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INCIDENCE OF HEALTHCARE-ASSOCIATED GASTROENTERITIS IN CHILDREN HOSPITALIZED ON PAEDIATRIC WARD IN PROVINCIAL HOSPITAL IN 2007-2013

St. Lukas Provincial Hospital in Tarnów

ABSTRACT

OBJECTIVE. This article aimed at evaluating the incidence and distribution of healthcare-associated (HAI) gastroenteritis (GE) in patients hospitalized on paediatric ward in St. Lukas Provincial Hospital in Tarnów.

INTRODUCTION. Gastroenteritis remains a common manifestation of healthcare-associated infections on paediatric wards. In Poland, there are limited data on the proportion of healthcare-associated GE in the epidemiology of healthcare-associated infections. It was decided to present the incidence and etiology of these infections in a 7 year study period.

METHODS. For the purpose of this study, standard definitions of healthcare-associated infections issued by the European Centre for Disease Prevention and Control (ECDC) were adopted. Cumulative incidence rates and incidence density rates were calculated.

RESULTS. A total of 11,966 records of children hospitalized in 2007-2013 were subject to analysis. In this period, 251 healthcare-associated gastroenteritis cases of viral etiology were identified. For these infections, cumulative incidence rate (CIR) and incidence density rate (IDR) were 2.11% and 3.37/1,000 person-days, respectively. GE was most frequently reported in children aged less than 2 years (average-1.6, SD- 2.1). Average hospitalization of a child who was not diagnosed with healthcare-associated GE was 6.2 days while for GE case it amounted to 11.2 days. GE was equally present in girls and boys, i.e. 2.1%. Rotavirus-induced GE was the most commonly diagnosed (GE-RV - Rotavirus Gastroenteritis). Such virus was identified in 189 children (CIR-1.58%, IDR-2.51/1,000 person-days). Rotavirus GE was followed by concomitant infections with rotaviruses and adenoviruses. A total of 12 patients were diagnosed with such co-infection (CIR-0.10%, IDR-0.16/1,000 person-days). Infections caused by adenoviruses (GE-AV - Adenovirus Gastroenteritis) occurred in 7 patients (CIR-0.06%, IDR-0.09/1,000 person-days). For 43 (17%) children, etiological agents of healthcare-associated GE were not determined.

SUMMARY. Rotaviruses were the most commonly identified etiological agents of healthcare-associated gastroenteritis on paediatric ward. Children aged less than 2 years were those most frequently affected.

Key words: *healthcare-associated infection (HAI) in children, gastroenteritis (GE), rotavirus, adenovirus, paediatrician*

INTRODUCTION

Healthcare-associated gastroenteritis (GE) of viral etiology still remains a problem in hospitals in Poland. Due to the enhancement of hygienic and sanitary standards, improvement of life conditions and introduction of surveillance over food production, there was a change in the distribution of etiological agents causing healthcare-associated gastroenteritis in Poland. In the 70s of the 20th century, Gram-negative coccobacilli prevailed over other etiological agents of GE (*Salmonella*, *Shigella*, patho-

genic *E. coli*) (1). Nowadays, it is considered that viruses (rotaviruses, noroviruses, adenoviruses) are the most significant etiological agents of healthcare-associated GE on paediatric wards in Poland and worldwide (2). Infections, accompanied by acute viral diarrhoea occur in infants and children, however, they are also present in adult patients treated in hospital settings. Rotaviruses, noroviruses and adenoviruses are pathogens of high communicability and resistance to unfavourable environmental conditions. For rotaviruses, prolonged survival on hands, even up to 4 hours, and environmental surfaces, up to 6 days

(max. 60 days), is typical. Consequently, it hinders their elimination from patient care settings. Noroviruses and adenoviruses can survive on surfaces up to 7 days (max. 3 months) and 8 hours (max. 7 days), respectively (3). On paediatric wards, infected patients (children, parents, personnel), who excrete such pathogens while suffering from acute viral diarrhoea, are the reservoir of the viruses, thus, leading to a substantial contamination of environment. Viruses may be transmitted 2-5 days prior to the onset of symptoms and for up to 14 days after the recovery. Observations, however, suggest that communicability may be prolonged up to several weeks (4). Infections with these viruses spread mainly by faecal-oral route, but they may be also transmitted by respiratory droplets and fomites (2, 5).

