia combined with complicated bronchopneumonia, colitis and gastritis. The strongest correlation between the parasite burden and selected laboratory test data (eosinophil count, haemoglobin, total serum iron) was found in children of 2 years of age ($P < 0.05$) and decreased with age.

Keywords: children; ascariasis; trichuriasis; McMaster technique; clinical manifestations

Introduction

Ascariasis is one of the most common parasitic infections. An estimated 25 % of the population is affected, i.e. 0.8 to 1.22 billion people worldwide (Bethony *et al*., 2006). More than 80 % of cases occur in Africa, Asia and Central America. Ascariasis has also been detected in several countries of Eastern Europe (Hotez, 2000). Soil transmitted helminthiases have been diagnosed in the Ukraine (Bliznjuk, 1971; Savčenko *et al*., 1971), the Czech Republic (Zitek & Palička, 1973), and Poland (Mizgajska, 1998). *A. lumbricoides* has been recorded in several regions of Slovakia (Fabian & Kavanová, 1956; Giboda, 1978; Straka & Škračiková, 1986; Straka *et al*., 2001; Koňaková, 2000; Totková *et al*., 2004).

Ascariasis is often asymptomatic, while some patients may manifest with mild gastrointestinal symptoms and signs (abdominal pain, nausea, vomiting or diarrhoea). Migration of larvae through the internal organs can produce fever, dry cough or shortness of breath. Severe infection of the lungs can cause Löffler's syndrome with eosinophilia and pulmonary infiltrates. Patients' bloody sputum usually contains Charcot-Leyden crystals. Migration of adult worms may cause cholecystitis, cholangitis, appendicitis, biliary colic, upper gastrointestinal haemorrhage, peritonitis and granulomatous liver abscess (Salman, 1997). Massive gastrointestinal infections in children result in anaemia, growth impairment, poor nutritional status and protein-energy malnutrition (Stephenson *et al*., 1989; Stephenson *et al*., 2000).

In addition to *A. lumbricoides*, human whipworm *T. trichiura* also occurs in Slovakia (Magrová, 1963; Sobota *et al*., 1975; Straka *et al*., 1975; Giboda, 1978; Škračiková *et al*., 1991; Škračiková *et al*., 1992; Koňaková, 2000). Trichuriasis affects an estimated 900 million people worldwide (Stejskal, 2005), causing inflammation of large intestine and lower intestinal bleeding. A severe infection can even cause rectal prolapse. Most common symptoms of *T. trichiura* infections are abdominal pain, loss of appetite and weight, headache and chronic diarrhoea (Sobota *et al*., 1975). Infections with both worms also tend to affect laboratory findings (Sobota *et al*., 1979; Stejskal, 2005).

In many cases, migrating *A. lumbricoides* larvae or adults are very rarely found in stomach contents, vomit or sputum, and eggs are seldom found in children's faeces (Stejskal, 2005). The presence of parasite eggs in the stool still plays an essential role in the diagnosis of geohelminthiases, but if samples are not collected for three consecutive days, false negative findings may occur (Totková *et al.*, 2001). Eggs of *Ascaris* are broad, oval in shape, brown in colour, 60 x 50 μm in size and have three layers. Eggs of

