

# Nosocomial Rotavirus Infection: Epidemiology, Clinical Manifestations, and Effectiveness of Infection Control Measures in Pediatric Ward in Bamrasnaradura Infectious Diseases Institute, Thailand

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## ABSTRACT

Rotavirus (RV) is the major causative agent of gastroenteritis in young children, and nosocomial rotavirus (NRV) transmission has been reported. However, limited data are available in Thailand. The routine detection of RV antigen in the stool has been performed in hospitalized children with diarrhea concomitant with vomiting in Bamrasnaradura Infectious Diseases Institute, Thailand, since January 2004. We found the incidence of RV infection/total hospitalized diarrhea cases was 24.6 percent. The bundle of RV infection control measures have been strengthened since October 2006. We then analyzed the incidence of NRV diarrhea (defined as diarrhea occurred after 72 hours of hospitalization or within 48 hours after discharge in patient with positive RV antigen in the stool), comparing between pre-RV intervention period (October 2005 to September 2006) and RV intervention period (October 2006 to September 2007). Significant decreased trend of the proportion of NRV/RV was observed as 5.7 percent (9 of 156 patients) and 0.7 percent (1 of 137 patients) in pre-RV and RV intervention period, respectively (P value = 0.02). Of these 10 NRV patients, the mean age was about 17.1 months old, and most patients occurred around day 5 of hospitalization. All patients had severe vomiting, and 60 percent of patients had high grade fever. All patients had good recovery from the infection. RV infection could be one of the most important nosocomial pathogens, especially during RV season. Pediatricians should be aware of making an early diagnosis, and apply special infection control measures to prevent NRV transmission. (*J Infect Dis Antimicrob Agents* 2008;25:33-41.)

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## INTRODUCTION

Rotavirus (RV) is the major causative agent of viral diarrhea in children worldwide. Worldwide, an estimation of 111 million RV-associated diarrheal episodes associated with 440,000 deaths occurs annually.<sup>1</sup> RV has also been recognized as nosocomial pathogen, and outbreaks of RV diarrhea have been reported in healthcare settings, particularly in the pediatric age group.<sup>2-5</sup> In developed countries, viruses account for 91-94 percent of all patients of nosocomial diarrhea, and RV is the major causative agent (31-87% of cases).<sup>6-9</sup> However, there are limited data regarding the true incidence of nosocomial rotavirus (NRV) diarrhea and also some controversial issues regarding the effectiveness of hospital infection control measures to prevent NRV transmission.<sup>10</sup> In Thailand, community surveillance revealed that the proportion of patients of RV diarrhea in the community had been much lower than that in the hospitalized population (12.2% and 43.0%).<sup>11</sup> The data regarding the incidence of NRV infection are also limited in Thailand.

In Bamrasnaradura Infectious Diseases Institute, Thailand, bacteriologic study for causative agents of diarrhea has been implemented for years. We routinely perform stool cultures for *Vibrio cholera*, *Salmonella* and *Shigella* in all hospitalized diarrheal patients, both in adults and children. In addition, the detection of RV antigen in the stool has also been carried out in hospitalized children with diarrhea concomitant with vomiting since 2004. The bundle of RV infection control measures have been strengthened since 2006. Regarding our infection control measures, we generally recommend the standard and contact precautions for diarrheal patient, and also the droplet precaution if they have respiratory tract symptoms. We thus aimed to study the epidemiology, clinical manifestations of NRV infection, and the effectiveness of the infection control measures to prevent NRV transmission, comparing

between the pre-RV and RV intervention periods.

## MATERIALS AND METHODS

This study was conducted in our general pediatric ward (1 month old to less than 15 years old) from January 2004 to December 2007. Our ward contained 25 common beds (4 cohort rooms, and 5 beds/room), 5 private rooms, 5 isolation rooms, and one common playing area.

