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Observations on the epidemiology of rotavirus infection among hospitalized children younger than 5 years in 2 Ukrainian hospitals, 2007–2015

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Abstract

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Conflict of interest

All authors, no conflicts.

Disclaimers

The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the World Health Organization or Ministries of Health with which they are affiliated.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Background: Acute gastroenteritis remains a burden among children under 5 years of age. Ukraine joined the World Health Organization's Global Rotavirus Surveillance Network in 2006, with a goal of providing accurate rotavirus burden data to aid policy makers in planning for rotavirus vaccine introduction. This analysis describes rotavirus epidemiology among Ukrainian children enrolled in Kyiv and Odesa, two large Ukrainian cities.

Methods: Children 0–59 months of age hospitalized for acute gastroenteritis at 2 sentinel sites in Kyiv and Odesa were enrolled into the active, prospective surveillance program. In Odesa, the surveillance period was during 2007–2015 and in Kyiv, it was during 2011–2015. Acute gastroenteritis was defined as 3 or more episodes of diarrhea per day during a 24 h period, with symptom duration before hospitalization not exceeding 7 days. Guardians of enrolled children completed a questionnaire including demographic, clinical and treatment information. Each child provided a stool specimen within 2 days of hospitalization. Stools were tested for rotavirus using ProSpecT™ Rotavirus Kit (Oxoid Ltd., Great Britain), and positive specimens were genotyped. Descriptive data are reported, as well as comparison of demographic, clinical and treatment data among rotavirus positive and negative children.

Results: During July 2007–June 2015, 12,350 children were enrolled in the surveillance programs and had stool specimens collected and tested for rotavirus. Overall, rotavirus infection was diagnosed in 5412/12350 (44%) of children, 929/1734 (54%) of those in Kyiv and 4483/10616 (42%) in Odesa. Rotavirus infections peaked during the winter months. Children with rotavirus acute gastroenteritis displayed more severe clinical symptoms than those without rotavirus. Predominant genotypes identified included G1P[8], G2P[4], G3 P[8], G4 P[8] and G9 P[8].

Conclusion: Active surveillance of acute gastroenteritis in hospitalized children younger 5 years in two large Ukrainian cities reveals a significant burden of rotavirus infection. These data provide scientific justification for incorporating rotavirus vaccines into the Ukrainian national immunization schedule.

Keywords

Rotavirus; Acute gastroenteritis; Diarrhea; Pediatric; Vaccine

1. Background

Acute gastroenteritis (AGE) remains a burden among Ukrainian children, with more than 50,000 cases of AGE registered annually [1]. The etiology of the majority of these AGE cases remains unspecified and data concerning rotavirus detection are lacking because diagnosis of rotavirus infection is not routinely performed in medical units. In December 2006, Ukraine joined the World Health Organization's Global Rotavirus Surveillance Network (WHO GRSN) [2,3] in order to document rotavirus disease burden for future consideration of rotavirus vaccine (RVV) introduction. Data from 2007, the first year of the network, showed that among hospitalized Ukrainian children with AGE, 49% were rotavirus positive in Kyiv and 41% in Odesa [3].

In 2010, the Ministry of Health of Ukraine (MOH) recommended use of monovalent Rotarix (RV1, GlaxoSmithKlein), and it was subsequently offered through the private

market. The health benefits of RVV after its incorporation into national immunization schedules elsewhere has been well documented [4–7]. After universal RVV introduction in the Republic of Moldova, the percentage of hospitalization with rotavirus gastroenteritis fell from 45% to 25% in the first post-vaccine year and 14% in the second post-vaccine year, among children less than 5 years of age [8]. Similarly in Armenia in the first and second surveillance years after RVV introduction, the percentage of rotavirus-positive hospital admissions among those aged less than 5 years fell from 38% to 20% and 10%, respectively [9]. In Ukraine, the introduction of RVV as a recommendation and not as an obligatory vaccine in the national immunization program, has led to coverage of only 0.15–0.6% (our unpublished data).

As incorporation of RVV into the national immunization schedule is currently under consideration, our objective is to describe the epidemiology of rotavirus disease among Ukrainian children from sites participating in the WHO GRSN during 2007–2015.

