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Original Article

Rotavirus Gastroenteritis Outbreaks in a neonate intermediate care unit: Direct detection of rotavirus from a computer keyboard and mouse

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Abstract *Background:* During one week in September, one index case, followed by two cases of rotavirus gastroenteritis infection, was identified in a neonate intermediate care unit of a tertiary teaching children's hospital. An outbreak investigation was launched to clarify the possible infection source and to stop the spread of infection.
Methods: Cohort care and environmental disinfection were immediately implemented. We screened rotavirus in all the unit neonates' stool samples as well as environmental swab samples. The precautionary measures with regard to hand hygiene and contact isolation taken by healthcare providers and family members were re-examined.
Results: The fourth case was identified 5 days after commencement of the outbreak investigation. There were total 39 contacts, including 6 neonates, 8 family members, and 25 healthcare providers. Nineteen stool samples collected from other neonates in the units revealed one positive case (the fourth case). However, one sample taken from the computer keyboard and mouse in the ward was also positive. The observation of hygiene precautions and the use of isolation gowns by healthcare workers were found to be inadequate. Following the

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intensification of infection control measures, no further cases of infection were reported.
Conclusions: Hand hygiene and an intensive isolation strategy remained the most critical precautions for preventing an outbreak of healthcare-associated viral gastroenteritis in the neonate care unit.

Introduction

Healthcare-associated infections (HAIs) are a major health concern and can cause significant morbidity and mortality, especially in vulnerable patients including neonates and the prematurity group.[1]

Rotavirus—a double-stranded RNA virus of the family *Reoviridae*—is the leading cause of dehydrating gastroenteritis in children of less than 5 years of age throughout the world. Children who become infected with rotavirus may experience severe watery diarrhea (often with vomiting), mild-to-moderate fever, and abdominal pain.[2] The gastrointestinal symptoms are generally resolved in 3—7 days. The incubation period is only 1—3 days. Infections in neonates are generally mild or asymptomatic. However, some infants may present with necrotizing enterocolitis with severe complications.[3,4] Moreover, rotavirus is often reported in outbreaks of HAI. In a meta-analysis study conducted in 2012, Patricia et al. reported a nosocomial rotavirus infection rate of 2.9 per 100 hospitalizations.[5] In the present paper, we report a small-scale outbreak of rotavirus infection in a neonate intermediate care unit of a tertiary teaching children's hospital in Taiwan. One infant was diagnosed with rotavirus infection; subsequently, three other patients were found to have rotavirus gastroenteritis. Thanks to a timely investigation, we stopped the outbreak and reinforced the infection control measures observed by the healthcare workers.

Facility and settings

The present investigation was conducted in a university teaching children's hospital in northern Taiwan with 292 beds. The neonate intermediate care unit takes care of up to 36 patients, spaced 1—1.5 m apart, in three shifts per day. A nurse takes care of 4—6 patients in a shift. The most common diagnoses include post-neonatal intensive care unit (NICU) prematurity, low birth weight, and neonatal diseases admitted from the emergency room or out-patient clinics. The neonatal intermediate care unit comprises five open 4-bed rooms, and two open 8-bed rooms (Fig. 1). The milk handling room is dependently located next to the neonatal intermediate care unit. The protocol for the handling, storage, and transport of expressed breast milk, banked milk, and infant formula was standardized and followed the infection control guideline.[6—9] The infant formula was pasteurized to prevent potential pathogen transmission before portioning into individual bottles for feeding.

Index case and clusters

A one-month old male infant (birth weight 3320 g and gestational age 39 weeks and 1 day) presented with fever up to 38.4 °C and one episode of watery diarrhea with some mucoid substance at home. He was admitted to the neonatal intermediate care unit on 9th September. Examinations revealed white blood cells at a concentration of 6960/μL (neutrophils 30.2% and lymphocytes 49.4%), and C-reactive protein at a concentration of 0.08 mg/dL. This infant had frequent watery stools after admission (9—11 times per day). The stools tested positive for rotavirus antigen.

Three days later, two other infants in the same ward developed diarrhea. One of these two patients was premature, had a very low birth weight, was admitted to NICU on the 29th July, and was transferred to the neonatal intermediate care unit on the 15th August. This infant had fever with diarrhea from the 12th September. The other 2-month-old patient was also premature, and was admitted for upper airway symptoms and fever on the 9th September. This patient was initially defervescent, but there was a subsequent temperature spike to 39 °C again on the 14th September, accompanied by frequent loose stools. Stool samples from both of the two patients described above were positive for rotavirus antigen. On the 14th September, the infection control team and the pediatric infection physicians were consulted with regard to a possible HAI.

