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Diarrhea hospitalization costs among children <5 years old in Madagascar

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Abstract

Background: Following a recommendation by the World Health Organization, Madagascar introduced rotavirus vaccine in 2014. Though national rotavirus vaccine coverage has remained <80%, rotavirus hospitalizations declined by 78%. Gavi, the Vaccine Alliance, has provided financial support for rotavirus vaccine, however the Malagasy government has increasing responsibility for the financial cost.

Methods: In this evaluation, we describe the direct medical, direct non-medical, and indirect cost of illness due to diarrhea among children <5 years old at a public pediatric referral hospital. A 3-part structured questionnaire was administered during and following the hospitalization and the child's hospital record was reviewed.

Results: In total, 96 children were included in this analysis. The median total cost of the illness was \$156.00 (IQR: 104.00, 210.86) and the median direct medical cost was \$107.22. Service delivery costs represented a median of 44% of the inpatient costs; medications and diagnostic tests represented a median of 28% and 20% of the total costs of the hospitalization, respectively. The median percentage of the total illness costs paid by the household was 67%. Among households with income of <\$61/month, the median costs of the illness paid by the household were \$78.55, representing a median of 168% of the household's monthly expenses. Among households earning >\$303/month, the median costs paid by the household were \$147.30, representing a median of

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53% of the household's monthly expenses. Among all household income levels, caregivers commonly paid these bills from savings, borrowed money, and donations.

Conclusions: Our findings will be useful in assessing the cost-effectiveness of rotavirus vaccine by decisionmakers. These results may also help hospital administrators and healthcare providers better understand the financial constraints of families

Keywords

Rotavirus; diarrhea; Madagascar

Introduction

In 2016, rotavirus caused an estimated 450,000 hospitalizations and 100,000 deaths among children <5 years old in Africa [1]. In response to the high morbidity and mortality due to rotavirus, rotavirus vaccines have been recommended for use in all countries by the World Health Organization (WHO) since 2009 [2]. In 2014, Madagascar introduced Rotarix (GlaxoSmithKline Biologicals, Rixensart, Belgium), a monovalent, human strain, live, oral rotavirus vaccine, into the national, routine infant vaccination schedule with 2 doses administered at 6 and 10 weeks of age. Though national rotavirus vaccine coverage has remained below 80% in Madagascar, diarrheal reductions during the first two years after vaccination have been substantial [3, 4]. All-cause acute gastroenteritis hospitalizations declined by 36% and hospitalizations due to rotavirus diarrhea declined by 78% among children <5 years old [4].

The Centre Hospitalier Universitaire Mère Enfant Tsaralalàna (CHU-MET) is a public pediatric referral hospital with 52 beds in 2018 located in Antananarivo, the capital of Madagascar. Overhead costs of the hospitalization are paid by the government of Madagascar, however medications, diagnostic tests, and consumables such as intravenous (IV) kits and specimen collection kits are paid by the families of the patients. Some charity is available through the hospital and is typically used to pay for medical costs and food for caregivers.

In this evaluation, we describe the cost of illness due to diarrhea resulting in a hospitalization among children <5 years old in Madagascar. Although there have been previous evaluations to estimate the cost of diarrhea hospitalizations and to demonstrate the cost-effectiveness of rotavirus vaccine in Africa [5–8], this is the first description of such data from Madagascar and includes non-medical and indirect costs, in addition to the direct costs of the hospitalization. We also describe the proportion of these costs paid by the government and by the children's caregivers. Gavi, the Vaccine Alliance, has provided financial support for rotavirus vaccine in Madagascar as part of a cost-sharing agreement, however the Malagasy government has increasing responsibility for the financial cost of vaccination [9]. This information provides useful information for national decisionmakers to evaluate the cost-effectiveness of rotavirus vaccine.