2. Methods

2.1. Patients and setting

Children under 5 years of age who were hospitalized for AGE at 2 sentinel sites in Kyiv and Odesa, which are the largest and third largest cities in Ukraine, respectively, were enrolled into the active, prospective surveillance program. In Kyiv, the site was a large pediatric hospital with 450 beds, which included an infectious disease department with 40 beds, while in Odesa, the site was an infectious disease hospital with 90 pediatric beds. Both the pediatric hospital and the pediatric unit of the infectious disease hospital served children under 18 years of age. Initially, surveillance in Odesa was conducted three times weekly during Monday–Friday, increasing to daily surveillance by 2013. Since joining the GRSN in 2006, Ukraine's sentinel sites experienced interruptions in surveillance, which precluded inclusion of all surveillance years in this analysis; in Odesa, the uninterrupted surveillance period included 2007–2015 while in Kyiv, it included 2011–2015.

2.2. Case definition and enrollment

Enrollment procedures followed the WHO standard protocol for rotavirus surveillance [10]. Children aged 0–59 months were included if they were hospitalized for AGE. AGE was defined as 3 or more episodes of non-bloody diarrhea per day during a 24 h period, with the duration of symptoms before hospitalization not exceeding 7 days. Once consent was provided, guardians of enrolled children were administered a standard questionnaire collecting demographic and clinical information and afterwards, a stool specimen was collected from enrolled children. The ethical commission of both hospitals approved this surveillance protocol.

2.3. Laboratory testing

Stool samples were collected within 2 days of hospital admission and sent to the virology laboratories of the Sanitary and Epidemiological Service (SES) for testing. Rotavirus detection was performed using ELISA (ProSpecT™ Rotavirus Kit, Oxoid Ltd., Great Britain) testing. One-hundred rotavirus positive and 50 rotavirus negative samples were

randomly sampled and sent to the WHO reference laboratory (London, UK, 2007; Minsk, Belarus - since 2008) for confirmatory testing and characterization of rotavirus genotypes. Genotyping of positive samples was performed using multiplex RT-PCR. In some cases, when genotyping by RT-PCR yielded un-typable results, sequencing of VP4 (P) and VP7 (G) genes was conducted.

2.4. Analysis

We report descriptive data for children enrolled during the surveillance period for years where data were available continuously for every month of the year. Surveillance was interrupted for one month in Odesa during January 2011, otherwise data were available for 2007–2015. Continuous data were available for 2011–2015 in Kyiv. Surveillance years were defined as July of one year through June of the following year. Analyses were restricted to data from children with a stool specimen collected within 2 days of hospital admission to avoid detection of nosocomial infections. Severity scores were modeled after the Vesikari scale [11]. As information on temperature and dehydration status, both required for the traditional Vesikari scale, were not systematically collected, a maximum 15 point scale was constructed using available variables. These included: duration of diarrhea, maximum number of episodes of diarrhea, duration of vomiting, maximum number of episodes of vomiting, IV rehydration, and whether the child spent at least one night in the hospital. A two-level (0–8 and 9 and above) and three-level (0–8, 9–10 and 11 and higher) severity score was calculated. Higher scores indicate greater severity. We also categorized children as rotavirus positive or negative and compared these groups using Chi-square, Fisher's exact or Wilcoxon-Mann-Whitney tests. P-values $< .05$ were considered statistically significant.

3. Results

During July 2007–June 2015, 10,784 children younger than 5 years were enrolled in the surveillance programs in Odesa, and during July 2011–June 2015 1771 children were enrolled in Kyiv (Table 1), representing 78% and 88% of eligible children, respectively. Of these enrolled children, 10,616 (98%) and 1734 (98%) had stool specimens collected and tested for rotavirus in Odesa and Kyiv, respectively. During the surveillance period, fluctuations in enrollment at each site were observed. A lower percentage of enrolled children was observed during Jul 2011–Jun 2012 in Kyiv, with 64% of children enrolled, and in Odesa lower enrollment was seen during each of the surveillance years between Jul 2007 – Jun 2012, with between 56–64% of eligible children enrolled.

Overall, rotavirus infection was detected in 5412/12350 (44%) of children; 929/1734 (54%) of those in Kyiv and 4483/10616 (42%) in Odesa. In some years the proportion of rotavirus positive cases was as high as 60% (Kyiv) or as low as 39% (Odesa). In general, the proportion of rotavirus positive children was higher in each year in Kyiv as compared to Odesa.

