

TRENDS IN HOSPITALIZATIONS FROM ALL-CAUSE GASTROENTERITIS IN CHILDREN YOUNGER THAN 5 YEARS OF AGE IN BRAZIL BEFORE AND AFTER HUMAN ROTAVIRUS VACCINE INTRODUCTION, 1998–2007

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Abstract: Rotavirus vaccination was introduced in Brazil in March 2006. We describe trends in hospitalizations from all-cause gastroenteritis in children younger than 5 years during pre- and postvaccination periods using hospital discharge data from Brazil Hospital Information System (SIH-SUS). A reduction in gastroenteritis hospitalizations of 26% and 48% in 2006 and in 2007, respectively, was observed among children younger than 1 year compared with prevaccination period (1998–2005). The largest reduction rates among children younger than 1 year were noted in the South and Southeast regions, approximately 56% in 2007, where vaccine coverage was the highest.

Key Words: gastroenteritis, rotavirus, hospitalizations, human rotavirus vaccine, Brazil

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Rotavirus, the leading cause of severe dehydrating gastroenteritis (GE) in infants and young children, accounts for an estimated 2 million hospitalizations and 352,000 to 592,000 deaths each year in children younger than 5 years worldwide.¹ A review of studies published during 1986–1999 indicated that rotavirus causes ~22% (range 17%–28%) of childhood diarrhea hospitalizations worldwide, increasing to 39% (range 29%–45%) during 2000–2004.² In Brazil, rotavirus infections were estimated to cause ~3.5 million diarrhea episodes, 655,853 outpatient visits, 92,453 hospitalizations, and 850 deaths of children ≤5 years of age each year before vaccine introduction.³

Brazil was one of the first countries worldwide to include the rotavirus vaccine in the official vaccination calendar targeting infants. The National Immunization Program of the Ministry of Health calculates vaccine coverage using the number of second doses of rotavirus vaccine administered to infants (recorded at local level) divided by the number of live births. National vaccine coverage was 46.5% in 2006 and 78.3% in 2007 and varied greatly by region.⁴

As recommended by the World Health Organization,⁵ vaccine impact may be assessed by monitoring trends in hospitalizations from all-cause acute GE using secondary data sources. In Brazil, an estimated 76% to 81% of the population relies on public health care provided by the National Unified Health System (SUS),⁶ which provides more than 1.3 million hospitalizations per month, through public, associated, and contracted hospitals throughout the country. The Hospital Information System (SIH-

SUS), implemented in 1986, has been designed for the reimbursement of SUS hospitalizations. This countrywide public database contains information on medical procedures, diagnoses, type of admissions, selected demographic information, place and date of admission, length of stay, hospitalization costs, and other reimbursement data. Data are generated in the hospitals, analyzed by the municipal and state health departments, and transmitted to the national level. The SIH-SUS is being increasingly used for the analysis of relevant public health issues, including hospital morbidity and mortality, evaluation of the performance of medical care, epidemiologic surveillance, and in the validation of other health information systems.⁷

In this study, we describe the trends in hospitalizations from all-cause GE in children younger than 5 years before and after implementation of rotavirus universal mass vaccination in Brazil using data from the SIH-SUS.

METHODS

We extracted aggregated hospital discharge data from the SIH-SUS coded with all-cause GE among children <5 years of age from 1998 to 2007, using the International Classification of Diseases 10th Revision, which included codes A00 to A09 (intestinal infectious diseases). Mean, standard deviation (SD), and proportion of GE hospitalizations during prevaccination period (1998–2005) were calculated and compared with 2006 and 2007, by age group (younger than 1 year and 1–4 years) and by region.

RESULTS

During 1998–2007, a total of 1,071,755 hospitalizations among children younger than 1 year were caused by GE, representing 15% of all hospitalizations in this age group, which decreased from 16% during 1998–2005 to 14% in 2006 and 10% in 2007. The proportion of hospitalizations caused by GE among all hospitalizations among children younger than 1 year during 1998–2005 ranged from 9% (Southeast) to 26% (North) and decreased in 2006 (range 7%–23%) and 2007 (range 4%–18%).

The mean number of GE hospitalizations among children younger than 1 year during 1998–2005 was 115,748 (SD = 15,228) per year, with a downward annual trend averaging 5% (Fig. 1). In 2006 and 2007, GE hospitalizations decreased by 25.8% (n = 85,835) and 48.2% (n = 59,939), respectively, compared with the prevaccination period of 1998–2005. In the Southeast and South regions, GE hospitalizations (1998–2005 means = 23,250 and 10,848, respectively) decreased by approximately 35% in 2006 (n = 15,136 and 7038) and 56% in 2007 (n = 10,168 and 4765). The North region (1998–2005 mean = 16,649), with the lowest vaccine coverage, had declines of 3.5% in 2006 (n = 16,060) and 28.8% in 2007 (n = 11,854). In the Midwest and the Northeast regions, respective decreases of 21.9% (from 1998–2005 mean of 8409 to 6570) and 27.5% (from 56,591 to 41,031) in 2006, and 47.7% (n = 4395) and 49.2% (n = 28,757) in 2007 were observed (Fig., Supplemental Digital Content 1, <http://links.lww.com/INF/A435>).

Among children aged 1 to 4 years, a total of 1,581,617 GE hospitalizations were recorded during 1998–2007, representing 18% of all hospitalizations in this age group. This proportion was 18% during 1998–2005 (range 12%–27%), increasing in all regions in 2006 (21%, range 13%–30%), and decreasing in 2007 (17%, range 10%–26%), except for the Northeast region.

