

Risk analysis of respiratory infections in facilities for patients with severe motor and intellectual disabilities in Japan

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ABSTRACT

Background: The present study aimed to identify risk factors for respiratory infections in facilities for pediatric patients with severe motor and intellectual disabilities (SMID) in order to establish effective respiratory infection countermeasures.

Method: A retrospective chart review of 92 SMID patients who were admitted to a SMID facility in Japan between April 2014 and March 2015 was conducted. Stepwise multiple logistic regression analysis was performed regarding the relationship between respiratory infection and 60 patient factors, such as quadriplegia and activities of daily living, and 53 care factors, such as oral care and *ryouiku* (therapeutic education).

Results: Respiratory infection incidences were as follows: pneumonia, 39.1%; respiratory syncytial virus (RSV) infection, 26.1%; and respiratory syndrome, 31.5%. The primary risk factor for respiratory infection was movement education, a group *ryouiku* program (pneumonia: odds ratio [OR] 15.22, 95% confidence interval [CI] 2.99-77.40; RSV infection: OR 13.85, 95% CI 2.72-70.50; and respiratory syndrome: OR 10.84, 95% CI 1.78-65.93).

Conclusion: The present findings indicated that movement education sessions at SMID facilities should be promptly suspended in cases of respiratory infection outbreak. Ongoing respiratory syndrome surveillance is required to enable early recognition of an outbreak.

KEYWORDS

Infection control; patients with severe motor and intellectual disabilities (SMID); respiratory tract infections; *ryouiku*; long-term care

INTRODUCTION

In Japan, residential facilities are available for pediatric patients with severe motor and intellectual disabilities (SMID). Approximately 30% of SMID patients in these facilities receive medical interventions such as artificial respiration, oxygen administration, total parenteral nutrition, and tube feeding. They also receive *ryouiku* (therapeutic education) to maintain health, promote development, and improve social skills and quality of life. *Ryouiku* programs “combine medical interventions, nursing care, education, and childcare in order to promote all-round

development and foster a strong foundation for life with the goal of helping individuals to overcome their disabilities” [1]. *Ryouiku* can be conducted individually or in groups. During group *ryouiku*, pediatric patients engage in play and exercise that involve physical contact in the form of physical interaction on the floor or therapy mats and hugs from helpers. Many activities involve sharing toys in group *ryouiku*. Patients in SMID facilities include those who have difficulty sitting upright or who move around by crawling along the floor of corridors and shared

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rooms. There are also patients who can walk and run without difficulty despite intellectual disabilities. The risk of spread to other patients and staff from even one case of infection is high in SMID facilities due to the high frequency of interpersonal and environmental contact.

The leading cause of death in SMID patients in Japan is respiratory infection [2]. Related patient factors reportedly include neuromuscular disorders [3], bronchial asthma [3], and degree of paralysis associated with the underlying condition [4-6]. Meanwhile, the related care factors include tube feeding [7] and inadequate oral care [8]. However, no studies to date have investigated the risk of respiratory infection in SMID facilities after controlling for these potentially confounding factors. In addition, no studies have investigated the relationship between *ryouiku* programs and respiratory infection. The present study aimed to identify risk factors for respiratory infection in SMID facilities in order to establish effective respiratory infection countermeasures.

MATERIALS AND METHOD

Sample and setting

Subjects comprised 102 individuals who were admitted to one of two wards (A or B) at a standard SMID facility in Japan between April 1, 2014 and March 31, 2015. Each ward (A or B) had 55 beds. The average number of hospitalization days of both wards exceeded 1,000 days. There were no significant differences between ward A and ward B in terms of age, sex, activities of daily living, and severity.

Data collection and procedures

Survey items comprised 60 patient factors, such as degree of paralysis and activities of daily living, and 53 care factors, such as *ryouiku*, tube feeding, and oral care. Data were obtained from medical charts.

Respiratory infection

Outbreaks of the following respiratory infections occurring between April 1, 2014 and March 31, 2015 were investigated. These infections were selected for investigation based on reports of previous outbreaks at SMID facilities in Japan: respiratory syncytial virus (RSV) infection [9], human metapneumovirus (hMPV) infection [10], influenza [11], adenovirus infection [12], *Bordetella parapertussis* infection [13], and pneumonia. As unidentified causative organisms are responsible for at least half of respiratory infection outbreaks at SMID facilities [12], respiratory syndrome, which can be determined based on clinical symptoms alone, was also included in the present study.

Outbreaks that met at least one of the below criteria for identification of specific respiratory infection were included in the analysis:

1. RSV infection: positive RSV rapid antigen detection test (RADT), RSV detection on polymerase chain reaction (PCR), fourfold or greater increase or decrease in antibody titer, and/or RSV identification by viral culture [14, 15].
2. hMPV infection: positive hMPV RADT [16], hMPV detection on PCR, fourfold or greater increase or decrease in antibody

titer, and/or hMPV identification by viral culture [15].

