

Original Article

The effects of nosocomial rotavirus gastroenteritis on the length of hospital stay and cost

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Abstract

Introduction: In this study, the goal was to evaluate the impact of nosocomial rotavirus gastroenteritis in pediatric patients by determining the incidence of nosocomial rotavirus gastroenteritis, the resulting duration of hospital stay, and direct cost. To our knowledge, this is the first study in Turkey that evaluates the impact of pediatric nosocomial rotavirus gastroenteritis on duration of hospital stay and calculates the direct cost.

Methodology: Forty-nine patients who were diagnosed with nosocomial rotavirus gastroenteritis and hospitalized were included in the study. Nosocomial infection rates, organ systems affected by the nosocomial infections, and patients who had nosocomial rotavirus gastroenteritis were identified. A direct cost analysis of patients who were diagnosed with nosocomial rotavirus gastroenteritis was performed using copies of the invoices for the hospital bills.

Results: During the study period, there were 49 cases of nosocomial rotavirus gastroenteritis. The length of hospitalization was extended, on average, by more than 6.3 days in cases of nosocomial rotavirus gastroenteritis. The cost of hospitalization for patients with nosocomial rotavirus gastroenteritis was on average $1,554 \pm 2,067$ US dollars, compared to a cost of only 244 ± 103 US dollars for patients who did not have nosocomial rotavirus gastroenteritis. This difference in cost was statistically significant ($p < 0.05$).

Conclusions: Nosocomial rotavirus gastroenteritis is important because it significantly prolongs hospital stay and increases the social and economic burden of the hospitalization. Nosocomial rotavirus gastroenteritis can be reduced with prevention measures such as handwashing, isolation, and cohorting.

Key words: nosocomial gastroenteritis; rotavirus; children; economic burden.

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Introduction

Rotavirus is a double-stranded RNA virus belonging to the Rotavirus family, and it is highly pathogenic. Rotavirus is transmitted mainly by the fecal-oral route, but it can also be transmitted via respiratory droplets. Rotavirus can be shed in the stool prior to the start of diarrhea and for weeks after symptoms have resolved. Rotavirus can live for more than 10 days on dry surfaces and more than four hours on hands [1,2]. Children's hospitals and other child service centers are often important reservoirs for rotavirus. In these areas, infection can spread via the hands of children, parents, or healthcare personnel and via toys touched by infected individuals. Nosocomial rotavirus gastroenteritis prolongs hospital stay and increases the economic and social burden [3].

Rotavirus gastroenteritis has a substantial impact on childhood mortality and morbidity worldwide and is the main cause of serious diarrhea in infants and children. It was reported that, in 2004, 527,000 children under the age of five died from rotavirus infection and more than 85% of these deaths occurred in Asian and Sub-Saharan African countries [4]. Rotavirus positivity in children with gastroenteritis has been reported to be between 21% and 43.6% in Turkey [5].

Twelve percent of mortality in children five years of age and younger in our country is related to diarrhea and diarrheal diseases [6]. According to a study comparing 49 European countries, although the national income per capita in Turkey is in the high-medium range, it has the highest annual mortality rate ($> 10/100,000$) from rotavirus gastroenteritis, even

when compared to countries with the lowest income per capita. The same European study estimated that 6,550 deaths due to rotavirus occurred in the 49 countries included in the study and that Turkey had the most deaths, with an estimated 1,700 (26%) [7]. The aim of the current study was to determine the incidence of nosocomial rotavirus gastroenteritis and to evaluate its impact on the duration of hospital stay and direct cost.

Methodology

Study design

This retrospective study included patients at the Diyarbakır Children's Hospital between April 2012 and March 2013. The Diyarbakır Children's Hospital is a 442-bed, second-tier hospital; patients undergo daily laboratory and clinical investigations in the hospital. Data from the infection control committee were retrospectively examined, and patients who were diagnosed with nosocomial rotavirus gastroenteritis were identified. Hospital invoice data, patient's sex, age, diagnosis at hospitalization, length of stay until the onset of diarrhea, clinical findings, duration of hospital stay, and treatments were extracted from medical records. During the study, all stool samples were tested using the enzyme-linked immunosorbent assay (ELISA) method (Vidas; bioMerieux, Marcy l'Etoile, France). Medical costs were directly calculated from copies of patient invoices. The direct cost was calculated based on drug, medical material, and laboratory costs as well as bed and medical personnel fees. The costs were converted into US dollars based on the monthly average exchange rate listed by the TR Merkez Bank at the time of hospitalization. A study group was comprised of patients who were hospitalized for lower respiratory tract infections in the same department (infant services) as the study group in order to evaluate the impact of nosocomial rotavirus gastroenteritis on patient cost and duration of hospital stay. Patients with nosocomial rotavirus gastroenteritis who required care in the intensive care unit (ICU) or neonatal unit and patients who were re-hospitalized after being diagnosed with nosocomial rotavirus gastroenteritis after discharge were not included in the calculations comparing duration of hospital stay and direct cost. Acute gastroenteritis was defined as an acute onset of diarrhea with or without vomiting or fever (38.5°C, rectal) without a suspected noninfectious cause. Diarrhea was defined as the occurrence of three or more watery stools in a period of 24 hours.