Trichuris have typical lemon-like appearance and are 50 to 54 μm x 22 to 23 μm in size with characteristic mucous plugs. The examination of stool samples before day 40 post infection (the time required for development of the parasite), however, could give a false-negative result, too. One adult *Ascaris* female can produce up to 200 000 eggs per day, and quantitative techniques are therefore suitable for the diagnosis of infection. The most commonly used techniques for quantifying eggs and estimating intensities of infection are the Kato-Katz and the McMaster techniques (Hotez, 2000). Flohr *et al*. (2007) found that the quantitative McMaster technique is as sensitive as the formol-ether sedimentation technique. The McMaster technique, recommended by the World Association for the Advancement of Veterinary Parasitology, has been successfully used in veterinary parasitology also for the quantification of parasite eggs (Coles *et al*., 1992). The technique plays an important role in the faecal egg count reduction test, where the efficacy of anthelmintics is tested. McMaster method may be more successfully used (and with a better technical feasibility) than the stool thick smear for the detection and identification of geohelminth eggs. Moreover, additional benefits include the ability to perform further quantitative analyses of the sample when required, to determine the intensity of infection and, last but not least, to determine the efficacy of antiparasitic treatments (Bondarenko *et al*., 2009). In human parasitology, the McMaster technique was used in a study evaluating the efficacies of mebendazole against soil-transmitted helminth infections in Vietnam (Flohr *et al*. 2007) and of albendazole against *A. lumbricoides* and *T. trichiura* in school-aged children in Kenya (Stephenson *et al*., 1989), the regions endemic for geohelminths.

The aim of this study were to record the occurrence of intestinal nematode infections in hospitalised children in Eastern Slovakia and to assess the correlation between the intensity of both infections with clinical symptoms, haematological and biochemical abnormalities.

Material and methods

During the two-year study (2008 – 2009), a total of 1800 children, hospitalised for acute or chronic respiratory and gastrointestinal infections, were examined at the Paediatric Clinic of Children´s Hospital in Košice. Stool samples have been collected for three consecutive days, and a single thick smear, using the Hein protocol (Beaver, 1950), was prepared from each stool sample. Positive samples from 46 children (age: 9 months to 16 years) with confirmed ascariasis and/or trichuriasis were re-examined using the quantitative coprological McMaster technique (Coles *et al*., 1992). To determine the number of faecal eggs per gramme (EPG), we used a modified McMaster method with a sucrose solution of a density of 1.3 g/cm^3. Briefly, the test employed a two-chambered, engraved slide (both chambers were of 0.5 ml volume) onto which was placed a sample of the supernatant of the faecal suspension in saturated sugar. The technique has a sensitivity of 50 eggs/g of faeces. During their hospitalisation (10 – 14 days), the children were monitored for haematological and biochemical markers, clinical signs, and symptoms.

Statistical data processing using Statistica 6.0 software (STATSOFT, Tulsa, USA) involved Fisher test for the comparison of age- and gender-relevant differences (P = 0.05) and the non-parametrical Kruskall-Wallis test (P level indicated in the text). This was applied for the comparison of age-related prevalence and intensity of *A. lumbricoides* infections, haematological and biochemical findings in the infected children to control group of healthy children (n = 7). Spearman´s correlation coefficient was calculated as well.

Results

Epidemiological study

In the hospitalised children, 46 of the total 1800 examined were positive for either *A. lumbricoides* and/or *T. trichiura* infection (2.55 %). Of these, *A. lumbricoides* infection only was identified in 30 children (65.21 %), *T. trichiura* infection only was detected in 3 patients (6.52%), and 13 patients were infected with both nematodes (28.27 %) (Table 1). There were no marked differences in the numbers of infected males versus females. Single infection with *A. lumbricoides* or mixed with *T. trichiura* occurred more frequently in females (52.20 %) than in males (41.29 %). Table 2 shows the age-related prevalence and the intensity of both nematode infections. Children of 3 – 5 years of age were infected with *A. lumbricoides* (26.0 %) and in a mixed infection with *T. trichiura* (15.2 %), while

Table 1. Gender-related occurrence of single or mixed infection with *Ascaris lumbricoides* and *Trichuris trichiura* in nematodes-positive children (n = 46) examined by the Hein's and McMaster techniques

Infection	Males		Females		Together	
	n	%	n	%	n	%
A. lumbricoides	14	30.43	16	34.81	30	65.21
A. lumbricoides + *T. trichiura*	5	10.86	8	17.39	13	28.27
T. trichiura	1	2.17	2	4.34	3	6.52
TOTAL	20	43.46	26	56.54	46	100

n - numbers of patients with either *Ascaris lumbricoides* and *Trichuris trichiura* single infection or mixed infection with both nematodes. Proportion (%) was calculated from the total of 46 positive children.