In Poland, rotaviruses and noroviruses are listed as alert organisms. Therefore, infections caused by these pathogens are to be obligatorily notified to the central register. In 2013, a total of 23,529 cases of viral diarrhoea were reported in Poland (incidence-61.1 per 100,000). However, this number includes both community-acquired and healthcare-associated infections (6). Exact incidence of healthcare-associated infections of rotavirus, norovirus and adenovirus etiology on paediatric wards remains unknown. Nevertheless, there is a number of studies discussing such problem (2, 4, 5, 7-9).

This article aimed at evaluating the incidence of healthcare-associated gastroenteritis in children hospitalized on paediatric ward based on standard, uniform rates, i.e. cumulative incidence rate (CIR) and incidence density rate (IDR).

MATERIAL AND METHODS

In 2007-2013, a monitoring of healthcare-associated infections occurring in children hospitalized on paediatric ward in St. Lukas Provincial Hospital in Tarnów was conducted. Of patients diagnosed with gastroenteritis (not with healthcare-associated infection), children

hospitalized due to community-acquired diarrhoea were excluded from analysis. Data on gender and age of hospitalized children, hospitalization and occurrence of infections by months were subject to analysis. Gastroenteritis was diagnosed pursuant to the definition issued by the European Centre for Disease Prevention and Control (ECDC) in Stockholm (10). Healthcare-associated gastroenteritis, detected in hospitalized children, was grouped by the etiological agents identified, including rotaviruses, adenoviruses and unspecified etiology.

Cumulative incidence rate was calculated, using the number of new cases of GE in the analyzed population over a specified time period: the number of GE divided by the number of hospitalizations and multiplied by 100. Incidence density rate (IDR/1,000 person-days) was calculated as follows: the number of GE divided by the number of person-days and multiplied by 1,000. Hospital outbreak was defined as the occurrence of at least two infections caused by the same pathogen, suggesting an epidemiological link.

Frequency of hand disinfections per one patient was calculated as follows: the amount of disinfectant used on ward was portioned into 3-ml-doses (one disinfecting dose) and divided by the number of hospitalized children. Having presumed that hands should be disinfected following each removal of gloves, the number of diagnostic gloves used (1 pair) was collated with the frequency of hand disinfections per one patient on paediatric ward.

Faeces sample testing was performed using the following culture media: chromogenic medium Chromid ID CPS, MacConkey agar, Hektoen agar, sodium selenite medium (bioMérieux media), Sorbitol MacConkey agar (selective isolation of *E. coli* O157:H7 – Grasso media), Sabouraud agar (with gentamicin and chloramphenicol). Furthermore, testing for rotaviruses and adenoviruses (VIKIA® Rota-Adeno by bioMérieux) and *C. difficile* (*C. DIFF* QUIK CHEK COMPLETE by TECHLAB) was also performed. No testing for noroviruses was conducted.

Table I. Gastroenteritis (GE) on paediatric ward by cumulative incidence rate (CIR) and incidence density rate (IDR) in 2007–2013

Year	Hospitalizations	Person-days	Number of healthcare-associated and community-acquired GE	HAI-GE case			Number of infected children in HAI-GE outbreaks
				N	CIR/100	IDR/1000	
2007	1594	13058	73	27	1.69	2.07	21
2008	1579	10501	69	38	2.41	3.62	25
2009	1649	10779	75	53	3.21	4.92	20
2010	1748	10505	62	36	2.06	3.43	29
2011	1860	10055	63	36	1.94	3.58	12
2012	1651	9341	59	32	1.94	3.43	10
2013	1885	11100	62	29	1.54	2.61	11
Total	11966	75339	463	251	2.11	3.37	128

GE - gastroenteritis, N - number of infections, CIR/100 hospitalizations – cumulative incidence rate, HAI - healthcare-associated infection, IDR/1,000 person-days - incidence density rate.

