

Short Report: Hospitalizations and Deaths Caused by Diarrhea in Children Five Years Old and Younger at Four Hospitals in Haiti, 2010–2012

Kiersten S. Derby, Mentor Ali Ber Lucien, Eyal Leshem, Maria W. Steenland, Stanley Juin, Gerard A. Joseph, and Mark A. Katz*

US Centers for Disease Control and Prevention – Haiti, Port-au-Prince, Haiti; Laboratoire National de Sante Publique (National Public Health Laboratory), Port-au-Prince, Haiti; US Centers for Disease Control and Prevention, Atlanta, Georgia

Abstract. Worldwide, diarrhea is a major contributor to morbidity and mortality in children; however, there are few data on the burden of diarrheal disease in Haiti. We conducted a retrospective review of hospital discharge registries from 2010 to 2012 in the pediatric wards of four Haitian hospitals and recorded the number of all-cause hospitalizations and deaths as well as diarrheal hospitalizations and deaths by age (≤ 2 and 3–5 years) and epidemiological week. Diarrhea was associated with 3,582 (33.7%) of 10,621 hospitalizations and 62 (11.5%) of 540 in-hospital deaths in children ≤ 5 years old. Of these children, 88.5% and 96.8%, respectively, were among children ≤ 2 years old. The highest proportions of diarrhea-associated hospitalizations occurred from January to April. At four Haitian hospitals over a 3-year period, during which time a major epidemic of cholera occurred, diarrheal disease in children ≤ 5 years was a major contributor to pediatric hospitalizations and mortality.

Diarrhea is an important cause of hospitalizations and death in children under 5 years old, particularly in low-income countries. Globally, diarrhea was estimated to cause 17.4% of deaths in children 1–11 months old and 11.9% of deaths in children 1–4 years old in 2010.¹ A Haitian Ministry of Health annual report from 2006 reported that an average of 14.3% of hospitalizations in children < 5 years old were because of diarrhea, and 9.7% of hospitalizations in children < 5 years old were because of parasitosis; taken together, they accounted for 24.0% of hospitalizations.² A 2012 study that used data collected from 1980 to 2009 from eight countries, including Haiti, estimated the proportion of deaths attributed to diarrhea (the diarrhea proportionate mortality) among children < 5 years to be 10.0% in the Americas.³

Rotavirus is a major cause of moderate-to-severe diarrhea in children under 5 years old worldwide.^{4,5} Haiti plans to introduce a vaccine against rotavirus in 2013. Current information about diarrhea burden in Haiti, particularly in the context of the ongoing cholera outbreak, which began in October of 2010,⁶ is important to evaluate the impact of the vaccine.

We conducted a retrospective review of hospital discharge registries from 2010 to 2012 in the pediatric wards of four large hospitals that are part of a laboratory-enhanced syndromic surveillance system in Haiti.⁷ These hospitals were chosen for inclusion in the surveillance system, because they are large facilities and located within a 3-hour drive of the National Public Health Laboratory (LNHP) in Port-au-Prince, making transport of specimens easily manageable. Two hospitals are in Port-au-Prince (one public and one mission hospital), and one hospital is in each of the Artibonite and Southeast Departments (both public hospitals) (Table 1). We recorded the number of all-cause and diarrheal hospitalizations and deaths by age (≤ 2 and 3–5 years) and epidemiological week. We considered the following admitting diagnoses to represent diarrheal illness: diarrhea, acute gastroenteritis, parasitosis, cholera, and dehydration. We conducted our review as part

of a laboratory-based sentinel surveillance system, which was approved as a non-research activity by the Centers for Disease Control and Prevention—Atlanta and the Haiti Ethical Review Committee.

From January 1, 2010 to December 3, 2012, there were 10,621 total hospitalizations in children ≤ 5 years old at the four hospitals. Of these children, 3,582 (34%) children were admitted for diarrhea, including 665 (27% of total hospitalizations for that year), 1,117 (33%), and 1,800 (38%) children in 2010, 2011, and 2012, respectively (Table 1). The change in the proportion of diarrhea patients among total hospitalizations in children ≤ 5 years over the 3-year period was statistically significant (χ^2 test for trend, $P < 0.001$). Of all pediatric diarrheal hospitalizations, 3,169 (89%) hospitalizations were in children ≤ 2 years old.

