Rotavirus epidemiology in Queensland during the pre-vaccine era

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Abstract

Rotavirus, the most common cause of severe gastroenteritis in early childhood, is now a vaccine preventable disease with immunisation added to the Australian publicly funded schedule in July 2007. To better understand rotavirus epidemiology in Queensland prior to vaccine introduction, we used 3 routinely-collected data sources. We analysed hospital records of all children less than 5 years of age admitted to Queensland hospitals between July 2001 and June 2006 with any rotavirus-specific code or with an acute gastroenteritis (AGE) code in the principal field. We linked a sample of public hospital admission records to laboratory test requests to determine the extent of diagnostic testing for causes of AGE. Finally, we analysed rotavirus notifications for the same age group between December 2005 and December 2006. Hospitalisation and notification data both identified Indigenous children as having a higher burden of rotavirus illness than non-Indigenous children. Hospitalisations occurred disproportionately in Indigenous children, at a younger age, and resulted in a longer duration of stay. AGE hospitalisations occurred more commonly than rotavirus admissions, but the seasonal trend mirrored rotavirus data. Linking a sample of hospitalisations with laboratory testing data showed that, for admissions having a rotavirus-specific discharge code, 89% had laboratory-confirmed rotavirus infection. In the pre-vaccine era, rotavirus had the greatest impact in the young and Indigenous. Using routinely collected data, it should be possible to monitor the impact of vaccine introduction in Queensland. *Commun Dis Intell* 2009;33:204–208.

Keywords: rotavirus, epidemiology, Queensland, Indigenous, separation, hospitalisation, diagnostic, laboratory testing, acute gastroenteritis

Introduction

Rotavirus is the most common cause of acute gastroenteritis in children. Prior to vaccine introduction, it is estimated the virus was responsible for up to 50% of diarrhoea hospitalisations in childhood, with approximately 10,000 Australian children hospitalised each year.[1] These figures considerably underestimate overall burden of disease as they miss community-managed illness: only the more serious cases of childhood gastroenteritis are likely to result in hospital admission. Of these, it is likely there is significant under-identification of rotavirus, as laboratory confirmation is not required and this is not undertaken for all acute gastroenteritis (AGE) admissions. This means our understanding of the burden of rotavirus infection in children in Australia is incomplete.

We have now entered a new era of rotavirus epidemiology, with the prospect of disease prevention through vaccination. Two rotavirus vaccines are licensed for use in Australia: Rotarix (GSK Biologicals), a single strain, live attenuated human rotavirus strain, and RotaTeq (Merck, distributed in Australia by CSL Biotherapies), a pentavalent, live human-bovine rotavirus reassortant. Both have excellent efficacy in reducing severe rotavirus gastroenteritis.[2,3] Queensland children born on or after 1 May 2007 were eligible to receive 3 doses of RotaTeq from 1 July 2007.

Since June 1999 the National Rotavirus Reference Centre has been reporting strain surveillance for rotavirus.[4] Rotavirus research within Australia has provided epidemiologic data[1,5,6] including national population based estimates of rotavirus hospitalisation rates,[7,8] and the direct economic cost of these has been calculated.[1,9] Queensland has not consistently contributed rotavirus samples to the National Rotavirus Reference Centre, and little is known about the epidemiology of rotavirus in Queensland. To better understand rotavirus epidemiology in Queensland children during the pre-vaccine era, and provide a baseline for future comparisons, we used 3 sources of routinely collected data — hospitalisations, laboratory testing, and notification data.

Methods

These studies were approved by The University of Queensland Medical Research Ethics Committee, the Royal Children's Hospital and Health Service District Human Research Ethics Committee, and the Queensland Health Corporate Office Human Research Ethics Committee. An application to use data for research purposes under the *Public Health Act 2005* was approved by Queensland's Chief Health Officer.

Hospital discharge coding

We retrieved data for analysis from the Queensland Health Patient Admitted Dataset. All private and public hospital separations in children less than 5 years of age in Queensland, with a rotavirus-specific principal or other diagnosis code (ICD-10-AM code A08.0)[10] from 1 July 2001 to 30 June 2006 were included. We examined age and sex-specific hospitalisation rates, reported Indigenous status, seasonality, and average length of stay (ALOS), as they were recorded in the dataset. The 95% confidence intervals around ALOS and percentage of Indigenous rotavirus notifications were calculated using Stata 9.0 (Stata Corp, College Station, Texas).