Table II. Gastroenteritis (GE) of viral etiology on paediatric ward by cumulative incidence rate and incidence density rate in 2007-2013

Healthcare-associated GE by viral etiological agents										
Year	Rotaviruses			Adenoviruses			Rotavirus and Adenovirus			Number of GE – unspecified etiological agent
	Number of GE-RV	CIR GE-RV	IDR GE-RV	Number of GE-AV	CIR GE-AV	IDR GE-AV	Number of GE-RV and GE-AV	CIR GE-RV and GE-AV	IDR GE-RV and GE-AV	
2007	26	1.63	1.99	0	0.00	0	0	0.00	0.00	1
2008	29	1.84	2.76	1	0.06	0.10	2	0.13	0.19	6
2009	41	2.49	3.80	3	0.18	0.28	3	0.18	0.28	6
2010	28	1.60	2.67	0	0.00	0.00	1	0.06	0.10	7
2011	23	1.24	2.29	1	0.05	0.10	2	0.11	0.20	10
2012	18	1.09	1.93	2	0.12	0.21	3	0.18	0.32	9
2013	24	1.27	2.16	0	0.00	0.00	1	0.05	0.09	4
Total	189	1.58	2.51	7	0.06	0.09	12	0.10	0.16	43

HAI - healthcare-associated infection, GE - gastroenteritis, GI-RV - rotavirus gastroenteritis, GE-AV - adenovirus gastroenteritis CIR/100 hospitalizations – cumulative incidence rate, IDR/1,000 person-days - incidence density rate.

Table III. Etiological agents of healthcare-associated gastroenteritis (GE) on paediatric ward in 2007 do 2013 – incidence of HAI (%)

Incidence of HAI (GE) by etiological agent									
Etiological agent / year		2007	2008	2009	2010	2011	2012	2013	Total %
Rotaviruses	%	96.3	76.3	77.4	77.8	63.9	56.3	82.8	75.3
Adenoviruses	%	0.0	2.6	5.7	0.0	2.8	6.3	0.0	2.8
Rotaviruses and Adenoviruses	%	0.0	5.3	5.7	2.8	5.6	9.4	3.4	4.8
Unspecified etiological agent*	%	3.7	15.8	11.3	19.4	27.8	28.1	13.8	17.1
Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Unspecified etiological agent - etiological agent was not identified or material was not collected from patient

RESULTS

In a 7-year period, a total of 11,966 children were hospitalized in St. Lukas Provincial Hospital in Tarnów. Of them, 463 were diagnosed with gastroenteritis, including 251 healthcare-associated gastroenteritis. As many as 14 HAI-GE outbreaks were detected, where 128 children were affected. Incidence rates of HAI-GE were estimated at: CIR-2.11% and IDR-3.37 (Tab.I). In the study group, no healthcare-associated gastroenteritis of bacterial origin was identified. Out of all gastroenteritis cases, those healthcare-associated infections caused by rotaviruses were differentiated (GE-RV - Rotavirus Gastroenteritis), whose number amounted to 189 (CIR-1.58%, IDR-2.51/1,000 person-days). Then, healthcare-associated GE caused by co-infection with rotaviruses and adenoviruses was separated. Such co-infections were identified in 12 patients (CIR-0.10%, IDR-0.16/1,000 person-days). Infections caused by adenoviruses (GE-AV - Adenovirus Gastroenteritis) were detected in 7 patients (CIR-0.06%, IDR-0.09/1,000 person-days) (Tab. II).

Of all healthcare-associated GE detected on paediatric ward, the most common etiological agent was rotavirus, i.e. 189 cases (75.3%), then co-infections with rotaviruses and adenoviruses – 12 cases (4.8%), and adenoviruses - 7 patients (2.8%). For 43 children

(17%), no etiological agents of GE were determined. It may be assumed that noroviruses were attributable to a part of GE identified (Tab. III).