There were 540 total deaths in hospitalized children ≤ 5 years old at the four hospitals; 62 (11.5%) deaths were caused by diarrhea. There was a small increase by year in the diarrhea proportionate mortality—from 9.4% in 2010 and 10.6% in 2011 to 14.1% in 2012—but the difference in proportions was not statistically significant (χ^2 test for trend, $P = 0.35$). Of 62 deaths in hospitalized diarrheal patients ≤ 5 years old, 60 (96.8%) deaths were among children ≤ 2 years old. The case fatality rate among hospitalized diarrheal patients was 1.7% for children ≤ 5 years old and 1.9% in children ≤ 2 years old.

The burden of diarrheal disease varied by hospital (Table 1). During the 3-year period, the proportion of hospitalizations in children ≤ 5 years old that was associated with diarrhea varied from a high of 50.0% (1,426/2,852) in St. Camille Hospital to a low of 13.3% (270/2,035) in St. Michel Hospital of Jacmel. Each year, there were seasonal peaks in diarrhea-associated hospitalizations from January to April (Figure 1).

From 2010 to 2012, diarrhea was a major cause of hospitalization and death in children ≤ 5 years old in four hospitals in Haiti; the greatest burden of disease was among children ≤ 2 years old. Our finding that 33.7% of hospitalizations in children ≤ 5 years old during this 3-year period were caused by diarrhea is higher than the percentage of diarrhea-associated hospitalizations (24%) which was reported by the Haitian Ministry of Health for 8 of 10 departments in 2006.² In comparison, in the United States in the mid-1990s, a decade before the introduction of the rotavirus vaccine in that

*Address correspondence to Mark A. Katz, US Centers for Disease Control and Prevention - Haiti, Unit 3400, Box 68, DPO, AA 34060, USA. E-mail: cfq6@cdc.gov

TABLE 1

Diarrheal hospitalizations among children ≤ 5 years from hospital discharge registries at four sentinel surveillance hospitals in Haiti from 2010 to 2012

	Diarrheal hospitalizations/total hospitalizations (percentage of total hospitalizations because of diarrhea)			
	2010	2011	2012	Total
Total	665/2,419 (27)	1,117/3,425 (33)	1,800/4,777 (38)	3,582/10,621 (34)
Stratified by age (years)				
Children ≤ 2	596/2,041 (29)	990/2,917 (34)	1,583/4,145 (38)	3,169/9,103 (35)
Children 3–5	69/378 (18)	127/508 (25)	217/632 (34)	413/1,518 (27)
Stratified by hospital				
HUP (Port-au-Prince)	96/252 (38)	114/353 (32)	222/625 (36)	432/1,230 (35)
HSC (Port-au-Prince)	147/407 (36)	469/1,000 (47)	810/1,445 (56)	1,426/2,852 (46)
HSN (Artibonite)	344/1,161 (30)	468/1,450 (32)	642/1,893 (34)	1,454/4,504 (32)
SMJ (Southeast)	78/599 (13)	66/622 (11)	126/814 (15)	270/2,035 (13)

HSC = Hôpital St. Camille; HSN = Hôpital St. Nicolas; HUP = Hôpital Université de la Paix; SMJ = Hôpital St. Michel de Jacmel.

country, an estimated 13.5% of hospitalizations of children ages 1 month to 4 years were associated with diarrhea.⁸ In Haiti, the presence of a massive outbreak of cholera during much of the time period reflected in our data undoubtedly contributed to an increase in diarrhea-associated hospitalizations and mortality. The progressive annual increase in the proportion of diarrheal patients among all hospitalized patients during the 3-year period likely reflects a true increase in cholera-related admissions, and it may also reflect increased healthcare use for pediatric diarrhea because of increased public concern related to the cholera epidemic that began in October of 2010.

According to the Pan-American Health Organization (PAHO), rotavirus infection is responsible for approximately 40% of worldwide hospitalizations for diarrhea among children < 5 years old.⁹ In a study of sentinel hospital surveillance for rotavirus in 11 Latin American and Caribbean countries in 2006–2007, the median percentage of stool samples positive for rotavirus from children < 5 years old hospitalized for diarrhea was 31.5%.¹⁰ If a similar proportion of diarrhea hospitalizations attributable to rotavirus occurred in Haiti as those hospitalizations reported worldwide and in neighboring countries, the introduction of a rotavirus vaccine may dramatically reduce diarrhea hospitalizations.