The mean number of GE hospitalizations among children aged 1 to 4 years during 1998–2005 was 160,096 (SD = 9564) per year. A trend toward an increase by an annual average of 2% during 1998–2005 was followed by an increase by 7.0% (n = 171,368) in 2006 and a decrease by 19.1% in 2007 (n = 129,481) (Fig. 1). In the

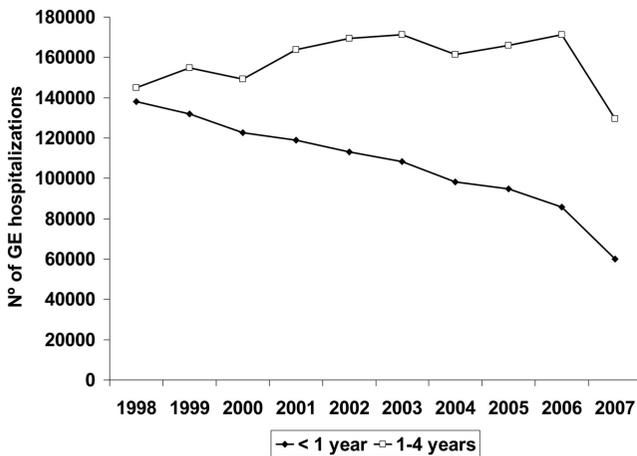


FIGURE 1. Trends in hospitalizations from all-cause gastroenteritis in children younger than 1 and 1 to 4 years, Brazil, 1998–2007.

Midwest and the Northeast regions, respective increases by 10.9% and 11.7% were observed in 2006 (from 1998–2005 mean of 13,992 and 68,868 to 15,525 and 76,951), decreasing by 30.9% (n = 9661) and 12.9% (n = 59,964) in 2007. GE hospitalizations decreased in the Southeast and South regions by 8.4% and 6.7% in 2006 (from respective means of 33,785 and 19,121 during 1998–2005 to 30,956 and 17,848) and by approximately 35% in 2007 (n = 22,088 and 12,525). In the North region, an increase was observed both in 2006 and 2007, 23.7% and 3.8%, respectively (from 1998–2005 mean of 24,330 to 30,088 and 25,243) (Fig., Supplemental Digital Content 1, <http://links.lww.com/INF/A435>).

DISCUSSION

The introduction of rotavirus vaccination in Brazil in 2006 may have contributed to the marked decline in the number and proportion of all-cause GE hospitalizations among children younger than 1 year in 2007 compared with prevaccination period. The proportion of GE hospitalizations among children younger than 1 year varied largely across regions; however, trends within each region show that the decrease in 2007 was much greater than the slight decrease observed annually during the prevaccination period.

The impact of vaccine is expected to be greater in children younger than 1 year in the first year of vaccination. After a few more years, impact in older children is also expected. Rotavirus vaccination began in March 2006; however, vaccine coverage was low and not homogeneous across all regions. Although vaccine coverage increased in 2007, it remained below the 95% level targeted by the Ministry of Health. We observed greater reduction rates in regions with higher vaccine coverage. It is worthy mentioning that a trend toward an increase in hospitalizations among children aged 1 to 4 years was reversed in 2007, which is possibly related to the partial vaccination of the 2006 cohort or indirect effect. In the United States, indirect benefits of vaccination seem to have occurred 1 year after the introduction of the human-bovine rotavirus vaccine.⁸

According to the World Health Organization rotavirus surveillance network, during 2001–2008, approximately 40% (range 10%–59%) of diarrhea hospitalizations among children younger than 5 years worldwide, and 34% (range 10%–51%) in the region of the Americas were attributed to rotavirus infection.⁹ Results

from the phase 3 clinical trials of human rotavirus vaccine (Rotarix, GlaxoSmithKline Biologicals, Rixensart, Belgium) in Latin America showed that hospitalization for GE of any cause was reduced by 39%.^{10,11} These findings highlight that the burden of rotavirus disease on health systems would be substantially reduced with vaccination. In our study, we observed rates of reduction of ~25%–50% on both absolute numbers and proportion of all-cause GE hospitalizations among children younger than 1 year, which may represent a significant reduction of direct medical costs. In fact, a cost reduction of approximately US\$ 10 million was observed in 2007 when costs of hospitalizations because of all-cause GE were compared with the average annual costs during 1998–2005.¹² Results from a cost-effectiveness study of a national rotavirus vaccination program for Brazilian children estimated that vaccination was likely to reduce the overall healthcare burden of rotavirus-associated GE (change in number of life-years saved) in the country by 75%.¹³

Nearly 80% of the total population in Brazil relies on health care provided by the SUS, varying from 68% in the Southeast to >90% in the North and Northeast.⁶ One of the main limitations of this study was the inability to estimate rates of all-cause GE hospitalizations because of the lack of adequate denominators. Hospitalizations for diarrhea may be overrepresented in the North and Northeast, where a high percentage of the population is dependent on the SUS. Data on rotavirus-specific GE hospitalizations, stratification by other age groups (only 2-year olds, for instance), and month of hospitalization to describe seasonality patterns were not available. The effect of other interventions (sanitation, hygiene, breast-feeding, nutrition, water and food safety, and oral rehydration, increased access to care) known to influence diarrhea morbidity and mortality was not evaluated. However, the rate of increase in population coverage of sanitation, water supply or access to private health care remained constant during 1998–2007.⁶

Although this ecologic study analyzes all-cause GE hospitalizations, rotavirus vaccine introduction is likely to have been the major influence for the decreasing trends during 2006–2007. The impact was greater among children younger than 1 year and in regions with higher vaccine coverage. Trends in GE hospitalizations should continue to be assessed to monitor the impact of the vaccination program. After a few years, additional mortality data that become available should also be included in the analysis. Maximizing vaccine coverage should lead to the greatest impact.

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