Analysis of demographics of study population suggests that the average age of hospitalized children was 4.6 years (SD 4.8), while healthcare-associated GE was most commonly detected in children aged less than 2 years (1.6 year on average, SD 2.1) (Tab. IV). In a group of children aged less than 2 years, healthcare-associated GE was most commonly reported in those between 1 and 2 years - 108 (43%) and up to 1 year - 65 (25.9%) (Tab. V). No differences were observed between boys and girls with regard to the incidence of healthcare-associated GE ($p < 0.737$). Cumulative incidence rates for healthcare-associated GE were the highest in a group of children aged 0-4 years ($p < 0.001$). Children diagnosed

Table IV. Age (years) and gender of children hospitalized on paediatric ward in 2007 - 2013 with data on HAI

N = 11966	Number	Average	Minimum	Maximum	SD
Age (years)	11966	4.6	0	18	4.8
Gender	B	6370	4.3	0	4.5
	G	5596	5.0	0	5.0
HAI-GE	no	11715	4.6	0	4.8
	yes	251	1.6	0	2.1

N – number of patients, B – boy, G - girl, GE - gastroenteritis, SD – standard deviation, HAI - healthcare-associated infection.

Table V. Age of non-infected patients and patients diagnosed with HAI-GE hospitalized on paediatric ward in 2007–2013

Age (years)	Total	Non-infected patients		Patients diagnosed with HAI (GI-GE)	
		Number of patients	%	Number of patients	%
0	2049	1984	16.9	65	25.9
1	2402	2294	19.6	108	43.0
2	1275	1239	10.6	36	14.3
3	1015	1005	8.6	10	4.0
4	733	722	6.2	11	4.4
5	606	596	5.1	10	4.0
6	473	471	4.0	2	0.8
7	419	414	3.5	5	2.0
8	309	308	2.6	1	0.4
9	300	300	2.6	0	0.0
10	332	331	2.8	1	0.4
11	313	313	2.7	0	0.0
12	309	309	2.6	0	0.0
13	327	327	2.8	0	0.0
14	370	370	3.2	0	0.0
15	451	450	3.8	1	0.4
16	270	269	2.3	1	0.4
17	12	12	0.1	0	0
18	1	1	0.0	0	0
Total	11966	11715	100.0	251	100

with healthcare-associated GE were hospitalized longer compared to those non-infected ($p < 0.001$) (Tab. VI). Average hospitalization was 6.2 days while for children with healthcare-associated GE – 11.2 days (Tab. VII).

Analysis of the occurrence of healthcare-associated GE by months suggests a seasonality of infections. The highest number of infections was reported between January and May with the peak noted in January. The highest number of hospital outbreaks was observed between January and March (Fig. 1.).

On paediatric ward studied, an awareness of proper hand disinfection was gradually increasing. An increase in the amount of disinfectant used per one patient, i.e. from 14 (2005) to 63 (2013) hand disinfections, was indicative of the positive changes. Comparative analysis of the frequency of hand disinfections per patient and number of diagnostic gloves used per patient showed a significant predominance of the former. Authors suggest that it results from the high awareness of personnel on the significance of hand disinfection in the prevention of healthcare-associated GE and proper use of personal protective equipment (Tab. VIII).

DISCUSSION

Diagnosis of GE in hospitalized children should be followed by a number of prophylactic actions aimed at interrupting the transmission of infection to other patients. A list of such actions includes: isolation, meticulous compliance with the principles of hygiene, espe-

Table VI. Number and percentage of GE cases on paediatric ward by age and gender in 2007-2013

Total n = 11966		Non-infected patients	%	Patients diagnosed with HAI-GE	%	p
age (years)	0-4	7244	96.9	230	3.1	$p < 0.001$
	more than 4	4471	99.6	21	0.5	
gender	B	6239	97.9	131	2.1	$p < 0.737$
	G	5476	97.9	120	2.1	
average hospitalization (days)	0-10	10240	98.1	157	1.51	$p < 0.001$
	more than 10	1475	94.1	94	5.99	

n – number of patients, p - statistical significance, B - boy, G – girl, HAI - healthcare-associated infection, GE - gastroenteritis

Table VII. Average hospitalization (days) of patients in total and GE cases on paediatric ward in 2007-2013

