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Rotavirus outbreak in central Australia

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Abstract

In May 2001, one of the largest outbreaks of Rotavirus in living memory swept through central Australia, resulting in 246 emergency department presentations and the hospitalisation of 137 children in a single month. Hundreds more throughout the region were afflicted. Of the hospitalised cases, 96 per cent were under 4 years of age and over 90 per cent were Aboriginal. There were no reported deaths from the outbreak.

The response by health personnel was similar to that experienced during other natural disasters, stretching local resources beyond their normal capacity. This report summarises the pathogenesis, clinical features and treatment of Rotavirus, and describes the management of a major outbreak of this potentially lethal and devastating disease in a unique and isolated context.

Introduction

Rotavirus was first identified as a causative agent in childhood gastroenteritis in 1973. Worldwide, Rotavirus is responsible for more than 125 million cases of diarrhoea per year, 25 per cent of all deaths due to diarrhoeal disease and 6 per cent of all deaths of children less than 5 years of age. Estimates of deaths due to Rotavirus range from 600,000 to 870,000 per annum, with developing countries experiencing the greatest burden of this disease.

In more developed countries such as Australia, the incidence of Rotavirus infection remains high while the mortality rate is very low. Carlin et al. notes that in Australia there are almost 20,000 hospital admissions per year due to acute gastroenteritis in children under 5 years, 50 per cent of which are attributable to Rotavirus infection. This implies a rate of hospitalisation for Rotavirus-related gastroenteritis of 7.5/1000/year. In those under 2 years of age, this rate is 11.6/1000/year.

However, in the Northern Territory where Aboriginal people comprise 30 per cent of the total population, the incidence of gastroenteritis generally and Rotavirus specifically is 3-4 times the national average.

In temperate climates in Australia and throughout the world, the number of Rotavirus infections peaks in the winter months. In the tropics, the seasonality of such infections is less distinct – within 10 degrees latitude (north and south) of the equator, most studies show no seasonal trends.

Group A Human Rotavirus comprises a number of different serotypes, the most common being G1, G2, G3 and G4. These serotypes were the target of the recently developed and subsequently withdrawn vaccine against Rotavirus. However, the significant presence of G9 serotype throughout Australia in recent years suggests the emergence of a compounding implication for future vaccine types.

The economic and social costs of Rotavirus infection are enormous, notwithstanding the emotional trauma for children and parents. The cost of treating Rotavirus infection alone has been estimated to be in excess of £6.5 million annually in the United Kingdom. In the USA, direct medical costs are estimated to be $264 million with $1 billion in total costs to society. In Australia, hospital and social costs for all Rotavirus infections are approximately $26 million annually. Clearly there are substantial benefits in better understanding how to prevent and manage this disease.
Pathogenesis and clinical features

Rotavirus is ingested, usually via the faecal-oral route and the Rotavirus particles subsequently invade the small intestine. The incubation period is approximately 2 days but can be as long as 7 days. Initially, there is an acute onset of low grade fever, anorexia and vomiting lasting up to 48 hours. The enterocytes of the small intestine are destroyed by lytic processes, resulting in significantly stunted villi and hence much reduced gut surface area. The epithelium is rapidly repopulated with immature enterocytes. These lack digestive enzymes such as lactase as well as the mechanisms for active sodium and water absorption.

This results in diarrhoea through at least two mechanisms. Undigested and unabsorbed carbohydrates such as lactose lead to osmotic diarrhoea. Water absorption is impaired while crypt hypertrophy leads to active secretion of water and electrolytes. Symptomatic infection is rare in the first 6 months of life because of maternal protective immunity and breast feeding.

The profuse watery diarrhoea typical of Rotavirus infection may lead to dehydration, acidosis and electrolyte imbalance, particularly in small children. In contrast to bacterial infections, the stool does not contain blood, white cells or mucus. Abdominal cramps are less frequent, although still present in many cases, while irritability and lethargy is common. In severe cases, febrile convulsions, hyponatremia, severe acidosis, Reyes’ syndrome, encephalitis, rectal bleeding and intussusception have been reported in association with Rotavirus infection.

Prevention and treatment

Measures to prevent Rotavirus infection

Prevention of Rotavirus infection, especially in children at risk such as those already hospitalised with other illnesses at the time of a Rotavirus epidemic, may include administration of a hyperimmune bovine colostrum substance containing antirotavirus immunoglobulin. Feeding this formulation three times a day to children at high risk for Rotavirus infection is a form of passive immunity showing success in some Australian studies.

