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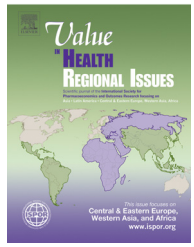

Cost Burden of Severe Community-Acquired Rotavirus Gastroenteritis Requiring Hospitalization in the Czech Republic, Slovakia, Poland, and Hungary: A Retrospective Patient Chart Review

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A B S T R A C T

Objectives: To provide valuable local data on the economic burden of rotavirus gastroenteritis (RVGE) for decision making on introduction of rotavirus vaccination in Central European countries. **Methods:** We conducted a retrospective patient hospital chart review during the winter RVGE peak in the Czech Republic (n = 109), Hungary (n = 109), Poland, (n = 112), and Slovakia (n = 115) to estimate resource use and associated costs from the payer's perspective in children younger than 5 years with severe RVGE requiring hospitalization. Microcosting analysis was used to estimate the average costs of treating RVGE inpatients including pre- and posthospitalization costs. **Results:** The average cost of treatment was €476, €316, €741, and €594 in the Czech Republic, Hungary, Poland, and Slovakia, respectively. Extrapolating these costs to the total number of RVGE hospitalizations gives annual cost estimates of €2.1 million, €1.5 million, €13.2 million, and €1.5 million, respectively. The main component of expenditure in all the four countries is the hospital stay, but wide variation among countries was observed (total cost of treating RVGE in hospital was almost 2.5-fold higher in Poland than in Hungary). In countries with diagnosis related group (DRG) costs available, the best agreement between real resource-use–driven costs and the DRG cost was found in the Czech Republic and Hungary, with differences of only €22 and €33, respectively. In Poland, the microcosting indicated higher overall costs incurred in hospital than the DRG cost, with a difference exceeding €190. **Conclusions:** Hospitalization of children with RVGE represents a substantial economic burden for the national health systems in these countries.

Keywords: chart review, cost burden, incidence, rotavirus gastroenteritis, vaccination, Visegrad region.

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Introduction

Rotavirus (RV) is one of the leading causes of gastroenteritis, often associated with severe diarrhea and dehydration, in infants and young children throughout the world [1]. RV infection among children younger than 5 years is associated with significant mortality, predominantly in countries with insufficient health care infrastructure and access [2]. It causes an estimated 6,550 deaths (range 5,671–8,989) and 146,287 hospital admissions (range 38,374–1,039,843) each year in children younger than 5 years in the World Health Organization (WHO) European region [3]. The average annual mortality rate for children younger than 5 years in this region is 2 per 100,000, calculated from the United Nations Children's Fund data [4].

RV caused 25.3% to 63.5% of acute gastroenteritis cases in children younger than 5 years in Western Europe, with a peak

Conflicts of interest: A. Tichopad and J. Müllerová are employees of Kantar Health (formerly CEEOR), which received funding from the GSK group of companies to complete the work presented in this article. T. Jackowska received honorarium from CEEOR, on the basis of a civil law services contract, for providing her support, advice, professional expertise, and project dossier validation as well as for project running in one of the partaking research sites. She also received honorarium from the GSK group of companies for holding lectures and trainings within other projects and was the investigator in clinical studies conducted by the GSK group of companies. B. Sloesen is an employee of the GSK group of companies and holds stock options in the GSK group of companies. E. Nemes, P. Pazdiora, and M. Štefkovičová declare no conflicts of interest.

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during winter, according to a recent review of 76 studies from 16 countries [5]. The first infection is usually the most severe [6], and most symptomatic episodes occur in young children between the ages of 3 months and 2 years. It was estimated that 3.6 million episodes of RV disease occur annually among the 23.6 million children younger than 5 years in the European Union (EU), accounting for more than 87,000 hospitalizations and almost 700,000 outpatient visits per year [7].

Many countries in Europe have implemented the vaccination of healthy infants against RV as recommended by the WHO in 2009 [8,9], including Austria, Belgium, Estonia, Finland, Germany, Greece, Latvia, Luxembourg, Norway, and the United Kingdom, as well as some regions in Italy and Sweden.