Table 2. Age-related prevalence of single infection with *Ascaris lumbricoides* and *Trichuris trichiura* or mixed infection and the intensity of infection expressed as EPG

Age-groups/ years	Nematode infections / Numbers of the patients and proportion (%) from 46 infected children						Intensity of infections (min-max)	
	A. lumbricoides		*A. lumbricoides* + *T. trichiura*		*T. trichiura*		*A. lumbricoides*	*T. trichiura*
	n	%	n	%	n	%	EPG	EPG
0 – 1	3	6.5	0	--	0	--	150 – 4050	0
2	6	13.0	3	6.5	1	2.2	100 – 2850	50 – 100
3 – 5	12	26.0	7	15.2	2	4.4	150 – 4450	50 – 250
6 – 10	8	17.4	3	6.5	0	--	550 – 2750	50 – 150
11 – 16	1	2.2	0	--	0	--	750	0
Σ	30	--	13	--	3		--	--

Intensity of infection was determination by the McMaster technique and expresses the number of eggs per 1g (EPG) of children faeces, n = number of patients in age-related group

the lowest occurrence of intestinal nematodes was detected in children up to 12 months of age (6.5 %, ascariasis only). The quantitative McMaster technique detected a mean of 1050 EPG of *A. lumbricoides* eggs, ranging from 150 to 4450 EPG, in 43 infected patients. The mean number of *T. trichiura* eggs was 150 EPG (range 50 – 250 EPG). In the children aged 3 – 5 years the highest intensity of *A. lumbricoides* was 4450 EPG and in case of *T. trichiura,* the highest count was 250 EPG. *T. trichiura* eggs were not detected in a 16 years old patient. Gender-related intensities of the single *A. lumbricoides* infection in all age groups are given in Table 3. A Fisher test (P = 0.05) did not confirm any age- and gender-relevant differences in the prevalences and intensities of infection.

the values obtained for the healthy children (control group) giving the interval of standard values. Increased eosinophil counts were detected in the majority of patients in patients with single A. *lumbricoides* infection but in the age group of 2 years high eosinophilia above 9.5 % was present in all 6 patients (Table 4). However, the highest values of eosinophil counts (35.4 %) were found in a child in age group 3 to 5 years. In general, intensity of eosinophilia declined with the age of patients. Infection was accompanied by anaemia in most patients. The lowest value of 86.0 g/l was recorded in a 16 years old patient and such low value coincided with the lowest concentration of serum iron (1.2 μmol/l). Iron deficit was the most severe in all 6 patients aged 2 years (2.3 – 3.8 μmol/l). In contrast, only 2 of total

Table 3. Gender - related intensity of a single *A. lumbricoides* infection in individual age-groups of children

Age-groups	Number of patients positive for *A. lumbricoides* infection in individual age-groups									
	0 – 1 years		2 years		3 – 5 years		6 – 10 years		11 – 16 years	
Gender	M (n = 1)	F (n = 2)	M (n = 3)	F (n = 6)	M (n = 7)	F (n = 5)	M (n = 3)	F (n = 5)	M (n = 0)	F (n = 1)
Min-max EPG	4050	150, 1500	1100 – 2850	100 – 1900	150 – 4450	550 – 4450	600 – 2750	550 – 1250	--	750

M - male patients; F - female patients; n = number of patients; EPG (eggs per gramme of faeces)
Fisher test did not showed significant differences between EPG values found in males and females in the same age-group (P = 0.05)

Haematological and biochemical parameters and clinical symptoms.