3. Influenza: positive influenza A or B virus RADT and/or influenza A or B virus detection on PCR [15].
4. Adenovirus infection: positive adenovirus RADT [17], adenovirus detection on PCR, fourfold or greater increase or decrease in antibody titer, and/or adenovirus identification by viral culture [15].
5. *B. parapertussis* infection: *B. parapertussis* identification by bacterial culture and/or *B. parapertussis* detection on PCR [15].
6. Pneumonia: new or progressive and persistent infiltrate on two or more serial chest radiographs on a single chest x-ray with i) axillary temperature $\geq 38.0^{\circ}\text{C}$ and/or ii) white blood cell count decrease ($< 4,000/\text{mm}^3$) or increase ($\geq 12,000/\text{mm}^3$).
7. Respiratory syndrome: axillary temperature $\geq 38.0^{\circ}\text{C}$ on two consecutive days with percutaneous arterial blood oxygen saturation $\leq 93\%$ and/or increased oxygen demand [18-20].

Statistical analysis

Univariate and multivariate analyses were conducted regarding the relationships with respiratory infections. Univariate analysis comprised Fisher's exact test or Wilcoxon's rank sum test depending on variable type and distribution. Stepwise multiple logistic regression was performed for multivariate analysis. Patient and care factors with a relationship to respiratory infection suggested by univariate analysis ($\alpha = 0.2$) were selected as independent variables. Multicollinearity between independent variables was assessed using variance inflation factor. Goodness of fit of the final models was determined using the Hosmer-Lemeshow test. Analyses were performed using SAS Studio version 3.5 (SAS Institute, Cary, NC, U.S.A.) with significance set at $\alpha = 0.05$.

RESULTS

Of 102 patients, 92 patients were analyzed; ten patients who were transferred to another facility during the study period were excluded. The median age was 39 years (range: 1 to 67 years) and the number of male patients was 53 (57.6%). A total of 96.7% of patients participated in group *ryouiku*.

Respiratory infection incidences were as follows: pneumonia, 39.1% (36/92); RSV infection, 26.1% (24/92); and respiratory syndrome, 31.5% (29/92). No cases of hMPV infection, influenza, adenovirus infection, or *B. parapertussis* infection were observed.

Risk factors of respiratory infection

Independent variables selected by multiple logistic regressions for inclusion in the final model for each respiratory infection type were as follows. Pneumonia: movement education (odds ratio [OR] 15.22; 95% confidence interval [CI] 2.99-77.40), inability to wear a surgical mask (OR 4.26; 95% CI 1.27-14.35), and chest computed tomography (CT) findings of obsolete aspiration pneumonia (OR 2.81; 95% CI 1.00-7.90). RSV infection: movement education (OR 13.85; 95% CI 2.72-70.50) and ward type (OR 9.63; 95% CI 2.56-36.32). Respiratory syndrome: movement education (OR 10.84; 95% CI 1.78-

65.93), inability to roll over (OR 8.43; 95% CI 1.45-49.12), male sex (OR 4.54; 95% CI 1.43-14.40), and gastrostomy feeding (OR 3.12; 95% CI 1.06-9.22). For all models, satisfactory goodness of fit was achieved and no multicollinearity was detected (Table 1).

TABLE 1: Results of stepwise multiple logistic regression analysis regarding respiratory infection outbreaks.

Respiratory infection			
Independent variable	Pneumonia ^{a)}	RSV infection ^{b)}	Respiratory syndrome ^{c)}
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Movement education (physical activity)	15.22 (2.99-77.40)	13.85 (2.72-70.50)	10.84 (1.78-65.93)
Ward type	n.s.		n.s.
A		1.00	
B		9.64 (2.56-36.32)	
Inability to wear surgical mask	4.26 (1.27-14.35)	-	-
Chest CT findings of obsolete aspiration pneumonia	2.81 (1.00-7.90)	-	-
Inability to roll over	n.s.	-	8.43 (1.45-49.12)
Sex	n.s.	-	
Female			1.00
Male			4.54 (1.43-14.40)
Gastrostomy feeding	n.s.	-	3.12 (1.06-9.22)
Variance inflation factor	1.86-5.30	4.58, 1.50	1.44-3.71
Hosmer-Lemeshow goodness-of-fit test			
χ^2	0.580	0.266	5.067
Degrees of freedom	3	1	6
<i>p</i> -Value	0.901	0.606	0.535

