MAJOR ARTICLE

Potential Intussusception Risk Versus Health Benefits From Rotavirus Vaccination in Latin America

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Background. With the recent postlicensure identification of an increased risk of intussusception with rotavirus vaccine, the 14 Latin American countries currently using rotavirus vaccine must now weigh the health benefits versus risks to assess whether to continue vaccination. To inform policy considerations, we estimated excess intussusception cases and mortality potentially caused by rotavirus vaccine for each of the 14 countries and compared these estimates to hospitalizations and deaths expected to be averted through vaccination.

Methods. We used regional rotavirus disease burden and rotavirus vaccine efficacy data, global natural intussusception and regional rotavirus vaccine-related risk estimates, and country-specific diphtheria, tetanus, and pertussus vaccination coverage rates to estimate rotavirus vaccine coverage rates. We performed a probabilistic sensitivity analysis to account for uncertainty in these parameters.

Results. For an aggregate hypothetical birth cohort of 9.5 million infants in these 14 countries, rotavirus vaccine would annually prevent 144 746 (90% confidence interval [CI], 128 821–156 707) hospitalizations and 4124 deaths (90% CI, 3740–4239) due to rotavirus in their first 5 years of life but could cause an additional 172 hospitalizations (90% CI, 126–293) and 10 deaths (90% CI, 6–17) due to intussusception, yielding benefit-risk ratios for hospitalization and death of 841:1 (90% CI, 479:1 to 1142:1) and 395:1 (90% CI, 207:1 to 526:1), respectively. In an uncertainty analysis using 10 000 simulations of our probabilistic parameters, in comparing rotavirus disease averted to intussusception events caused, the hospitalization ratio was never below 100:1, and our death ratio fell below 100:1 only once.

Conclusions. The health benefits of vaccination far outweigh the short-term risks and support continued rotavirus vaccination in Latin America.

Rotavirus is the leading cause of severe childhood gastroenteritis worldwide [1]. Since 2006, 14 Latin American countries have implemented a national rotavirus vaccination program, with 12 countries using Rotarix, a monovalent human rotavirus vaccine, and 2 using RotaTeq, a pentavalent bovine-human reassortant rotavirus vaccine [2]. In postvaccination years, substantial declines in diarrhea hospitalizations and deaths have been documented in many of these countries [3–10].

In 1999, a previous rotavirus vaccine, RotaShield, was withdrawn postlicensure from the US market after being associated with intussusception, a form of bowel obstruction [11]. The risk of intussusception with both Rotarix and RotaTeq was evaluated in large prelicensure trials of >60 000 infants each; no increased risk was observed. However, postlicensure evaluations have recently identified a short-term 4–6-fold elevated relative risk of intussusception in 1–7 days after dose 1 of Rotarix in Mexico [12, 13] and with both Rotarix and Rotateq in Australia [14], which is substantially

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lower than the 30-fold increased risk in the first week after dose 1 of Rotashield [15].

With these new risk data, Latin American countries need data on benefits and risks of vaccination in their own setting to help decide whether they should continue rotavirus vaccination programs. We modeled the excess number of intussusception hospitalizations and deaths caused by rotavirus vaccination for each of 14 Latin American countries and compared these to the number of rotavirus hospitalizations and deaths averted by vaccination, under a variety of vaccine risk and efficacy scenarios and incorporating country-specific published data whenever available.

