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Review

Treatment costs of diarrheal disease and all-cause pneumonia among children under-5 years of age in Colombia

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ABSTRACT

Objective: We estimate treatment costs associated with diarrheal disease and all-cause pneumonia among children under-5 years of age in Colombia and assess similarities or differences with previous cost estimations in developing countries of the Americas.
Methods: Macro-costing methods were used to carry out an analysis of diarrhea and all-cause pneumonia costs in Colombia in 2010. The perspective of the health care system was taken. Data were extracted from a health insurer database that includes information on health service utilization among 130,800 children from low-income households. Lengths of stay for hospital admissions and frequencies of cases at all levels of care registered in the database were estimated.
Results: There were 1456 diarrheal disease cases among the 130,800 children (aged ≥60 months) included in the study. The median cost per case was $27.10 (interquartile range [IQR]: $15.60–77.40). A total of 1545 all-cause pneumonia cases were reported to the insurer in 2010, resulting in a frequency of 1181 cases per 100,000 children (95% confidence interval [CI] = 1122, 1240). The overall cost of all-cause pneumonia cases was $858,791, and the median cost per case treated was $263 (IQR: $27–546). Comparisons by level of care showed that costs were significantly different for the two diseases ($p < .05$). Costs for the diseases did not differ by age group ($p > .05$).
Conclusions: Diarrhea and all-cause pneumonia constitute a significant economic and health burden in Colombia. The relatively large size of our sample allowed us to provide reliable national estimates of the costs associated with these diseases. Our results for Colombia are similar to previous estimates from developing countries in the Americas. These data provide valid estimates that may be used decision makers in other countries to make appropriate recommendations on the introduction of rotavirus and pneumococcal vaccines.

Contents

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1. Introduction

Childhood pneumonia is the leading cause of mortality in children under 5 years old worldwide, causing 1.39 million deaths in 2010 [1]. The incidence in this age group is estimated to be 0.29 episodes per child-year in developing countries and 0.05 episodes per child-year in developed countries [2]. In addition, diarrheal disease is one of the most common childhood illnesses in both developing and developed countries [3]. In 2004, there were 10.4 million deaths reported among children under-5 years of age worldwide, and diarrhea caused an estimated 17% of these deaths (1.87 million; uncertainty range: 1.56–2.19) [4]. Rotavirus was estimated to have caused 453,000 deaths in 2008 [5]. Also, diarrheal disease was the third most common cause of death in children and the second most common cause of hospitalizations and outpatient visits [6–8].

Timely case management of diarrheal disease and pneumonia, including the use of oral rehydration therapy and prompt use of antibiotics, can substantially reduce the risk of fatal outcomes. However, the world's poorest populations often have limited access to these basic health services.

Treatment cost analyses of pneumonia and diarrheal disease among children under-5 are scarce in Latin American and Caribbean (LAC) countries. In the published literature on pneumonia treatment costs, data are available for only a limited number of countries [9–15]. In Colombia, for example, only two studies have described pneumonia costs among children [16,17]. These studies were hospital based and involved a relatively small, non-representative sampling of nationwide disease costs. Studies related to disease management costs of diarrhea among children >5 years are also scarce in LAC countries. In Colombia, only one hospital-based study has described the costs of diarrhea among children >2 years in inpatient and outpatient settings [18].

The purpose of the present study was to estimate treatment costs (direct medical costs) of diarrhea and all-cause pneumonia in a hospital-based population of children and to assess similarities with or differences from previous cost estimations in the Americas.

2. Methods

This descriptive cost study of diarrheal disease and all-cause pneumonia in children under 5 was carried out in Colombia. The study was based on a 2010 database of information on health service visits (*Registros Individuals de Prestación de Servicios* [RIPS]) among a hospital-based population of children from low-income households. The perspective of the health care system was taken.

We used a step-down, macro-costing approach, estimating costs for all patients and costs per treated case of all-cause pneumonia and diarrhea [19].