### Implementation of RV infection control measures

Apart from already existed infection control measures for diarrheal patients in pediatric ward, we have implemented the bundle of RV infection control measures to specifically prevent NRV transmission in our pediatric ward since October 2006. We have educated all health care workers (HCWs) regarding the rotavirus transmission and control measures. The implemented RV infection control measures included a) informing the relatives of each patients about the diagnosis and requesting for their compliance with infection control measures to prevent transmission, b) providing a single isolation if the room was available, c) applying the strict precautions regarding the restricted use of the wasted bin for each patient and the prohibition of the patient to enter the common playing area, if the isolation room was not available, d) daily cleaning of bed, bedside table, and the common playing area with 70 percent alcohol, and e) enforcement of hand hygiene for the relatives, visitors, and all HCWs with provided individual alcohol hand rub for every patient.

### NRV case definitions

We aimed to study the incidence of NRV patients which were defined as diarrhea occurred after 72 hours of hospitalization or within 48 hours after discharge, in patient with positive rotavirus antigen in the stool.<sup>12-13</sup> If the patients had respiratory symptoms, they must

get better before episode of diarrhea occurred.

**Cases exclusion**

We excluded the patients with immunocompromised condition. The patient who had both respiratory symptoms and diarrhea on the first day of hospitalization was also excluded from this study.

**Laboratory-surveillance method**

Regarding the purpose of rapid diagnosis of RV for early intervention, the chromatographic immunoassay for the qualitative detection of Rotavirus antigen was used (ROTA CARD, New Market Laboratories, UK), this assay has 100 percent sensitivity and 98 percent specificity.

**Statistic analysis**

We assessed the effectiveness of the bundle of RV infection control measures by comparing the case proportion of NRV/RV during pre-RV intervention period (October 2005 to September 2006) and that of the RV intervention period (October 2006 to December 2007). The proportion was compared using the Chi-square test where expected cell values were greater than 5 and Fisher’s exact test otherwise, and  $P < 0.05$  was considered to be significantly different.

**RESULTS**

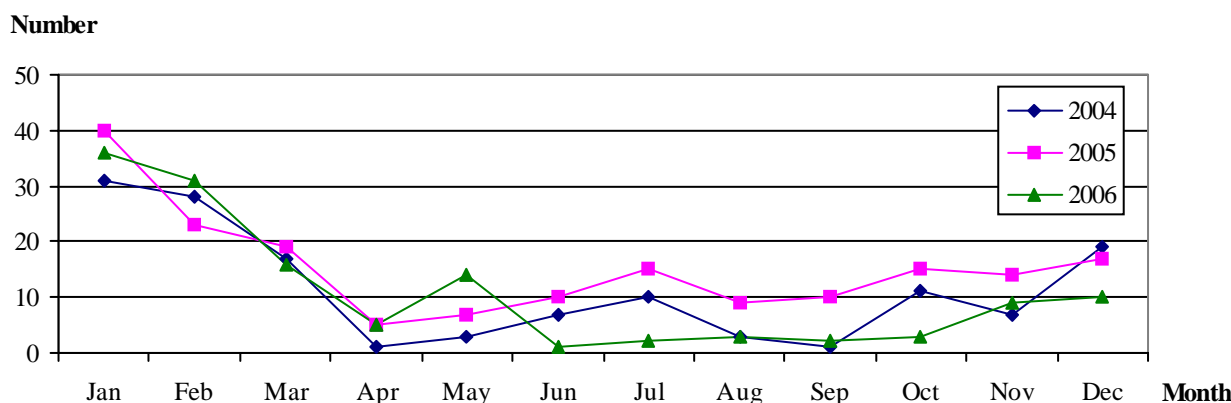
**Epidemiology of RV diarrhea**

From January 2004 to December 2006, there were 521, 489 and 587 total hospitalized diarrhea patients with 116 (23%), 129 (26%), and 148 (25%) of RV patients in the years 2004, 2005, and 2006, respectively. Overall, the incidence of RV diarrhea was 24.6 percent (393 of 1,597 patients). The monthly and age group distributions are shown in Figure 1 and Table 1 as well as Figure 2, respectively.

**Evaluation of the effectiveness of the infection control measures to prevent NRV transmission**

The incidence of RV and NRV infection during the pre -RV intervention and RV intervention period as monthly distribution is shown in Figure 3. We observed the seasonal pattern of RV and NRV infections, with the peak RV infection occurred during the winter period from October to March in both periods.

