

Rotavirus infection in hospitalised children: incidence and impact on healthcare resources

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Abstract

Background and aims In anticipation of vaccine development this study sought to determine the incidence, disease burden and associated financial burden of rotavirus (RV) infection, in hospitalised children.

Methods Prospective observational study in two Dublin paediatric centres.

Results Of 663 confirmed infections, 485 (73%) patients were hospitalised with community acquired (CA) RV; 178 (27%) cases were hospital acquired (HA) RV. A total of 243 (50%) children were <12 months of age, with peak incidence in the 6 to <12 month age group. CA RV resulted in utilisation of 2,305 bed days, with a median bed stay of three days (range 1-91), representing a minimum cost of €176,637 per year to the hospitals. When nosocomial spread and secondary cases are included, this increases to €258,695 per year.

Conclusion CA RV infection accounted for 1% of all admissions during the study period at a minimum cost of €728.40 per case. A safe and effective vaccine could reduce morbidity and advantage children by allowing redeployment of healthcare resources to other critical areas.

Introduction

Since its discovery in 1973,¹ rotavirus (RV) has emerged as the most common cause of acute gastroenteritis in children worldwide.² Children less than two years of age are particularly susceptible and suffer the highest mortality. Worldwide, 130 million children are infected and almost one million children die annually.³ It is the most common enteric pathogen detected in young children accounting for 64% of all paediatric enteric pathogens in one Irish study.⁴

In developed countries, mortality due to RV is low; however, morbidity and associated costs involved in diagnosis and treatment are high. In the US, the annual cost burden attributed to RV hospitalisation has been estimated in excess of one billion dollars (one billion euro).⁵ In the UK, the annual RV-related costs in a 120 bedded general paediatric hospital was estimated at stg£95,400 (€149,062.50)⁶ and in Tralee hospital, which has a 30 bedded paediatric unit, estimated costs were €39,656.46.⁴

In 1998, an oral tetravalent RV vaccine was developed and licenced for use in children in the USA. Subsequent concern regarding associated intussusception led to its withdrawal and re-evaluation. New vaccines are under development. As a prerequisite to the evaluation of any future vaccines for use in Irish children, it is first necessary to establish the current impact of RV infection on child health in Ireland.

This study sought to determine the incidence of RV infection in children admitted to two Dublin paediatric hospitals, to assess the related paediatric morbidity, duration of hospitalisation and the associated financial burden on the healthcare system.

Methods

This two-year, prospective, observational study was initiated on 1 January 1999 and completed on 31 December 2000. A single investigator using a structured questionnaire for parent interview

and chart review recorded clinical symptoms, basic demographics, investigations performed, medical interventions and management. Cases were categorised as community acquired (CA [symptom onset before or within 72 hours of admission]) or hospital acquired (HA [symptom onset >72 hours of admission]). The occurrence and number of secondary cases attributable to each index case was also noted. To assess the additional burden of costs associated with HA RV infection, for each HA case we sought to enrol two uninfected control cases, matched for age, contemporaneous admission, hospital ward placement and broad diagnostic category to facilitate comparative cost analysis.

All children aged <15 years with laboratory confirmed RV infection and hospitalised in either of the two major paediatric centres in Dublin were included. Children ≥15 years of age and children with bloody stools were excluded from the study. Diarrhoea was defined as three consecutive, unformed, non-bloody stools within a 24-hour period. In breast-fed babies, it was defined as a change in the frequency or consistency of stools in a 24-hour period. Pyrexia was defined as a temperature of ≥38.5°C. The severity of dehydration was based on the clinical examination with changes in vital signs and physical appearance used to estimate the degree of dehydration.

Laboratory testing for the presence of the RV antigen was made using commercial enzyme immunoassay and latex agglutination assay according to the manufacturers' instructions (Combi-strip Diagnostica, [Corus Bio Concept], & Diarlex® Rota-Adeno [Orion Diagnostica]). Statistical analysis was performed using Epi Info 6.01 version (CDC, Atlanta, GA, USA). Medical and ethical approval was obtained from both institutions.

Results

The study was conducted at Our Lady's Hospital for Sick Children (OLHSC), Crumlin and The Children's University Hospital (TCUH), Temple Street, Dublin. OLHSC is a 234 bedded hospital with 17,000 admissions per year, including day cases. TCUH is a 134 bedded hospital with 10,500 admissions

Table 1. Rotavirus associated cost estimates

	CA RV (485 cases)	HA cases (178)	Controls (117)	HA RV (178 cases) Attributable cost/case
Mean cost	€	€	€	€
Bed days	506,316 (2,305 days)	1,069,085 (4,867days)	629,326 (2,865 days)	
Lab. Investigations	70,334	94,538	69,502	
Imaging	10,033	27,025	15,071	
Intravenous Therapy	2,455	676	0	
Medications	1,912	N/A	N/A	
Total	590,050	1,191,324	712,899	
Mean cost/case	1,216	6,693	6,093	600
Median cost	€	€	€	€
Bed days	659 (3 days)	3,294 (15 days)	2,416 (11 days)	
Lab. Investigations	64	167	127	
Imaging	0	33	33	
Intravenous Therapy	5	4	N/A	
Medications	0.40	N/A	N/A	
Median cost/case	728.40	3,498	2,576	922

per year, including day cases. Both serve as national referral hospitals for a variety of subspecialties.