2.1. Population and data collection

All health providers (inpatient and outpatient) in Colombia are required to provide information for the RIPS database; each medical procedure administered to a patient is recorded, along with the total cost charged to the health insurer. The database reports diagnosis data (according to the *International Classification of Diseases* (10th revision; *ICD-10*)) and cost data (medication, diagnostics, personnel, and hospital bed-day costs) for each patient visit or admission. Information is provided by the attending physician in every consultation made within the Colombian health care system, and the database serves as an annex for disbursements made to any health facility within the system.

The Colombian health system covers 96% of the population through two regimes: contributive (covering those who can afford to pay a premium rate) and subsidized (covering those who cannot afford to pay a premium rate and are entitled to subsidized services from the Colombian government) [20]. This study focuses on a database of health service visits from a health insurer in the subsidized regime. This insurer covers approximately 1.25 million people who cannot afford to pay a premium. These individuals are distributed across the country, in 12 states (of a total of 32 states) and 144 municipalities (of a total of 1108), and 130,800 (10.4%) of them are under-5 years of age. Overall, the health insurer covers 2.8% of the Colombian population and 3.1% of the under-5 population.

According to the national poverty line 37.2% of the country's population has an income falling below the national poverty line, and according to the international definition (power purchasing parity of $2 a day) 6.8% of the population is does [21,22].

We used *ICD-10* diagnosis codes to identify all diarrheal disease cases (codes A00–A09) and pneumonia cases (codes J180, J181, J188, J189, J158, J159, P361, A408, and A409) reported to the database. In Colombia, all-cause pneumonia is diagnosed radiologically, usually according to the criteria of the World Health Organization [23]. In addition to costs, we estimated lengths of stay and frequencies of pneumonia health care visits.

The RIPS database reflects the clinical history of a disease in the Colombian health system. As such, several health care encounters may be registered for the same disease in different time periods. As a means of correcting this possible bias, different health care encounters labeled with the same *ICD-10* code were considered as the same pathology if they occurred within a day from the date of discharge to the subsequent admission day.

The data were categorized by age group and level of care. The Colombian health system divides care by level of complexity, depending on the health care service structure available to provide support to patients with severe illness.

2.2. Statistical analysis

Data were extracted and analyzed in Microsoft Excel. We report continuous data as means and medians, depending on the probability distribution of the variable in question. We report parametric variables as means and nonparametric variables as medians. Categorical variables are reported as percentages. We report costs as medians (as an aggregate measure) and interquartile ranges (IQRs; as a measure of dispersion). We converted costs to 2010 US dollars ($) at an exchange rate of 1913.9 Colombian pesos to 1 US dollar. Nonparametric tests (Mann–Whitney) were used in performing cost comparisons. The level of statistical significance was set at $p < .05$.

3. Results

The sample included 130,800 children under-5. Cost comparisons showed no significant differences in median costs for all-cause pneumonia and diarrhea between different age groups ($p > .05$). The results for each disease are outlined below.

3.1. All-cause pneumonia

A total of 1545 inpatient cases of pneumonia were reported in 2010, resulting in a rate of 1181 cases per 100,000 children (95% confidence interval [CI] = 1122, 1240). The overall cost of all cases combined was $858,791, and the median cost per case was $263 (IQR: $27–546) (Table 1).

Case frequencies and costs by age groups and levels of care are shown in Tables 1 and 2. The median length of stay was 2 days (IQR: 1–5), and there were significant differences in lengths of stay

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Table 1
Frequency of all-cause pneumonia among children >5 years of age in Colombia.

Age group (months)	No. of children	No. of cases (%)	Total cost (US $)	Median cost per case (US $) (IQR)[a]	Frequency per 100,000 (95% CI)
0–11	17,250	281 (18.2)	184,466	331 (19–693)	1629 (1437–1821)
12–23	41,945	596 (38.6)	370,855	285.5 (29–555.5)	1421 (1306–1535)
24–35	22,099	308 (19.9)	142,267	244 (37.5–506.5)	1394 (1237–1551)
36–47	24,541	178 (11.5)	82,208	185 (29–524)	725 (617–834)
48–60	24,965	182 (11.8)	78,995	226.5 (23–478)	729 (621–837)
Total	130,800	1545 (100)	858,791	263 (27–546)	1181 (1122–1240)

[a] Comparisons of age groups did not show statistically significant differences ($p > .05$).