Laboratory indices evaluated during the hospitalisation were concentration of haemoglobin (Hb, g/l), total serum iron (Fe, μmol/l), C-reactive protein (CRP, mg/l), hepatic enzymes ALT and AST (μkat/l) and eosinophil count in the peripheral blood (Eo, %). These were compared with

8 patients aged 6 – 10 years had pathologically decreased concentration of iron. Concentrations of C-reactive protein, the marker of inflammation, were markedly elevated in most of the children with single *A. lumbricoides* infection, reaching the highest values in the age group of 6 – 10 years (268.70 mg/l) and in patients up to 12 months (144.0 mg/l). Serum concentrations of ALT and AST were within the

Table 4. Haematological and biochemical parameters in control-healthy children and children with single *A. lumbricoides* infection in individual age – groups

Parameter (unit) / standard values	Number of patients in examined age – groups (years) / min-max values of parameters and number of patients with non-physiological values					
	2 – 12 (healthy, 7)	0 – 1 (3)	2 (6) R	3-5 (12) R	6 – 10 (8) R	11 – 16 (1)
Eo (%) 0 – 5	2.1 – 4.6	2.0 – 34.0 (2∗)	9.5 – 27.6 (6∗) 0.783	2.6 – 35.4 (10∗) 0.224	0.2 – 15.0 (5∗) 0.383	11.0 (1∗)
Hb (g/l) 118 – 150	120.0 – 140.0	96.0 – 106.0 (3∗)	92.0 – 114.0 (6∗) 0.783	98.0 – 124.6 (8∗) 0.210	95.7 – 134.0 (4∗) 0.383	86.0 (1∗)
Fe (μmol/l) 9.5 – 30	17.1 – 25.4	5.8 – 10.8 (2∗)	2.3 – 3.8 (6∗) 0.783	2.0 – 24.2 (10∗) 0.224	1.9 – 12.7 (2∗) 0.383	1.2 (1∗)
CRP (mg/l) 0 – 5	1.14 – 3.24	8.4 – 144.0 (3∗)	5.0 – 50.8 (6∗) 0.783	0.9 – 89.0 (1∗) 0.224	5.0 – 268.7 (6∗) 0.383	13.9 (1∗)
ALT (μkat/l) 0.05 – 0.80	0.22 – 0.47	0.30 – 3.79 (2∗)	0.27 – 0.59 (0∗)	0.22 – 0.53 (0∗)	0.23 – 0.77 (0∗)	0.27 (0∗)
AST (μkat/l) 0.10 – 0.80	0.31 – 0.80	0.38 – 3.67 (2∗)	0.43 – 0.66 (0∗)	0.43 – 0.99 (0∗)	0.33 – 0.64 (0∗)	0.30 (0∗)

N∗ - number of patients (out of total in the age-group), where parameter´s value was higher or lower than min-max of the standard values.
R - Spearman´s rank correlation coefficient (P<0.05) correlating EPG value with haemathological parameters in the age group.
R was not calculated in groups (0-1) and (11-16) due to the low number of examined children

reference range in the majority of patients, except for the increased levels found in 2 patients from age group of 0 – 1 years. We also tested if there is correlation between egg counts and haematological test data in different age groups by means of calculation of Spearman´s rank correlation coefficient ($P < 0.05$). Strongest correlations between all haematological parameters and egg counts were found in two years old patients ($R = 0.783$, $P < 0.05$; Table 4).

The association of mixed infection with both nematodes with the changes in selected haematological and biochemical parameters in the group of 13 children is shown in Table 5, with only three age-groups present (2 year, 3 – 5 years, 6 – 10 years) because children in age groups 0 – 1 years and 11 – 16 years were not positive for mixed infec-

Table 5: Haematological and biochemical parameters in control-healthy children and children with mixed *A. lumbricoides* and *T. trichiura* infection in individual age-groups