Methods

CHU-MET has been a rotavirus and expanded enteropathogen sentinel surveillance site as part of the WHO Global Rotavirus Surveillance Network since 2013. Children <5 years old admitted as inpatients to CHU-MET for acute watery diarrhea from May to November 2018 were eligible for enrollment in this evaluation. Acute watery diarrhea was defined as 3 or more loose, non-bloody stools in a 24-hour period lasting no more than 7 days. A stool specimen was collected within 48 hours of admission from all children enrolled in sentinel surveillance and tested for rotavirus by ELISA. Assuming 200 annual diarrhea cases as shown in previous evaluations from this surveillance system [4], a 10% level of precision, and a coefficient of precision of 0.5, we estimated that a sample size of 65 children was needed.

Study staff provided information about this evaluation to the caregivers of eligible children and informed consent was obtained. For those who agreed to participate, a 3-part structured questionnaire was administered. The first part was an in-person interview with the caregiver during the hospitalization. This section documented information about the household's socio-economic status and care received for this illness before the hospitalization. After the child was discharged, the second part was completed by study staff who reviewed and abstracted information on medications and diagnostic tests ordered during this hospitalization from the medical record. For the third part of the questionnaire, the family was contacted by phone about 10 days after discharge for a final interview, during which the caregiver was asked about direct and indirect costs of the hospitalizations to the family and any care for this illness after hospital discharge. Inpatient service delivery cost estimates were calculated by WHO-CHOICE [10]. All economic data were collected in Malagasy Ariary and converted to 2019 US dollar (\$) or USD) using a conversion rate of 3300 Ariary to \$1.

Analysis

To calculate direct medical costs, we summed the costs of medications, consumables, diagnostic tests, community-based care (outpatient visits, pharmacy visits, and traditional medicine consultations) collected using a questionnaire with the information on the cost of inpatient and outpatient service delivery from the WHO-CHOICE, which includes personnel, infrastructure and equipment, and other operational costs of the hospital [11]. To calculate direct non-medical costs, we summed the costs of transportation to and from the hospital and lodging for caregivers while the child was hospitalized [11]. Finally, lost income for household members due to the hospitalization was self-reported and used to calculate the indirect cost [11]. We did not assign an opportunity cost to non-wage work. Costs to the household were calculated by summing reported medical and non-medical costs paid by the household well as indirect costs (lost income). As self-reported monthly household income was collected categorically, we compared the household expenditures for this illness to the household's reported monthly expenses. We also stratified the children by diagnosis with any comorbidity and by rotavirus enzyme immunoassay (EIA) result. In this descriptive analysis, we present the medians and interquartile ranges (IQR) and the percent

and absolute number. Statistical significance between medians were tested using a Wilcoxon rank sum test. All analyses were performed using SAS 9.4 and R 3.5.2.

The protocol for this evaluation was reviewed and designated as non-research by the US Centers for Disease Control and Prevention, the World Health Organization and CHU-MET.

Results

There were 115 children with diarrhea enrolled and all 3 forms were completed for 99 children; 3 additional children were excluded because they were diagnosed with measles. In total, 96 children are included in this analysis. The median age was 12 months (IQR: 9–16.5) and 43% (n=41) were female (Table 1). The median number of household members was 4 (IQR: 3–5) and the median number of household members <5 years old was 1 (IQR: 1–2). Among households, 33% (n=31) reported a monthly income <\$61; 39% (n=37) reported a monthly income of \$61–152; 21% (n=20) reported a monthly income of \$153–303; and 7% (n=7) reported a month income of >\$303. Median monthly household expenses were \$52.72 (IQR: 32.72, 67.58) in the earning <\$61/month income group, \$99.09 (IQR: 71.82, 124.00) among those earning \$61–152/month, \$165.82 (IQR: 84.70, 249.24) among those earning \$153–303/month, and \$345.45 (IQR: 244.85, 460.61) among those earning > \$303/month. The majority of households used a shared tap as their water source (66%; n=63) and a latrine as their toilet (86%; n=82). Few children had health insurance (5%; n=5).