Table 2
Treatment costs for all-cause pneumonia and diarrhea, by level of care, among children >5 years of age in Colombia.

Level of care	All-cause pneumonia				Diarrhea			
	No. of cases (%)	Length of stay (days) (IQR)	Total cost (US $)	Median cost (US $)[a] (IQR)	No. of cases (%)	Length of stay (days) (IQR)	Total cost (US $)	Median cost (US $)[a] (IQR)
Primary	247 (16)	2 (1–2)	70,474	71 (20–268)	654 (44.9)	1 (1–1)	33,951.4	25.1 (17.8–45.9)
Secondary	1208 (78.2)	4 (1–5)	555,790	283.5 (25–533)	779 (53.5)	1 (1–2)	108,978.4	34.8 (13.3–169.7)
Tertiary	47 (3)	6 (3–9)	40,376	482 (306–1067)	19 (1.3)	1 (1–2)	6120.7	175.6 (55.7–357.8)
Critical care	43 (2.8)	13 (6–14)	192,151	3393 (1358–7164)	4 (0.3)	15 (7–29)	31,885.1	7184.2 (2270.6–13,672)

[a] Comparisons by level of care showed statistically significant differences ($p < .001$).

according to level of care ($p < .001$). Median costs were also significantly different according to level of care (Table 2).

3.2. Diarrhea

In 2010, 1456 children were treated for diarrhea in inpatient and outpatient settings. The total cost of these health services was $180,936. The frequency of diarrhea was 904 cases per 100,000 population (95% CI = 760, 1049). Frequencies were greater in children aged >1 year and in children between 12 and 35 months of age (Table 3). Median costs did not differ according to age group.

The median cost per case was $27.10 (IQR: $15.60–77.40). Costs were significantly different according to level of care ($p < .001$) (Table 2). The median duration of follow-up in primary (outpatient) care was 1 day. Median lengths of stay were 1 day (IQR: 1–2) in secondary and tertiary care hospitals and 15 days (IQR: 7–29) in critical care hospitals. Median costs ranged from $25.10 (IQR: $17.80–45.90) in primary care facilities to $175.60 (IQR: $55.70–357.80) in tertiary care facilities. Although critical care admissions occurred at a low frequency, these admissions involved the highest median cost per stay ($7184.20; IQR: $2270.60–13,672).

4. Discussion

To our knowledge, this is the largest population-based study to measure diarrhea and all-cause pneumonia management costs in a Latin American and Caribbean country. Our data provide reliable statistics on costs, frequencies of inpatient admissions, lengths of stay, and the economic burden of disease in Colombia, an upper-middle-income LAC country.

In cost-effectiveness studies of pneumococcal and rotavirus vaccines in LAC, sensitivity analyses typically show that vaccine price, mortality rate, and treatment costs are key drivers of cost-effectiveness [24–30]. Thus, our estimates are reliable parameters to assess and validate past estimates in Colombia and possibly other LAC countries, and these data can be useful for future cost-effectiveness studies as well.

Research has shown that per-case costs for inpatient all-cause pneumonia range between $440.10 in Brazil [15] and $5547.80 in Argentina (prepaid health system) in complicated pneumonia cases [31]. Our results showed that, in Colombia, the median cost per case for all-cause pneumonia treated at the secondary care level was $482 (IQR: $306–1067). At $859.10 per admission, tertiary care facilities incur roughly two times the cost of secondary-level care (as just noted, $482) and approximately five times the cost of primary-level care ($71; IQR: $20–268). These results are similar to cost data reported in other resource-constrained settings such as India [32], and Pakistan [33], as well as the estimates reported for LAC countries by Constenla et al. [34].

Treatment costs for diarrhea cases attended in tertiary care facilities were similar to those reported in studies conducted in Mexico, Venezuela, Argentina, Brazil, Chile, and Panama [24–26,35]. With the exception of studies from Chile [24,36] and Venezuela [24], the treatment costs we estimated for lower-level care facilities were similar to outpatient visit costs in the studies reviewed.