Parameter (unit) / standard values	Number of patients in examined age – groups/ min – max values and number of patients with non-physiological values			
	2 – 12 (healthy, 7)	2 (3)	3 – 5 (7)	6 – 10 (3)
Eo (%) 0 – 5	2.1 – 4.6	12.1 – 45.6 (3∗)	4.1 – 14.0 (6∗)	9.1 – 13.7 (3∗)
Hb (g/l) 118 – 150	120.0 – 140.0	79.2 – 108.0 (3∗)	101.0 – 119.0 (5∗)	101.0 – 151.0 (2∗)
Fe (μmol/l) 9.5 – 30	17.1 – 25.4	1.9 – 5.0 (3∗)	3.0 – 12.4 (5∗)	3.4 – 13.4 (2∗)
CRP (mg/l) 0 – 5	1.14 – 3.24	12.9 – 269.0 (3∗)	5.8 – 76.0 (7∗)	5.0 – 50.8 (2∗)
ALT (μkat/l) 0.05 – 0.80	0.22 – 0.47	0.40 – 0.45 (0∗)	0.25 – 0.53 (0∗)	0.29 – 0.34 (0∗)
AST (μkat/l) 0.10 – 0.80	0.31 – 0.80	0.47 – 0.58 (0∗)	0.43 – 0.99 (0∗)	0.36 – 0.57 (0∗)

N∗, number of patients (out of total in the age-group), where parameter´s value was higher or lower than min-max of the standard values.
Children in age- groups (0 – 1) years and (11 – 16) years were not positive for mixed infection

Table 6. Statistical significance of differences of the clinical parameters between age-groups calculated by the Kruskal – Wallis test ($P = 0.05$)

Compared age groups (years)	Clinical parameters and statistical significance of their differences			
	Eosinophils	Haemoglobin	Ferrum	CRP
0 – 1 vs 2	$P < 0.05$	NS	NS	NS
0 – 1 vs 3 – 5	NS	NS	NS	NS
0 – 1 vs 6 – 10	NS	$P < 0.05$	$P < 0.05$	$P < 0.05$
2 vs 3 – 5	NS	NS	NS	NS
2 vs 6 – 10	NS	$P < 0.05$	$P < 0.05$	NS
3 - 5 vs 6 – 10	NS	NS	NS	NS

NS - not signicant difference between age-groups ($P > 0.05$)

tion. Eosinophilia was detected in 12 patients, where the highest eosinophil counts were recorded in three two-years old patients (12.1 – 45.6 %). In the same patients, the very low values of Hb (79.2 – 108.0 g/l) and Fe (1.9 – 5.0 μmol/l) were detected in a mixed infection. CRP values were elevated in 12 of total 13 patients, with the highest values being detected in children aged 2 years (12.9 – 269.0 mg/l). In general, CRP values reached lower values in elder patients aged from 6 to 10 years.

Significant differences in the haematological and biochemical test data between individual age groups of patients with single *A. lumbricoides* infection were calculated using the Kruskall-Wallis test ($P < 0.05$) (Table 6). Due to only one patient being in the group of age 11 – 16 years, this group was excluded from the statistical analysis. Significant difference in eosinophil counts was found only between patients aged 0 – 1 year and 2 years. Hb, Fe and CRP levels were significantly different between very young patients up to 2 years of age and older children aged 6 – 10 years.

Clinical signs and symptoms in a set of 46 infected patients varied according to the intensity of infections, larval stage and degree of larval migration (Table 7). In heavily a severe *A. lumbricoides* infection, X-ray scans showed massive bronchopneumonia (15 patients, 50.0 %) and bronchitis obstructive in 28 patients (93.3 %), fever (38 – 40°C)

Table 7. Clinical symptoms of hospitalised children positive for either single *A. lumbricoides* and *T. trichiura* infections or both infections

Signs and Symptoms	*A. lumbricoides*		*A. lumbricoides* + *T. trichiura*		*T. trichiura*	
	N	P (%)	N	P (%)	N	P (%)
Fewer	5	16.5	4	30.7	0	-
Anaemia	4	13.3	6	46.2	3	100
Vomiting	0	-	1	7.6	2	66.6
Diarhoea	0	-	1	7.6	2	66.6
Bronchopneumonia	15	50.0	10	76.9	0	-
Bronchitis obstructive	28	93.3	10	76.9	0	-
Hepatosplenomegalia	5	16.5	0	-	0	-
Colitides	5	16.5	2	15.3	0	-
Gastritis	0	-	3	23.0	2	66.6