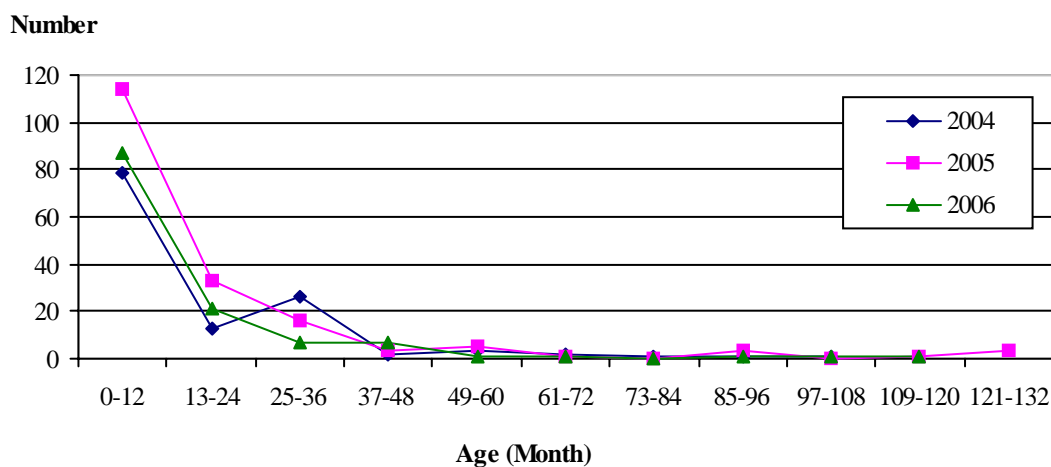
We assessed the effectiveness of our RV infection control measures by comparing the proportion of NRV/RV during the two periods (Table 2). During one year of the pre-RV intervention period, the all case proportion of NRV/RV was 5.7 percent, comparing with 0.7 percent during one year of the RV



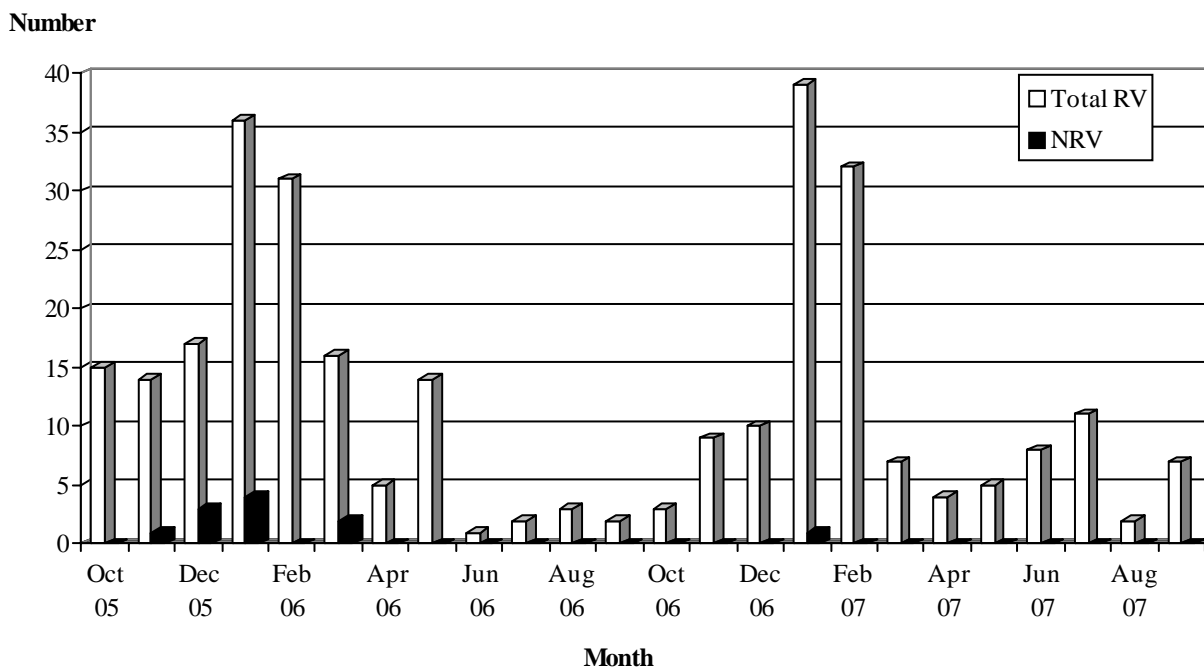
**Figure 1. The incidence of all hospitalized rotavirus patients from 2004 to 2006.**