In 2007, De la Hoz et al. estimated that the annual numbers of diarrhea cases requiring hospitalization in children under 2 years old were 2586 (uncertainty range: 2294–2823) in the absence of a rotavirus vaccination program and 1883 (uncertainty range: 1671–2056) in the presence of such a program [18]. Colombia

Table 3
Frequency of diarrheal disease among children >5 years of age in Colombia.

Age (months)	No. of children	No. of cases (%)	Total cost (US $)	Median cost (US $) (IQR)[a]	Frequency per 100,000 (95% CI)
0–11	17,250	156 (10.7)	35,941.7	28 (14.1–131.3)	904 (760–1049)
12–23	41,945	644 (44.2)	83,016.6	27.9 (15.6–78)	1535 (1416–1654)
24–35	22,099	335 (23)	33,304.5	27.2 (17.2–76.2)	1516 (1353–1679)
36–47	24,541	141 (9.7)	11,219.4	22.3 (14.2–48.2)	575 (478–671)
48–60	24,965	180 (12.4)	17,453.4	30.5 (14.7–87.3)	721 (614–828)
Total	130,800	1456 (100)	180,935.6	27.1 (15.6–77.4)	904 (760–1049)

[a] Comparisons between different age groups showed that median costs were not significantly different ($p > .05$).

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introduced the monovalent rotavirus vaccine in 2008 and achieved 82.4% national coverage of the full schedule in 2009 [37].

To extrapolate results on diarrhea and all-cause pneumonia to rotavirus-specific diarrhea and pneumococcal pneumonia, there is a need to consider the possible differences between disease-specific costs and syndrome costs. In the United States, diarrhea costs and rotavirus-specific diarrhea costs are very similar (a median of $3900 for both in 2001–2003), despite slightly longer lengths of stay for rotavirus disease [38]. In addition, a study conducted in eastern China showed that the direct costs of rotavirus diarrhea and non-rotavirus diarrhea were statistically similar ($p = .462$) [39]. We were unable to locate data on the costs of pneumococcal pneumonia in the literature; in most cost-effectiveness analyses, pneumonia costs are used as a proxy for pneumococcal-specific disease costs.

There is a need to consider some limitations of our analysis. We used secondary data from a health insurer, and such information is potentially subject to selection and misclassification bias. Selection bias in this regard can lead to an underestimation of the true incidence of diarrhea, since a portion of the insured population may not have access to hospitalization or health care. However, it is unlikely that selection bias altered our cost results since our estimates were based on a large number of cases. Misclassification of diagnoses may result in both underestimation and overestimation of the incidence of diarrhea. However, for the same reason just described, it is unlikely that misclassification bias led to overestimations in our results. Underestimations are possible if a significant number of cases of diarrhea are classified as other diagnoses or are not classified at all. Another limitation of our study is related to the database we used, which did not allow for identification of specific cost components.

Among the strengths of this investigation is the fact that our sample was relatively large for a cost study, allowing us to make reliable national cost estimates for Colombia. Despite its overall low severity, diarrhea is a significant economic and health burden in Colombia as a result of the frequency of cases. Our findings are similar to previous diarrheal disease estimates from developing countries in the Americas.

Our study adds to the knowledge base regarding the frequency and costs of diarrhea and all-cause pneumonia in a developing country. Our data can assist decision makers in making appropriate recommendations on the introduction of vaccines with the aim of lowering the burden of disease in Colombia.