METHODS

Vaccine Coverage

World Health Organization (WHO) birth cohort data were obtained from 14 Latin American countries with active rotavirus vaccination programs [16] (Table 1). Six countries (Venezuela, Mexico, Brazil, Panama, Columbia, and Peru) were considered upper-middle-income countries, and 8 countries (Ecuador, El Salvador, Guatemala, Paraguay, Honduras, Bolivia, Guyana, and Nicaragua) were considered lower-middle-income countries, on the basis of 2009 World Bank Gross National Income per capita [16]. To model a fully matured rotavirus vaccination program, we based coverage estimates on diphtheria, tetanus, and pertussis vaccine (DTP) coverage rates. Because intussusception rates vary markedly by age during infancy, risk of intussusception attributable to vaccine is closely linked to age at vaccination. Thus, we applied dose-specific coverage at specific ages (<15 weeks, <6 months, and <9 months) using survey-based estimates of the timing of DTP administration [17]. Nicaragua and Guyana use the 3-dose RotaTeq vaccine, but the other 12 Latin American countries in this study use the 2-dose Rotarix vaccine. For simplicity, we assumed that all countries used the Rotarix dosing schedule and that infants received Rotarix doses 1 and 2 at the same time as DTP doses 1 and 2. The survey-based coverage rates were adjusted to reflect the reported national DTP1 and DTP2 (midpoint of DTP1 and DTP3) coverage rates for the year 2009 [18]. We applied upper age limits of 15 weeks for dose 1 and 9 months for dose 2, which closely reflects the current WHO recommendation (15 weeks and 32 weeks, respectively) [19]. Available data on timing of rotavirus vaccine administration from several countries, including Nicaragua, El Salvador, Mexico, and Brazil, indicate excellent compliance with this WHO recommendation [5, 8, 13]. The number of dose-specific vaccinations was computed as a product of the birth cohort and the proportion receiving DTP within each respective age category: <15 weeks, 15 weeks–5 months, and 6–8 months.

Baseline Intussusception Rates

Few studies have assessed age-specific intussusception rates in the Latin Americas. Thus, pooled estimates of baseline intussusception hospitalization rates were calculated using published global literature for 3-month age intervals in the

Table 1. 14 Latin American Countries With Rotavirus Vaccination Programs, Pentavalent Diphtheria, Tetanus, and Pertussis Vaccine (DTP5) Dose 1 Coverage Rates

Year Vaccine Introduced	Country	2009 World Bank–Gross National Income per Capita, %	Vaccine	Birth Cohort (Thousands)	DTP5 Dose 1 (15 weeks), %[a]
Upper-middle-income countries					
2006	Venezuela	10 090	RV1	595	71
2006	Mexico	8960	RV1	2097	83
2006	Brazil	8070	RV1	3703	85
2006	Panama	6570	RV1	70	81
2009	Colombia	4990	RV1	879	80
2009	Peru	4200	RV1	586	88
Lower-middle-income countries					
2007	Ecuador	3970	RV1	284	68
2006	El Salvador	3370	RV1	159	73
2010	Guatemala	2650	RV1	446	54
2009	Paraguay	2250	RV1	153	72
2009	Honduras	1800	RV1	199	92
2008	Bolivia	1630	RV1	263	73
2009	Guyana	1450	RV5	14	72
2006	Nicaragua	1000	RV5	140	79

Abbreviations: RV1, Rotarix (GlaxoSmithKline Biologicals, Rixensart, Belgium); RV5, RotaTeq (Merck Vaccines, Whitehouse Station, New Jersey).

[a] Dose 1 received by 15 weeks of age.

first year of life: 0–2 months (11.9 per 100 000), 3–5 months (89.1 per 100 000), 6–8 months (83.2 per 100 000), and 9–11 months (47.6 per 100 000) [20–31]. For all countries in our analysis, we assumed equal background rates for each week within each age interval. We used these pooled estimates to calculate the annual number of intussusception cases occurring in these age groups in each country in the absence of a rotavirus vaccination program (ie, baseline).

Potential Vaccine Risk

To compute the excess number of intussusception cases attributable to rotavirus vaccination, we applied risk ratio (RR) estimates generated by a recent postlicensure study in Mexico and Brazil to the baseline estimates of intussusception incidence. In this study, dose 1 of Rotarix was associated with a 5.3-fold (95% confidence interval [CI], 3.0–9.3-fold) increase in baseline risk of intussusception during the first week after administration in Mexico. An independent manufacturer-led study in Mexico and a study from Australia also evaluated post−dose 1 vaccine risk windows, and both studies found clustering of excess intussusception cases in week 1 after dose 1, confirming the small excess risk during this period [12–14, 32, 33]. In contrast, there was no evidence for excess risk following the first dose of Rotarix in Brazil (RR, 1.1; 95% CI, .3–3.3) [13, 33]. On the other hand, a 2.6-fold (1.3–5.2-fold) increase in baseline risk of intussusception was observed during the first week after dose 2 of Rotarix in Brazil, but this increased risk after dose 2 was not observed in Mexico (RR, 1.8; 95% CI, .9–3.8). We used these country-specific RRs for Mexico and Brazil. To generate conservative estimates of safety for Latin American countries other than Mexico and Brazil, we assumed both a 5.3-fold increase in risk in week 1 after dose 1 and 2.6-fold increase in risk in week 1 after dose 2.