Legend

RSV: respiratory syncytial virus infection

OR: odds ratio

CI: confidence interval

CT: computed tomography

n.s.: not significant (not selected in the final model)

-: variables not included as independent variables

- a) Selected independent variables: age, weight, sputum suctioning, nebulizer inhalation, bronchial asthma, long-term low-dose macrolide therapy, H2 blocker use, sputum suctioning during meals, visitation from family members who live with child in nursery school/kindergarten, hugs, trunk muscle tone, inability to hold up head, tracheotomy, ward *ryouiku*, visiting education, frequency of oral care, intake of solid food, intake of liquid food, nasal feeding, swallowing training, detection of Methicillin-resistant *Staphylococcus aureus* (MRSA), detection of *H. influenzae*.
- b) Excluded independent variables: age, weight, prone position, hugs, inability to hold up head, visiting education, frequency of oral care, items used for oral care, frequency of hand hygiene assistance, blood total protein, Glasgow Coma Scale score, intake of solid food, detection of *H. influenzae*, detection of *S. pneumoniae*, hemiplegia, full-body wiping, entry into a room with two or four beds.
- c) Excluded independent variables: age, weight, sputum suctioning, nebulizer inhalation, bronchial asthma, long-term low-dose macrolide therapy, visitations, guaranteed time in prone position, inability to hold up head, impaired mouth closure, food recognition, visiting education, length of stay, frequency of oral care, frequency of bowel movements, intake of solid food, swallowing training, motor function (bedridden), detection of MRSA, detection of gram-negative bacteria, quadriplegia.

DISCUSSION

Five patient factors (male sex, inability to wear surgical mask, chest CT findings of obsolete aspiration pneumonia, inability to roll over, and gastrostomy feeding) and two care factors (movement education and ward type) were identified as risk factors for respiratory infection in SMID facilities.

Movement education was a risk factor for pneumonia, RSV infection, and respiratory syndrome infections. Movement education, a development support program created in the United States [21], is widely incorporated into *ryouiku* programs for SMID patients in Japan [22]. In the present SMID facility, movement education was conducted jointly for two wards by three to four helpers for groups of eight to ten patients in a dedicated *ryouiku* room. Movement education included laying and sitting multiple patients on a shared therapy mat; interactive activities among two to three patients on one mat; sharing toys such as trampolines, water guns, and big drums; and activities involving close physical contact between patients and helpers such as helpers hugging patients and patients leaning against helpers. Furthermore, movement education always involves "touch time," when patients use their hands to touch each other and the helpers. The number of participants in movement education makes it difficult for helpers to ensure hand hygiene for each patient, change personal protective equipment, and wipe and disinfect shared toys and environmental surfaces. Many causative organisms of respiratory infection can survive on environmental surfaces for several hours or more [23], making it difficult to control the spread of respiratory infection during movement education. From the perspective of infection prevention, suspension of movement

education should be considered. In Japan, 56% of SMID facilities suspend *ryouiku* due to respiratory infection outbreaks each year [22]. Delayed suspension of group *ryouiku* such as movement education may allow infection to spread, ultimately prolonging the overall suspension time. There are reports of *ryouiku* suspensions lasting ≥ 4 weeks [22]. Movement education is indicated to be effective for maintaining and developing function in SMID patients [24-26] and long-term suspension is undesirable. Therefore, quickly recognizing the signs of respiratory infection outbreak and promptly changing the content of movement education to minimize contact between patients or switching to individual *ryouiku* would constitute an effective countermeasure. This approach requires the implementation of respiratory syndrome surveillance to enable early detection of the signs of an epidemic. In Japan, only 13% of SMID facilities perform respiratory syndrome surveillance [22], indicating the need for wider adoption.

The other care factor identified was ward type. The risk of RSV infection was greater in ward B than ward A. During the study period, there was an RSV infection outbreak in both wards; however, the outbreak started earlier in ward B, and ward A used the experience from ward B to rapidly implement effective RSV infection countermeasures, including hand hygiene [27], the use of gloves, gowns, and protective eyewear [28-31], and suspension of group *ryouiku*. Ward type was likely identified as a proxy variable representing these comprehensive infection countermeasures.

Since the five specified patient factors are not suitable for intervention, SMID patients who are male, unable to wear surgical mask, unable to roll over, receive gastrostomy feeding, and who present chest CT findings of obsolete aspiration pneumonia should be closely observed as a high-risk group regarding respiratory infection and efforts made to quickly recognize signs of respiratory infection.

The present findings suggested that movement education is a risk factor for respiratory infection in SMID facilities. However, as this was a retrospective study performed at a single facility, further investigation using a prospective study method at multiple facilities is required. Widespread adoption of respiratory syndrome surveillance is necessary to enable early recognition of the signs of an epidemic.

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