Year	Average hospitalization on paediatric ward n=11966	Average hospitalization of HAI-GE case n=251
2007	8.1	18.2
2008	6.5	13.0
2009	6.4	12.0
2010	5.8	10.7
2011	5.3	7.9
2012	5.6	8.2
2013	6.0	10.1
Total	6.6	11.4

HAI - healthcare-associated infection, GE - gastroenteritis

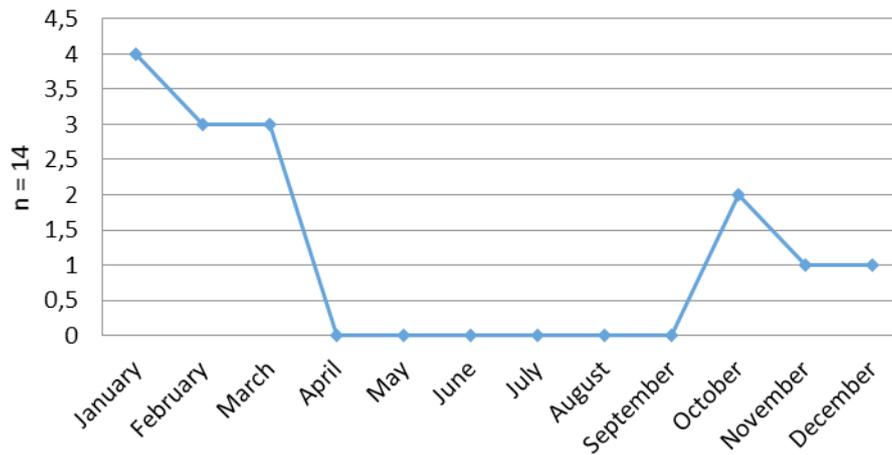


Fig. 1 Number of hospital GE outbreaks in hospitalized children in 2007 - 2013

Table VIII. Frequency of hand disinfection and number of diagnostic gloves used on paediatric ward in 2005-2013

Year	Frequency of hand disinfection	Number of diagnostic gloves used
2005	14	15
2006	12	26
2007	26	37
2008	39	32
2009	62	31
2010	60	33
2011	63	29
2012	68	38
2013	63	34
Total	407	275

cially hand disinfection and effective decontamination of equipment and rooms where patients stay. Possible reasons of healthcare-associated viral GE transmission on paediatric wards are: the presence of patients infected with rotaviruses, noroviruses and adenoviruses, lack of control in children over excretions and secretions, overcrowded wards, inappropriate hygiene behaviour in children, parents and medical personnel, failure or delay in patient's isolation and the lack of proper conditions for patient's isolation (9, 11, 12).

On ward studied, healthcare-associated GE of rotavirus origin predominated, i.e. 75.3%. A total of 4.8% of infections were attributed to co-infections with rotaviruses and adenoviruses. For 17.1% of children, no etiological agents were determined. According to Łoś-Rycharska et al. (4), infections caused by rotaviruses are very common. They account for even more than 50% of acute gastroenteritis. It is estimated that for 30% of acute diarrhoea, it is not feasible to determine the etiology. The report of the Provincial Sanitary and Epidemiological Station in Cracow as of 2013 suggests a systematic increase in the number of registered gastroenteritis of rotavirus and norovirus origin. It also

confirms an increase in the total number of gastroenteritis of viral unspecified origin. It is possible that such infections include those caused by noroviruses but were not diagnosed. Such situation results from limited laboratory diagnostics, mainly in case of outbreaks (13).