A vaccine against Rotavirus was recently introduced in the USA but the product has now been withdrawn from the market due to the increased risk of intussusception associated with its use. This vaccine has never been available in Australia. Other vaccines are being developed, but it is likely to be a few years before they are available.

Treatment of infection

Clinical management protocols for dehydration associated with Rotavirus infection recommend initial use of a rehydrating solution. For more serious conditions, children are referred to hospital for treatment.

Children with weight loss greater than 5 per cent of their most recent weight or with signs of shock or severe dehydration are generally treated with intravenous fluid and, in severe cases, intraosseous fluid infusion may be required. Initial emergency treatment in more severe cases usually involves a bolus of rehydration fluid and continual assessment until the child is stable. Potassium supplementation and other vitamin and mineral supplements may be required.

Early resumption of oral feeding, or breastfeeding in infants, is encouraged. Vomiting and diarrhoea in the hospital setting are managed conservatively and are generally self-limiting. Antibiotics are not indicated unless secondary bacterial infections such as pneumonia are identified.

Once admitted to hospital, the management of Rotavirus is conservative and supportive, the disease is self-limiting and discharge can occur anywhere between 2-10 days (less in places where greater access to health services and supportive infrastructure is available).

General care of children with Rotavirus infection

• Isolation of infected children from non-infected children and visitors.
• Rehydration and implementation of prescribed fluids and treatments.
• Encouraging and supporting oral diet including breastfeeding.
• Maintenance of fluid balance chart.
• Recording of stool amount and appearance.
• Charting of other observations including temperature, pulse, respirations and weight.
• General hygiene including skin care and application of protective creams for excoriation or fungal infections as required.
• Emotional care and support to child and carer/family.
• Education of carers regarding diet, care and prevention of disease transmission.

Central Australian Rotavirus outbreak, May 2001

The setting

A widely reported outbreak of Rotavirus occurred in central Australia in May 2001, stretching local health resources beyond their normal capacity and requiring a regional, multi-disciplinary, multi-agency, whole of community response. The coordinated effort was nicknamed Operation Desert Pooh.
500 kilometres to the north and has a total bed capacity of 20 with a normal occupancy of just 10 patients.

The region’s catchment area is over 1 million km² (the size of New South Wales), containing 47,000 people. Twenty eight thousand people live in Alice Springs, 4,000 in Tennant Creek and the remainder live in small remote communities ranging in size from a dozen people to 800. Around 40 per cent of the total population in the region identify themselves as Aboriginal; most remote communities have over 90 per cent Aboriginal residents. A number of the communities that utilise Alice Springs Hospital are located across the Western Australian and South Australian borders.

The staff of the paediatric service at Alice Springs Hospital comprise five medical consultants, approximately ten registrars and residents and 45 full time nursing staff. The service generally plans for occupancy of 30-35 beds at any given time. Additionally, in most remote communities with more than 150 people, there are remote health services operated by both Territory Health Services and non-government Aboriginal medical services. The Royal Flying Doctor Service is designed to arrange emergency and planned medical escorts over vast distances. Finally, Alice Springs has a number of general practices and a significant Aboriginal health service – the Central Australian Aboriginal Congress – providing primary health care services to the Alice Springs community.

The outbreak

Rotavirus is a common winter phenomenon for the paediatric service, although severe outbreaks are difficult to predict in central Australia 5, 16-20 and elsewhere in rural and remote Australia 21,24. During the month of May 2001, 246 children with acute gastroenteritis presented to the emergency department, resulting in 145 hospital admissions; 137 cases of Rotavirus infection were confirmed.

The definitive pathology test used to identify positive cases was a Latex test (Slidex Rota-kit 2® by bioMérieux). The total number of patients tested was 220, with 166 positive results, 47 negative results and 7 unknown. The most severe peak in this epidemic was the fortnight commencing Saturday 12 May 2001 (Figure 1).

Of the 137 children admitted with Rotavirus infection in May, 54 (39 per cent) were identified as urban children (from Alice Springs and surrounding areas) and 83 (61 per cent) were from remote regions up to 600kms from the nearest hospital. More than 90 per cent of the admitted children were identified as Aboriginal, 59 per cent were under the age of 12 months and 96 per cent were under the age of 4 years.
The rapid influx of children admitted to the hospital was massive compared with numbers in previous years (1998-2000) and compared with the living memory of most clinical staff of the Alice Springs Hospital (Figure 2). The impact was widespread.