Rotavirus detection occurred similarly among boys and girls (Table 2). The median age of rotavirus positive children was slightly higher as compared to rotavirus negative cases in both sites (21 vs 18 months in Kyiv and 24 vs 21 months in Odesa, both $p < .01$). Both in Kyiv and in Odesa AGE was significantly more often due to rotavirus rather than

non-rotavirus etiology among children 12–23 months old; 36% vs 29% in Kyiv and 30% vs 25% in Odesa, both $p < .01$. Among the rotavirus positive cases, 50% occurred among children between 6–23 months of age in Kyiv, and 45% in Odesa.

Similar clinical characteristics were observed in both Kyiv and Odesa. Rotavirus positive children had significantly more episodes of diarrhea as compared to rotavirus negative children, and a significantly higher proportion had experienced vomiting, with higher number of vomiting episodes reported. Rotavirus positive children were also significantly more febrile and scored higher on the severity grouping scores as compared to their negative counterparts.

Treatment differed between the sites, with nearly all children receiving intravenous hydration in Odesa, whether rotavirus was detected or not, whereas in Kyiv, rotavirus positive children received significantly more intravenous hydration than rotavirus negative children (42% vs 23%, $p < .01$). A protracted disease course was observed more often in cases of gastroenteritis due to rotavirus, with a significantly higher proportion of rotavirus positive children hospitalized for 3–6 days as compared to rotavirus negative children ($p < .01$) at both sites. There were no deaths among rotavirus positive cases in either site, while 3 deaths occurred among rotavirus negative AGE cases in Odesa, one of which was diagnosed with salmonellosis, while a definite etiology was not found for the remaining 2 cases.

Seasonal fluctuations in the frequency of rotavirus AGE were observed both in Kyiv and in Odesa (Figs. 1a, 1b). Peak rotavirus activity occurred in the winter months in both sites, while the lowest proportion of detections occurred during the summer.

In all years at both sites, 5 predominant genotypes were identified. G4P[8] was most commonly identified at both sites, ranging from 61–78% of detections in Kyiv and 7–69% in Odesa. This was followed by G1P[8], G2P[4], G3P[8], and G9P[8]. All together, these 5 genotypes accounted for 97% of identified strains in Kyiv and 95% in Odesa (Table 3a, 3b).

4. Discussion

During 9 years of active AGE surveillance, rotavirus infection was the predominant etiology for AGE hospitalizations among children younger than 5 years of age in two large Ukrainian cities. These rotavirus AGE hospitalizations followed a typical seasonality seen in similar geographical settings, with increased activity in cooler months [12]. In both Kyiv and Odesa, the proportion of rotavirus AGE among hospitalized children was high and remained elevated during the surveillance period. In Odesa, when surveillance activities increased in 2013 to daily from 3 days per week, there was an increase in the total numbers of rotavirus positive children, though the proportion that were rotavirus positive remained between 39–42% for these subsequent years. In Ukraine the proportion of rotavirus diarrhea in hospitalized children younger than 5 years of age was the highest among countries of the newly independent states included in the Global Rotavirus Surveillance Network [2,3]. Data from the newly independent states indicates that in Ukraine, among children younger than 5 years hospitalized with diarrhea, rotavirus was detected in 45% of all cases. Before rotavirus vaccine introduction, 38% of such detections were observed in Tajikistan, 40% in

Georgia, 38% in Armenia, and 45% in Republic of Moldova [3,8,9]. With its large birth cohort, estimated at 475,052 for 2017 [13], in comparison to these countries, the potential benefits of rotavirus vaccine introduction in Ukraine could be substantial.

We found that rotavirus positive children had a median age between 21 and 24 months and that of all the rotavirus positive children enrolled in the surveillance systems, cumulatively 57% and 50% had been infected by rotavirus by 2 years of age in Kyiv and Odesa, respectively. This is slightly older than that seen in other regions in the pre-vaccine era. In a South African literature review including 11,682 cases, 75% of rotavirus infections were seen by 1 year of age [14]. In a multi-year US analysis of hospitalization discharge data, which saw an average of 184,097 AGE hospitalizations peryear, 75% were seen by 2 years of age [15]. Finally, a Latin American review including 1949 children reported 90% infections by 2 years of age [16]. However, similar numbers were seen in pre-vaccine data reported from Armenia and the Republic of Moldova [8,9]. One possible explanation for this variation in age distribution could be that overall fewer children in the youngest age categories were enrolled into this study. Despite the variance in age groups in comparison to other areas, these results reveal the substantial burden of rotavirus infection for young children in two of the most populated cities in Ukraine.

