Parainfluenza Virus Type-3 Outbreak in Level II Neonatal Care Unit: Role of Nursing Infants inside Closed Incubators in the Control of the Viral Outbreak

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Abstract Parainfluenza type 3 virus (PIV-3) outbreaks in neonatal care units are rare. We aimed to report our experience of PIV-3 outbreak in level II neonatal care unit (NCU-II). A retrospective review of medical records of all infants managed in NCU-II during the PIV-3 outbreak period. During the viral outbreak, 49 infants were cared for in NCU-II, and only 7 infants proved to be infected with PIV-3. The attack rate was 14%. The first 4 infected infants were transferred to standby isolation room outside NCU-II, and the unit was closed. All exposed and infected infants were cohorted, nursed inside closed incubators and other infection control measures were reinforced. Due to bed crises and 5 days after the closure of the unit and before the end of the viral outbreak; the standby isolation room was closed and NCU-II was reopened for new admissions and was divided into 3 zones for: infected, exposed, and newly admitted infants. Three more infants that were initially exposed to index case turned positive. There was no further transmission of the PIV-3 after opening the neonatal unit. Infants nursed in open crib at onset of PIV-3 outbreak were at high risk for infection (P value <0.0001). All infected infants survived and were discharged in good condition. Re-enforcing standard infection control measures, cohorting and placing all the exposed and infected infants inside closed incubators could contain respiratory outbreaks in neonatal nurseries without significant morbidity or mortality and most probably without the need to close the unit.

Keywords: parainfluenza virus, neonatal care unit, incubators, open cribs, infection control

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1. Introduction

Parainfluenza virus (PIV) is an enveloped RNA paramyxovirus with four distinct subtypes. It causes more than 30 % of all acute respiratory infections in infants and children [1]. It is only second to respiratory syncytial virus as a cause of lower respiratory tract infection in young children [2-3]. Of the four serotypes of human PIV, type-3 causes the majority of infections in this age group. Although highly infective, outbreaks of PIV-3 in nursery accounts for 1-3% of all cases of viral infections in neonatal care unit [4]. PIV-3 outbreaks in infants are rare probably due to presence of maternal antibodies which are transferred antenatally through placenta [5] and possibly postnatally through breast milk [6]. Premature infants might be more susceptible because of the insufficiency of transferred maternal antibodies secondary to the premature delivery.

Some of the previously reported PIV-3 outbreaks in newborn nurseries were difficult to control without

closing the unit while others were associated with mortalities [6,7]. We are describing an outbreak of PIV-3 in NCU-II which was successfully contained with use of infection control measures and nursing exposed and infected infants inside closed incubators without prolonged closure of the unit and with no significant morbidity or mortality.

2. Material and Methods

A retrospective review of the medical records of all infants who were managed in the NCU-II during the PIV-3 outbreak period from April 26 to May 7, 2008 at King Abdul-Aziz Medical City-Riyadh, a tertiary care center in Riyadh, Saudi Arabia. The NCU-II is a rectangular, 28 bedded unit that receives 1200 admission per year and is separate from level III neonatal intensive care unit.

We studied the demographic data, clinical presentation, management, and outcome of all the involved infants during the viral outbreak. The demographic data of the infected and uninfected infants were compared to study the possible risk factors for the PIV-3 outbreak.

2.1. Statistics

Statistical analysis was done using STATA program version 11.1 (2009), STATA corporation LP, TX, USA. Student-t test was used for analysis of continuous data and Chi Square Test was used for analysis of categorical data. P value less than 0.05 was considered to be significant.

2.2. Patients

Patients were considered symptomatic if they developed any of the following: coryza, cough, recurrent apneas, retraction, wheezes, bradycardia, tachypnea or desaturation. Symptomatic infants were placed in closed incubators and given intravenous antibiotics for 48 hours pending the bacterial culture result. Infants with apnea or unstable oxygen saturation were given oxygen by nasal cannula, and were initiated on intravenous fluids. Salbutamol nebulization was administered only to wheezing infants. Patients who needed mechanical ventilation support were transferred to the fully equipped Standby Isolation Room outside NCU-II.

Infants on the right and left side of any symptomatic baby were considered exposed and they were nursed inside closed incubators. Unless symptomatic all other infants were considered unexposed. Infected infants were considered recovered if they tested negative on the PIV-3 antigen detection.

2.3. Laboratory Studies

Nasopharyngeal swabs were obtained from symptomatic and exposed infants and were sent to the laboratory on the Universal Viral Transport Media. The swabs were tested for PIV-3 antigen detection by direct immune fluorescence antibody using the Ultra PARA3 DFA reagent with or without viral culture using the R-Mix SV/CS. All the used laboratory products were obtained from Diagnostic Hybrids Inc, CA, USA. Positive nasopharyngeal swabs were repeated every third day until turned negative for the infected infants while the exposed infants were rescreened twice during the outbreak duration. Chest X-ray and other investigations were done when clinically indicated.