Figure 2. Confirmed Rotavirus infections of patients admitted to Alice Springs Hospital 1998-2001.

The large increase in admissions of infected children resulted in the need to remove non-infected children from the hospital prematurely to avoid nosocomial transmission of Rotavirus. Notwithstanding the discharge of relatively stable children from the hospital, the overall number of children admitted, according to the official census at midnight each evening, was as high as 75 and anecdotally as high as 90 during some of the busier days (Figure 3). The normal paediatric census at midnight is approximately 25-35 children.

Logistical management
The large and sudden influx of acutely ill young children, the majority of whom were Aboriginal, from remote communities and under 2 years of age, created many logistical problems. A summary of the main issues and strategic response to each are outlined below:

Specific infection control measures
Standard precautions and contact isolation were reinforced to all staff to prevent the spread of the disease. The cohorting of infected children and the need to prevent contact between infected and non-infected children were major considerations in the management of this particular outbreak when so many infected children were in the hospital at one time.

Visitors to the paediatric units were directed to leave well children at home. All staff were advised to limit the amount of equipment taken into the isolation rooms and encouraged to leave patient charts in outside areas. Increased signage was placed in the permanent and temporary paediatric areas advising staff and visitors to wash their hands. Rotavirus posters (Figure 4) were displayed in every public and paediatric area of the hospital. More contact isolation signs

Figure 4. Public message poster on Rotavirus.
were made and distributed to the relevant clinical areas. At times when the majority of beds were occupied with infected children, signs would be placed on the non-infectious rooms stating 'non-infectious room'. Paediatric boarder parents and carers were restricted from all other areas of the hospital. White name bands were utilised for all paediatric boarders to facilitate traffic restrictions to other clinical areas.

Regular visits by the infection control team to the paediatric unit provided opportunities for assessment of the environment and education of all staff. Information was provided on cleaning of equipment between clients, handwashing, care of uniforms, use of personal protective attire and preventing transmission of Rotavirus. Meetings were held with the paediatric housekeeping staff to ensure all were informed about transmission prevention and the need to maintain a high standard of environmental cleanliness.

General environmental cleaning was performed with a pH neutral detergent as per Alice Springs Hospital policy; additional decontamination was achieved using a chlorine-based disinfectant on all surfaces after cleaning with detergent. Carpeted areas commandeered as temporary paediatric units were steam-cleaned and allowed to dry before reoccupation.

Staff were advised to stay home and contact infection control if diarrhoea and/or vomiting occurred. Five staff members acquired Rotavirus infection.

Extra beds
At the peak of the outbreak the hospital had in excess of 75 admitted paediatric patients and their carers. To manage this, all elective procedures and operations were deferred. Any patients that could be sent to Tennant Creek Hospital for recuperation were sent. The 12 bed/chair day surgery unit was converted to a paediatric ward and a mixed adult and paediatric overflow unit was converted to a 30 bed paediatric unit. This resulted in three separate paediatric unit locations.

Extra staff
The paediatric clinical nurse consultants (unit nurse manager) remained supernumerary to the establishment for the crisis period to coordinate patient placement and to ensure safe clinical practice was maintained across all areas. It was also important to ensure patients were triaged to the most appropriate areas.

Additional nurses (up to 20) from Darwin were transferred to Alice Springs in the first week. Sensible use of overtime, cancellation of educational programmes and non-essential meetings, and re-deployment of nurse educators and theatre staff were all mechanisms used to cope with the immediate crisis and demand.

Extra equipment/supplies/medications
By 13 May it was clear the hospital was going to run out of cots, carer mattresses, IV poles, fluid pumps and IV fluids. In addition, nappies and 'blueys' were in short supply. Pharmacy, laundry, supply and pathology managers were called in to assess requirements and organise rapid replenishment of supplies. The managers initiated new orders from interstate suppliers immediately for the next day to bolster regional supplies of items that would be in strong demand. IV poles and pumps were flown from Tennant Creek Hospital initially and company suppliers leased additional IV fluid pumps from Adelaide the following day. Three thousand extra nappies that had been ordered for the region were released into circulation.

Regional coordination
On Sunday 13 May all hospital senior managers, medical directors and senior nursing personnel available were briefed by the hospital General Manager regarding the emerging
Rotavirus outbreak. They were asked to cooperate with the effort and, wherever possible, resist admissions and facilitate discharges.