Excess intussusception risk within a week after vaccination was calculated as the product of the baseline intussusception risk by week of age and the dose-specific vaccine-associated relative risk minus the baseline risk. The excess numbers of intussusception events after vaccination were calculated as a product of the number of dose-specific rotavirus vaccinations administered within each age interval (see above) and the excess intussusception risk within a week after vaccination with either rotavirus dose 1 or dose 2.

In the hospital-based postlicensure safety study, intussusception case fatality was 1% in Mexico and 5% in Brazil [13, 33]. Population-based data on intussusception case fatality are not available. Because of the possibility of out of hospital intussusception deaths, we conservatively assumed the higher mortality rate of 5% among intussusception cases in upper-middle-income countries, and, to account for the decreased healthcare access in poorer countries, we assumed a 10% mortality rate in lower-middle-income countries.

Table 2. Vaccine Efficacy Estimates for Lower-Middle and Upper-Middle Income Countries by Outcome and Vaccine Schedule

Estimate	VE Against Rotavirus Death, % (range)	VE Against Rotavirus Hospitalization, % (range)
Upper-middle–income countries		
Full series	100 (74–100)	85 (72–93)
Partial series	51 (26–67)	51 (26–67)
Lower-middle-income countries		
Full series	80 (59–90)	66 (31–83)
Partial series	51 (26–67)	51 (26–67)

Abbreviation: VE, vaccine efficacy.

Baseline Rotavirus Hospitalization and Mortality Rates

Rotavirus gastroenteritis hospitalization and mortality rates in the prevaccine era were obtained from country-specific publications when available [34–43]. For upper-middle and lower-middle-income countries without published rotavirus hospitalization rates, we took the product of a pooled value of all-cause diarrheal hospitalization rates from Latin American settings and country-specific etiologic fractions of rotavirus diarrhea hospitalizations [34, 36, 42, 43]. For countries without published rotavirus mortality data, we used WHO country-specific estimates of rotavirus deaths [44]. We used published studies from the year 2000 or later to generate age distributions for rotavirus hospitalization and mortality for upper-middle-income [45–60] and lower-middle-income countries [61–65]: 0–2, 3–5, 6–8, 9–11, 12–23, 24–35, 36–47, and 48–59 months. To determine the mean proportion of children hospitalized by age category, we averaged the proportion of children in each age category across studies. For studies that did not provide such precise age categories, we extrapolated the age distribution based on the average proportions from countries that did.

Vaccine Benefits

Estimates of rotavirus vaccine efficacy were based on published Latin American Rotarix and RotaTeq studies (Table 2). Separate estimates were obtained for upper-middle-income and lower-middle-income countries, with both partial (1-dose) and full (2-dose) vaccination schedules. Although efficacy against hospitalizations was available from clinical trials, efficacy against rotavirus deaths has not been directly evaluated. However, reductions in childhood diarrhea deaths after rotavirus vaccine introduction have been similar to estimates based on vaccine efficacy against hospitalizations [4]. Thus, we assumed that efficacy against death was equal to the efficacy against "very severe" rotavirus disease on basis of the 20-point Vesikari clinical severity score from the clinical trials (score ≥19) or effectiveness studies (score ≥15–20). In upper-middle-income countries, we estimated full vaccine schedule efficacies to be

85% for hospitalization and 100% for death [66]. In lower-middle-income countries, we estimated full vaccine schedule efficacies to be 66% for hospitalization and 80% for death [5, 8]. In all countries, we estimated partial vaccine schedule efficacies of 51% for hospitalization and death [5]. However, it is possible that efficacy of partial series of vaccine is even higher, which would further reduce the burden of severe rotavirus disease occurring between ages 2 and 4 months.