There were 54,141 patients admitted to the hospitals between 1 January 1999 and 31 December 2000. A total of 34,191 children were admitted to OLHSC and 20,950 children to TCUH. There were 663 (1.2%) children admitted with or who acquired RV infection while in hospital. Of those, 485 children (0.9% of all hospital admissions) were CA and 178 HA. Of 485 CA RV, 54 (11%) were discharged within 24 hours of admission and a further 121 (25%) were discharged within two days of admission. A total of 436 (90%) patients were isolated on admission.

In all, 178 (0.3% of all hospital admissions) children acquired RV infection while in hospital. Of these, 16 (9%) children were discharged on the day of diagnosis and 59 (33%) were discharged within three days of diagnosis. A confirmed diagnosis of RV often prompted early discharge in this cohort. A total of 107 (60%) cases were isolated on day one of symptom onset.

Seasonality

As anticipated, RV infection demonstrated seasonal peaks in winter/spring with a reduction during the summer months (see Figure 1).

Age at diagnosis

Cases were identified in children 0.02-96 months of age (see Figure 2). Fifty per cent (247) of CA cases and 78% (138) of HA cases were <12 months of age, with the median age of onset at 11 months and six months respectively. No gender bias was noted.

Presenting symptoms

The predominant symptoms at time of admission included vomiting (427, 88%), dehydration (387, 80%), pyrexia (160, 33%) and coryza (127, 27%). Twenty-seven per cent (133) of children had some respiratory tract symptoms on admission; 24% (32) of whom were diagnosed with bronchiolitis, 5% (7) with pneumonia and 5% with otitis media. Fourteen per cent of children were subsequently confirmed to have a urinary tract

infection (UTI) on admission. Five per cent of children had one or more seizures. The presenting features of HA RV infection did not differ and included vomiting (78%), dehydration (55%), pyrexia (22%) and (18%) coryza.

Profuse diarrhoea was not a common feature, 198 (62%) CA RV cases and 107 (60%) HA RV cases had less than five stools per day. A total of 423 (87%) CA RV cases received intravenous rehydration (minimum four hours, median 24 hours) while 61 (13%) children were rehydrated orally. A total of 110 (64%) HA RV cases required intravenous rehydration (median 12 hours), while 68 (36%) received oral rehydration.

Investigations

RV detection in stool was a criterion for study entry. Serum urea and electrolytes (U/E), complete blood count (FBC) and urine analysis (MSU) were the next most frequently sought investigations (see Figure 3). Forty-seven per cent (225) of children had blood obtained for culture and 30% (149) had radiological investigations performed (chest radiograph 20%, renal ultrasound 19%). Investigations ordered in children with HA RV cases were more diverse. They included determination of liver transaminase, serum glucose, therapeutic drug levels and wider microbiological evaluation.

Estimation of the cost of CA RV infection

A median cost estimate was generated based on the median bed stay, the median number of investigations, intravenous interventions, and antipyretics administered per patient. The actual total cost was generated based on the actual interventions and investigations documented in the individual case records and a mean cost calculated (see Table 1).

In this study, CA RV resulted in the utilisation of 2,305 bed days at €219.66 per night, which cost the health service €506,316 (€253,158 per year). These costs were based on the hospital charge per bed and not adjusted according to age group or ward placement of the patients. The median bed stay was three days (range 1-91) at a cost of €659 per patient. The median number of laboratory investigations

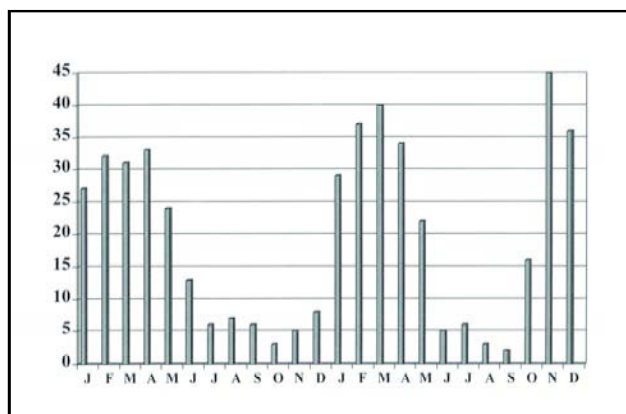


Figure 1. Seasonality of CA RV, January 1999 to December 2000 (n=485)

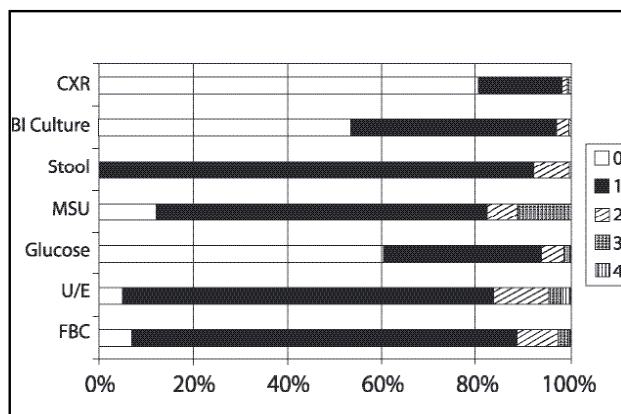


Figure 3. Frequency of investigations, CA RV (n=485)