We compared rotavirus-coded hospitalisations with the burden due to related and less specific AGE admissions and to allow comparison with other published data.[1,11] We retrieved data on a range of AGE codes where this was the principal diagnosis. The codes used were (ICD-10-AM):[10]

- Bacterial: A00 Cholera, A01 Typhoid and paratyphoid fevers, A02 Other salmonella infections (excluding A02.2), A03 Shigellosis, A04 Other bacterial intestinal infections, excluding A05 Other bacterial foodborne intoxications;

- Protozoal: A06 Amoebiasis (excluding A06.4, A06.5, A06.6, A06.7, A06.8), A07 Other protozoal intestinal disease;

- Viral: A08 Viral and other specified intestinal infections; and

- Non-specific: A09 Diarrhoea and gastroenteritis of presumed infectious origin, and K52 Other non-infective gastroenteritis and colitis.

Data linkage with laboratory testing

A sample of all AGE-related records (including rotavirus) were systematically selected from the merged hospital dataset and linked to the Queensland Health Auslab database to determine the extent of diagnostic testing for causes of AGE, and rotavirus specifically. Records were sorted by separation date, and every 10th separation was chosen for data linkage. Where a record was not from a Queensland Health hospital, meaning any associated stool testing may not have been done in a Queensland Health laboratory, the record was excluded from the analysis without replacement. Testing records for each child were viewed to determine if any faecal testing was done during the admission of interest (including, specifically, whether rotavirus testing had been done), and whether there was a conclusive result. We compared these findings with the hospital discharge code data.

Notifications

Laboratory-confirmed rotavirus became notifiable in Queensland on 1 December 2005, in accordance with the *Public Health Act 2005*.[12] Data on all children aged less than 5 years with a rotavirus notification between December 2005 and December 2006 were collected from the Queensland Health Notifiable Conditions (NOCS) database and analysed.

Results

Hospital discharge coding

Between July 2001 and June 2006, there were 3,139 hospital separations in Queensland children aged less than 5 years with the rotavirus-specific discharge code in any field. With a mean 2001–2006 birth cohort of 49,676,[13] this means during the period under review, approximately 1.3% of children were hospitalised for rotavirus. Rotavirus was the principal diagnosis for 2,808 (90%) discharges. Numbers of hospitalisations with a rotavirus code in any position varied year-to-year: the year from 1 July 2002 to 30 June 2003 was a peak year with 787 hospitalisations, and 1 July 2003 to 30 June 2004 a low year with 500 hospitalisations (Figure 1). In each year, the highest number of separations occurred in children between one and two years of age, and overall and in each year of age, there were more separations for males than females (overall male:female ratio 1.27:1).

During the review period there were 18,743 admissions in the same age group with a non-rotavirus AGE code as the principal diagnosis. In the merged dataset, rotavirus made up 14% of combined admissions for AGE or rotavirus in this age group.

Figure 1: All rotavirus-specific separations and discharges with acute gastroenteritis code* as principal diagnosis in children aged less than 5 years, Queensland, 1 July 2001 to 30 June 2006, by month and year
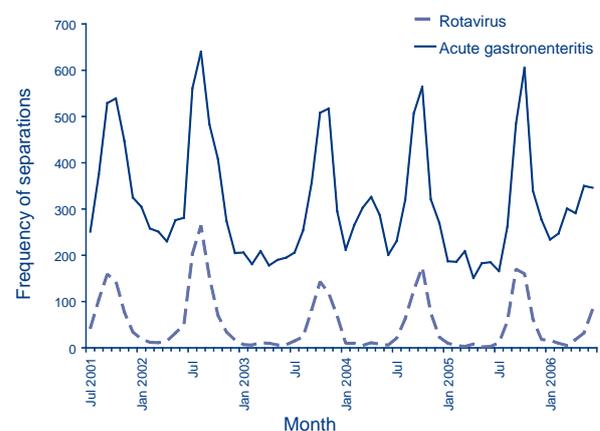

* Excludes rotavirus-specific separations.