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References

[1] Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE, et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. Lancet 2012;379:2151–61.
[2] Rudan I, Boschi-Pinto C, Biloglav Z, Mulholland K, Campbell H. Epidemiology and etiology of childhood pneumonia. Bull World Health Organ 2008;86:408–16.
[3] World Health Organization. Guidelines for estimating the economic burden of diarrhoeal disease with focus on assessing the impact of rotavirus diarrhoea. Geneva, Switzerland: World Health Organization; 2005.
[4] Boschi-Pinto C, Velebit L, Shibuya K. Estimating child mortality due to diarrhoea in developing countries. Bull World Health Organ 2008;86:710–7.
[5] Tate JE, Burton AH, Boschi-Pinto C, Steele AD, Duque J, Parashar UD. 2008 estimate of worldwide rotavirus-associated mortality in children younger than 5 years before the introduction of universal rotavirus vaccination programmes: a systematic review and meta-analysis. Lancet Infect Dis 2012;12:136–41.
[6] World Health Organization. The global burden of disease: 2004 update. Available at: http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf[accessed 18.04.13].
[7] Kosek M, Bern C, Guerrant RL. The global burden of diarrhoeal disease, as estimated from studies published between 1992 and 2000. Bull World Health Organ 2003;81:197–204.
[8] Parashar UD, Bresee JS, Glass RI. The global burden of diarrhoeal disease in children. Bull World Health Organ 2003;81:236.
[9] Augustovski FA, Garcia Marti S, Pichon-Riviere A, Debbag R. Childhood pneumococcal disease burden in Argentina. Rev Panam Salud Publica 2009;25:423–30.
[10] Castaneda-Orjuela C, Alvis-Guzman N, Velandia-Gonzalez M, De la Hoz-Restrepo F. Cost-effectiveness of pneumococcal conjugate vaccines of 7, 10, and 13 valences in Colombian children. Vaccine 2012;30:1936–43.
[11] Constenla D. Evaluating the costs of pneumococcal disease in selected Latin American countries. Rev Panam Salud Publica 2007;22:268–78.
[12] Giachetto Larraz G, Telechea Ortiz H, Speranza Mourine N, Giglio N, Cane A, Pirez Garcia MC, et al. Cost-effectiveness of universal pneumococcal vaccination in Uruguay. Rev Panam Salud Publica 2010;28:92–9.
[13] Giglio ND, Cane AD, Micone P, Gentile A. Cost-effectiveness of the CRM-based 7-valent pneumococcal conjugated vaccine (PCV7) in Argentina. Vaccine 2010;28:2302–10.
[14] Sinha A, Constenla D, Valencia JE, O'Loughlin R, Gomez E, de la Hoz F, et al. Cost-effectiveness of pneumococcal conjugate vaccination in Latin America and the Caribbean: a regional analysis. Rev Panam Salud Publica 2008;24:304–13.
[15] Vespa G, Constenla DO, Pepe C, Safadi MA, Berezin E, de Moraes JC, et al. Estimating the cost-effectiveness of pneumococcal conjugate vaccination in Brazil. Pan Am J Public Health 2009;26:518–28.
[16] Rodriguez Martinez CE, Sossa Briceno MP. Cost-effectiveness of chest X-rays in infants with clinically suspected viral bronchiolitis in Colombia. Rev Panam Salud Publica 2011;29:153–61.
[17] Alvis Guzmán N, de la Hoz Restrepo F, Higuera AB, Pastor D, DiFabio JL. The economic costs of pneumonia in children under 2 years of age in Colombia. Rev Panam Salud Publica 2005;17:178–83.
[18] De la Hoz F, Alvis N, Narvaez J, Cediel N, Gamboa O, Velandia M. Potential epidemiological and economical impact of two rotavirus vaccines in Colombia. Vaccine 2010;28:3856–64.
[19] Conteh L, Walker D. Cost and unit cost calculations using step-down accounting. Health Policy Plan 2004;19:127–35.
[20] Guerrero R, Gallego AI, Becerril-Montekio V, Vasquez J. The health system of Colombia. Salud Publica Mex 2011;53(Suppl. 2):s144–55.
[21] Departamento Nacional de Planeación. Pobreza y desigualdad en Colombia. Available at: http://www.dnp.gov.co/Portals/0/archivos/documentos/DDS/Pobreza/En_Que_Vamos/ESTRATEGIA%20libro%20def.pdf [accessed 18.04.13].
[22] World Bank World development indicators. Available at: http://data.worldbank.org/data-catalog [accessed 18.04.13].
[23] World Health Organization. Programme for the control of acute respiratory infections: technical bases for the WHO recommendations on the management of pneumonia in children at first level health facilities. Geneva, Switzerland: World Health Organization; 1991.
[24] Rheingans RD, Constenla D, Antil L, Innis BL, Breuer T. Potential cost-effectiveness of vaccination for rotavirus gastroenteritis in eight Latin American and Caribbean countries. Rev Panam Salud Publica 2007;21:205–16.
[25] Constenla D, Velazquez FR, Rheingans RD, Antil L, Cervantes Y. Economic impact of a rotavirus vaccination program in Mexico. Pan Am J Public Health 2009;25:481–90.
[26] Valencia-Mendoza A, Bertozzi SM, Gutierrez JP, Itzler R. Cost-effectiveness of introducing a rotavirus vaccine in developing countries: the case of Mexico. BMC Infect Dis 2008;8:103.
[27] Constenla DO. Economic impact of pneumococcal conjugate vaccination in Brazil, Chile, and Uruguay. Rev Panam Salud Publica 2008;24:101–12.
[28] Navas E, Salleras L, Gisbert R, Dominguez A, Timoner E, Ibanez D, et al. Cost-benefit and cost-effectiveness of the incorporation of the pneumococcal 7-valent conjugated vaccine in the routine vaccination schedule of Catalonia (Spain). Vaccine 2005;23:2342–8.
[29] Ess SM, Schaad UB, Gervaix A, Pinosch S, Szucs TD. Cost-effectiveness of a pneumococcal conjugate immunisation program for infants in Switzerland. Vaccine 2003;21:3273–81.
[30] Claes C, Graf von der Schulenburg JM. Cost effectiveness of pneumococcal vaccination for infants and children with the conjugate vaccine PnC-7 in Germany. Pharmacoeconomics 2003;21:587–600.
[31] Uruena A, Pippo T, Betelu MS, Virgilio F, Giglio N, Gentile A, et al. Cost-effectiveness analysis of the 10- and 13-valent pneumococcal conjugate vaccines in Argentina. Vaccine 2011;29:4963–72.
[32] Madsen HO, Hanehøj M, Das AR, Moses PD, Rose W, Puliyel M, et al. Costing of severe pneumonia in hospitalized infants and children aged 2–36 months, at a secondary and tertiary level hospital of a not-for-profit organization. Trop Med Int Health 2009;14:1315–22.
[33] Hussain H, Waters H, Omer SB, Khan A, Baig IY, Mistry R, et al. The cost of treatment for child pneumonias and meningitis in the northern areas of Pakistan. Int J Health Plann Manage 2006;21:229–38.
[34] Constenla D, Gomez E, de la Hoz F, O'Loughlin R, Sinha A, Valencia JE, et al. The burden of pneumococcal disease and the cost effectiveness of a pneumococcal