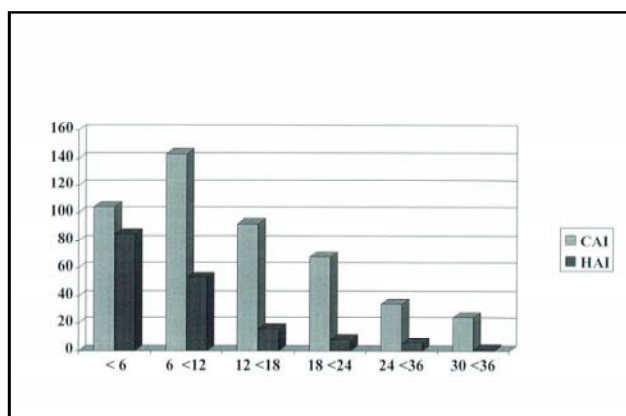


Figure 2. Age at diagnosis, January 1999 to December 2000 (n=633)

performed was four, at a cost of €64 per patient. The median cost of intravenous therapy (one cannula, giving set, intravenous fluid bag) was €5 per patient. Antipyretics were costed at €0.40 per patient. Based on these figures the minimum median cost of CA RV infection is €728.40 per patient. Therefore, the minimum costs to these hospitals ranged between €176,637 and €294,880 per year.

Estimated cost of HA RV infection

One hundred and seventy-eight patients acquired RV infection while in hospital. The aim to assign two matched uninfected control patients per case was limited by patient availability. A total of 117 control patients were identified. The overall bed day usage cost incurred by HA cases and by their controls were compared and the excess attributable to RV infection estimated (see Table 1).

The 178 patients with HA RV infection utilised a total of 4,867 bed days, a median of 15 days (range 4-398) per patient representing a median cost of €3,294 per case. The median cost of laboratory investigations for HA cases was €167 per case (representing serum U/E determined twice, two stool analyses, FBC, serum creatinine, LFTs, serum glucose and blood culture on one occasion each). A median of one chest radiograph was performed at a cost of €33 each,

and intravenous therapy requirements cost €4 per case. Based on these figures the median cost of hospital acquired RV infection was estimated at €3,498.00 per case, with the mean costs of €6,693 per case.

Control group

During this study period, 117 control patients utilised 2,865 bed days resulting in a cost to the healthcare system of €629,326 (€314,663 per year). The median number of bed days utilised was 11 (range 3-200), at a cost of €2,416 per patient. The median cost of laboratory investigations for the control group was €127 per case (representing serum U/E, LFTs, serum creatinine, serum glucose, FBC, MSU, stool analyses and MRSA screen). A median of one chest radiograph was performed at a unit cost of €33. Therefore, the median cost of hospitalisation for the control group was €2,576 per case and the mean cost per case was €6,093. Analysis of case control data (178 cases, 117 controls) indicated the additional RV-related cost ranged from €600 to €922 per case (based on the mean and median figures per case) for annual HA RV-related cost of €53,400-€82,058.

Estimate of financial burden of RV infection

In this study of 485 CA RV and 178 HA RV over a two-year period, the annual costs of RV infection for the two paediatric hospitals range from €258,695 to €348,280 based on median and mean estimates respectively.

Discussion

RV accounted for 1% of all admissions to two major paediatric hospitals in Dublin. The incidence peaked in the first year of life, and the associated morbidity is substantial. RV infection can also adversely affect child health by impacting on infant bed availability, particularly during times of peak demand (e.g. wintertime, bronchiolitis season). Twenty per cent of children admitted with RV were not clinically dehydrated, 62% had less than five stools in 24 hours. Thirty-one per cent had a bed stay of <2 days suggesting that a structured intervention programme, with a more rapid turn around of stool test results could prevent some hospital admissions.

The frequency of HA RV (27% of cases) highlights the need for vigilance in infection control practices and also represents a further indirect cost burden associated with the

introduction of CA RV into the hospital setting. In many instances, the diagnosis of HA RV resulted in prompt discharge; however, prolongation of hospitalisation and deferral of planned surgeries did occur with additional costs incurred. Cost estimates in this study are very conservative as direct costs (nursing care, medical time, laboratory time) and indirect costs (GP visits, A&E visits, societal costs, loss of parental earnings) associated with RV infection are very difficult to establish. The costs incurred are substantial, reaching almost €350,000 per year in just two paediatric hospitals. These data provide the basis for determining countrywide costs that will need to be determined and balanced against the cost of a vaccination programme, if vaccine prevention becomes a realistic option.

Acknowledgements

We would like to thank Wyeth Laboratories Ltd. & The Research Centre, Our Lady's Hospital for Sick Children for funding this study.

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