The estimated number of rotavirus-associated deaths and hospitalizations prevented with the rotavirus immunization program in each of the 14 Latin American countries was a product of (1) number of rotavirus-associated deaths and hospitalizations among children <5 years in each age category for each Latin American country; (2) schedule-specific vaccine efficacy for death and hospitalization in upper-middle and lower-middle-income countries; and (3) DTP dose 1 and DTP dose 2 vaccine coverage estimates at the beginning of each age category for each Latin American country.

Risk-Benefit, Sensitivity, and Uncertainty Analysis

We generated a country-specific table of baseline intussusception hospitalizations and deaths and rotavirus hospitalizations and deaths, as well as a benefit-risk table using the excess intussusception hospitalizations and deaths and the averted rotavirus hospitalizations and deaths. We performed a probabilistic uncertainty analysis for the hospitalization and death ratio of averted rotavirus disease for intussusception events to capture uncertainty in combinations of vaccine benefit and intussusception risk parameters. Uncertainty was accounted for in intussusception cases and death by simultaneously varying vaccine coverage, intussusception risk, and the intussusception case-fatality proportion and—in hospitalizations and deaths averted—by varying vaccination coverage, vaccine efficacy against hospitalization and death, number of intussusception hospitalizations or deaths, and the proportion of diarrheal deaths due to rotavirus, using the ranges and distributions (Supplementary Table 1). Ninety percent CIs are reported from 10 000 simulations to minimize the influence of outlying values of inputs with long-tailed distributions[67].

RESULTS

In total, 7.8 million doses of rotavirus vaccine dose 1 are administered annually in the 14 Latin American countries included in this study, corresponding to 81% of their aggregate birth cohort. At 15 weeks, a crude average of 81% of infants had received DTP dose 1 in upper-middle-income countries compared with 73% of infants in lower-middle-income countries.

In the 14 countries, there are an estimated 13 rotavirus deaths (country-specific range, 5–134) and an estimated 479 rotavirus hospitalizations (country-specific range, 144–1016) annually per 100 000 children <5 years of age. These rates translate to an estimated 6302 deaths and 229 656 hospitalizations occurring annually from rotavirus disease among children <5 years of age. Pooled global age-specific estimates for baseline intussusception hospitalization rate per 100 000 infants were 11.9 (0–2 months), 89.1 (3–5 months), 83.2 (6–8 months), and 47.6 (9–11 months). Given these rates, at baseline a total of 5556 intussusception hospitalizations and 326 intussusception deaths were estimated to occur annually among an unvaccinated birth cohort of infants born in these 14 Latin American countries in their first year of life (Table 3).

Rotavirus vaccination would avert 144 746 rotavirus hospitalizations (90% CI, 128 821–156 707) and 4124 rotavirus deaths (90% CI, 3740–4239), whereas it would potentially result in an excess of 172 intussusception hospitalizations (90% CI, 126–293) and 10 intussusception deaths (90% CI, 6–17) annually during the first year of life, yielding benefit-risk ratios for hospitalization and death of 841:1 (90% CI, 479:1 to 1142:1) and 395:1 (90% CI, 207:1 to 526:1), respectively (Table 4).

Absolute numbers of lives saved and hospitalizations prevented in these 14 countries were 3998 (90% CI, 3717–4236) and 142 804 (90% CI, 129 126–156 832), respectively. Aggregate age-specific excess intussusception events and averted rotavirus disease from rotavirus vaccination, as well as baseline values without vaccine, are presented for all 14 Latin American countries (Figure 1). In an uncertainty analysis using 10 000 simulations of our probabilistic parameters, in comparing rotavirus disease averted to intussusception events caused, the hospitalization ratio was never below 100:1, and our death ratio fell below 100:1 only once (Supplementary Figure 1).

DISCUSSION

To err on the side of safety in our analysis, we made several conservative assumptions for model parameters. First, the baseline estimates of intussusception rates from the pooled global analysis (35–119 events per 100 000 live births) [20–28] were greater than estimates from 3 small regional studies in Latin America (22–55 events per 100 000 live births) [29–31]. We chose the global analysis because they offered age-specific intussusception rates and included national data rather than hospital-based cohorts. Second, we extended both the risks from Mexico for dose 1 and from Brazil for dose 2 to the other 12 Latin American countries without country-specific data, because the reasons for differences in risk between Mexico and Brazil remain unclear [13]. Third, we assumed higher intussusception case fatality for middle-income countries than those reported from a study performed in Mexico, in order to reflect events occurring in areas with poor healthcare access.