Before their hospitalizations, the children had been sick for a median of 4 days (IQR: 3–5) and most received community-based care for their illness (82%; n=79) (Table 2). The children were hospitalized for a median of 3 days (IQR: 2–5) and were prescribed a median of 4 medications (IQR: 3–5) and had median of 4 diagnostic tests ordered (IQR: 3–6). Additionally, 93% received ORS (53%; n=51) or ORS with IV fluids (40%; n=38) during the hospitalization. There were 64 children (67%) who were diagnosed with a comorbidity in addition to diarrhea during this hospitalization, of which 45 (70%) were also diagnosed with pneumonia. Only 1 child (1%) died; 97% (n=91) survived and were discharged home. After discharge, 16% (n=15) received additional medical care.

The median total cost of the illness was \$156.00 (IQR: 104.00, 210.86) (Figure 1). The median direct medical cost was \$107.22 (IQR: 81.78, 143.30) and the median cost of the child's hospital stay was \$83.92 (IQR: 59.13, 122.65). Service delivery costs represented a median of 44% (IQR: 30–60) of the inpatient costs; medications and diagnostic tests represented a median of 28% (IQR: 15–47) and 20% (IQR: 13–26) of the total costs of the hospitalization, respectively. Direct non-medical costs were a median of \$28.55 (IQR: 10.91, 56.12) and indirect costs were a median of \$18.18 (IQR: 9.09, 30.30) for each child. Costs of components are further described in supplementary table 1. There was no statistically significant difference in direct medical costs between children who were diagnosed with a comorbidity (\$111.44; IQR: 83.30, 166.30) and children who were not (\$102.82; IQR: 70.62, 118.44) (p=.24); or children who were positive for rotavirus (\$105.25; IQR: 83.89, 132.64) and negative for rotavirus (\$104.84; IQR: 70.25, 140.59) (p=.83); or by rehydration method (IV and ORS: 116.91, IQR: 83.03, 175.72; ORS: 98.40, IQR: 66.62, 122.96; IV:

125.78, IQR: 88.65, 163.58; P=0.051). Means and standard deviations are presented in supplementary table 1.

The median percentage of the total illness costs paid by the household was 67% (IQR: 54, 78). Among households with income of less than <\$61/month, the median costs of the illness paid by the household were \$78.55 (IQR: 46.67, 160.61) (Figure 2a), representing a median of 168% (IQR: 106, 269) of the household's monthly expenses (Figure 2b) and 60% (IQR: 49, 70) of the total illness costs (Figure 3c). Among households earning \$61–152/month, the median costs paid by the household were \$96.61 (IQR: 67.73, 141.09), representing a median of 100% (IQR: 59, 156) of the household's monthly expenses and 65% (IQR: 54, 76) of the total illness cost. Among households earning \$153–303/month, the median costs paid by the household were \$111.03 (IQR: 75.12, 194.64), representing a median of 79% (IQR: 37, 156) of the household's monthly expenses and 71% (IQR: 61, 82) of the total illness cost. Among households earning >\$303/month, the median costs paid by the household were \$147.30 (IQR: 91.27, 161.45), representing a median of 53% (IQR: 27, 78) of the household's monthly expenses and 81% (IQR: 66, 85) of the total illness cost. Among all household income levels, the most common ways caregivers reported paying these bills were savings (69%, n=66), borrowing (43%, n=41), and donations (22%, n=21).

Discussion

This evaluation found that in total diarrhea illnesses requiring hospitalization among children <5 years old in Madagascar cost about \$150. Unsurprisingly, direct medical costs, and specifically hospitalization costs, make up most of the total cost. This finding is slightly higher than estimated hospitalization costs from other African countries, although these other studies are a few years old and healthcare systems vary between countries [6, 7]. To the best of our knowledge, this is the first description of the costs of diarrhea illnesses in Madagascar. Modeled estimates in 2015 USD was substantially lower: \$29.69– 78.36 [12]. Our measured estimates will be helpful in future modeling assessments. Future assessments could improve the precision of these figures by calculating the service delivery costs directly.