**Table 1. Demography of all hospitalized rotavirus patients.**

Year	RV patients	Male:female	Age range (month)	Ratio of patients of < 24 and ≥ 24 months	Mean age (month)
2004	116	1.9:1	1-108	2.6:1	19.2
2005	129	1.5:1	1-132	4.6:1	20.3
2006	148	1.8:1	4-127	5.7:1	19.3
<b>Total</b>	<b>393</b>	<b>1.7:1</b>	<b>1-132</b>	<b>4.4:1</b>	<b>19.6</b>



**Figure 2. Age group distribution of all hospitalized rotavirus patients from 2004 to 2006.**



**Figure 3. Monthly distribution of all nosocomial rotavirus and rotavirus patients from October 2005 to 2007.**

**Table 2. The incidence of total diarrhea rotavirus (RV), and nosocomial rotavirus (NRV) patients.**

Year	RV patients	NRV patients	NRV/RV patients (%)
Pre-RV intervention period			
- 1 year: Oct 2005-Sep 2006	156	9	9/156 (5.7) <sup>a</sup>
- RV season: Oct 2005-Mar 2006	129	9	9/129 (7) <sup>b</sup>
RV intervention period			
- 1 year: Oct 2006-Sep 2007	137	1	1/137 (0.7) <sup>a</sup>
- RV season: Oct 2006-Mar 2007	100	1	1/100 (1) <sup>b</sup>
Total	293	10	10/293 (3.4)

<sup>a</sup>1-year period: P=0.02 (Fisher's exact test)

<sup>b</sup>RV-season period: P=0.04 (Fisher's exact test)

intervention period (P = 0.02). In addition, there was a significant reduction of the case proportion of NRV/RV during the RV season (October to March) during the RV intervention period compared with the pre-RV intervention period (P = 0.04).

### Clinical characteristics of NRV patients (Table 3)

Of 10 NRV patients, the mean age was 17.1 months old, with most cases occurring at the mean of day 5 (range 2-8 days) of hospitalization. NRV cases could be categorized into 2 groups including group 1 (7 patients) which the infection occurred during the first hospitalization and group 2 (3 patients) which the infection occurred within 2 days after previous discharge from the hospital. All patients had severe vomiting, and 60 percent of patients had high-grade fever ( $\geq 38.5^{\circ}\text{C}$ ). All patients had good recovery from the infection.

### DISCUSSION

In this study, we found the incidence of RV diarrhea was 24.6 percent, in consistent with other studies which described around 25 percent-50 percent

of hospitalized patients with gastroenteritis.<sup>1,14-15</sup> The age distribution in patients of less than 2 years old and the peak incidence in winter season were similar to previous studies from both developing and developed countries.<sup>1</sup> We also found the peak incidence of NRV infection in winter season, in consistent with the previous study in Europe.<sup>2</sup> The case proportion of NRV/RV in this study (3.4%) was lower than previous studies which revealed the proportion ranging from 14.3 percent to 50.8 percent.<sup>16,17</sup> The difference may be due to the different NRV case definitions or the impact of our infection control measures in the pre-RV intervention period. However, there have been several reports that described both hygienic and sanitary measures are likely to be insufficient for control of RV infection, which is contrary to other infectious diarrhea<sup>18,19</sup>, due to its property as the hardy virus (a nonenveloped RNA virus, which resists to common chemical disinfectants) and its ability to remain viable on inanimate surface for many days which could serve as indirect (fomite) transmission.<sup>20,21</sup> It can survive at least 4 hours on human hands; this can facilitate the spreading via HCW hands.<sup>22</sup> RV is inactivated by 70

Table 3. Clinical descriptions of all 10 nosocomial rotavirus patients.