Table 3. Estimates of the Burden of Disease Attributable to Intussusception and Rotavirus in the Absence of Rotavirus Vaccination

		Intussusception		Rotavirus Disease			
Estimates	Birth Cohort (Thousands)	Hospitalizations[a]	Deaths[b]	Hospitalizations	5-year Risk of Hospitalization (per 100 000)	Deaths	5-year Risk of Death (per 100 000)
Upper-Middle-Income Countries							
Venezuela	595	345	17	13 754	462	384	13
Mexico	2097	1215	61	15 097	144	923	9
Brazil	3703	2146	107	117 015	632	850	5
Panama	70	41	2	1684	481	37	11
Colombia	879	509	25	14 061	320	219	5
Peru	586	340	17	29 779	1016	691	24
Lower-Middle-Income Countries							
Ecuador	284	165	16	4107	289	271	19
El Salvador	159	92	9	3262	411	295	37
Guatemala	446	258	26	13 529	607	776	35
Paraguay	153	88	9	3250	426	185	24
Honduras	199	115	12	2801	281	663	67
Bolivia	263	153	15	6630	503	817	62
Guyana	14	8	1	228	336	91	134
Nicaragua	140	81	8	4460	638	100	14
Total	9588	5556	326	229 656	479	6302	13

[a] Intussusception hospitalizations were calculated by multiplying age cohorts by global age-specific intussusception rates for each country.

[b] Intussusception deaths were calculated by multiplying intussusception hospitalizations by a hospitalization fatality rate of 5% for high-middle-income countries and 10% for low-middle-income countries, based on available literature.

We also doubled intussusception case fatality in low-middle-income countries relative to high-middle-income countries to account for the relatively larger rural zones in these countries. Finally, indirect benefits of vaccination have been documented with rotavirus vaccines, and if these were included in our analysis, they would further tip the balance in favor of rotavirus vaccination [5, 6].

Despite these conservative assumptions, our benefit-risk analysis shows that the annual number of deaths and hospitalizations from rotavirus disease averted by vaccination far exceeds the annual number of intussusception deaths and hospitalizations that could be potentially caused by vaccination in these 14 Latin American countries. Even considering the relatively high proportion of intussusception hospitalizations requiring surgical intervention, the benefit-risk ratios for death and hospitalization of 395:1 and 841:1 overwhelmingly favor the benefits from vaccination. Together, these findings support the public health benefits of continuing rotavirus vaccination in Latin America.

Estimates of disease incidence, vaccine efficacy, and intussusception risk are the main drivers of the benefit-risk analysis, and our confidence in the model results depends heavily on the accuracy of these inputs. The incidence of rotavirus hospitalization has been well established in Latin America, with country-specific estimates of laboratory-confirmed rotavirus hospitalization burden being available for 9 of the countries in our analysis [36–41]. However, few studies have made postmortem determination of the etiologic cause of diarrheal deaths. Thus, in our model we used published country-specific rotavirus death estimates, which have been determined on the basis of rotavirus prevalence among children hospitalized with diarrhea. Reassuringly, however, the observed reductions in diarrhea deaths after rotavirus vaccination in Mexico [4] and Brazil [68] have validated the estimate of the vaccine-preventable burden of diarrhea deaths attributable to rotavirus before rotavirus vaccines were introduced. These findings substantially improve our confidence in the rotavirus mortality inputs for the model. The large clinical trial of Rotarix was conducted in 11 Latin American countries providing robust and representative vaccine efficacy data [69], which have been confirmed by postlicensure effectiveness studies [5, 68]. Moreover, several Latin American countries are now in their third or fourth year of vaccine use, and the sustained declines in diarrhea deaths and hospitalizations after vaccine introduction have reaffirmed vaccine efficacy estimates (Supplementary Table 2) [3–8, 10]. In our analysis, we did not assume any reduction in vaccine effectiveness over time, as this was not significantly appreciated in clinical trial data [69]. The intussusception risk used in our model was obtained from postlicensure trials, which are subject to reporting bias;