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vaccine in latin America and the Caribbean: a review of the evidence and a preliminary economic analysis. Washington, DC: Albert B. Sabin Vaccine Institute; 2007.
[35] Constenla D, Perez-Schael I, Rheingans RD, Antil L, Salas H, Yarzabal JP. Assessment of the economic impact of the antiretroviral vaccine in Venezuela. Rev Panam Salud Publica 2006;20:213–22.
[36] Constenla D, O'Ryan M, Navarrete MS, Antil L, Rheingans RD. Potential cost effectiveness of a rotavirus vaccine in Chile. Rev Med Chil 2006;134:679–88.
[37] Programa Ampliado de Inmunizaciones. Coberturas de vacunación en Colombia. Available at: http://www.minproteccionsocial.gov.co/salud/Paginas/pai.aspx [accessed 18.04.13].
[38] Fischer TK, Viboud C, Parashar U, Malek M, Steiner C, Glass R, et al. Hospitalizations and deaths from diarrhea and rotavirus among children <5 years of age in the United States, 1993–2003. J Infect Dis 2007;195:1117–25.
[39] Jin H, Wang B, Fang Z, Duan Z, Gao Q, Liu N, et al. Hospital-based study of the economic burden associated with rotavirus diarrhea in eastern China. Vaccine 2011;29:7801–6.

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