The Visegrad Group (V4) is a group of four former socialist countries in the central part of Europe: the Czech Republic, Hungary, Poland, and Slovakia. It represents an integrated sociopolitical region with similar history, economy, and health care systems. All four have been members of the EU since 2004. The underlying epidemiology and health care may have been substantially shaped by the residual cultural and economic influences of the past, yet both have rapidly improved during the past two decades, largely as a result of decentralizing the health care sector in varying degrees [10]. With the increasing significance of health technology assessment procedures in all EU countries, there is a fundamental need for solid underlying evidence in any further consideration of reimbursement of innovative medicinal products [11].

In the most recent article from the region, the incidence of rotavirus gastroenteritis (RVGE) per 100,000 in children younger than 5 years was reported as 649.1 in the Czech Republic, 168.55 in Hungary, and 1125.64 in Slovakia. The underlying data, however, are most likely underreported [12,13]. Moreover, testing the disease etiology of gastroenteritis is not mandatory and not systematically performed, especially for patients treated in an outpatient setting without referral to a hospital. Moderate RVGE cases treated as outpatients or mild cases treated at home are therefore largely unknown. Severe RVGE cases requiring hospitalization may be better captured within the national databases hosted by epidemiology surveillance programs or national health care fund records, but these may not fully reflect the real burden [7].

In this article, we report results from a burden-of-disease study based on a retrospective patient chart review conducted in patients admitted to hospitals in the V4 during 2013. Health resource use in prehospitalization and posthospitalization care was also captured. In addition, we attempted to establish, by means of extrapolation, the overall burden of disease for all cases of RVGE, regardless of the point of care, using empirical ratios between the three RVGE severity classes.

Methods

Retrospective Patient Chart Review

The study was based on a multicenter, international, retrospective patient chart review involving 14 hospital centers in the Czech Republic, 10 in Hungary, 9 in Poland, and 14 in Slovakia. In total, 445 patient charts from the Czech Republic (n = 109), Hungary (n = 109), Poland (n = 112), and Slovakia (n = 115) were randomly selected and studied. The selection of centers involved in the study aimed to achieve a good representation of all national regions and a good distribution between city and rural centers in the sample. Inclusion criteria for the selection of patient charts restricted the reported cases to all hospitalized children younger than 60 months (at diagnosis of RVGE) with RVGE as defined by either the Ninth or Tenth revision code of the *International Classification of Diseases* (*ICD-9* or *ICD-10*), confirmed by an etiology test. The complete patient charts were required to be available to provide information on previous medical care and/or subsequent referral, if any. Nosocomial infections were not considered in this study. Because of the local regulations on noninterventional retrospective chart reviews, no informed consent was required. The project approval was issued within a centralized course of proceedings by an ad hoc body competent to examine the dossier under the local regulations relevant in this matter. No approval was required in Poland.

Because of the seasonal character of RVGE, the preferred method was to select 10 cases randomly from the list of patients hospitalized for RVGE in the winter RVGE peak between January 1 and May 31, 2013. The physician provided an anonymized list of identifiers of all patients to the research organization and received back a list of randomly selected patients to include in the study. The sample size was selected on a pragmatic basis, and the study planned to capture data from a minimum of 100 patients hospitalized with RVGE in each of the countries. Data were entered by doctors in an electronic case report form and immediately transferred and stored within a secured database. The method used in RV testing was selected from a list containing the following options: enzyme-linked immunosorbent assay, electron microscopy, latex agglutination, polymerase chain reaction, immunochromatography, or any other (which needed to be specified). There was no need of any further specification of the manufacturer, specificity, and sensitivity.

The database was locked as soon as all the centers confirmed that they had provided data on all available patients, when the total number of patients within each national database reached at least 100.