Rotavirus AGE was characterized by more severe symptoms than non-rotavirus AGE, as has been reported elsewhere [17,18]. A higher proportion of rotavirus positive children experienced 6 or more episodes of diarrhea in a 24 h period compared to their negative counterparts, as well as more reports of fever, vomiting and number of vomiting episodes in a 24 h period. A higher proportion of the rotavirus positive children were admitted for 3–6 days as compared to their negative counterparts, who were admitted for shorter stays. Overall a significantly higher proportion of rotavirus positive children received the highest scores on the 2- and 3-level calculated severity groups. Nearly all children in Odesa received treatment with IV hydration, while a smaller proportion did in Kyiv, though the rotavirus positive children received it more often that the rotavirus negative children. This was likely due to intravenous hydration being the standard of care in Odesa, but not in Kyiv.

Five main genotypes – G1P[8], G2P[4], G3P[8], G4P[8] and G9P[8] were associated with rotavirus gastroenteritis. Overall these genotypes were detected in 97% and 95% of cases in Kyiv and Odesa respectively, during the surveillance period. In Kyiv G4P[8] remained the leading genotype in all years, while in Odesa there was variation between years among these leading genotypes. Similar findings were reported from a study of 210 stool samples from children with diarrhea from different regions of Ukraine during 2006–2009 [19]. Rotaviruses with these four genotypes G1P [8], G2P[4], G3P[8], and G9P[8] were commonly reported during 2000–2009 in Asia [20]. The predominant genotypes from June 2006 through December 2008 were G1P [8], G2P [4], and G9P [8] for GRSN-participating countries in Africa [21].

This analysis was subject to several limitations. Enrollment practices changed over time in Odesa, with initially thrice weekly enrollment, changing to daily enrollment by 2013. From 2011 onwards, enrollment at the 2 sentinel sites was quite similar though Odesa experienced lower enrollment in 2010 because the facility was undergoing repairs. Despite

these factors affecting enrollment, however, we were able to demonstrate a predictable seasonality. Another limitation in this analysis was that information was not systematically collected on all variables (recorded temperature, dehydration status) for the Vesikari score, as such a modified scale was used, which may not capture dehydration status as accurately. Another variable not recorded was the vaccine status of these children, however, given the very low national coverage reported, this likely did not affect our analysis. Finally, this surveillance is hospital-based, and as such is not representative of the epidemiology of milder cases not requiring hospitalization; however, as rotavirus vaccine is effective against severe rotavirus disease requiring hospitalizations, this surveillance does capture the children at highest risk of severe complications from rotavirus.

5. Conclusion

Active epidemiologic surveillance of AGE in hospitalized children younger 5 years in Kyiv and Odessa reveals a significant burden of rotavirus infection. These data provide the scientific background supporting the implementation of universal vaccination against rotavirus infection in Ukraine.