Rotavirus separations exhibited a distinct winter seasonal peak between the months of July and November of each year. AGE data had a general pattern that mirrored rotavirus separations, other than for a small autumnal peak in AGE during 2004 (Figure 1).

Rotavirus hospitalisation disproportionately affects Indigenous children. Nearly one tenth (9.4%) of hospitalisations in children less than 5 years of age were identified as occurring in Indigenous children; this compares to the Australian Bureau of Statistics census data, which show Indigenous children make up 6.4% of the general population in Queensland for this age group.[14] This finding varied by age group, with Indigenous children making up 21% of rotavirus admissions in children less than 1 year of age. This resulted in Indigenous children having a younger age at hospitalisation during the review period. Sixty-one per cent of recorded Indigenous hospitalisations for children less than 5 years of age occurred in the 1st year of life, compared with 25% in the non-Indigenous cohort (Figure 2). Indigenous children also had a longer average length of stay when admitted with rotavirus. The ALOS for discharges that had rotavirus as the principal diagnosis for Indigenous children was 2.9 days (95% CI 2.89 to 2.96) compared with 2.1 days (95% CI 2.09 to 2.11) in non-Indigenous children.

Figure 2: Percentage of all rotavirus separations (with 95% confidence interval bars) from each age group, in children aged less than 5 years, Queensland, 1 July 2001 to 30 June 2006, by year of age and Indigenous status
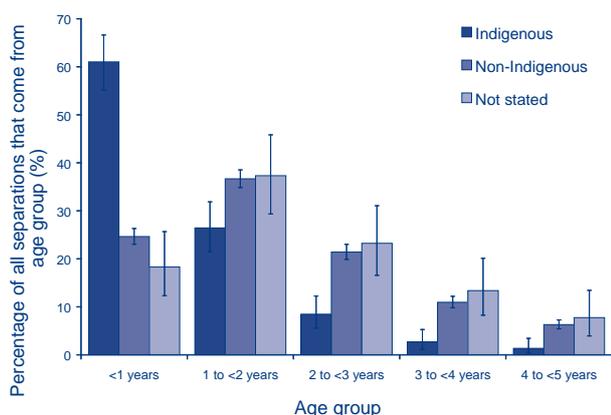
Data linkage with laboratory testing

The systematic sampling method yielded 2,188 patient records for potential analysis. Of these, 578 records were excluded as they were from non-Queensland Health facilities (and therefore had no Auslab record), and 5 records were excluded as the Auslab record did not match the Patient Admitted Data Collection age for the patient. We linked 1,605 hospital discharge records with the laboratory testing history for that child: 222 rotavirus (any field) admissions and 1,383 non-rotavirus AGE (principal field) admissions.

Of the 222 rotavirus admissions: 7 (3%) had no record identified on Auslab; 11 (5%) had no faecal testing performed; and 204 had faecal testing performed (92%). For those that had faecal test results available, 201 (91%) had a rotavirus test result available, and 197 (89%) were positive for rotavirus. Of the 1,383 non-rotavirus AGE admissions: 183 (13%) had no record identified on Auslab; 523 (38%) had no faecal testing performed; and 677 had faecal testing performed (49%). For those that had faecal test results available, 428 (31%) had a rotavirus test result available, and 113 (8%) were positive for rotavirus. Various different ordering patterns were evident, with some children having up to 4 faecal specimens sent for analysis during an AGE admission without rotavirus testing being requested.

Notifications

There were 2,156 rotavirus notifications to NOCS in children aged less than 5 years in Queensland from December 2005 to December 2006. The highest numbers were from children aged 1 to 2 years (40%), followed by notifications in children aged less than 1 year (26%). Males at all ages had more notifications than females with an overall male:female ratio of 1.2:1.

Indigenous status was not reported for 42% of notifications. In the remainder, Indigenous children were over-represented, making up 11% of notifications.

The month with the highest number of rotavirus notifications was September 2006, 566 (26%), and there was a winter/spring seasonal peak between June and December 2006—93% of notifications were made during these months.