Nosocomial rotavirus gastroenteritis was defined as rotaviral gastroenteritis in which symptoms started between 48 hours after admission and 72 hours after

discharge, with rotavirus detected in the stool sample by ELISA.

The control group was randomly selected from patients who did not have diarrhea and who were hospitalized due to lower respiratory tract infections in the department of infant services.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS), version 15.0. A Chi-square analysis was used to compare categorical data, and a Mann-Whitney U test was used to compare numerical data; $p < 0.05$ was considered statistically significant.

Results

Between the dates when this study was conducted, April 2012 and March 2013 (141,857 patient days), 218 nosocomial infections in 35,107 patients were recorded. Regardless of the year of surveillance, the three most commonly detected nosocomial infections were bloodstream infections (69; 33%), pneumonia (56; 26.4%), and gastrointestinal system infections (49; 24.7%). Rotavirus antigen positivity was detected in 1,010 (19.3%) of the 5,240 stool samples. Forty-nine of the nosocomial gastrointestinal system infections were gastroenteritis, and seven were necrotizing enterocolitis. During the study period, there were 49 cases of nosocomial rotavirus gastroenteritis, and the incidence density of nosocomial rotavirus gastroenteritis was 0.34 per 1,000 patient days. Ten of the patients were female and 39 were male. The median age of the patients was 8 months, and ranged from 1 month to 26 months. At the time of diagnosis with nosocomial rotavirus gastroenteritis, 18 patients (36.7%) had fever with an average temperature of 38.5°C. Forty-two of the patients (85.7%) had both diarrhea and vomiting. On average, diarrhea occurred 5.6 ± 3.4 days after admission. In 18 patients (36.7%), no change in treatment was made, and in 31 patients (63.2%), a change in treatment was made after diagnosis with nosocomial rotavirus gastroenteritis. The changes in treatment are shown in Table 1. A total of 17 (34.7%) hospitalized patients who had diarrhea within 72 hours of discharge were hospitalized again and diagnosed with nosocomial rotavirus gastroenteritis. The majority of nosocomial rotavirus gastroenteritis infections occurred between October and March (77.5%) and peaked in February (22.4%). A total of 25 patients were hospitalized because of lower respiratory tract infections and diagnosed with nosocomial rotavirus gastroenteritis. Eighty patients

who had no diarrhea and were hospitalized because of lower respiratory tract infections were randomly selected from the infant services department as a control group. Table 2 compares the duration of hospital stay and cost between the control and study groups.

Discussion

The most common nosocomial infections in children are catheter-related bloodstream infections and pneumonia. Nosocomial gastroenteritis is the third-most common pediatric nosocomial infection [8,9]. Studies have shown that viruses are responsible for 91%–94% of nosocomial gastroenteritis. Although studies have shown that nosocomial gastroenteritis can be caused by several different viruses such as norovirus, astrovirus, and adenovirus, many studies have revealed that the most common cause in children is rotavirus. In European countries, rotavirus was responsible for 31%–87% of cases of pediatric nosocomial gastroenteritis [3,10,11]. Another study reported that 21% of all patients with nosocomial gastroenteritis were infected with rotavirus [12].

In our study, the most common nosocomial infections were bloodstream infections, followed by respiratory system infections and gastroenteritis, which is in accordance with the literature. The most frequent nosocomial infections in our pediatric intensive care unit and newborn intensive care units were respiratory and bloodstream infections. In units outside of the intensive care units, the most frequent nosocomial infection was nosocomial gastroenteritis, and the most common pathogenic agent was rotavirus. However, laboratory tests cannot be performed for other viruses and nosocomial gastroenteritis because these viruses cannot be detected.

Nosocomial rotavirus gastroenteritis usually occurs two to six days after hospitalization. Patients who have

nosocomial rotavirus gastroenteritis may be asymptomatic in 20%–40% of cases [3]. In symptomatic rotavirus gastroenteritis, patients usually have vomiting and diarrhea and frequently have a fever $> 39^{\circ}\text{C}$ [13]. Similar to the results of other studies, we found that patients developed diarrhea 5.6 ± 3.4 days after hospitalization, on average. All of the patients who were diagnosed with nosocomial rotavirus gastroenteritis had diarrhea. Because it was a retrospective study, it is possible that cases of asymptomatic rotavirus gastroenteritis were missed. Vomiting was present in 85.7% of patients and fever was present in 36.7% of patients, with an average temperature of 38.5°C .

In past studies, it was noted that nosocomial rotavirus gastroenteritis was common in children five months of age and younger, and 42.7%–69.9% of the children who had nosocomial rotavirus gastroenteritis were under six months of age. Asymptomatic rotavirus gastroenteritis is frequently seen in children younger than six months of age, especially in newborns [14,15]. The median age of our patients was eight months. Because this is a retrospective study, asymptomatic cases were not detected, and this may partially explain why the median patient age is higher in this study.

Studies have shown that rotavirus gastroenteritis is more frequent in the autumn and winter months [16,17]. Similarly, we found that rotavirus gastroenteritis was more frequent (77.5%) between October and March.

