RESEARCH BRIEF

Direct Medical Costs in Children with Rotavirus and Non-rotavirus Diarrhea Admitted to a Pediatric Intensive Care Unit and High Dependency Unit in Delhi

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Objective: To estimate direct medical costs of diarrheal hospitalization of children <5 years admitted in pediatric intensive care unit (PICU) or high dependency unit (HDU).

Methods: Analysis of medical records and hospital bills of 84 children during two time frames, 2005-08 and 2012-14.

Results: Direct medical costs in PICU increased from INR 17,941 to INR 50,663 per child for rotavirus diarrhea and INR 11,614 to INR 27,106 for non-rotavirus diarrhea, and in HDU from approximately INR 5,800 to INR 10,500 per child for all-cause diarrhea between the two time frames.

Conclusions: Costs of PICU and HDU care are high and should be included in cost-effectiveness analysis of vaccination.

Keywords: *Diarrhea, Direct costs, Economic burden.*

Rotavirus is the commonest cause of severe diarrhea and is responsible for 25-40% of all diarrhea hospitalizations in India [1,2]. Children with severe diarrhea may have co-morbidities and complications [3-8] that may require more intensive care than that provided in ward settings. The prevalence of underweight children in India is high (39-75%) and confers an additional risk of deaths from diarrhea [8,9].

Rotavirus vaccines have the potential to alleviate some of the burden associated with disease. Data on the cost of treatment is required for assessment of economic cost- benefit of a rotavirus vaccination program. Though previous costing studies of rotavirus hospitalizations in India have shown that most costs were direct medical costs [10,11], there has not been any published study evaluating costs in intensive care settings. The purpose of this study was to determine the direct medical costs of treatment of children with rotavirus and non-rotavirus diarrhea who were hospitalized in the high dependency unit (HDU) or pediatric intensive care unit (PICU).

Methods

The study was done at St. Stephen's Hospital – a 595 bedded not-for-profit, urban, referral hospital in Delhi. Based on severity of illness and physician assessment, children with diarrhea were admitted to the ward (37 beds), HDU (6 beds) or PICU (6 beds), and treated according to standard guidelines. At our hospital, patients pay for services, which are calculated for general patients on a no-profit no-loss basis, and are revised annually by the hospital management. The study was approved by the hospital Research and Ethics committee.

Data were analyzed for two periods, December 2005 to December 2008 (36 months) and November 2012 to January 2014 (15 months). During these periods, there was active rotavirus surveillance as part of the Indian National Rotavirus Surveillance Network [2]. Children aged <5 years with diarrhea admitted to the PICU or HDU, who had stool samples tested for rotavirus by enzyme linked immunosorbent assay (ELISA) were included, in the study. Children with an admission diagnosis other than acute diarrhea were not included and six children with a co-primary diagnosis of sepsis were excluded from analysis. Clinical and cost details were obtained from the Hospital Information System (HIS) and patient records. For costs not incurred by all children, the average costs were calculated by dividing the total among all children receiving the care, such as for ventilation where only some children needed to be ventilated. Data were analyzed with SPSS v15. Cost data were presented as median (IQR) and differences were calculated using Mann Whitney U test.

WHAT THIS STUDY ADDS?

- 9% of children admitted for rotavirus gastroenteritis required high dependency unit and intensive care unit admission and cost of such admissions are high even at a not-for-profit hospital.

Costs were adjusted for the consumer price index (CPI) [12] for assessment of whether the increase in INR costs paralleled the CPI. Difference between proportions was evaluated by Chi square or Fisher exact test. Nutritional status was graded using WHO growth tables [13].

RESULTS

A higher proportion of hospitalized children with rotavirus diarrhea (50/571, 8.8%) as compared to non-rotavirus diarrhea (34/816, 4.2%) required PICU and HDU care (P<0.001). History of rotavirus vaccination was not obtained from the children.

The majority of children admitted to the HDU (27/35) and the PICU (46/49) were infants, with mean duration of 3.4 days of diarrhea at admission. Approximately a quarter (20/84) were referred from elsewhere and three-quarters (63/84) had severe dehydration, with a quarter (21/84) in shock. The proportion of children in PICU with severe dehydration, acidemia, shock and hypokalemia was comparable in both rotavirus and non-rotavirus diarrhea; hypernatremia and hypocalcemic seizures were present in a higher proportion of rotavirus positive children (data not shown). There was one death each in rotavirus-positive and rotavirus-negative children. Underweight children were more likely to have severe disease requiring PICU (OR 3.5, 95% CI 1.1,11.5).