Diarrheal hospitalization occurred throughout the year, but the percentage of diarrhea-associated hospitalizations was highest from January to April of all 3 years. In Haiti, this period, particularly from January to March, is generally cooler and characterized by less rainfall and lower average humidity compared with other months in the year.¹¹ The seasonal increase in diarrhea-associated hospitalizations that we found in Haiti is similar to findings in other tropical countries, including the Caribbean region, where increased diarrheal cases in children, largely driven by rotavirus, have been shown to occur during the cool and dry season.^{10,12} Recent results from a laboratory-based surveillance system for diarrhea in Haiti showed that, during 2012–2013, rotavirus peaked in the first few months of the calendar year.⁷ More years of data collection are needed to better understand the seasonality of diarrheal hospitalizations in Haiti.

Our study had several limitations. We conducted our chart review at four hospitals in Haiti, and therefore, our findings may not be representative of diarrheal trends in the whole country or generalizable to the whole Haitian pediatric population. Our chart review also did not include external cholera treatment facilities, where presumptive cholera cases are hospitalized. Additionally, the criteria used by the healthcare professionals at each hospital to make discharge diagnoses

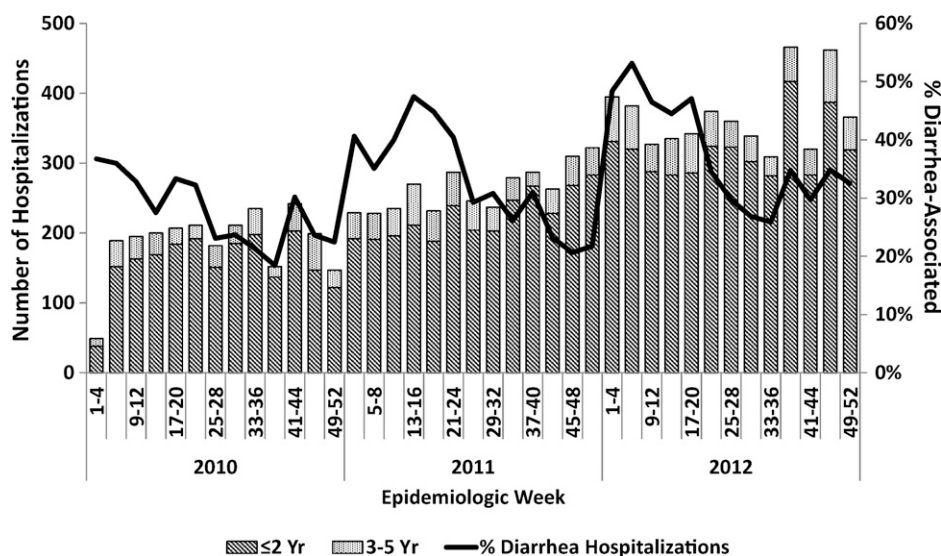


FIGURE 1. Total number of hospitalizations and percentage of diarrhea-associated hospitalizations among children ≤ 5 years at four sentinel surveillance hospitals in Haiti from 2010 to 2012.

may have differed between sites and between clinicians in the various sites. We were not able to validate the data from hospital registries. Furthermore, no laboratory testing was conducted to discern the etiology of diarrhea; as a result, we cannot comment on the specific pathogens that were associated with diarrhea during the study period. Potential changes in other factors that affect diarrhea incidence, such as water and sanitation, will make it challenging to assess the effect of rotavirus vaccine introduction using this data.

However, the data from these four hospitals will serve as a useful baseline for the burden of diarrhea-associated hospitalizations in children before rotavirus vaccine introduction. The planned national introduction of rotavirus vaccine and the implementation of the recently launched National Plan of Action for the Elimination of Cholera in Haiti¹³ have the potential to significantly reduce the burden of diarrhea in children. Pediatric diarrhea hospitalizations and deaths should be monitored to document trends in the burden that occur after these interventions.

Received June 23, 2013. Accepted for publication September 20, 2013.

Published online December 16, 2013.