Resource Use Analysis

From each individual patient chart, physicians transferred information into the electronic case report form relating to the age of the patient, length of hospital stay, type of ward, medication used, route of admission and previous treatment, examinations and diagnostic tests performed, and subsequent referral or follow-up. To ensure sensitivity to various cost sources, specific types of hospital wards were selected in each country. In the Czech Republic and Slovakia, data were obtained for patients hospitalized in pediatric wards or in infectious disease wards. In Hungary, data were obtained for patients hospitalized in pediatric gastroenterology or in infectious disease wards. In Poland, children are hospitalized only in pediatric wards. Therefore, to be sensitive to cost variations, hospitals in Poland were selected according to their regional importance, that is, county hospital, regional hospital, or university hospital.

Costs

Costs were considered solely from the perspective of the payer. The costs were categorized by phase of treatment: 1) before hospitalization, associated with the initial physician contact followed by referral to hospital; 2) during hospitalization; and 3) posthospitalization but still associated with the cause of hospitalization. The total cost per RVGE case treatment encompassed the following items: prehospitalization cost (cost of a single consulting), admission cost, etiology test cost, medication cost, examinations cost, interventions cost, posthospitalization cost, and the cost of hospital stay. The overall cost burden of severe RVGE in the four countries was estimated on the basis of the national epidemiological data provided on our formal demand by the relevant data holders managing local health insurance funds and incidence registers. Indirect costs were not considered. In three countries, national diagnosis related group (DRG) codes were available and were used to estimate the reimbursement level for each treated case. In the Czech Republic and Poland, more than one DRG code was recorded and a weighted mean was used

to establish a central estimate for each country. In Hungary, the average DRG cost for *ICD-10* code A08.0 (rotavirus enteritis) was obtained from the National Health Fund. In Slovakia, where no DRG system is in place, the arithmetic mean of reimbursement figures received during an investigation in five hospitals was calculated and used for all patients in the study regardless of hospitalization facility (referred to in this article as "contractual reimbursement") [14]. Nevertheless, the contractual reimbursement is specific to each hospital, often based on confidential agreements between the respective hospital and a health fund.

Microcosting analysis was used to estimate total costs including prehospitalization and posthospitalization costs. In the Czech Republic [15], Slovakia [16], and Hungary [17], resource use data on examinations, test procedures, and medication [18–23] were associated with reimbursement levels retrieved from national reimbursement lists governed by national law acts and implementing decrees. The costs of hospital stay in the Czech Republic were obtained on the basis of a length-of-stay principle as described in the Collection of Laws of the Czech Republic [24,25]. In Poland, the cost of all microcosting items was calculated on the basis of the hospitals' price lists published on the Internet [26–31]. These price lists are usually used in cases in which medical care is provided to uninsured beneficiaries. For this reason, expenses determined by this method may diverge slightly from the "real prices" of medical care as considered from the payer's perspective. These, however, were the only reliable sources providing detailed accounts suitable for use in microcosting.

Burden of Disease

Reporting of infectious diseases is mandatory in the Czech Republic. The obligation to report is based on Act No. 258/2000 on the protection of public health. In 2011, 4494 RVGE cases in children younger than 5 years were captured within the EPIDAT surveillance system under the *ICD-10* code A08.0. RV testing is mostly conducted in inpatient cases and therefore the cases reported to EPIDAT are almost exclusively severe.

In Hungary, the number of hospitalized RVGE cases was derived from data obtained on authors' request from the Hungarian National Health Fund (OEP) for 2012. Our study showed that in Hungary, only 33% of RVGE cases are reported as under A08.0 code (1413 children <5 years in 2012), and hence the total true number of RVGE cases requiring hospitalization can be estimated as 4282 because many other real RV-positive cases were reported by physicians under other DRG (*ICD-10*) codes, as our chart review showed.

In Poland, publicly available data published once per annum by the National Healthcare Fund (NFZ) include only the hospitalized RVGE cases, reported within a broad reference group labeled P22 (infectious and noninfectious stomach and intestine inflammations in patients aged 0–18 years). To obtain a specific number of RVGE cases in those younger than 5 years (17,794 children in 2012), additional specifications had to be provided by the National Healthcare Fund upon authors' request.