N - number of infected children with indicated symptom/sign. P - proportion in % from the total number of patients with either single infection (*A. lumbricoides* = 30, *T. trichiura* = 3) or with mixed infection *A. lumbricoides* and *T. trichiura* (n = 13)

and colitis were recorded in 5 patients (16.5 %). In 13 patients with mixed infection, commonest pathological symptoms were bronchopneumonia (10 patients, 76.9 %) and anaemia (6 patients, 46.2 %). Less common symptoms included vomiting, diarrhoea, gastritis and colitis. Anaemia was recorded in all three patients with trichuriasis, and other signs were vomiting, diarrhoea and gastritis (66.6 %).

Discussion

This study, conducted during 2008 – 2009, confirmed the presence of *A. lumbricoides* and *T. trichiura* in Slovak children, with the highest intensity of infection in the patients aged 6 – 10 years (> 3999 EPG). The overall occurrence of these infections in the hospitalised children was 2.5 %. Both high intensity of infection and reinfection occurred particularly in children living in communities with low hygienic standards.

Over the past 50 years, the presences of *A. lumbricoides* and *T. trichiura* infections in children of Slovakia were reported by many authors showing marked differences. Fabian and Kavanová (1956) recorded a higher prevalence of *A. lumbricoides* in children aged 6 – 11 years living in rural areas (14.4 %) than in those living in urban environments (3.7 %). Giboda (1978) found a 16.83 % prevalence of ascariasis in the same age group and 4.3 – 26.6 % prevalences of trichuriasis in Gipsy children up to 15 years of age. In infants, parasitic infections with *T. trichiura* were rare (3.0 %); prevalence increased with age, peaking in school-age children (16.9 – 28.0 %), as reported by Pazdziora and Palička (1971) and Straka *et al*. (1975). Similarly, Magrová (1963) detected a 16.1 % prevalence of *T. trichiura* in children living in lowland areas. Sobota *et al*., (1975) detected *T. trichiura* prevalences of 12.9 – 21.4 % in children from boarding schools and homes for children. Straka *et al*. (1975), on the other hand, observed a *T. trichiura* prevalence of only 2.3 % in children from nurseries. In the late 1980s, Straka and Škračiková (1989) confirmed the presence of eggs of *T. trichiura* (0.4 %) and *A. lumbricoides* (0.3 %) in stool smears of school-age children. Lengyelová (1988) reported similar low intensities of infections. According to Totková *et al*. (2004), by the late 1980s, helminthic infections in children of pre-school and school age were being kept at bay. However, this was not the case as an increased prevalence of geohelminths in Central Slovakia was also reported by Straka *et al*. (2001).

In contrast with these reports, our study was focussed on a group of children hospitalised for acute or chronic respiratory and gastrointestinal infections associated with the various clinical symptoms. We found that 46 of the total 1800 examined patients were positive for either *A. lumbricoides* and/or *T. trichiura* infection. Occurrence and intensities of infections for both nematodes reported in the present study fell in the range of values reported by Flaková and Hocmanová (1989) who found *A. lumbricoides* in 1.7 % and *T. trichiura* in 2.1 % children population in Eastern Slovakia. As stated by Koňáková (2000), not only the prevalence of individual species increased, but the species variability as well. The commonest parasites were *Enterobius vermicularis*, *A. lumbricoides, T. trichiura*, and *Giardia intestinalis.* Totková *et al*. (2001) reported similar results from an examination during 1990 – 1999 of more than 2000 children of preschool and school age in West Slovakia, recording the highest prevalence of *Enterobius vermicularis* (15.01 %), the geohelminths *A. lumbricoides* and *T. trichiura* (5.73 %), and the protozoa *Giardia intestinalis* (10.27 %) and *Entamoeba histolytica* (2.07 %). It should be emphasised that previous epidemiological studies referred only to the prevalence of infections, but the intensities of nematode infections were not examined quantitatively. This seems to be a factor related to the levels of eosinophilia, Hb, Fe and CRP, which correlated tightly with egg counts mainly in children of 2 years of age. In an endemic area, Flohr *et al*. (2007) found the prevalence of *A. lumbricoides* of 6 % and *T. trichiura* of 3 %, with the highest intensity of parasitic infection (> 3999 EPG) in children of 2 – 5 years of age. These findings are comparable to our data on *A. lumbricoides* and *T. trichiura* intensities of infection in the same age group in a non-endemic area. We also found that an infection with *T. trichiura* only was very uncommon in our group of patients.