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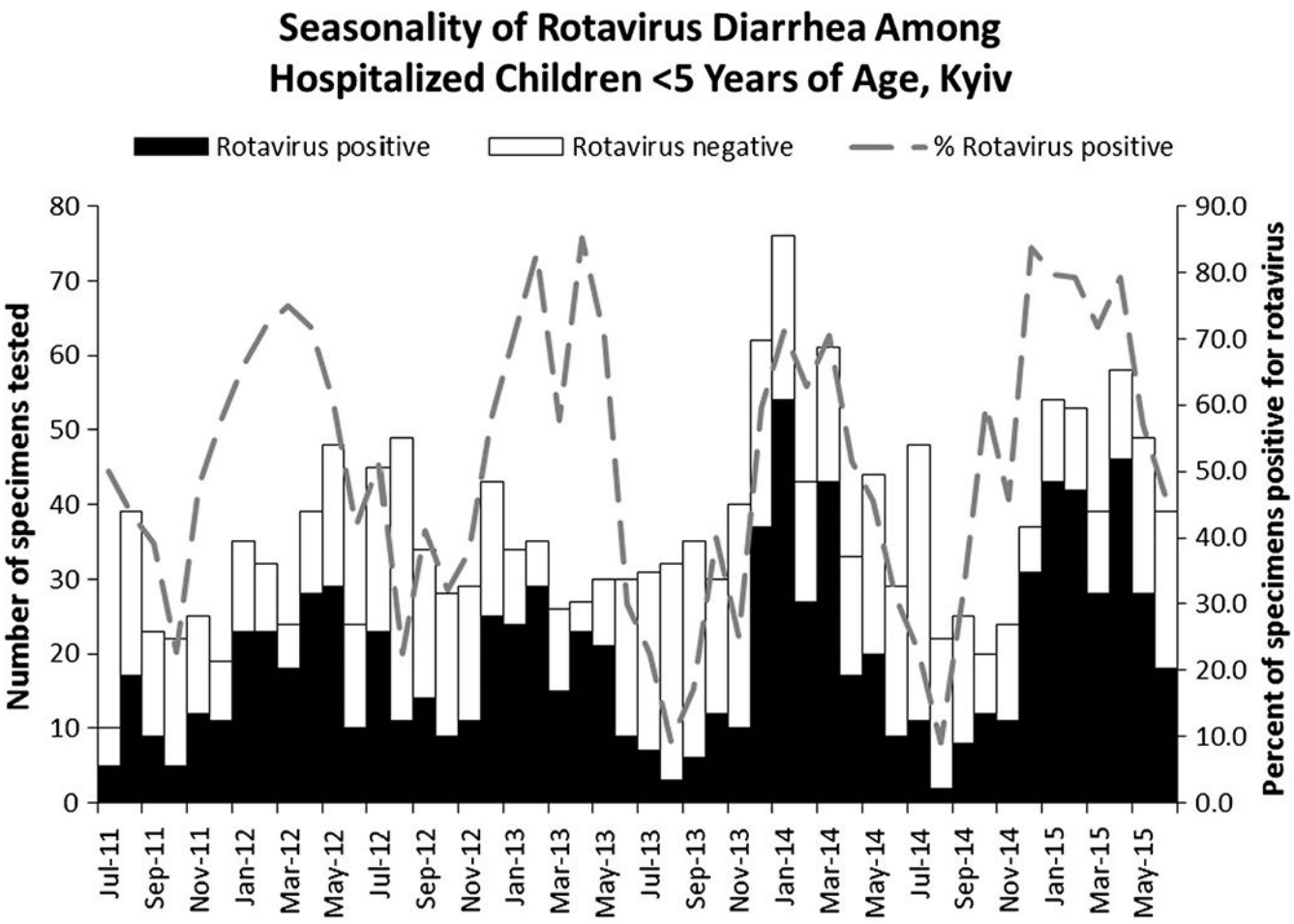

Fig. 1a.

Seasonality of rotavirus diarrhea among hospitalized children < 5 years of Age, Kyiv, July 2011–June 2015.