Healthcare-associated GE-RV incidence on ward studied was 1.58% (from 1.09 to 2.49%). Studies conducted in Warsaw in 2000–2001 by Frącka et al. (14) suggested incidence at 9.0% (from 5.9 to 13.4%). In the study of Sulik et al. (15), conducted in Białystok in 2003, GE-RV incidence was estimated at 2.1% (from 0.6 to 5.4%). Study of Jackowska et al. (8), carried out in Warsaw in 2005-2007, showed GE-RV incidence amounting to 2.5% (from 2.0 to 3.0%). In studies performed in Warsaw in 2006-2009 by Kuchar et al. (16), healthcare-associated GE-RV was identified in 1% of hospitalized children (from 0.9 to 1.0%). According to the results of Oldak et al. (17), the percentage of healthcare-associated GE caused by rotavirus was 0.3% (from 0.3 to 0.4%). Kuchar et al. (9) collated the results of aforesaid five studies in a meta-analysis. It suggests that approximately 0.62% (from 0.58 to 0.66%) of children hospitalized due to other reasons are affected by healthcare-associated GE-RV in Poland. Based on the review of aforesaid articles, it was noted that healthcare-associated GE-RV incidence on ward studied is higher compared to that specified in literature.

On paediatric ward studied, the average age of a child diagnosed with healthcare-associated GE-RV was 1.6. A number of publications also confirm such observations, suggesting high incidence in children aged less than 4 years (7, 8, 13, 14, 18). Several authors claim that GE-RV infections may occur more frequently in boys. Material collected in the present study, however, showed no association between GE-RV and child gender. GE-RV infections were diagnosed in boys and girls to the same extent (18, 19). Healthcare-associated GE prolongs the hospitalization of patients. From studies conducted transpires that the average hospitalization

of non-infected child on paediatric ward was 6.2 days while for those diagnosed with GE -11.2 days. Such data are similar to literature data. A number of authors emphasize that healthcare-associated GE prolongs hospitalization by 1-12 days (5, 20).

Observation of GE incidence trends suggests the seasonality of infections (14, 18). On paediatric ward studied, the peak of infections was reported between January and March. From the meta-analysis of *Kuchar et al.* (9) transpires that other studies define the peak of infections as the period between April and May. *Jackowska et al.* (8) highlight that healthcare-associated infections correlated with those community-acquired. Based on the analysis of healthcare-associated GE-RV occurrence, it was noted that such infections are closely linked with community-acquired rotavirus infections (21).

On paediatric ward enrolled into the present study, for 17% of children, no etiological agents of GE were determined. A part of these infections could have been caused by noroviruses. In the study of *Oldak et al.* (2), GE-NV incidence was 35/242 of children (14.5%). An in-depth analysis of data suggests that the peak of GE-NV incidence occurs from October to November and February and March. Literature data underscore the role of noroviruses in the etiology of GE and outbreaks (22-26). Introduction of routine testing for noroviruses in children suspected of GE could result in a decrease of infections of unspecified etiology.

Having responded to a high GE incidence in 2009 (CIR-3.21% - Tab. I), prevention actions were undertaken on paediatric ward studied, leading to a 0.5-fold decrease of GE incidence in 2013 (CIR-1.54%). A segregation point for children admitted to hospital was established with an observatory section functioning within hospital emergency department. Prophylactic actions consisted also in: precise epidemiologic interviewing at admission to hospital with regard to the general health of child and his family, strict compliance with segregation of children admitted to hospital and suspected of GE, rapid empiric isolation if GE is suspected in children hospitalized on ward, education of children, parents and guardians on hand hygiene and isolation principles. Educational activities were held at the day of admission to hospital and repeated in the successive days of hospitalization. Furthermore, ward rooms were modernized by placing a cooker for parents as to prepare meals for children aged less than 2 years, who do not eat food cooked in hospital milk kitchen, and setting an additional sanitary unit with a shower for parents of isolated children.

SUMMARY AND CONCLUSIONS

In the light of results of the present study and our considerations, we claim that effective methods of prevention of healthcare-associated GE are: precise epidemiological interviewing, rapid microbiological diagnostics, children segregation at admission to hospital, effective isolation of both children infected and suspected of infection, compliance with hand hygiene principles by personnel, patients, guardians and visiting persons and promoting vaccination against rotavirus. Prophylactic actions introduced on paediatric ward of St. Lukas Provincial Hospital in Tarnów resulted in a significant decrease of healthcare-associated GE incidence. Routine testing of patients for noroviruses may be of assistance in explaining GE of unknown etiology.

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