Similar to the Czech Republic, reporting of infectious diseases into their surveillance system called EPIS is mandatory in Slovakia as dictated by Act No. 355/2007. In total, 2560 RVGE cases in children younger than 5 years reported in 2012 served as the basis for extrapolation.

Starting with the total number of RVGE cases, the extrapolation rules as published by Soriano-Gabarro et al. [7] helped us to roughly reproduce the whole RVGE burden of disease across all severity grades. The approach is based on empirical observation that for each child hospitalized, approximately 8 children (range 5–10) require a visit to a health care facility or physician's office, and that for each child requiring medical care, approximately 4 children are treated at home.

Statistical Analysis

Descriptive statistics were applied to metric and categorical data using SAS 9.3 (SAS Institute, Inc., Cary, NC) for Windows. The data were classified by country to permit national comparisons. No formal study hypothesis was defined.

Results

Study Population

The retrospective chart reviews were accomplished by 14 Czech centers in 7 days, by 10 Hungarian centers in 51 days, by 9 Polish centers in 32 days, and by 14 Slovak centers in 14 days. The mean (minimum to maximum) age was 26.4 (1–60) months in the Czech Republic, 21.9 (1–57) months in Hungary, 20.1 (0–56) months in Poland, and 21.4 (0–58) months in Slovakia. No deaths due to RVGE were reported in the assessed period.

Resource Use

The mean (minimum to maximum) length of stay across all age groups was 4.9 (2–13) days in the Czech Republic, 5.6 (2–16) days in Hungary, 5.2 (2–19) days in Poland, and 5.1 (3–18) days in Slovakia. The longest stay was consistently observed in the group of patients younger than 12 months in all countries, with a tendency to decrease toward older ages (Table 1). In the Czech Republic, 35% of patients stayed in the intensive care unit for at least 1 day, with a mean length of stay of nearly 3 days.

The most frequently used RV diagnostic tests during hospitalization were immunochromatography in Hungary, Poland, and Slovakia (78%, 99%, and 93% of cases, respectively) and latex agglutination in the Czech Republic (44% of cases) (Table 2). The second most frequent RV diagnostic tests used during hospitalization were latex agglutination in Hungary, Slovakia, and Poland (14%, 7%, and 1% of cases, respectively) and immunochromatography in the Czech Republic (39% of cases).

Among other tests performed during hospitalization, the most frequent were biochemistry C-reactive protein (97% of cases) in

Table 1 – Length of hospital stay in days by age group and country and the number of subjects in each group.

Age group (mo)	Czech Republic	Hungary	Poland	Slovakia
<12	5.8 (3.0–13.0; 23)	6.9 (3.0–16.0; 30)	6.3 (5.0–19.0; 36)	5.8 (2.5–14.0; 38)
12–23	5.0 (3.0–12.0; 33)	5.1 (2.0–10.0; 37)	5.0 (4.0–12.0; 38)	4.7 (3.0–9.0; 33)
24–35	4.1 (3.0–8.0; 18)	5.4 (3.0–8.0; 22)	4.5 (4.0–8.0; 23)	4.6 (3.0–7.0; 17)
36–47	4.6 (3.0–7.0; 19)	5.1 (3.0–10.0; 11)	3.6 (3.5–5.0; 8)	4.5 (3.0–6.0; 15)
48–59	4.3 (2.0–7.0; 16)	4.1 (2.0–7.0; 9)	4.7 (5.0–7.0; 7)	5.0 (3.0–8.0; 11)
Total	4.9 (2.0–13.0; 109)	5.6 (2.0–16.0; 109)	5.2 (2.0–19.0; 112)	5.1 (3.0–18.0; 115)

Note. Values are shown as mean (minimum–maximum; N).

Table 2 – Frequency (%) of RV diagnostic test and other tests used.