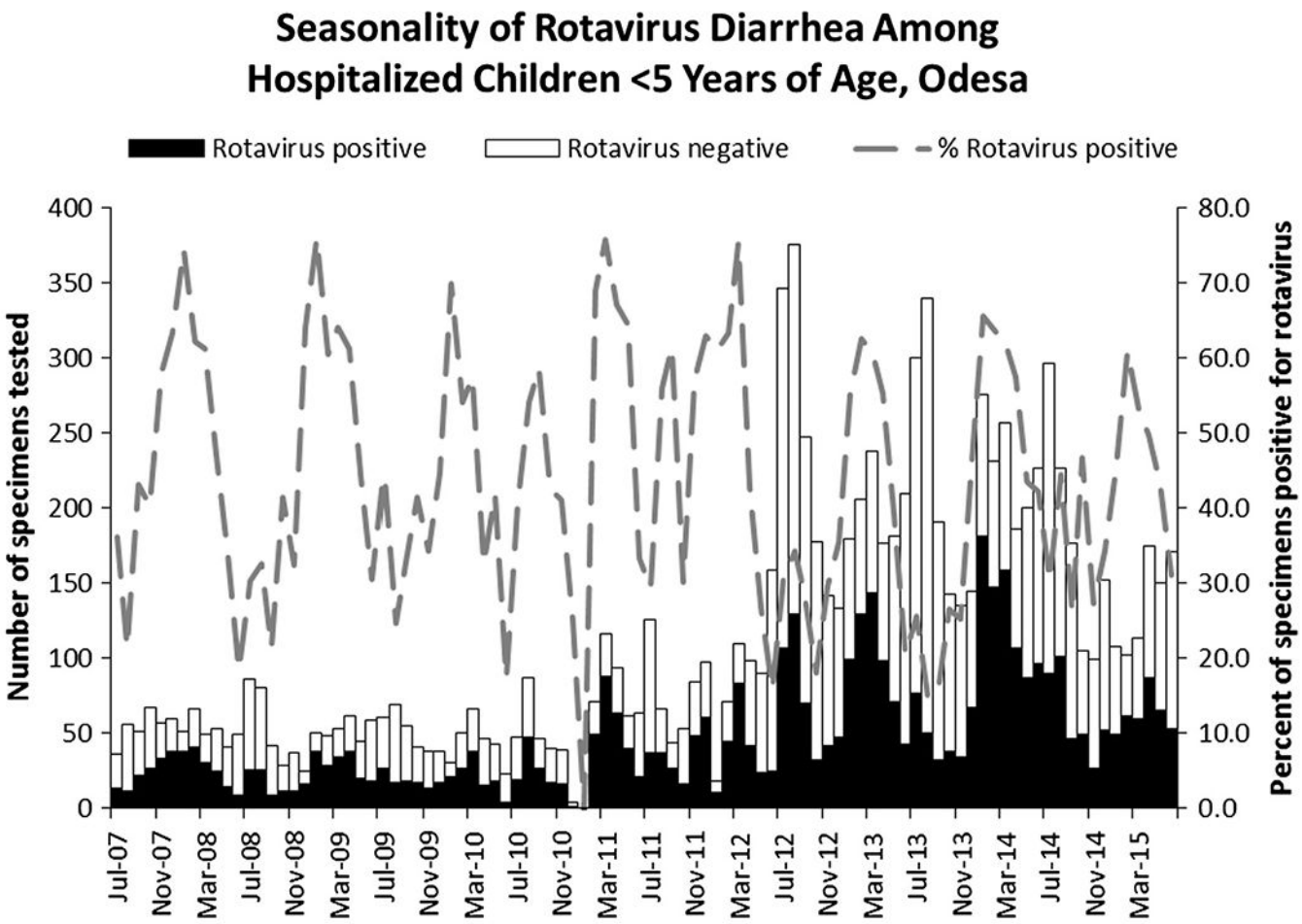

Fig. 1b.

Seasonality of rotavirus diarrhea among hospitalized children < 5 years of age, Odesa, July 2007–June 2015. *Surveillance interrupted for one month during January 2011.

Table 1

Enrollment of children < 5 years of age with diarrhea and results of rotavirus testing: Kyiv, Ukraine, Jul 2011–Jun2015 and Odesa, Ukraine, Jul 2007–Jun2015.

Rotavirus Surveillance Year	Number of children eligible	Number (%) of children enrolled[a]	Number (%) of children with stool specimen collected and tested	Number (%) of children with rotavirus positive stool
Kyiv				
Jul 2011–Jun 2012	534	343 (64)	340 (99)	190 (56)
Jul 2012–Jun 2013	453	412 (91)	410 (100)	214 (52)
Jul 2013–Jun 2014	536	532 (99)	516 (97)	245 (47)
Jul 2014–Jun 2015	484	484 (100)	468 (97)	280 (60)
Total in Kyiv	2007	1771 (88)	1734 (98)	929 (54)
Odesa				
Jul 2007–Jun 2008	1103	647 (59)	636 (98)	302 (47)
Jul 2008–Jun 2009	1114	631 (57)	616 (98)	278 (45)
Jul 2009–Jun 2010	1070	594 (56)	560 (94)	232 (41)
Jul 2010–Jun 2011	1238	717 (58)	669 (93)	388 (58)
Jul 2011–Jun 2012	1659	1069 (64)	1016 (95)	456 (45)
Jul 2012–Jun 2013	2877	2617 (91)	2613 (100)	1011 (39)
Jul 2013–Jun 2014	2747	2634 (96)	2631 (100)	1075 (41)
Jul 2014–Jun 2015	1929	1875 (97)	1875 (100)	741 (40)
Total in Odesa	13737	10784 (78)	10616 (98)	4483 (42)
Kyiv and Odesa				
Total Kyiv and Odesa	15744	12555 (80)	12350 (98)	5412 (44)

[a] In Odesa, enrollment data were not available for Jan 2011.