Table 4. Estimated Change, After Implementation of Rotavirus Vaccination, in the Burden of Disease From Intussusception and Rotavirus

	Excess Intussusception		Averted Rotavirus Disease			
Estimates	Hospitalizations (90% CI)	Deaths (90% CI)	Hospitalizations (90% CI)	Deaths (90% CI)	Hospitalization Ratio (90% CI)[a]	Death Ratio (90% CI)[a]
Upper-Middle-Income Countries						
Venezuela	13 (6–28)	1 (0–2)	7817 (6464–9031)	255 (209–287)	607 (268–1345)	396 (137–1644)
Mexico	17 (8–32)	1 (0–2)	10 005 (8260–11 567)	714 (584–803)	584 (295–1202)	834 (324–3396)
Brazil	68 (14–168)	3 (0–10)	79 626 (65 877–92 020)	676 (552–756)	1176 (454–4922)	200 (63–1325)
Panama	2 (1–4)	0 (0–0)	1087 (901–1257)	28 (23–31)	654 (276–1405)	335 (111–1375)
Colombia	23 (10–51)	1 (0–3)	8939 (7416–10 363)	162 (132–182)	390 (169–877)	142 (47–584)
Peru	13 (6–27)	1 (0–2)	21 153 (17 463–24 584)	575 (467–644)	1641 (749–3422)	892 (314–3392)
Upper-middle-income total	135 (84–249)	7 (3–14)	128 626 (113 687–141 257)	2410 (2117–2517)	952 (504–1523)	357 (160–684)
Lower-Middle-Income Countries						
Ecuador	6 (3–14)	1 (0–2)	1748 (1066–2206)	138 (109–162)	300 (108–634)	237 (84–543)
El Salvador	4 (2–8)	0 (0–1)	1494 (796–1642)	159 (128–189)	385 (132–771)	410 (163–1053)
Guatemala	7 (3–17)	1 (0–2)	4589 (2824–5777)	333 (249–370)	627 (236–1393)	454 (164–999)
Paraguay	3 (2–8)	0 (0–1)	1469 (892–1845)	99 (79–118)	421 (156–935)	284 (107–697)
Honduras	7 (3–15)	1 (0–2)	1575 (981–1981)	444 (355–523)	242 (93–566)	682 (260–1742)
Bolivia	7 (3–15)	1 (0–2)	2964 (1845–3733)	435 (345–512)	443 (168–1044)	650 (248–1691)
Guyana	0 (0–1)	0 (0–0)	101 (62–127)	48 (38–56)	317 (120–733)	1510 (561–3791)
Nicaragua	3 (1–6)	0 (0–1)	2181 (1349–2409)	59 (46–69)	760 (297–1579)	205 (81–468)
Lower-middle-income total	37 (31–58)	4 (2–4)	16 120 (13 172–17 429)	1715 (1535–1816)	437 (256–511)	465 (263–551)
All countries	172 (126–293)	10 (6–17)	144 746 (128 821–156 707)	4124 (3740–4239)	841 (479–1142)	395 (207–526)

Abbreviation: CI, confidence interval.

[a] Ratios given here as whole numbers correspond to the number of averted rotavirus events that are estimated to occur for each excess intussusception event.

however, a similar small post−dose 1 rotavirus vaccination risk has been confirmed by 2 independently conducted studies [14, 70]. The use of inputs generated by regional studies conducted under real world conditions, as well as the bounds of our uncertainty analysis, suggests that our conclusions are robust.