Test used	Czech Republic (n = 109)	Hungary (n = 109)	Poland (n = 112)	Slovakia (n = 115)
RV diagnostic test				
ELISA	23	7	0	1
Latex agglutination	44	14	1	7
Immunochromatography	39	78	99	93
PCR	0	0	0	1
Other	0	1	0	0
Other tests performed during hospitalization				
Biochemistry, chlorides	84	51	61	98
Biochemistry, ALT	91	42	81	90
Biochemistry, C-reactive protein	97	86	99	97
Biochemistry, potassium	92	88	100	98
Biochemistry, sodium	92	88	100	98
Blood cell counts with differential	87	83	100	82
Glucose—quantitative determination	82	60	70	97
Stool culture	89	91	39	97
Urinalysis chemically and microscopically	93	82	93	95

Note. In the Czech Republic and Slovakia, more than one RV diagnostic test might have been used simultaneously.
ALT, alanine aminotransferase; ELISA, enzyme-linked immunosorbent assay; PCR, polymerase chain reaction; RV, rotavirus.

the Czech Republic; stool culture (91%) in Hungary; biochemistry sodium, potassium, and blood counts (100%) in Poland; and biochemistry sodium, chlorides, and potassium (98%) in Slovakia (Table 2).

Intravenous rehydration was applied in 84% of cases in the Czech Republic, 95% in Hungary, 99% in Poland, and 97% in Slovakia.

The routes of hospital admission by country are presented in Table 3. In the Czech Republic and Slovakia, patients were admitted to hospital mainly via the emergency unit (45% and 61%, respectively), whereas in Hungary and Poland, the most prevalent route for admission to hospital was following a visit to a general pediatric practitioner (43% and 41%, respectively). The pathway followed by patients also differed between countries (Table 3). In all four countries, most of the patients arrived at hospital after previous outpatient contact and were followed-up again in an outpatient setting after hospitalization (65% in the Czech Republic, 70% in Hungary, 66% in Poland, and 98% in Slovakia).

The types of medication used by country and type of facility are presented in Table 4. The largest differences between countries were observed in the use of probiotics, whereas the smallest differences related to the use of anti-inflammatories.

A specific question added for Poland revealed that for 100% of the children hospitalized, one of the parents stayed in the hospital for the whole duration of hospitalization.

Costs

An overview of the total cost by type of facility, including the costs incurred before and after hospitalization, is presented in Table 5.

Considering hospitalization costs alone, the discrepancy observed between the truly reimbursed costs (DRG or contractual reimbursement) and the costs as calculated by microcosting varied by country. Using microcosting analysis, the estimated average costs of treating an RVGE inpatient case including prehospitalization and posthospitalization costs were €476, €316, €741, and €594 in the Czech Republic, Hungary, Poland, and Slovakia, respectively. In Slovakia, where the DRG system is not in place, reimbursement levels are subject to individual

Table 3 – Frequency (%) of route of hospital admission and treatment pathways for patients with severe RVGE requiring hospitalization.

Patient pathway & admission	Czech Republic (n = 109)	Hungary (n = 109)	Poland (n = 112)	Slovakia (n = 115)
Route of admission				
Emergency	45	20	28	61
Central admission	21	24	31	1
GPP referral	34	43	41	34
Other	0	13	0	4
Patient pathway				
Direct hospital admission, no FU	4	1	1	0
Hospital → outpatient FU	17	23	30	1
Outpatient → hospital → outpatient FU	65	70	66	98
Outpatient → hospital	14	6	3	1

FU, follow-up examination in another outpatient setting or in the hospital following discharge from the hospital; GPP, general pediatric practitioner; RVGE, rotavirus gastroenteritis.

Table 4 – Medication used during hospital stay by type of ward/department and country.