The most common signs and symptoms of ascariasis in children include loss of appetite and weight (37.5 %), abdominal pain (31.2 %), anal and skin itching (18.7 %), diarrhoea, headache, and anxiety (12.5 %) (Sobota *et al*., 1975). Chest pain, dry cough, dyspnoea, and fever can develop within two weeks post infection, depending on the sensitivity to the parasite or the degree of migration (Reeder, 1998). Our group of children infected with only *Ascaris* manifested with bronchopneumonia (50.0 %), bronchitis obstructive in 93.3 % of children, colitis and gastritis were less frequent (16.5 %). Interestingly, vomiting and diarrhoea occurred in this group of patients but were more common in patients having *Trichuris* infection. Reeder (1998) reported fever as a sign of *A. lumbricoides* infection. In our patients, fever occurred in only 16.5 % of cases, probably because the patients were hospitalised during the second stage of the infection (bronchopulmonary). We found that in our patients with mixed infections (n = 13), the frequency of bronchopneumonia were higher (76.9 %) in comparison with single infections (50 %) indicating on more severe pathological consequences of mixed infections. Higher frequency of anaemia accompanying *Trichuris* infection could have an additional diagnostic value. In endemic countries, chronic ascariasis in school-age children is the major cause of impaired physical growth, mental retardation, and serious malnutrition (Brooker *et al*., 2006). Ascariasis contributes to 35 % of cases of intestinal obstruction with a high risk of mortality in children in endemic countries (Reeder, 1998). Migration of the parasite can cause cholecystitis, cholangitis, appendicitis, biliary colic, gastric haemorrhage, granulomatous peritonitis, and liver abscess. Liver abscess is associated with symptoms such as loss of weight, fever, and epigastric pain related to hepatomegaly (Salman, 1997).

Most common laboratory findings reported by Sobota *et al*.

(1979) in Slovak patients with ascariasis included anaemia (10 %), sideropenic anaemia, and eosinophilia (4 %). In our group of children, laboratory findings confirmed eosinophilia nearly in all infected patients. Eosinophil counts were particularly high in two-years old children with mixed infections (12.1 – 45.6 %) and also with single *Ascaris* infection (9.5 – 27.6 %).

The most notable decreases in values of Hb and Fe were recorded in a group of children aged 0 – 2 years. These decreases correlated with the intensity of parasitic infection (> 3999 EPG), despite the lowest Hb and Fe values occurred in one 16-year old patient. Curtale *et al*. (2000) reported similar data and highlighted the fact that Hb values decrease with an increase in the intensity of parasitic infection, particularly when egg count is higher than 5000. Several studies have reported a negative correlation between intensity of *A. lumbricoides* infection and Hb values (Curtale *et al*., 1993), low food intake due to loss of appetite (Crompton, 1984) and changes in the integrity of the intestinal mucosal barrier due to *A. lumbricoides* infection (Curtale *et al*., 2000).

In conclusion, our study reported 2.55 % rate of infections with a common roundworm and/or whipworm in the group of hospitalised children indicating that these infections have not been eradicated in Slovakia. We found strong correlations between intensity of infection and Hb, Fe and CRP values, which were highest in children aged 2 years. Haematological indices tended to decrease with the age of patients irrespectively of the intensity of infection. Whereas bronchopneumonia and bronchitis obstructive were characteristic symptoms in case of *Ascaris* infection, anaemia was present more often in patients with *Trichuris* infections.

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