We found no statistically significant difference in total costs between children diagnosed with rotavirus and those who tested negative for rotavirus. This finding is reassuring but expected as clinicians do not know the lab results at the time of hospitalization and manage acute watery diarrhea, regardless of cause, with the same standard of care.

Households were financially responsible for two-thirds of the illness costs in this population in all income groups. For half of the children that participated in this evaluation, the household-paid portion for direct medical, direct non-medical, and indirect costs for this illness was more than 1 month of their normal household expenses. Differences in costs between income groups may be explained by differences in household income, and therefore lost income. This financial burden on families is anxiety-inducing and necessitates consideration when assessing rotavirus vaccine implementation.

This analysis has several limitations. Data were collected from a single sentinel site in Antananarivo and costs at this public tertiary care hospital may not be representative of costs of hospital stays at other facilities in Madagascar. Additionally, we did not enroll children who sought medical care but were not hospitalized for their illness. Second, we relied on caregiver recall for the costs of medical care and information about the child's illness before and after the hospitalization. This could have introduced bias. We also used WHO-CHOICE to estimate service delivery costs rather than directly measuring them. Direct non-medical costs were limited to transportation only as none of the families reported lodging costs associated with the hospitalization. Finally, we were not able to complete all 3 questionnaire parts for 16 of the children who were initially enrolled but lost to follow up. We do not know how their experiences and total costs may have differed from the other children.

Our findings provide important insight to local decisionmakers in Madagascar and will be useful in assessing the cost-effectiveness of rotavirus vaccine, both in Madagascar and in the region. These results may be useful for government planning, allocation of resources and also help the hospital administrators and healthcare providers better understand the financial constraints of families when their children are hospitalized.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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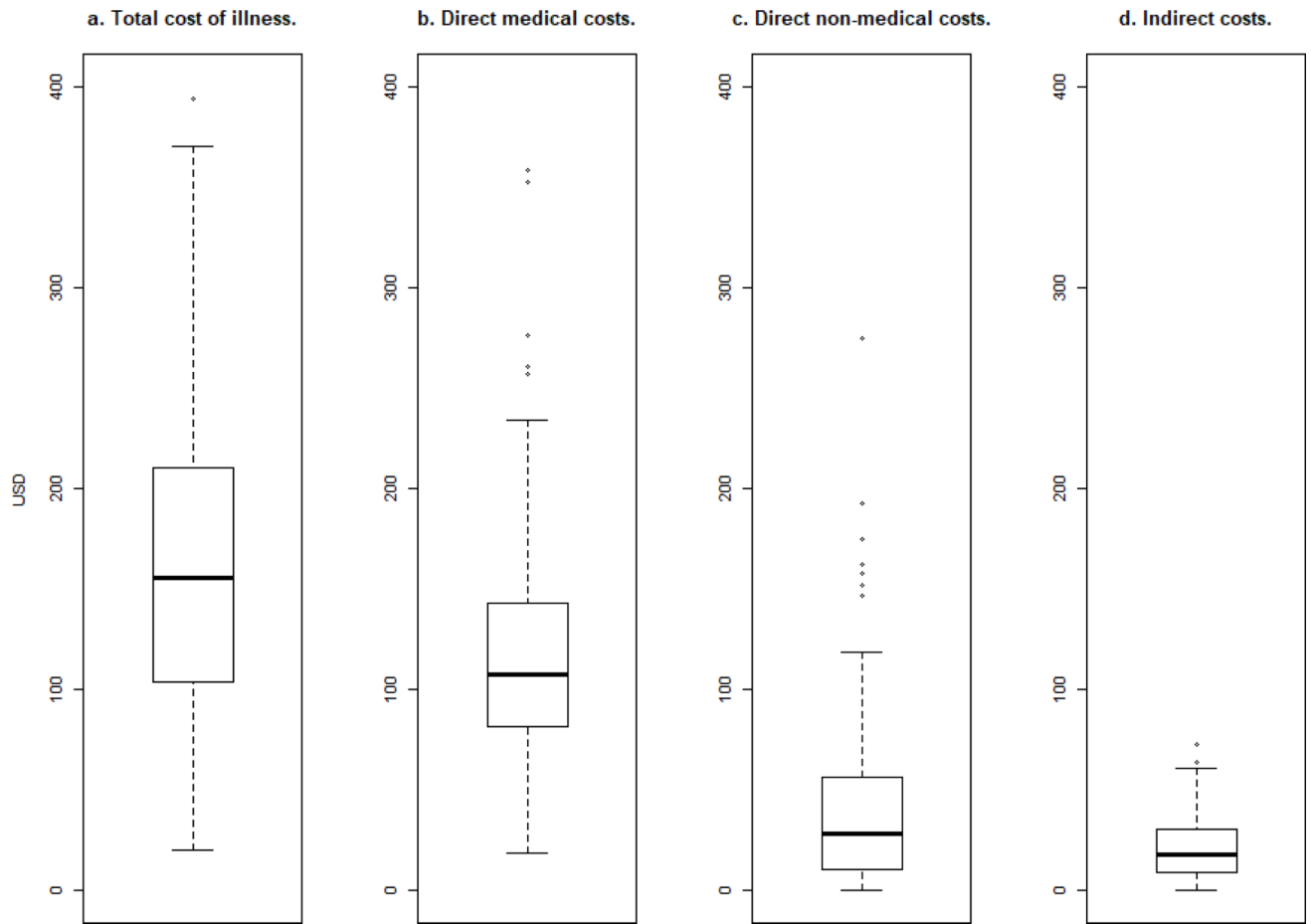