Table 2

Characteristics, clinical symptoms, treatment and outcome of enrolled children < 5 years of age hospitalized with rotavirus and non-rotavirus diarrhea, with stool specimen collected and tested: Kyiv, Ukraine Jul 2011–Jun 2015 and Odesa, Ukraine Jul 2007–June 2015.

Characteristics[a]	Kyiv		Odesa	
	Rotavirus positive cases n (%)	Rotavirus negative cases n (%)	Rotavirus positive cases n (%)	Rotavirus negative cases n (%)
Sex[b]				
Male	498 (54)	434 (54)	2389 (53)	3318 (54)
Female	431 (46)	370 (46)	2094 (47)	2815 (46)
Age				
Age group				
0–5 months	**64 (7)**	**105 (13)**	**201 (4)**	**692 (11)**
6–11 months	**128 (14)**	**141 (18)**	**685 (15)**	**1086 (18)**
12–23 months	**338 (36)**	**235 (29)**	**1343 (30)**	**1525 (25)**
24–59 months	**399 (43)**	**324 (40)**	**2254 (50)**	**2830 (46)**
Median age in months (range)	**21 (1, 59)**	**18 (1,59)**	**24 (0, 59)**	**21 (0,59)**
Duration of diarrhea in days				
1–4	917 (99)	795 (99)	**4240 (95)**	**5722 (93)**
5	8 (1)	10 (1)	**150 (3)**	**228 (4)**
6–7	4 (<1)	0 (0)	**93 (2)**	**183 (3)**
Maximum number of diarrhea episodes in 24-h period				
3	**116 (12)**	**137 (17)**	**490 (11)**	**1123 (18)**
4–5	**229 (25)**	**310 (39)**	**1819 (41)**	**3227 (53)**
6 or more	**584 (63)**	**358 (44)**	**2174 (48)**	**1783 (29)**
Experienced vomiting[c] (% yes)	**856 (92)**	**587 (73)**	**4157 (93)**	**4405 (72)**
Duration of vomiting in days[d]				
1	346 (40)	263 (45)	**2432 (59)**	**2996 (68)**
2	343 (40)	226 (39)	**1071 (26)**	**911 (21)**
3 or more	166 (19)	98 (17)	**654 (16)**	**496 (11)**
Maximum number of vomiting episodes in 24-h period[e]				
1	**44 (5)**	**83 (14)**	**280 (7)**	**759 (17)**

Characteristics[a]	Kyiv		Odesa	
	Rotavirus positive cases n (%)	Rotavirus negative cases n (%)	Rotavirus positive cases n (%)	Rotavirus negative cases n (%)
2–4	**370 (43)**	**273 (47)**	**2578 (62)**	**2856 (65)**
5 or more	**442 (52)**	**229 (39)**	**1299 (31)**	**787 (18)**
Experienced fever (% yes)[f]	**855 (92)**	**702 (87)**	**4129 (92)**	**5113 (83)**
2-level Severity Group[g]				
0–8	**238 (26)**	**411 (51)**	**635 (14)**	**2646 (43)**
9 or higher	**691 (74)**	**394 (49)**	**3848 (85)**	**3487 (56)**
3-level Severity Group				
0–8	**238 (26)**	**411 (51)**	**635 (14)**	**2646 (43)**
9–10	**308 (33)**	**230 (29)**	**2231 (50)**	**2618 (43)**
11 or higher	**383 (41)**	**164 (20)**	**1617 (36)**	**869 (14)**
Treatment (% yes)				
Intravenous rehydration[h]	**393 (42)**	**188 (23)**	**4419 (99)**	**5908 (96)**
Length of Hospital stay				
0	**4 (<1)**	**0 (0)**	**86 (2)**	**192 (3)**
1–2	**230 (25)**	**278 (35)**	**1126 (25)**	**2457 (40)**
3–4	**467 (50)**	**333 (41)**	**1639 (37)**	**1940 (32)**
5–6	**168 (18)**	**135 (17)**	**1102 (25)**	**937 (15)**
7 or more	**60 (6)**	**59 (7)**	**530 (12)**	**607 (10)**
Outcome at discharge				
Died	0 (0)	0 (0)	0 (0)	3 (<1)

Bold indicates p-value < .01.

[a]Percentages calculated based on cases with available information; those with missing or unknown data are excluded.

[b]Excludes 1 Rotavirus negative case with sex missing in Kyiv.

[c]Excludes 1 Rotavirus negative case with experienced vomiting missing in Kyiv.