On Monday 14 May, the other health regional managers were briefed by the hospital General Manager and on the 15 May a regional coordination taskforce was established to manage and monitor the outbreak. Participants on this group included: the regional director (chair), executive director of nursing (hospital), public health medical officer and director, remote health service general manager and nurse director, community health manager and a media liaison officer. Others were seconded as required. This group met twice daily for the next 5 days and then daily until 28 May. A formal debriefing was held on 31 May when the workload of the hospital had returned to near normal.

**Public health and community issues**

Given the scale of the outbreak and the media attention that occurred very rapidly, it was critical that public health messages be used both in the health facilities and in the broader community to help limit the spread of the disease. Examples of useful strategies included but were not limited to the following:

- **Media talent:** positive, credible staff from the health department were used to explain how the outbreak was being managed and also to ‘sell’ positive public health messages about hand washing, what carers of children could do to prevent contracting the virus and how they could limit the impact of the disease if it were contracted.
- **Posters** were developed in consultation with Aboriginal liaison officers of the hospital and the public health branch in simple but effective English that Aboriginal and non-Aboriginal people would understand. Some were translated into Aboriginal languages. They were distributed to all wards and patient areas of the hospital, every remote bush clinic, childcare centres, schools and other public places where children and their carers usually congregate.

Large gatherings of young children were advised against, including a large inter-school sports carnival scheduled for May in central Australia. Health Department officials maintained regular contact with the Education Department, non-government health agencies and other groups responsible for large numbers of children and families.

**Staff morale**

Frequent and timely memos of encouragement and a staff BBQ were arranged to ensure staff regularly received positive and encouraging feedback from management for their tireless performance during the outbreak. Care was taken to monitor nursing and medical staff, particularly those who completed double shifts and overtime regularly to ensure they received sufficient breaks between heavy periods of work.

**Discussion**

The enormous and rapid influx of flat, severely dehydrated and acidotic children to Alice Springs Hospital during this outbreak represented a situation comparable in scale (but different in context) to other overwhelmingly disasters. Most of the victims were under the age of 4 years, more than half under 12 months, and yet not a single death from Rotavirus was notified during the outbreak. The rule of thumb with Rotavirus in central Australia is that a child who makes it to hospital will survive.

The response to the outbreak by health staff was swift and coordinated. The first weekend was difficult as most non-hospital health personnel do not work on the weekend. Only emergency on-call services were in place; hence the initial response was by the hospital until a coordinated regional response could be implemented. The response was consolidated by formation of a management team that held regular meetings and ensured direction, coordination and appropriate communication between health department sections, staff and the broader community.

As with all disasters, the key to a successful outcome was coordination and communication. Two important facets of communication were learned in this experience. Firstly, the heavy work load of the paediatricians limited their involvement in the management team meetings. Their input was needed, especially when matters of clinical judgment were being debated or informed – their input should have been sought irrespective of their ability to attend such meetings personally.

Secondly, over-communication can be a trap, especially with respect to media interest and inquiries. To overcome this, media matters were last on the meeting agenda and only those directly involved in the media response were asked to remain to deal with how such matters were to be articulated. Media announcements and messages are a vital tool for public awareness and information and cannot be underestimated; however, the time involved in this work can be distracting for busy health professionals with more immediate considerations of patient and organisational safety.

No single source or index case was identified to explain the cause or size of this outbreak. It is hypothesised that it may have been the result of infection with Rotavirus serotype G9, a relatively new strain of the virus in Australia. For this reason it is thought that most children would not have developed any natural immunity or resistance to this strain of the disease.
It is also hypothesised that the original source of the outbreak may have come from the hospital. Some of the early cases in May and late April were children who had recently been in hospital or who had close contact with other children who had been in hospital. However, this does not account for all cases, nor does it explain the high incidence across such a large geographic area in less than 2 weeks.

Conclusion

Rotavirus is a major killer of children around the world, especially in developing countries. This rapid and severe outbreak of Rotavirus infection in central Australia demonstrates just how virulent and devastating the disease can be, especially for those in compromised environmental and social conditions such as Aboriginal children.

Fortunately, no children suffered long-term effects or death from this outbreak, a credit to the rapid, coordinated response of all health professionals, various health department branches and other community services in the region.

An outbreak of this magnitude highlights the need for an effective vaccine to limit the impact of Rotavirus infection on vulnerable children in our society. It also provides a timely reminder of the need for continued efforts to improve the living conditions and access to health resources for children living in remote central Australia.

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