Acknowledgments: We thank the surveillance nurses at the four hospitals (Chedelène Riviere, Lourdy Narcisse, Marie Géanne Ulysse, Fabiola Charles, Finelia Saint Louis, Dieunane Nikechta Cherisier, Mirlène Alix, and Chrisèmène Cyprien) for their help in collecting these data. We also thank Dr. Sine from Hôpital Universitaire la Paix for facilitating the collection of data. Additionally, we thank Barbara Marston from the Centers for Disease Control and Prevention—Atlanta for her careful review of this manuscript.

Authors' addresses: Kiersten S. Derby, US Centers for Disease Control and Prevention—Haiti, Port-au-Prince, Haiti, E-mail: kiersten.derby@seattlechildrens.org. Mentor Ali Ber Lucien and Gerard A. Joseph, Laboratoire National de Santé Publique—Haiti, Port-au-Prince, Haiti, E-mails: drmabl@yahoo.com and gerardajo944@gmail.com. Eyal Leshem, National Center for Immunization and Respiratory Diseases, US Centers for Disease Control and Prevention—Atlanta, Atlanta, GA, E-mail: wgp9@cdc.gov. Maria W. Steenland, National Center for Emerging Zoonotic Infectious Diseases, US Centers for Disease Control and Prevention—Atlanta, Atlanta, GA, E-mail: maria.steenland@gmail.com. Stanley Juin, Surveillance and Epidemic-Prone Diseases, US Centers for Disease Control and Prevention—Haiti, Port-au-Prince, Haiti, E-mail: Juins@ht.cdc.gov. Mark A. Katz, Center for Global Health, US Centers for Disease Control and Prevention—Haiti, Port-au-Prince, Haiti, E-mail: katzm@ht.cdc.gov.