[d]Excludes 74 Rotavirus positive and 218 Rotavirus negative cases with duration of vomiting missing in Kyiv and 326 Rotavirus positive and 1730 Rotavirus negative cases with duration of vomiting missing in Odesa.

[e]Excludes 73 Rotavirus positive and 220 Rotavirus negative cases with maximum number of vomiting episodes in 24-h period missing in Kyiv and 326 Rotavirus positive and 1731 Rotavirus negative cases with maximum number of vomiting episodes in 24-h period missing in Odesa.

[f] Excludes 1 Rotavirus negative case with experienced fever missing in Odesa.

[g] Severity groupings were modelled after the Vesikari scale; we constructed a maximum 15 point scale constructed using available variables: duration of diarrhea, maximum number of episodes of diarrhea, duration of vomiting, maximum number of episodes of vomiting, IV rehydration, and whether the child spent at least one night in the hospital. A two-level (0–8 and 9 and above) and three-level (0–8, 9–10 and 11 and higher) severity score was calculated. Higher scores indicate greater severity.

[h] Excludes 4 Rotavirus positive cases with information on intravenous rehydration missing in Kyiv and 3 Rotavirus positive and 3 Rotavirus negative cases with information on intravenous rehydration missing in Odesa.

Table 3a

Distribution of G- and P-typed strains in each rotavirus surveillance year: Kyiv, Ukraine July 2011–June 2015.

Rotavirus Strains	Rotavirus Surveillance Year				
	Jul 2011–Jun 2012 n (%)	Jul 2012–Jun 2013 n (%)	Jul 2013–Jun 2014 n (%)	Jul 2014–Jun 2015 n (%)	Total Strains n (%)
Kyiv					
G4 P[8]	50 (78)	47 (72)	82 (78)	52 (61)	231 (72)
G1 P[8]	2 (3)	2 (3)	7 (7)	20 (24)	31 (10)
G2 p[4]	6 (9)	4 (6)	6 (6)	2 (2)	18 (6)
G3 p[8]	4 (6)	7 (11)	2 (2)	2 (2)	15 (5)
G9 p[8]		3 (5)	5 (5)	6 (7)	14 (4)
G3 p[9]		1 (2)	2 (2)		3 (1)
G2 p[8]	1 (2)			1 (1)	2 (1)
G4 p[6]	1 (2)	1 (2)			2 (1)
Other			1 (1)	2 (2)	3 (1)
Total	64	65	105	85	319

Table 3b

Distribution of G- and P-typed strains in each rotavirus surveillance year: Odesa, Ukraine July 2007–June 2015.

Rotavirus Strains	Rotavirus Surveillance Year								
	Jul 2007–Jun 2008 n (%)	Jul 2008–Jun 2009 n (%)	Jul 2009–Jun 2010 n (%)	Jul 2010–Jun 2011 n (%)	Jul 2011–Jun 2012 n (%)	Jul 2012–Jun 2013 n (%)	Jul 2013–Jun 2014 n (%)	Jul 2014–Jun 2015 n (%)	Total Strains n (%)
Odesa									
G4 P[8]	13 (28)	3 (7)	5 (10)	26 (40)	51 (69)	52 (51)	52 (51)	27 (28)	229 (40)
G1 P[8]	23 (49)	20 (44)	10 (20)	3 (5)	15 (20)	25 (25)	26 (25)	20 (21)	142 (25)
G2 P[4]	7 (15)	10 (22)	5 (10)	12 (18)	5 (7)	1 (1)	15 (15)	38 (40)	93 (16)
G3 P[8]	1 (2)	5 (11)	24 (49)	22 (34)	1 (1)	17 (17)	2 (2)		72 (12)
G9 P[8]	1 (2)	1 (2)	4 (8)		2 (3)		2 (2)	4 (4)	14 (2)
G2 P[6]		5 (11)							5 (1)
G3 P[9]	1 (2)			1 (2)			2 (2)	1 (1)	5 (1)
G12 P[8]						5 (5)			5 (1)
G6 P[9]								2 (2)	2 (<1)
G1+4 P[8]				1 (2)			1 (1)		2 (<1)
G1+2 P[4+8]							1 (1)	1 (1)	2 (<1)
Other	1 (2)	1 (2)	1 (2)			1 (1)	1 (1)	3 (3)	8 (<1)
Total	47	45	49	65	74	101	102	96	579