WHO recommends that the first dose of rotavirus vaccine should be given by 15 weeks of age [71]. This maximizes the benefits from vaccination by immunizing children early in life before they are at greater risk from severe rotavirus gastroenteritis. Background rates of intussusception vary markedly by infant age, with an 8–10-fold increase between infants aged 1–3 and 4–6 months [20]. Assuming that rotavirus vaccine-associated intussusception risk, relative to background intussusception risk, is stable with age, administering vaccines early in life also minimizes the excess intussusception risk [72]. Because data from several Latin American countries indicate good compliance with WHO recommendation of initiating rotavirus vaccination by 15 weeks of age [5, 8, 13], it is possible that the vaccine-attributable risk of intussusception is lower in Latin America compared with a risk that could be seen in countries where delays in vaccination are common [17]. However, we showed elsewhere that even when an age restriction is not imposed, at hypothetical intussusception risks similar to those modeled in this study, the benefits in terms of lives saved are substantially greater than the risks of intussusception in settings with high rotavirus mortality and delays in vaccination [73]. Moving forward, each country will have to assess the risks and benefits of expanding the age of administration of rotavirus vaccination in their own setting based on the local burden of rotavirus disease, particularly mortality, and the timeliness of vaccination.

In summary, substantial reductions in deaths and hospitalizations from diarrhea have been well documented with use of rotavirus vaccines in Latin America and are in contrast to the short-term, lower-level risk of intussusception. For an individual child, decisions about vaccine-related benefits and risk should be made by informed parents after effective communication with their providers. From a public health perspective, however, our analysis shows that the documented health benefits of vaccination far outweigh the risks and supports continued rotavirus vaccination in Latin America.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online (http://www.oxfordjournals.org/our_journals/cid/). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyedited. The contents of all

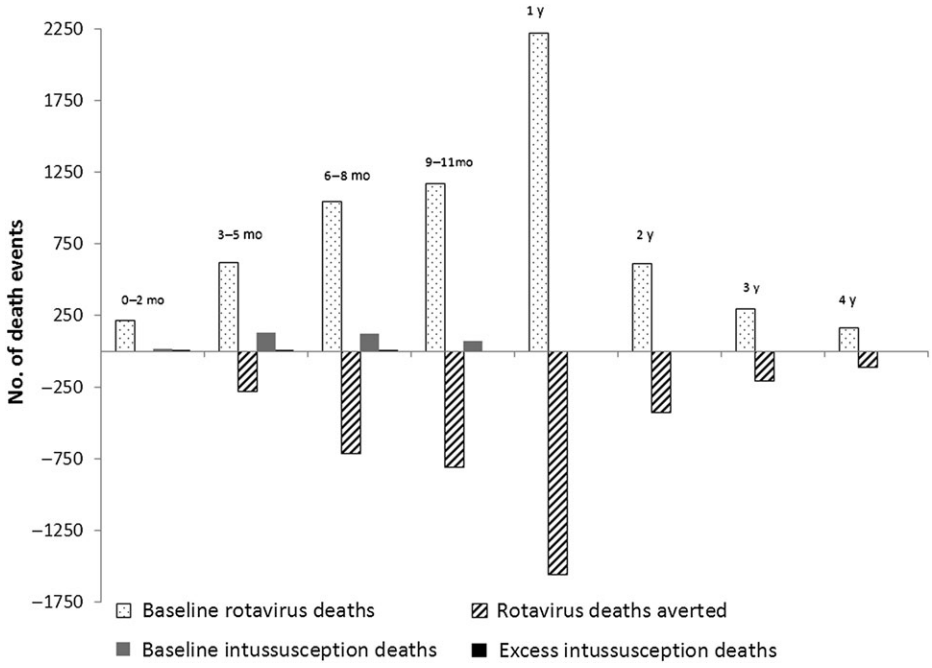

Figure 1. *A*, Baseline and averted rotavirus hospitalizations and baseline and excess intussusception hospitalizations by age. Excess intussusception hospitalizations by age group are as follows: 0–2 months (n = 50), 3–5 months (n = 120), 6–8 months (n = 2), and 9–11 months (n = 0). *B*, Baseline and averted rotavirus deaths and baseline and excess intussusception deaths by age. Excess intussusception deaths by age group are as follows: 0–2 months (n = 3), 3–5 months (n = 7), 6–8 months (n = 0), and 9–11 months (n = 0).

supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

Notes

Disclaimer. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention. All decisions regarding the collection, analysis, and interpretation of the data, writing of the report, and submitting the paper for publication were made solely by the authors of the paper. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Potential conflicts of interest. All authors: No reported conflicts.

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