Medication class	Czech Republic			Hungary			Poland				Slovakia		
	INF	PED	TOT	INF	PGE	TOT	COU	REG	UNI	TOT	INF	PED	TOT
Anti-inflammatories (%)	43	65	59	58	48	56	50	58	50	53	70	56	58
Antidiarrheal (%)	3	41	30	21	36	25	60	6	42	38	45	46	46
Antibiotics (%)	23	16	18	15	32	19	27	22	8	21	15	9	10
Probiotics (%)	40	80	69	25	48	30	75	58	96	74	20	73	63
Total number of patients	30	79	109	84	25	109	52	36	24	112	20	95	115

COU, county hospital; INF, infectious disease wards; PED, pediatric wards; PGE, pediatric gastroenterology; REG, regional hospital; TOT, total; UNI, university hospital.

negotiations. The striking difference between the two types of inpatient settings in Slovakia can be due to the inclusion of an extreme observation in one of the only two infectious disease settings involved (Table 5). The overall national structure of costs obtained by microcosting is shown in Figure 1. The cost of the hospital stay was the dominant source of expenditure in all four countries, representing 82% to 91% of the total cost.

Burden of Disease

There were in total 1.19 million cases of RVGE in the four countries, of which 29,130 required hospitalization, 233,039 were treated as outpatients, and 932,154 were mild cases treated at home. The burden of disease estimated for all three severity degrees and four countries is presented in Table 6.

On the basis of the number of cases, the total annual cost of severe RVGE from the payer's perspective in children younger than 5 years was estimated at €2.1 million in the Czech Republic, €1.5 million in Hungary, €13.2 million in Poland, and €1.5 million in Slovakia, giving a total of €18.2 million in the V4.

Discussion

The main reason for conducting this study was to provide sufficiently robust underlying data to facilitate health economic evaluations that are now fundamental to any discussion between protagonists of vaccination programs and payers. Although some useful epidemiology figures on RVGE are available already from secondary databases, the resource use and costs data essential to any health economic consideration have been missing. So far, only rough estimates on costs associated with the treatment of RVGE were available, or the costs were largely neglected because gastroenteritis is frequently perceived as only a minor impairment not requiring more than a single consultation of a family practitioner or pediatrician.

Since 2006, two RV vaccines have been available in Europe (Rotarix [GSK Biologicals, Rixensart, Belgium] and RotaTeq [Merck and Co., Inc., Kenilworth, NJ]). This has triggered studies estimating the economic burden of RV disease. The WHO has also recommended that economic aspects should be included in decision making about the potential introduction of a nationwide RV vaccination program, in their positive position toward RV vaccination [32]. A recently conducted cost-effectiveness evaluation in Germany revealed incremental costs of €184 to prevent one RVGE case and €2457 to prevent one RV-driven hospitalization when using Rotarix vaccine compared with no vaccination [33]. Results from lower income EU countries, such as the V4 countries studied here, are expected to differ from the German figures, largely because of differences in cost structures. The DRG system has been established in the Czech Republic, Hungary, and Poland in recent years with the aim of standardizing the reimbursement of inpatient costs. In Slovakia, the discussion on DRG introduction was ongoing and no implementation had yet taken place at the time of this study. It has been shown that the true costs may differ significantly from the DRG costs, if considered in detail using the microcosting approach [34].

In our analysis, the total cost for treating RVGE in hospital was considerably different among countries. The total cost was almost 2.5-fold higher in Poland than in Hungary. The best accord between real resource-use-driven costs and the DRG cost was in the Czech Republic and Hungary, with a difference of only €22 and €33, respectively. In Poland, however, the microcosting

Table 5 – Total costs (€) by type of facility and country including costs incurred before and after hospital stay.

Cost	Czech Republic (n = 109)	Hungary (n = 109)	Poland (n = 112)	Slovakia (n = 115)
Microcosting in hospital				
Infectious disease setting	396.8 (n = 30)	320.8 (n = 84)		1126.8 (n = 20)
Pediatric setting	506.7 (n = 79)			481.8 (n = 95)
County hospital			740.0 (n = 52)	
Regional hospital			701.2 (n = 36)	
University hospital			804.3 (n = 24)	
Pediatric gastroenterology		298.1 (n = 25)		
Average total hospital costs	460.9	306.2	716.9	577.6
Average total costs (including prehospitalization and posthospitalization costs)	476.4	315.6	741.3	594.0
DRG or contractual reimbursement	483 (DRG)	273 (DRG)	522 (DRG)	520 (Contractual)

DRG, diagnosis related group.