2.4. Control Measures

Initially the NCU-II was not closed, and continued to receive new admissions during the first 3 days of the outbreak. The unit is composed of 3 Zones: "Zone A" for newly admitted infants, while "Zones B and C" for asymptomatic exposed infants (Figure1). The infected infants were isolated in the Standby Isolation Room outside the NCU-II. As new infected cases continued to appear, the NCU-II was closed for new admission for 5 days, but due to bed crises, it was reopened 4 days ahead of the outbreak control, and utilized for all eligible infants. Zone A was continued to be used for newly admitted infants, Zone B for asymptomatic exposed infants, while infected infants were cohorted in Isolation Room in Zone C inside the NCU-II till their viral swabs turned negative then they were transferred to Zone B. All infants in Zones B&C were nursed inside closed incubators. Nurses were designated to care for newborn infants in only one zone during the outbreak period while strict hand washing and contact isolation precautions were emphasized. Active surface disinfection with soap, water and Muniten spray was done periodically during the outbreak. Two inservices on hand hygiene and PIV infections were given to the unit staff by the infection control department. Health care workers and visitors manifesting any respiratory tract symptoms were not allowed to enter the NCU-II.

3. Results

Forty-nine infants were managed in the NCU-II during the viral outbreak. The demographic data of the infected and non infected infants are shown in Table 1. Out of the 49 infants, 8 became symptomatic, 7 of them (14 %) tested positive for PIV-3 by both the antigen detection and viral culture and the outbreak was controlled after 12 days as shown in the Figure 2. Only one symptomatic infant tested negative for PIV-3 and his symptoms were thought to be secondary to bronchopulmonary dysplasia. The index case was 61 days old infant, with bronchopulmonary dysplasia; he was the product of 26 weeks gestation and weighed 730 grams at birth. The birth weight of the infected infants ranged from 735 grams to 2750 grams with a median of 1850 grams, the gestational age ranged from 26 to 39 weeks with a median of 30 weeks, and postnatal age ranged from 17 to 123 days with a median of 37 days.

Figure 1. Structure and distribution of patients in the Neonatal Care Nursery-II during the Parainfluenza-3 Virus Outbreak

Figure 2. Distribution of parainfluenza-3 virus cases between April 26th-May 7th 2008

All the infected infants were in the group of infants who were exposed to the index case of outbreak, and at the onset of outbreak were nursed in open incubators. All newly admitted babies during the two periods of opening the unit stayed asymptomatic.

The duration of symptoms ranged from 1 to 6 days with a median of 3 days, the duration of positivity ranged from 2 to 14 days with a median of 7 days. All symptomatic infants in the infected group were positive for PIV- 3 by antigen detection as well as cultures. Apnea developed in 5 infected infants but only in one infant in the non-infected group. Only one infected infant needed nasal intermittent mandatory ventilation for 5 days and was managed in the standby isolation room outside NCU-II. All the other infants were treated with only bronchodilators and other supportive care, antiviral medications were not prescribed for any infant. All the infants survived and were discharged in a good condition. The clinical symptoms of the infected infants are shown in Table 2.

Table 1. Demographic characteristics of all infants admitted to NCU-11 at the time of PIV-3 viral outbreak

	Non- Infected (n=42)	Infected (n=7)	P Value
Birth weight (Kg)			
Mean	2.61	1.67	0.0093
Median	2.5	1.4	
± SD*	0.81	0.82	
Gestational age(weeks)			
Mean	36.86	31	0.0032
Median	37	30	
± SD	3.38	4.43	
Postnatal age (days)			
Mean	5.64	60.1	<0.0001
Median	1.0	37.0	
± SD	10.45	44.57	
NCU-II days			
Mean	2.8	26	<0.0001
Median	1.0	14	
± SD	3.3	36.4	

*SD: Standard Deviation

Table 2. Clinical Manifestation of PIV-3 Infected Compared to Non-infected Infants

Nasal secretion	100% (7)	2.4%(1)	287 (12.1-13175.5)	<0.0001
Cough	57.1% (4)	00% (00)	54.7 (3.3-2750.4)	<0.0001
Wheezes	42.9% (3)	00%(00)	30.8 (1.7-1650.2)	0.0003
Tachypnea	71.4% (5)	00%(00)	102.5 (5.8-4947.1)	<0.0001
Change in oxygen requirement	42.9% (3)	2.4% (1)	15 (1.9-118.1)	0.0021

No viral screening was done for the nursing staff, 3 nurses were referred to employee health clinic because of respiratory tract symptoms. They were granted a sick leave with a strict recommendation not to come back to work unless asymptomatic. No sick parents were identified during that period.

The characteristics of the 2 groups were studied regarding: history of non- invasive mechanical ventilation,

history of invasive mechanical ventilation, nursed in open crib prior to outbreak, broncho-pulmonary dysplasia, history of systemic steroid therapy, chronic non respiratory problems for the identification of possible risk factors and all proved to reach statistical significance as possible risk factors with significant P value of less than 0.05 as shown in Table 3.