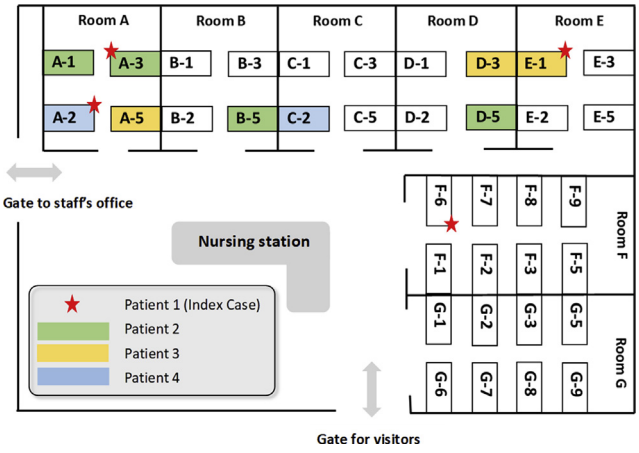

Figure 1. Top view of the neonatal intermediate care unit showing locations of the index case and the other three rotavirus-infected neonates before execution of cohort care. Frequent bed transfers are noted.

Methods

Ethics

All investigations were approved by the Hospital Research Ethics Committee and were conducted after obtaining informed consent from each subject. The data were collected by the certified infection control nurses (ICNs).

Study subjects and infection control measures

A confirmed case was defined as any patient that presented with clinical symptoms of diarrhea and had a stool that tested positive for rotavirus antigen. We started cohort care since 14th September. We arranged patients with confirmed rotavirus infection in the same room (Room A in this outbreak). All these patients were taken care by a same nurse in a given shift. Precautions of contact isolation were reinforced among all health care workers, including nurses and others. We reviewed the staffs' work assignments and visitor records, and identified potential contacts. The contacts were defined as those people who took care of, or had contact with, the three infected patients during a time period of 6 days—i.e., twice the incubation period—before the onset of symptoms. All contacts were followed up for related symptoms, such as fever, diarrhea, and vomiting. If diarrhea occurred, the stool samples were immediately tested for rotavirus antigen.

Environmental disinfection was carried out promptly using a chlorine sanitization solution (1000 ppm). Samples taken from all the unit neonates' stools and environments were collected for rotavirus antigen testing between the 19th and 20th of September. The precautionary measures with regard to hand hygiene and contact isolation taken by healthcare providers and family members were examined.

Determination of the rotavirus antigen

We used the RIDA®QUICK Rotavirus immunochromatographic test (R-Biopharm AG, Germany) for the qualitative determination of rotavirus antigen in the stool samples. According to the product sheet, the sensitivity and specificity were 100.0% and 94.4%, respectively, using the results obtained from a polymerase chain reaction (PCR) as gold standards.

The environmental swab samples were screened for rotavirus by real-time reverse transcription polymerase chain reaction (RT-PCR). Primers targeting the gene encoding non-structural protein 3 (NSP3) were used.[10,11] Swab samples were taken from computer keyboards and mouses, barcode scanner, infusion pump, cabinet for isolation gowns in Room A, the press-button of the electrocardiogram/pulse oximeter, and the oxygen flow meter in Room C.

Results

The layout and compartments of the neonatal intermediate care units are shown in Fig. 1. The timeline of bed transfer, the date of onset, and the diagnosis of each confirmed case are shown in Fig. 2. It revealed some overlapping in rooms and healthcare providers among patient 1—3. There were 39 contacts, including 6 neonates, 8 family members, and 25 healthcare providers. One healthcare provider contact, who is a nurse, experienced diarrhea. The nurse took care of patient 3 on 12th September and then had diarrhea on 14th September. The stool for rotavirus antigen from this nurse was negative on 15th September. The nurse isolated herself at home until symptom free. The other contacts experienced no symptoms during the follow-up period.

On average, the three patients were transferred between the different rooms in the neonatal intermediate care unit two times, as convenience for the healthcare providers dictated. The fourth case of infection to be identified was not listed in the contacts, but a stool sample from the patient tested positive for rotavirus antigen when all the hospitalized babies were screened. The patient was admitted for preterm premature rupture of the membrane to NICU on the 27th August, and was transferred to the neonatal intermediate care unit on the 31st August. He experienced occasional loose stools (8—16 times per day) without fever or vomiting, as of the 15th September. The stool was positive for rotavirus antigen on 19th September. Though his room was not overlapping with other three infected patients', the nurse who experienced diarrhea had taken care of him on 13th September. The primary care physician also took care of patient 2 and patient 4 at the same time during 9th-14th September.

Cohort care and contact isolation were then reinforced. All infected patients were isolated until discharge in room A after rotavirus infection was confirmed by the immunochromatographic test on separated dates (Fig. 1). The 18 stool samples collected from the other neonates in the units all tested negative for rotavirus antigen. However, one sample from the computer keyboard and mouse in the ward tested positive. The positive environmental screening rate was 14.3% (1/7). Moreover, the ICNs found that the observation of hygiene precautions and the use of isolation gowns by healthcare workers were inadequate. The concentration of the chlorine sanitization solution used for environmental cleaning was only 500 ppm, which did not meet the accepted requirement (1000 ppm). Therefore, under the instruction of the infection control team, we have intensified the infection control measures, including strictly execution of hand hygiene and use of mask, isolation gowns, and thoroughly cleaned the environment with chlorine sanitization solution (1000 ppm) since 14th September. No cases of infection were reported subsequently. The four patients with confirmed rotavirus infection were discharged smoothly and without any complications.

