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## The Occurrence of Acute Diarrhoeas Induced by Rotaviruses and *Salmonella* Strains in Children Hospitalised in the Lower Silesian J. Korczak Paediatrics Centre in Wrocław (Poland) in the Years 2002–2004

Występowanie ostrych biegunek  
wywoływanych przez rotawirusy i szczepy *Salmonella*  
u dzieci hospitalizowanych w Dolnośląskim Centrum Pediatrycznym  
we Wrocławiu w latach 2002–2004

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### Abstract

**Background.** Childhood diarrhoea is usually caused by viral or bacterial infection. Rotaviruses are the most common cause of severe diarrhoea in children worldwide and infect virtually children younger than 5 years of age. According to the Polish data, the analysis of etiological factors of acute diarrhoeas in children, shows the predominance of rotavirus and *Salmonella* as causative organisms in severe diarrhoea.

**Objectives.** Evaluation the incidence of rotaviral and salmonella infections in diarrhoeas occurring in children hospitalised in the Lower Silesian Paediatrics Centre in Wrocław in the years 2002–2004.

**Material and Methods.** In the years 2002–2004, 1800 children with symptoms of diarrhoea were received to the Lower Silesian Paediatrics Centre in Wrocław (Poland). The stool for testing was taken immediately after acceptance of a child to the hospital and it was transferred to the laboratory. The faeces samples were examined for the presence of rotaviruses and *Salmonella* species.

**Results.** The etiological factor of acute diarrhoea was identified in 856 (47.5%) out of 1800 examined children's infections. *Salmonella* aetiology of the diarrhoea was diagnosed in 9.8% of examined infections. The occurrence of rotaviral infections was observed in 37.7% of acute diarrhoeas. Clinical picture of rotaviral and *Salmonella* infections showed a cyclic pattern of occurrence.

**Conclusions.** Rotaviruses were the major cause of severe gastroenteritis in children hospitalised in the Lower Silesian Paediatrics Centre in Wrocław in the years 2002–2004 (Adv Clin Exp Med 2005, 14, 4, 759–763).

**Key words:** diarrhoea, rotaviruses, *Salmonella*, children.

### Streszczenie

**Wprowadzenie.** Biegunki dziecięce są zwykle wywoływane przez wirusowe lub bakteryjne zakażenia. Rotawirusy są główną przyczyną ostrych stanów biegunkowych u dzieci w wieku poniżej pięciu lat na całym świecie. Dane z opracowań z terenu Polski wskazują na rotawirusy i pałeczki *Salmonella* jako podstawowe czynniki etiologiczne ciężkich biegunek u dzieci.

**Cel pracy.** Określenie częstości występowania zakażeń rotawirusowych oraz wywołanych przez pałeczki z rodzaju *Salmonella* u dzieci hospitalizowanych w Dolnośląskim Centrum Pediatrycznym we Wrocławiu w latach 2002–2004.

**Materiał i metody.** W latach 2002–2004 do Dolnośląskiego Centrum Pediatrycznego we Wrocławiu przyjęto 1800 dzieci z objawami ostrej biegunki. Próbkę kału pobierano od każdego dziecka bezpośrednio po przyjęciu na oddział

i przekazywano do badań laboratoryjnych, gdzie opracowywano materiał diagnostyczny w kierunku obecności rotawirusów oraz szczepów z rodzaju *Salmonella*.

**Wyniki.** Czynniki etiologiczne biegunki oznaczono w przypadku 856 (47,5%) spośród 1800 badanych prób. Zakażenia wywołane przez bakterie z rodzaju *Salmonella* stanowiły średnio 9,8%, natomiast rotawirusowe 37,7%. Pojawianie się tych zakażeń wykazuje charakter sezonowy.

**Wniosek.** Rotawirusy były główną przyczyną ostrych zakażeń jelitowych u dzieci hospitalizowanych w Dolnośląskim Centrum Pediatrycznym we Wrocławiu w latach 2002–2004 (*Adv Clin Exp Med* 2005, 14, 4, 759–763).

**Słowa kluczowe:** biegunka, rotawirusy, *Salmonella*, dzieci.

Diarrhoea can be a symptom of many metabolic disorders, but the major causes of acute diarrhoea are viral and bacterial infections. Acute gastroenteritis is one of the most frequent reasons for medical consultation, particularly for children. Most cases of gastroenteritis are self-limited and antibiotics therapy is usually not necessary.