Table 3. Possible Risk Factors of PIV-3 Infected Compared to Non-infected Infants

	Infected % (n=7)	Non-Infected % (n=42)	OR (95% CI)	P Value
History of non- invasive mechanical ventilation	71.4 % (5)	23.8% (10)	8 (1.1-91.4)	0.01
History of invasive mechanical ventilation	71.4 % (5)	2.4% (1)	102.5 (5.8-4947)	< 0.0001
Nursed in open crib prior to outbreak	100% (7)	14.3% (6)	42 (3.8-1941.8)	< 0.0001
Broncho-pulmonary dysplasia	28.6% (2)	2.4% (1)	16.4 (0.7-989.8)	0.0075
History of systemic steroid therapy	28.6% (2)	2.4% (1)	16.4 (0.7-989.8)	0.0075
Chronic non respiratory problems **	42.9% (3)	7.1% (3)	9.8 (0.9-94.6)	0.0076

** Osteopenia of Prematurity, Retinopathy of Prematurity, Obstructive Genito-Urinary Disorders, Hydrocephalus, Chronic seizures disorders.

4. Discussion

Viral outbreaks in neonatal nurseries could cause serious morbidity and mortality. The most common reported respiratory viral outbreaks are due to respiratory syncytial virus (RSV). Overcrowding, prematurity, and noncompliance with infection control precautions play a major role in the spread of these viruses [8].

Although PIV-3 outbreaks are rare in neonatal nurseries partly because of the high reported frequency of passive immunity to PIV in the neonatal period from maternal antibodies [5]. The attack rate in our report was 14%, which is very low in comparison to other reports [7,9]. The increased susceptibility of NCU-II population could be due to the faded maternal neutralizing antibodies secondary to the long stay of premature infants in such nurseries [7]. The duration of the outbreak was 12 days; much shorter than other reports [10]. In concordance with Ben -Shimolet al report[11]; we encountered very low(14.3%) morbidity as only one infant needed mechanical respiratory support in the form of Nasal IMV, compared to other reports of 71.4% of infected infants needed mechanical respiratory support [10] and had no mortality in comparison to significant mortality reported by others[6].

The incubation period of PIVs lasts from 2 to 4 days. The immunocompetent children may shed the virus for up to 1 week before onset of clinical infection and up to 3 weeks after the resolution of symptoms. Similar to the observation of Ben- Shimol et al, at the onset of the viral outbreak; all infected infants compared to 13.9% of the control (P value <0.0001) were nursed in open crib. This finding suggests that infants nursed in open cribs are at high risk of infection at viral outbreak [11]. Transmission of parainfluenza infection occurs by direct person to person contact as well as inhalation of infected droplets [12,13]. Parainfluenza viruses have been found to survive for at least a few hours in air and on environmental surfaces [14,15]. Infectious viruses can be transferred from environmental surfaces to the hands of hospital personnel who appear to be responsible for the spread [13]. Nursing infectious infants inside closed incubators during parainfluenza viral outbreaks will prevent the transfer of the virus to surrounding environmental surfaces and thereby to the hands of health care providers, who may spread it to other patients. Such practice is the standards of practice in the control of RSV outbreaks in neonatal units [16]. During the viral outbreak in our NCU-II, we carried out a bundle of infection control measures (cohorting the infected and exposed infants in separate zones, placed all the infected and exposed infants inside closed incubators, grouping the nurses to care for infants in only one zone, and emphasizing hand washing and all the other infection control precautions) that enabled our team to contain the outbreak without prolonged closure of the unit. Despite the fact that our unit was partially closed i.e. the unit was closed for 5 days only, which is less than the period of expected infectivity of the PIV-3 virus, all the infected infants were in the group which was exposed initially to the index case and all the newly admitted infants remained not infected. This finding denotes that bundle of introduced measures were effective and adequate in spite

of reopening the unit for new admission 4 days ahead of the control of viral outbreak. Our finding supports the proposal of Ben Shimol et al [11] that closing the neonatal units during parainfluenza-virus outbreak most probably is unnecessary.

We strongly think that nursing infectious infants inside closed incubators during parainfluenza viral outbreaks will have a positive role that adds up to the currently used infectious control measures to contain the virus spread in this population and shorten the outbreak duration.

Finally, our result confirms that infants with lower gestational age and or lower birth weight, infants with longer stay in the NCU, and infants with history of chronic lung disease, who were exposed to systemic steroid therapy and had longer period of mechanical ventilation have higher risk of PIV-3 infection during the outbreak.

5. Conclusion

Cohorting infected and exposed infants and placing them inside closed incubators could contain respiratory outbreaks in neonatal nurseries. Implementing infection control measures is essential to control viral respiratory outbreaks without significant morbidities or mortalities. Closure of the neonatal units during such outbreak may not be necessary.

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Conflict of Interest Statement

The authors disclose that we don't have any financial or personal relationships with other people or organizations that could inappropriately influence (bias) our work and we don't have any competing interest to declare.

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