No	Sex	Age (month)	Diagnosis at admission	Day <sup>a</sup>	T (°C)	Complete Blood Count((CBC)					LOS <sup>b</sup> (days)
						Hct	WBC (/ml <sup>3</sup> )	N (%)	L (%)	Plt (x10 <sup>3</sup> /ml <sup>3</sup> )	
1	F	8	Chickenpox	4	38.2	ND	ND	ND	ND	ND	6
2	M	12	Asthmatic bronchitis	4	38.2	ND	ND	ND	ND	ND	5
3	F	19	Urinary tract infection	4	40	30	6,150	61	29	334	11
4	M	22	Bronchitis, cerebral palsy	5	39.8	ND	ND	ND	ND	ND	12
5	M	27	URI, febrile convulsion	5	39	41	6,110	27	65	293	7
6	F	19	Pneumonia	6	38.2	ND	ND	ND	ND	ND	8
7	M	13	Asthmatic bronchitis	7	37	ND	ND	ND	ND	ND	8
8	M	11	Rehospitalization 1 day after discharge; previous hospitalization	4 <sup>c</sup>	40	41	9,400	60	31	284	4
9	M	21	Rehospitalization 2 days after discharge; previous hospitalization with acute non-rotavirus diarrhea	5 <sup>c</sup>	38.5	41	7,200	44	43	315	4
10	M	19	Rehospitalization 1 day post discharge; previous hospitalization with perianal abscess	8 <sup>c</sup>	40.5	34	7,140	63	24	400	5

<sup>a</sup>Onset date of diarrhea after hospitalization<sup>b</sup>Length of hospital stay<sup>c</sup>In case of readmission, this reveals the onset date of diarrhea after previous admission

ND: not done, Hct: hematocrit, CBC: complete blood count, WBC= white blood cell count, N: neutrophil,

L: lymphocyte, Plt: platelet, F: female, M: male, URI: upper respiratory tract

percent ethanol which is a preferred solution for cleaning contaminated surface. In addition, RV infection is very contagious as a low inoculum of virus is needed to cause the infection; the estimated mean infectious dose is approximately 200 particles, corresponding to a  $10^9$  dilution of the stool excreted on the first day of illness in an infected child. Nosocomial transmission is believed to be feco-oral route, however, there have also been several reports described the droplet<sup>23</sup> and aerosolized<sup>10,24</sup> transmission. In Thailand, there have been no previous studies regarding the effectiveness of infection control measures for RV infection. In our institute, we have implemented the bundle of RV infection control measures including all standard, contact, and droplet precautions, and in this study we found a significant reduction of NRV patients, compared to the pre-RV intervention period.

In this study, the means age of NRV patients was 17 months old. Most NRV infections occurred around the day 5 of hospitalization, in consistent with the previous studies.<sup>3,6</sup>

We found the problem of making diagnosis of NRV infection since it has an incubation period of 2-4 days<sup>25</sup> and RV patients could also present as respiratory symptoms, developing prior to diarrhea.<sup>26</sup> Thus, we can not be sure whether our criteria in this study for NRV infection would be overlapped with community-acquired infection. However, we have used the same criteria for making diagnosis of NRV in both periods, and all NRV diagnoses were reviewed and approved by infection control nurses, responsible pediatricians, and a pediatric infectious diseases specialist. Thus, the problem of systematic bias should be eliminated. Other limitation in this study include the infection control measures. We could not assess the effectiveness for each infection control measure, as we have implemented all infection control measures at the same time. Some infection control measures have

been difficult to control including the compliance of the patient's caretaker, and the restriction of playing activity of patients. However, the result from this study supported that strict infection control measures and proper disinfection could reduce the NRV infection.

In conclusion, pediatricians should be aware of the existence of RV infection as an important nosocomial transmission. The strict implementation of infection control measures has shown to be effective to prevent NRV infection.

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