Discussion

Rotavirus is a ubiquitous pathogen of early childhood, affecting nearly all children by their 3rd birthday.[15,16] Hygiene improvements have had little to no effect in reducing the incidence of severe gastroenteritis in developed countries, making preventative vaccination the intervention of choice.[17] In large, phase III studies, both Rotarix and RotaTeq provided protection against any rotavirus disease (efficacy: 73%–74%) and severe disease (efficacy: 98%–100%).[17]

On 1 July 2007, Australian children born on or after 1 May 2007 were eligible for rotavirus vaccination on the National Immunisation Program, with either vaccine.[18] Given the impact of recurrent epidemics, and the high burden of disease and hospitalisations, the Northern Territory Government implemented an earlier program, providing Rotarix vaccine from 1 October 2006 for all children born on or after 1 August 2006.[19]

There are few consolidated rotavirus data from the pre-vaccine era available for Queensland. Prior to vaccine use in Australia, there has generally been little in the way of systematic surveillance of rotavirus disease and impact. Most surveillance information has been localised and comes from specific research projects. National hospitalisation data have been used intermittently to estimate the impact of severe rotavirus illness.[1,7,8] There is also little published literature on the potential impact of different diagnostic and laboratory testing patterns for rotavirus infection in hospitalised children with gastroenteritis. Rotavirus only became a notifiable condition in Queensland in December 2005.

We used routinely-collected data in an attempt to fill this gap about rotavirus epidemiology in Queensland. Our findings highlight the disproportionate impact of rotavirus in 2 groups: those under the age of 2 years, and Indigenous children. Overall, rotavirus hospitalisations and notifications peaked between the 1st and 2nd birthday. From hospitalisation and notification data, Indigenous children were at higher risk of being notified with or hospitalised due to rotavirus, and when hospitalisation occurred, it was at an earlier age and for longer than in non-Indigenous cohorts. These findings are similar to trends seen in the Northern Territory, where Indigenous children less than 5 years of age had an increased relative risk of 2.7 for rotavirus notification between 1995 and 2004.[20] Issues with timeliness of vaccine delivery for Indigenous children have been highlighted.[21–23] Due to the theoretical concern regarding intussusception following rotavirus vaccination, the rotavirus vaccines have restricted delivery times with the last (2nd) dose of Rotarix due by 24 weeks of age and the last (3rd) dose of RotaTeq by 32 weeks of age. To maximise any impact vaccines may have, delivering the full course in a timely manner to all children, but particularly to Indigenous children, should be a public health priority.

Based on data-linkage with laboratory testing data, a rotavirus-specific code in any discharge field position was supported by laboratory confirmation 89% of the time. Unless there are systematic changes in general coding procedures, this should mean tracking rotavirus-related hospitalisations is a reasonably specific means of assessing vaccine impact in the future. Internationally, other studies have also validated use of the rotavirus-specific code with between 91%[24] and 100%[25] of rotavirus-coded hospitalisations being supported by laboratory confirmation. Further, based on our findings, we believe hospital discharge codes considerably underestimate the burden of disease. Of non-rotavirus AGE-coded hospitalisations that had a rotavirus test performed, 113 (26.4%) were also found to be positive. We found that half the children with an AGE-related hospitalisation either had no Auslab record or no record of rotavirus testing for the AGE admission performed. It is possible these children had rotavirus testing performed at a privately pathology service; the results of such testing would not be available through the Queensland Health system. The seasonal pattern of AGE hospitalisations follows rotavirus closely, and in the absence of specific rotavirus testing, it is possible a proportion of these admissions are misclassified to less-specific AGE codes. Comparing hospital discharge coding with other sources of data has previously identified issues of sensitivity and specificity.[26] Again, assuming no systematic change in coding methods, it may be possible to observe rotavirus vaccine being effective in reducing not only rotavirus-specific hospitalisations, but admissions identified by less-specific AGE coding. A recent report of a retrospective United States of America cohort study showed that 3 doses of the now withdrawn RotaShield vaccine (Wyeth) had an effectiveness of preventing emergency department presentation and hospitalisation for all-cause AGE of 43% and 83%, respectively.[27]

Routinely collected data, in the absence of systematic changes in reporting or collection, are a simple and efficient method for monitoring the impact of new vaccines. Such data make it possible to fill in gaps in our understanding of disease epidemiology when results from prior targeted research are not available. Hospitalisation discharge data lack timeliness, but historical data allow for the monitoring of trends. The recent addition of rotavirus to the list of notifiable diseases, and the use of laboratory testing data should provide timely data on which to judge the impact of rotavirus vaccine in Australia.

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