The number of studies that evaluate the incidence of nosocomial rotavirus gastroenteritis are limited. Studies that attempt to determine the incidence can be difficult to interpret due to differences in patient selection and laboratory methods, as well as the fact that asymptomatic cases are often not identified. Prospective studies are needed to calculate a more accurate nosocomial rotavirus incidence [18]. In our

Table 1. Treatment changes in patients diagnosed with nosocomial rotavirus gastroenteritis

Treatment changes	Number of patients	%
No change	18	36.7
Probiotics added	23	46.9
Metronidazole added	10	20.4
Antiemetic added	4	8.1
Antibiotics changes	13	26.5
Zinc added	1	2

Table 2. Comparison of duration of hospital stay and cost.

	Nosocomial rotavirus (n = 25)	Control group (n = 80)	p
Length of hospital stay	9.72 ± 3.63	3.42 ± 1.09	$p < 0.001$
Hospital cost (dollars)	1554 ± 2067	244 ± 103	$p < 0.001$

study, the incidence of nosocomial rotavirus gastroenteritis was 0.34 per 1,000 patient hospitalization days. Because this is a retrospective study, we could not detect asymptomatic cases, and thus it is likely that we underestimated the incidence. In other studies, the incidence of nosocomial rotavirus gastroenteritis ranged from 0.46 to 15.8 per 1,000 patient hospitalization days [3,14,19,20].

Nosocomial rotavirus gastroenteritis prolongs hospital stay. Previous studies have found that hospital stay is prolonged by 1.7, 9, or 12 days [21-23]. Although it is commonly accepted that nosocomial rotavirus gastroenteritis prolongs hospital stay, the degree of prolongation is affected by the patient groups being studied. In our study, in order to make good comparisons, both the patient and control group were selected from patients who were hospitalized for acute lower respiratory tract infections. Because the hospitalization diagnoses of patients who were admitted to the ICU and newborn service were different and confounded by underlying disease, these groups were excluded from analysis of the effect of nosocomial rotavirus gastroenteritis on duration and cost of hospitalization. Seventeen of our patients (34.7%) had been re-hospitalized because of diagnosis of nosocomial rotavirus gastroenteritis after they had been discharged, and these patients were also not included in our analysis of duration of hospital stay. In our study, the duration of hospital stay in patients with nosocomial rotavirus gastroenteritis was 9.72 days on average compared to 3.42 days in the control group, which was a statistically significant difference ($p < 0.001$). We calculated that patients with nosocomial rotavirus gastroenteritis were hospitalized for an average of 6.3 extra days.

The economic impact of nosocomial rotavirus gastroenteritis can be evaluated in multiple ways, including quantitative/qualitative, direct/indirect, constant/variable analyses as well as cost analysis, which uses different combinations of the former categories [24-26]. In our study, the medical costs were calculated directly. The average cost for patients who had nosocomial rotavirus gastroenteritis was $1,554 \pm 2,067$ US dollars compared to 244 ± 103 US dollars for patients without nosocomial rotaviral gastroenteritis. The difference in cost was statistically significant ($p < 0.001$). The difference in cost was related to the marked difference in duration of hospital stay, resulting in more laboratory examinations and additional treatments. Treatment was changed in 63.3% of patients with nosocomial rotavirus gastroenteritis; 26.5% of the treatment changes were changes in antibiotics. Metronidazole was added in 20.4% of patients with

antibiotic changes. A probiotic was added in 46.9% of patients with nosocomial rotavirus gastroenteritis. In our study, we did not include patients who were re-hospitalized for nosocomial rotavirus gastroenteritis (34.7%) in the calculation of cost so that the comparison between the study and controls were be more valid. However, this additional cost is important and should not be ignored when analyzing the cost of nosocomial rotavirus gastroenteritis. In our study, we also found a significant amount of antibiotic misuse.

In the literature, studies that evaluated the direct cost of nosocomial rotavirus gastroenteritis estimated the additional cost to be between €135 (\$177) and €2,485 (\$3,255). In studies that analyzed both the direct and indirect costs, the estimated additional cost was €1,539 (\$2,016) to €2,602 (\$3,409) [23,27-30].

Our study has some limitations. Because the hospital billing includes total fees of medical cost except drug fee, we could not calculate the total cost of laboratory and medical material as well as bed and medical personnel fees separately to compare the two groups.

Conclusions

Rotavirus is the most common cause of gastroenteritis in children under five years of age worldwide, and is particularly known to cause hospitalization and infant death due to gastroenteritis. In addition to community-acquired rotavirus gastroenteritis, nosocomial rotavirus gastroenteritis is significant in terms of prolonging hospital stay and causing additional economic and social burden. Rotavirus is a disease that can be prevented with vaccination. Routine vaccination is recommended for countries with a high disease burden. Routine vaccination for rotavirus will decrease hospitalization due to rotavirus gastroenteritis and healthcare expenditures. In our country, the rotavirus vaccine has not been included in the routine childhood vaccination schedule yet. Our study is the first study in Turkey that evaluated the impact of nosocomial rotavirus gastroenteritis on hospital cost and duration of hospitalization.

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