Discussion

Herein, we report a small-scale rotavirus outbreak in the neonate intermediate care unit of a national tertiary children's hospital, which had performed well and had a low infection density according to past records.[12] The results of the environmental screening for rotavirus conducted in the current study may support the notion that rotavirus was transmitted by healthcare providers whose hand hygiene practice was inadequate.

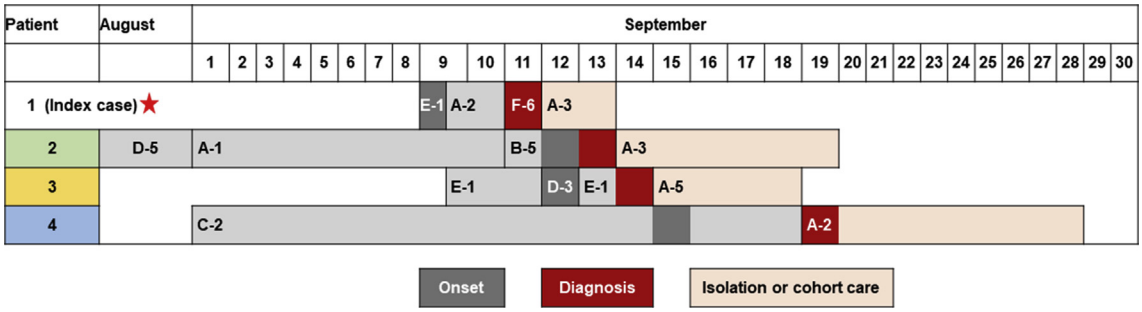

Figure 2. The timeline of bed transfer, date of symptom onset, and date of diagnosis for each rotavirus-infected neonate during the outbreak.

The patient 4 stayed in a room not overlapping with other three patients' but still became infected. The most plausible explanation for this is that some health care workers have acted as a vector and carried over the virus. Although we had no direct evidence showing the virus was transmitted from any specified healthcare workers to the infant, patient 4 indeed shared his primary care physician and nurse with confirmed cases. Furthermore, although we did not found rotavirus in any stool samples from health care workers, including the nurse who had diarrhea, we have identified rotavirus in samples taken from the computer keyboard and mouse from the ward. Thus, we believe rotavirus should have been carried from patients to patients, either directly by the same health care workers or indirectly to the environment first and then to the patient by different healthcare workers. We confirmed that hand hygiene and environment cleaning remain the key factors in HAI prevention. Won et al. reported that infection density decreased significantly from 15.13 to 10.69 per 1000 patient-days in a teaching hospital NICU after improvement of hand hygiene among healthcare workers in 2004.[13] Recent work has also shown that hand-touch sites are habitually contaminated with hospital pathogens, which are then transmitted to patients by hand. Prioritizing the cleaning of these sites might offer a useful adjunct to the current preoccupation with hand hygiene.[14]

Frequent bed transfer may also play a role in increasing the chance of rotavirus transmission. The average number of bed transfers for the infected infants before intervention was two. The most common reason for bed transfer was the convenience for the healthcare providers, without other clinical justification. Therefore, bed transfer should be restricted to the requirements necessitated by infection control or clinical needs, e.g., isolation or intensive care.

In recent decades, the HAI in NICU has increased. The infection rate varied from 4.8 to 22 per 1000 patient days.[15] Most studies have focused on bacterial and fungal infections in hospitals.[16,17] The current study provides a reminder that viral infections also play an important role in hospitals. The most prevalent viral agents in healthcare setting include rotavirus, respiratory syncytial virus, enterovirus, hepatitis A, and adenovirus.[1] The severity of the outbreak and the mortality rate vary according to the type of virus.

The disease burden of rotavirus was high in the pre-vaccine era, and may have been as high as three million rotavirus infections per year in the United States. Following the introduction of a rotavirus vaccine in 2006, rotavirus activity in the United States has decreased significantly.[18] Rotavirus is also one of the common pathogens of HAI. A review article published in 2004 reported that an average of 27% (range 14—51%) of rotavirus hospitalizations were nosocomial in nature.[19] In Taiwan, Tai et al. reported that three-quarters of the infants with rotavirus infections hospitalized in neonatal care units in a tertiary teaching hospital in northern Taiwan during 2008—2010 acquired their infection in the hospital, and more than 60% of the patients were preterm infants.[3] Therefore, rotavirus infection in neonate care units is an important issue, and warrants further attention.

Rotavirus is highly contagious and can survive on hands, surfaces, and fomites for weeks or months. It is resistant to several antiseptic solutions, including alcohol. Therefore, the disinfection of the environment and all surfaces used by patients with 1000 ppm (0.1%) chorine solution has been suggested by the Taiwan Centers of Disease control.[20]

In conclusion, hand hygiene and thorough cleaning of the environment with an appropriate disinfection agent are the most important steps in infection control when facing a highly contagious pathogen such as rotavirus. Suitable patient deposition with cohort care should also be promptly implemented to prevent the spread of infection.

Conflicts of interest

None of the authors has any conflict of interest to declare in relation to the materials discussed in the present article.

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