Diarrhoeal illnesses may occur because of insults to host defences or because of an attack by pathogens. The infectious agents that cause diarrhoea are usually spread via the faecal–oral route. Intestinal infection is the most common cause of diarrhoea worldwide and is responsible for the deaths of 3–4 million individuals each year, the majority of whom are children younger than 5 years [1]. Rotaviruses are the major cause of severe childhood diarrhoea. Rotaviral infections account for up to 60% and 40% of all diarrhoeal episodes in developing and developed countries, respectively.

There are also many bacteria pathogenic to the intestine, which have been identified among etiological factors of acute diarrhoea, especially the pathogenic *E. coli* is the most common in the poorest regions of the world. Other important ones are *Campylobacter* spp., *Salmonella* spp., *Shigella* spp., *Vibrio* spp. and *Yersinia* spp. There are also infections caused by viruses such as the Norwalk virus, Adenoviruses, Astroviruses, Corona viruses, or parasitic factors, e.g. *Cryptosporidium parvum*, *Entamoeba histolytica*, *Lamblia intestinalis*.

Diarrhoea is the leading cause of illness and death among children in developing countries, however, despite industrialization, acute intestinal infections are increasing in the Western world, particularly because of food-borne infections such as *Salmonella* spp., *Campylobacter jejuni*, enterohaemorrhagic *E. coli* O157:H7, enteroaggregative *E. coli* (EAEC) strains and water-borne ones as a result of contamination of domestic water supplies with the cysts of *Giardia intestinalis* and *Cryptosporidium parvum* [2, 3]. Other factors contributing to the rise in acute infectious diarrhoea in the developed countries include the widespread use of broad-spectrum antibiotics, impaired host immunity due to HIV infection and anti-cancer chemotherapy.

Nontyphoidal salmonellae are a major cause of food-borne infections in the developed countries and probably water-borne in the poorest ones. In the developing world *Salmonella typhi* is also an important cause of invasive disease, particularly in South and South-East Asia [4, 5].

*Salmonella enterica* subsp. *enterica* of the serovar Enteritidis (*S. Enteritidis*) is one of the most frequently occurring etiological factors of the alimentary tract infections in man. *S. enteritidis* is responsible for about 60% of salmonellosis in many countries [6, 7]. The strains of this serovar were responsible for about 90% of all registered salmonellosis in Poland in recent years [8, 9]. The main sources of the alimentary tract infections caused by the *S. Enteritidis* rods are infected poultry products and eggs, and in developing countries additionally water contaminated by municipal wastes [5]. Lastly the role of dendritic cells in the transport of the *Salmonella* rods through the intestinal barrier has been reported [10]. Young children, the elderly, and the immunocompromised are the most likely to have severe *Salmonella* infections.

The aim of the present work was to estimate rotaviral and salmonella infections in children with diarrhoea hospitalised in the Lower Silesian Paediatrics Centre in Wrocław during the period from January 2002 to October 2004.

## Material and Methods

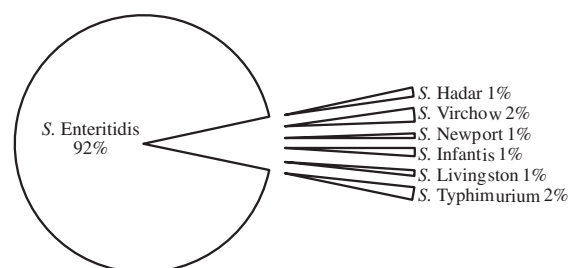
The studied group consisted of 1800 children treated in the Lower Silesian Paediatrics Centre in Wrocław, Poland in the period from January 2002 to September 2004. All patients aged 3 months–15 years were hospitalised due to acute diarrhoea defined as  $\geq 3$  profuse, watery, or mucous stools for  $> 1$  day but  $< 5$  days in the patients who required intravenous dehydration. The faeces samples from the patients were examined for the presence of *Salmonella* species and rotaviruses. Stool samples were collected at admission and were inoculated onto *Salmonella*-*Shigella* Agar and MacConkey Agar plates (bioMérieux, France) and incubated at 35°C for 24 hours. Organisms were

identified by commercial biochemical tests (ID32 E; bioMérieux, France), and were serotyped with a commercial serotyping antiserum (Biomed, Poland) [11]. The presence of rotaviruses was established with latex agglutination (Rota-Kit 2 test; bioMérieux, France) according to producer's instruction [12].