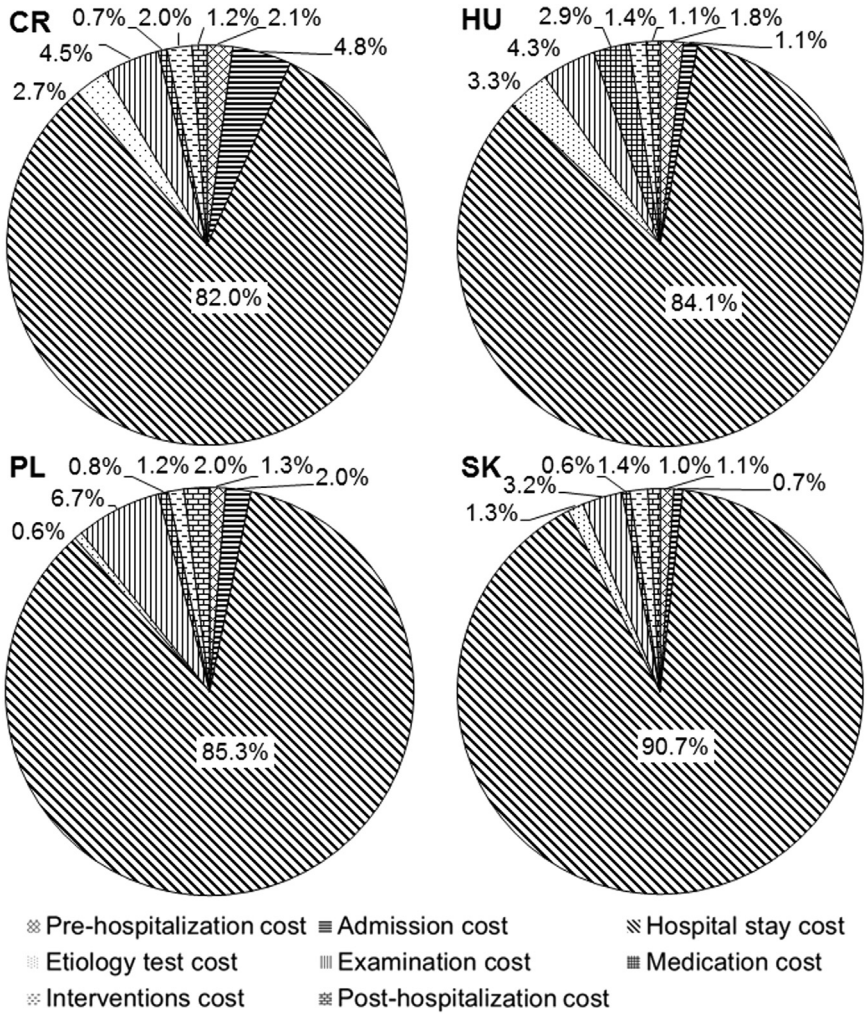

Fig. 1 – The national structure of costs of RVGE requiring hospitalization as reproduced by microcosting analysis. CR, Czech Republic; HU, Hungary; PL, Poland; RVGE, rotavirus gastroenteritis; SK, Slovakia.

indicated higher overall hospital cost than the DRG cost, with the difference exceeding €190. Such a discrepancy has also been previously reported for the treatment of community-acquired pneumonia [34]. In Poland, published price lists were applied in case of medical care provided to uninsured beneficiaries, including a higher margin. This explains why the expenses determined by this method could diverge from the "real prices" of medical care as seen from the payer's perspective. The Slovak system is based on bilateral contracts between hospitals and health funds, and unfortunately offers limited accuracy to power any similar quantitative analysis. The ordered by size expenditures for RVGE treated in hospital as provided herein correlate with the health expenditure per capita for the Czech Republic, Hungary, and Slovakia (1,982; 1,839; and 12,147 purchasing power parity US $ 2013) [35]. Discordant with this pattern, Poland shows disproportionally high calculated costs for treating RVGE requiring hospital

Table 6 – Annual burden of RV disease in children younger than 5 y.