REFERENCES

- Lozano R, Haghavi M, Foreman K, Lim S, Shiguya K, Aboyan V, Abraham J, Adair T, Aggarwal R, Ahn SY, Alvarado M, Anderson HR, Anderson LM, Andrews KG, Atkinson C, Baddour LM, Barker-Collo S, Bartels DH, Bell ML, Benjamin EJ, Bennett D, Bhalla K, Bikbov B, Bin Abdulhak A, Birbeck G, Blyth F, Bolliger I, Boufous S, Bucello C, Burch M, Burney P, Carapetis J, Chen H, Chou D, Chugh SS, Coffeng LE, Colan SD, Colquhoun S, Colson KE, Condon J, Connor MD, Cooper LT, Corriere M, Cortinovis M, de Vaccaro KC, Couser W, Cowie BC, Crippi MH, Cross M, Dabhadkar KC, Dahodwala N, De Leo D, Degenhardt L, Delossantos A, Denenberg C, Des Jarlais DC, Dharmaratne SD, Dorsey ER, Driscoll T, Duber H, Ebel B, Erwin PJ, Espindola P, Ezzati M, Feigin V, Flaxman AD, Forouzanfar MH, Fowkes FG, Franklin R, Fransen M, Freeman MK, Gabriel SE, Gakidou E, Gaspari F, Gillum RF, Gonzalez-Medina D, Halasa YA, Haring D, Harrison JE, Havmoeller R, Hay RJ, Hoen B, Hotez PJ, Hoy D, Jacobsen KH, James SL, Jasrasaria R, Jayaraman S, Johns N, Karthikeyan G, Kassebaum N, Keren A, Khoo JP, Knowlton
- LM, Kobusingye O, Koranteng A, Krishnamurthi R, Lipnick M, Lipshultz SE, Ohno SL, Mabweijano J, MacIntyre MF, Mallinger L, March L, Marks GB, Marks R, Matsumori A, Matzopoulos R, Mayosi BM, McAnulty JH, McDermott MM, McGrath J, Mensah GA, Merriman TR, Michaud C, Miller M, Miller TR, Mock C, Mocumbi AO, Mokdad AA, Moran A, Mulholland K, Nair MN, Naldi L, Narayan KM, Nasser K, Norman P, O'Donnell M, Omer SB, Ortblad K, Osborne R, Ozgediz D, Pahari B, Pandian JD, Rivero AP, Padilla RP, Perez-Ruiz F, Perico N, Phillips D, Pierce K, Pope CA 3rd, Porrini E, Pourmalek F, Raju M, Ranganathan D, Rehm JT, Rein DB, Remuzzi G, Rivara FP, Roberts T, De León FR, Rosenfeld LC, Rushton L, Sacco RL, Salomon JA, Sampson U, Sanman E, Schwebel DC, Segui-Gomez M, Shepard DS, Singh D, Singleton J, Sliwa K, Smith E, Steer A, Taylor JA, Thomas B, Tleyjeh IM, Towbin JA, Truelsen T, Undurraga EA, Venketasubramanian N, Vijayakumar L, Vos T, Wagner GR, Wang M, Wang W, Watt K, Weinstock MA, Weintraub R, Wilkinson JD, Woolf AD, Wulf S, Yeh PH, Yip P, Zabetian A, Zheng ZJ, Lopez AD, Murray CJ, AlMazroa MA, Memish ZA, 2012. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 380: 2095–2128.
- Ministère de la Santé Publique et de la Population, 2007. *Rapport Annuel 2006*. Available at: <http://www.mspp.gouv.ht>. Accessed April 1, 2013.
- Walker CLF, Aryee MJ, Boschi-Pinto C, Black RE, 2012. Estimating diarrhea mortality among young children in low and middle income countries. *PLoS One* 7: e29151.
- Kotloff KL, Nataro JP, Blackwelder WC, Nasrin D, Farag TH, Panchalingam S, Wu Y, Sow SO, Sur D, Breiman RF, Faruque AS, Zaidi AK, Saha D, Alonso PL, Tamboura B, Sanogo D, Onwuchekwa U, Manna B, Ramamurthy T, Kanungo S, Ochieng JB, Omore R, Oundo JO, Hossain A, Das SK, Ahmed S, Qureshi S, Quadri F, Adegbola RA, Antonio M, Hossain MJ, Akinsola A, Mandomando I, Nhampossa T, Acácio S, Biswas K, O'Reilly CE, Mintz ED, Berkeley LY, Muhsen K, Sommerfelt H, Robins-Browne RM, Levine MM, 2013. Burden and aetiology of diarrheal disease in infants and young children in developing countries (the Global Enteric Multicenter Study, GEMS): a prospective, case-control study. *Lancet* 382: 209–222.
- Natchu U, Bhatnagar S, 2013. Diarrhea in children: identifying the cause and burden. *Lancet* 382: 184–186.
- Barzilay EJ, Schaad N, Magloire R, Mung KS, Boney J, Dahourou GA, Mintz ED, Steenland MW, Vertefeuille JF, Tappero JW, 2013. Cholera surveillance during the Haiti epidemic—the first 2 years. *N Engl J Med* 368: 599–609.
- Steenland MW, Joseph GA, Lucien MA, Freeman N, Hast M, Nygren BL, Leshem E, Juin S, Parsons MB, Talkington DF, Mintz ED, Vertefeuille J, Balajee SA, Boney J, Katz MA, 2013. Laboratory-confirmed cholera and rotavirus among patients with acute diarrhea in four hospitals in Haiti, 2012–2013. *Am J Trop Med Hyg* 89: 641–646.
- Parashar U, Holman RC, Clarke MJ, Bresee JS, Glass RI, 1998. Hospitalizations associated with rotavirus diarrhea in the United States, 1993 through 1995: surveillance based on the new ICD-9-CM rotavirus-specific diagnostic code. *J Infect Dis* 177: 13–17.
- Pan American Health Organization, 2010. *Epidemiologic Surveillance of Diarrheal Diseases Due to Rotavirus: Field Guide. Scientific and Technical Publication No. 623*. Washington, DC: Pan American Health Organization.
- de Oliveira LH, Danovaro-Holliday MC, Andrus JK, de Fillippis AMB, Gentsch J, Matus CR, Widdowson M-A, 2009. Sentinel hospital surveillance for rotavirus in Latin American and Caribbean countries. *J Infect Dis* 200: S131–S139.
2009. *World Weather and Climate Information Website*. Available at: <http://www.weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine>, Port-Au-Prince, Haiti. Accessed April 22, 2013.
- Levy K, Hubbard AE, Eisenberg JNS, 2009. Seasonality of rotavirus disease in the tropics: a systematic review and meta-analysis. *Int J Epidemiol* 38: 1487–1496.
- Ministry of Public Health and Population, 2013. *National Plan for the Elimination of Cholera in Haiti, 2013–2022*. Port-au-Prince, Haiti: Ministry of Public Health and Population.