## Results

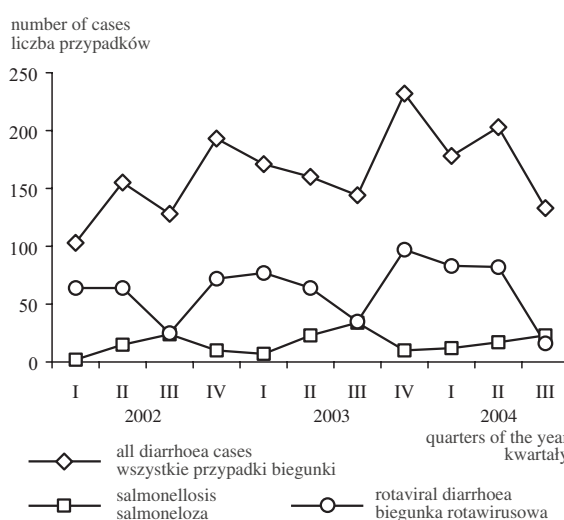
The etiological factor of acute diarrhoea was identified in 856 (47.6%) out of 1800 examined children's infections. General appearance of salmonella and rotaviral cases from January 2002 to September 2004 is shown in Table 1. *Salmonella* aetiology of the diarrhoea was diagnosed in 8.8, 10.5, and 10.1% of examined infections in the years 2002, 2003, and 2004, respectively. The occurrence of rotaviral infections was observed in 35.2–38.9% of acute diarrhoeas. In the group of salmonellosis (Figure 1) the most frequent were *Salmonella* Enteritidis serovar (92%). Several cases of *S. Hadar*, *S. Virchow*, *S. Newport*, *S. Infantis*, *S. Livingston*, and *S. Typhimurium* strains were also isolated.

The seasonal occurrence of acute diarrhoea is illustrated in Figure 2. The peak incidence of all acute diarrhoea cases were noticed in the fourth quarter of both the year 2002 (193) and 2003 (232). On the contrary, the lower number (128–144) of this kind of infections were stated from July to September of the three years tested, except the first quarter of 2002 (103 cases). The most of salmonella cases took place in the summertime. 24, 23, 34, and 23 acute diarrhoeas were noticed in III quarter of 2002, II and III of 2003, and III of 2004, respectively. The decrease of salmonellosis was observed in the cold seasons of the



**Fig. 1.** The occurrence of *Salmonella* serovars in the cases of children acute diarrhoea in the years 2002–2004

**Ryc. 1.** Występowanie serowarów *Salmonella* w przypadkach ostrych biegunek dziecięcych w latach 2002–2004



**Fig. 2.** The seasonal appearance of salmonellosis and rotaviral infections in children with acute diarrhoea in the years 2002–2004

**Ryc. 2.** Sezonowość występowania salmoneloz i zakażeń rotawirusowych u dzieci z ostrą biegunką w latach 2002–2004

**Table 1.** The incidence of salmonella and rotaviral acute diarrhoeas in children in the years 2002–2004

**Tabela 1.** Występowanie pałeczek *Salmonella* i rotawirusów w ostrych biegunkach dziecięcych w latach 2002–2004

Pathogen (Patogen)	2002		2003		2004		Total (Razem)	
	n	%	n	%	n	%	n	%
<i>Salmonella</i> spp.	51	8.8	74	10.5	52	10.1	177	9.8
Rotaviruses (Rotawirusy)	225	38.9	273	38.6	181	35.2	679	37.7
Other etiological factors (Inne czynniki etiologiczne)	303	52.3	360	50.9	281	54.7	944	52.5
Total (Razem)	579		707		514		1800	100

n – number of samples.

n – liczba próbek.

year (IV and I quarters) 2002, 2003 and 2004. The number of bacterial infections varied between 2–12 cases. The most children with rotaviral infections were hospitalised in the winter and spring of each year. In contrast, the lowest number of rotavirus diarrhoeas was noticed in the same period as the increase in salmonella cases.

## Discussion

Diarrhoea affects mainly infants and children. Rotaviral infections are associated with about 40% of diarrhoea episodes in young children who require hospitalisation, when dehydration and metabolic acidosis are profound. This etiological factor is the most important cause of acute seasonal diarrhoea among children worldwide and the infections caused by rotaviruses are the most common for the youngest children up to 2 years old [1, 13, 14].