Country	Cases			Incidence per 100,000		
	Hospitalized cases (severe RVGE)	GPP visits (medium RVGE)	No visits (mild RVGE)	Hospitalized cases (severe RVGE)	GPP visits (medium RVGE)	No visits (mild RVGE)
Czech Republic	4,494	35,952	143,808	761	6,090	24,360
Hungary	4,282 (1,413)*	34,255	137,018	909	7,273	29,085
Poland	17,794	142,352	569,408	865	6,923	27,692
Slovakia	2,560	20,480	81,920	884	7,073	28,292

GPP, general pediatric practitioner; RV, rotavirus; RVGE, rotavirus gastroenteritis.
* A total of 1413 cases reported with code A08.0.

stay (compared with its health expenditure per capita [1551 purchasing power parity US $ 2013]). The costs in Poland are the highest among the four countries regardless of whether they are based on DRG or microcosting. Another relative comparison of the RVGE expenditures can be facilitated by comparing it with the net average wages, ranging from €570 (Hungary) to €793 (the Czech Republic) as provided by Eurostat.

The low prehospitalization and posthospitalization costs identified in this study show that the different pathways followed by patients with severe RVGE have a relatively limited economic impact, compared with the cost of the hospitalization. Our estimate of the extrapolated overall economic burden of severe RVGE from the payer's perspective, including expenditures incurred in either outpatient or inpatient treatment, amounted to €18.2 million in the V4, which should be considered rather a very conservative estimation because it is generally recognized that the public RVGE records are underestimated. This refers only to direct costs and does not consider the indirect costs associated with, for example, the absence from work of parents who often accompany their children to hospital. This can be considered a major limitation of this study. The data were collected at hospitals, and hence are very detailed as to resource use during the hospital stay. The costs incurred before and after admission could be estimated only on the basis of reimbursement codes (individual medical consulting) without deeper investigation of individual medication and examinations use. For RVGE, however, the medication cost for the payer during initial and follow-up medical consultation is believed to be negligible (typically antipyretics) and rather paid out of the patient's pocket. During the hospitalization though, the patient typically incurs no costs. Regarding indirect costs for the society, a specific question added in Poland revealed that for 100% of the infants hospitalized, one of the parents also stayed in hospital during the whole hospitalization period. This absence from work/daily activities highlights that a case of severe pediatric RVGE represents an important burden for the family. Although this was not addressed in the other participating countries, it is expected to be similar. These indirect costs are often not presented to the payer or national regulator, yet they may represent a significant burden for the family, especially when both parents are full-time employees. In addition, it has been shown that parents of a child with acute RVGE experience worry, distress, and disruptions in daily life as a result of the child's illness, with a trend toward higher impact on parents' daily activities and higher parental distress as the severity of symptoms increases [36].

Nosocomial infections were not considered in this study. It has been suggested that nosocomial RVGE may affect as many children as can community-acquired RVGE [37]. Nosocomial RV infections impose a major burden among all other hospital-acquired infections, and data on their incidence are largely missing or underreported, often because of the limitations in conducting such studies [38]. Conducting a nonbiased study to evaluate nosocomial infections may be technically very challenging because a proportion of patients may manifest symptoms after discharge, thus obscuring the association to the primary source of the infection.

Conclusions

We conclude that RVGE in children, especially if it leads to hospitalization, imposes a substantial economic burden on payers, predominantly because of the costs of hospital stay. RVGE deserves increased attention in a European context for its economic impact, which could be substantially offset by prevention programs such as nationwide vaccination of infants.

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