The direct medical costs per child in rotavirus and non-rotavirus diarrhea in PICU and HDU are presented in ***Web Table* I**. Overall, there was a substantial increase in direct medical costs between the two time frames. The PICU costs for children with rotavirus diarrhea were higher than non-rotavirus diarrhea, but the differences were not statistically significant (*P*=0.056 in 2005-2008 and *P*=0.10 in 2012-2014). However, direct medical costs had risen significantly (*P*=0.003) between the two time frames. When adjusted for the change in the CPI, costs were 15% higher in the latter period. For the HDU, direct medical costs were not different between rotavirus and non-rotavirus diarrhea, but costs had increased significantly between the two time frames, 2005-08 and 2012-14 (*P*=0.005), and were 30% greater after adjusting for the CPI. For both PICU and HDU most of the costs and increase in costs was due to bed costs, but diagnostic costs more than doubled in the PICU and increased in the HDU (***Web Table* I**).

DISCUSSION

In this study, we describe the direct medical costs of diarrheal hospitalizations in the PICU and HDU of a private not-for-profit hospital, and documented no significant differences in costs between rotavirus and non-rotavirus cases. When comparing the first time frame of this study to two published studies in India that reported a total cost of approximately INR 3200-3600 in a similar period [10,11], the direct medical costs in the PICU were four times greater, and in the HDU were one and half times greater. About 9% (50/571) of children hospitalized with rotavirus diarrhea required this level of care; this high proportion could be because a quarter of the children were referred or previously treated elsewhere. The significant rise in direct medical costs, despite adjustment for the CPI, could be because management practices have changed over time, requiring more investigations and use of equipment in higher-level care.

There are several limitations to this study. This was a small study from a single center and may not represent treatment costs at all types of facilities nationally. Direct non-medical costs and indirect costs were not measured. Another limitation is that no history of rotavirus vaccination was obtained. Data from in-patient wards in India are available, but is now several years old and did not include HDU or PICU admissions [10,11]. Updated data on costs in in-patients, and additional data on out-patient costs as well as PICU and HDU costs from other sites would be useful both in estimating the direct medical costs of disease in different settings, and in evaluating the cost-effectiveness of vaccination.

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WEB TABLE 1 DIRECT MEDICAL COSTS IN CHILDREN ADMITTED WITH ROTAVIRUS *VS* NON-ROTAVIRUS DIARRHEA

	Pediatric Intensive Care Unit (PICU)				*High Dependency Unit (HDU)*			
	2005-08 (n=36)		*2012-14 (n=13)*		*2005-08 (n=15)*		*2012-14 (n=20)*	
	Rotavirus positive (n=22)	*Rotavirus negative (n=14)*	*Rotavirus positive (n=8)*	*Rotavirus negative (n=5)*	*Rotavirus positive (n=10)*	*Rotavirus negative (n=5)*	*Rotavirus positive (n=10)*	*Rotavirus negative (n=10)*
Length of stay (PICU/HDU d)	3 (2-6)	3 (3-4)	4 (2-6)	2.5 (1-3.5)	2 (1-3)	2 (1-2.5)	1.5 (1-2)	1 (1-2)
Length of stay (ward d)	2 (1-5)	1 (0.25-3)	1(1-3)	0 (0-0.5)	1 (1-1.5)	1 (0-2)	2 (1.5-2)	2 (1-2)
Bed costs in ward*	610 (397-1196)	610 (12-1110)	2,100 (1350-4050)	2,325 (1462-3187)	365 (250-720)	370 (0-960)	2,400 (1800-2700)	2,400 (1350-2700)
PICU /HDU bed costs	5,450 (3300-9300)	4,300 (3063-6000)	14,075 (8437-23525)	8,450 (4500-8850)	1,250 (900-1500)	1,250 (700-1800)	2,600 (1500-4050)	2,200 (1675-3225)
Lab Diagnostics	2,960 (2140-4172)	2,088 (1895-3008)	6,537 (5025-8806)	4,130 (3620-4224)	1,440 (1165-1693)	710 (660-1170)	2,090 (1417-2542	2,180 (1672-2720)
Equipment and procedure costs	2,413 (1522-3470)	1,540 (1314-3006)	8,105 (1960-12852)	4,240 (1380-5370)	898 (665-1570)	825 (775-1710)	1,020 (780-1100)	930 (450-1440)
Drugs and supplies costs	4,650 (3962-5305)	2,786 (1594-4148)	7,709 (3756-12249)	8,130 (4324-8237)	2,572 (2291-3313)	1,646 (894-2144)	3,067 (2143-3410)	2,425 (1868-3441)
Ventilator costs /child	4166 (3 children for 5.5 d)	3000 (2 children for 3 d)	22,200/ (2 children for 12 d)	2000 (1 child for 0.5 d)				
Direct medical costs	17,941 (13951-22930)	11,614 (10408-16952)	50,663 (19366-65324)	27,106 (14634-30909)	5,957 (4732-8709)	5,787 (4169-7461)	10,903 (7723-16300)	10,088 (7356-12814)

*Costs calculated as median (IQR) in Indian rupees, and are costs as recorded and are not adjusted to a base price; *Bed costs in the ward are for the children who were admitted in the ICU or HDU and also had a ward stay before discharge.*