Our results show that in the group of 1800 children up to 15 years of age with acute diarrhoea, hospitalised in the Lower Silesian Paediatrics Centre between the years 2002–2004, its rotaviral aetiology was diagnosed in 38.9, 38.6 and 37.7%, respectively. These data are similar to those published by various authors [13, 15, 16], but the highest detection rate of rotaviruses was observed among children aged from 6 to 24 months [14, 16]. Epidemiological studies presented by Pytrus [17] demonstrated that rotavirus is the leading etiologic agent of severe gastroenteritis in children up to 3 years old, treated in the Department of Paediatrics and Gastroenterology in Wrocław in the years 1992–2001, with frequency of rotaviral diarrhoea varying from 28.2% in 1992 to 62.1% in 2001. According to the data obtained in Tri-city in children aged 7–36 months, rotaviral infections were diagnosed in 80.7% of cases and were more frequent in boys than in girls [15]. In the presented study the authors did not find a significant difference in rotavirus frequencies between genders. The frequency of rotavirus detection showed a cyclic pattern of occurrence. The incidence of acute rotavirus diarrhoea observed in the temperate climate is increased in the autumn-winter and early-spring seasons, with epidemic peaks from November to March. Own observations were similar to those presented by various authors in Poland, that these infections were found to be more prevalent during the period of I and IV quarter of the year [13, 14, 16]. On the other hand, in Tri-city a higher frequency of rotavirus infections was observed between March and May, which was probably associated with the climate of this region and its location at the seaside

[15]. The faecal–oral route, person to person spread through contaminated hands is the most important means by which rotaviruses are transmitted. For this reason rotaviral diarrhoea often occurs as a result of hospital infection. According to the Polish data, 12–46% of children were infected during hospitalisation [13, 15].

In Poland salmonella infections were second after rotaviral ones among etiological factors of diarrhoeas in children with the frequency of occurrence on the average 15% in recent years [9], however in presented study *Salmonella* rods was detected at a lower rate, above 10%. Clinical picture of these infections in children showed differences reported in the literature on the subject. The results obtained by Polish authors vary from 3% in Lublin to 19.3% in Łódź [14, 18]. The age is related to the frequency of *Salmonella* detection in children. Gonera et al. showed that almost 40% cases of salmonellosis were diagnosed in children up to 10 years of age, with the highest incidence among children aged 2 [9]. The *Salmonella* strains of the serovar *S. Enteritidis* are among the most commonly occurring etiological factors of alimentary tract infections of man. Observations from many years [8, 19] show that the infections by the *Salmonella* strains of this serovar are about 90% of salmonellosis in Poland. Only in 1961–1962 other serovars of *Salmonella* were dominant [8]. Own data also show the predominance of the *Salmonella* Enteritidis serotype – 92% as the causative agent in salmonellosis. Serovars typhimurium, virchow, hadar, newport, infantis and livingston were detected only in single cases.

Opposite to rotaviral diarrhoeas, the seasonal incidence of salmonella infections was noted in III quarter of the year. This observation corresponds to the data demonstrated by Polish Institute of Hygiene, that the highest number of salmonellosis was recorded in July and August [9].

The obtained results lead to the conclusion that the infections by *Salmonella* rods are presently not the main cause of diarrhoea in children. However the infections must be treated seriously because of increasing resistance of these strains to antibiotics and carrier-state persisting in long time periods [20].

Prevention and control of infection disease require information about the leading medical causes of illnesses and etiological factors. On the basis of the analysis presented by various authors in a multi-centre European study, pathogens were identified in above 50–70% of stool samples from children with acute diarrhoea [1, 15, 17, 18, 21]. In general, using traditional diagnostic techniques the authors detected etiological factors from stool samples in 47.5% of hospitalised children up to



15 years of age with diarrhoea. Modern microbiological diagnostics of alimentary infections caused by viral, bacterial and parasitic agents, like the etiological factors of acute gastroenteritis in children, depends on the technical equipment of the laboratory, should be multilateral and expanding the rou-

tine search for various viruses, bacteria and parasites especially such as: rotaviruses, adenoviruses, astroviruses, *Salmonella* spp., *Escherichia coli* EPEC, *Campylobacter* spp., *Yersinia* spp., *Giardia lamblia* and *Cryptosporidium* spp.

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