Figure 1. Median and interquartile range of the total cost, direct medical costs, direct non-medical costs, and indirect costs of diarrhea illness resulting in hospitalization among children <5 years old in Madagascar in US dollars.

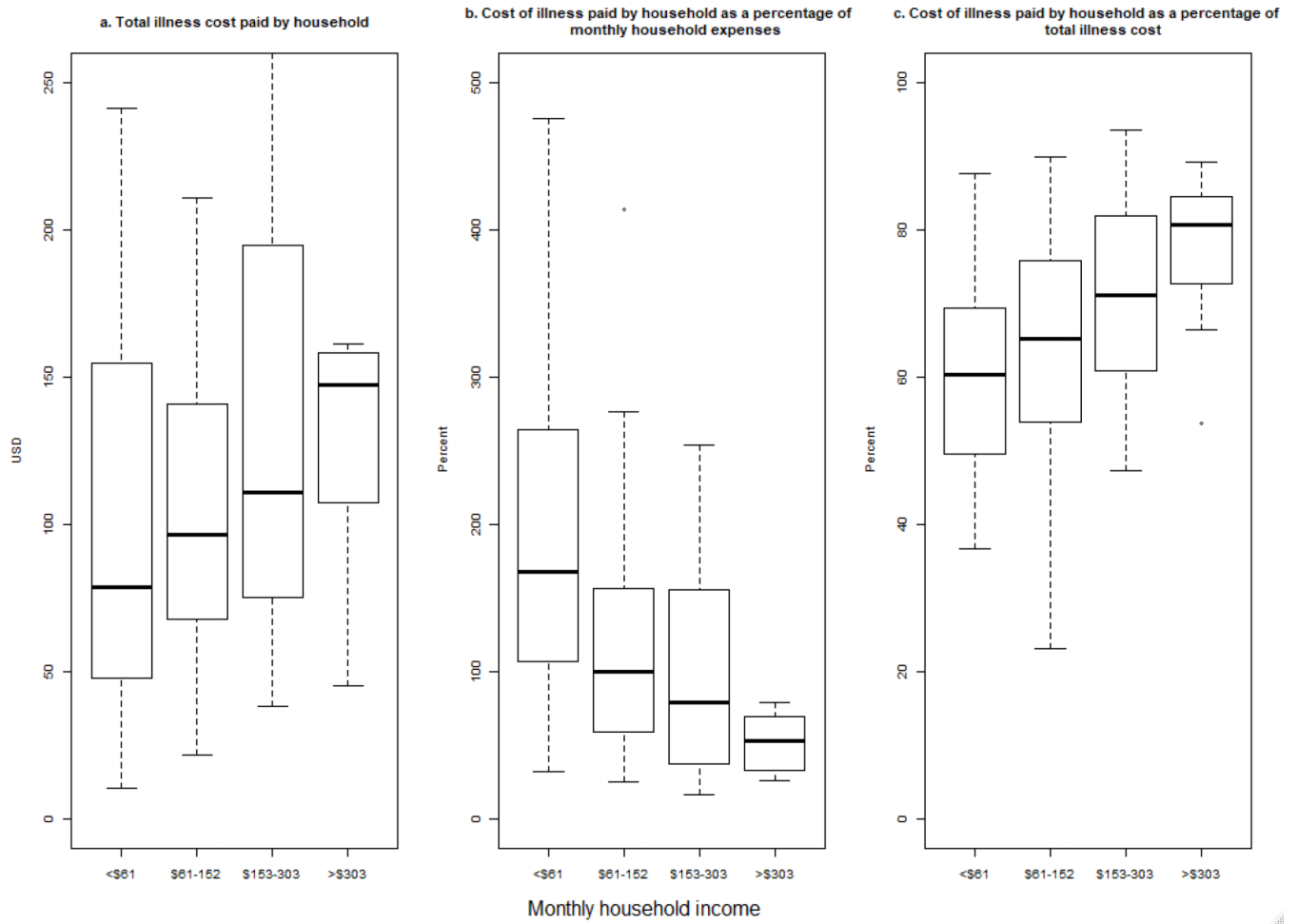


Figure 2. Total cost of a diarrhea illness resulting in hospitalization among children <5 years old in Madagascar paid by the child’s household and as a proportion of the household’s monthly expenditures by monthly income category.

Table 1.

Characteristics of patients and households

	Total n=96	
	n	%
Age, months (median, IQR)	12	9–16.5
Female	41	43
Monthly household income ¹		
<\$61	31	33
\$61–152	37	39
\$153–303	20	21
>\$303	7	7
Number of household members (median, IQR)	4	3–5
<5 years old (median, IQR)	1	1–2
Household water source		
Private tap	17	18
Shared tap	63	66
Covered well	16	17
Household toilet ¹		
Latrine	82	86
Improved latrine	2	2
Flush toilet	11	12
Health insurance	5	5

¹Missing for 1 child

Table 2.

Characteristics of illness and medical care

	Total (n=96)	
	n	%
<i>Before hospitalization</i>		
Days sick (median, IQR)	4	3–5
Received medical care	79	82
Community health worker	0	0
Health clinic	78	99
Traditional healer	1	1
Self	0	0
Transportation to hospital ¹		
Car	14	15
Bus	37	41
Motorcycle	3	3
Taxi	30	33
On foot	6	7
Ambulance	1	1
<i>During hospitalization</i>		
Days hospitalized (median, IQR)	3	2–5
Rotavirus positive ²	20	29
Number of medications received (median, IQR)	4	3–5
Number of diagnostic tests performed (median, IQR)	4	3–6
Rehydration		
ORS	51	53
IV fluids	6	6
ORS and IV fluids	38	40
None	1	1
Any comorbidity	64	67
Malaria	1	2
Pneumonia	45	70
Malnutrition	16	25
Other	21	33
Outcome ³		
Survived	91	97
Died	1	1
Transferred	1	1
Left against medical advice	1	1
<i>After discharge</i>		
Received medical care	15	16
Community health worker	0	0

	Total (n=96)	
	n	%
Health clinic	13	87
Traditional healer	1	7
Self	1	7

¹Missing for 5 children

²Missing for 26 children

³Missing for 2 children

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