

## Prolonged bedtime bottle feeding and respiratory symptoms in infants

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**Background:** Infants with chronic respiratory symptoms should be evaluated thoroughly because there are various causes which are different from those of children and adolescents.

**Objective:** This study was designed to investigate the relationship between chronic respiratory symptoms and bedtime bottle feeding in infants after the age of 6 months.

**Methods:** We conducted a prospective study that included 44 infants who presented with respiratory symptoms for more than 8 weeks and also had been bottle-fed during bedtime even after 6 months of age. The infants were divided into 2 groups; infants who discontinued bedtime bottle feeding and those who did not. Respiratory symptom scores were graded with a four-point scale at 0, 1, 2 and 3 months, and were compared between the 2 groups.

**Results:** Twenty eight infants (63.6%) stopped being bottle-fed during bedtime and 16 infants (36.4%) were still bottle-fed. The respiratory symptom scores were significantly decreased in infants who stopped bedtime bottle feeding ( $p = 0.0003$ ).

**Conclusion:** It is suggested that prolonged bedtime bottle feeding might be one of the causes of chronic respiratory symptoms in infants.

**Key words:** Feeding methods; Bottle feeding; Infants

### INTRODUCTION

Respiratory symptoms, the most common complaint presented in children, are caused mainly by upper respiratory infections and can be alleviated within 1–2 weeks. In contrast, chronic cough persist for longer periods and caused by various reasons other than viral infections. Cough may be classified as acute (lasting less than 3 weeks), subacute (lasting 3 to 8 weeks), chronic (lasting more than 8 weeks) [1]. In 1981, the National

Ambulatory Medical Care Survey in the United States reported that 6.7% of pediatric outpatients visited the clinic with a chief complaint of a chronic cough [2].

A careful evaluation of patients with chronic respiratory symptoms is mandatory for proper treatment. Asthma, sinusitis, gastro-esophageal reflux (GER) and micro-aspiration are most commonly associated with chronic respiratory symptoms [3, 4]. GER and micro-aspiration, which occur more often in infants than in adults, have been shown as related to immaturity in the

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Received: April 5, 2011  
Accepted: April 19, 2011

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coordination of sucking, swallowing and breathing as well as the intake of liquid formula in a supine position [5, 6]. Bottle feeding is more likely to stimulate GER than breast feeding [7, 8]. It has also been reported that the risk of developing GER and micro-aspiration is increased during sleep [9, 10]. These studies have suggested that GER and micro-aspiration caused by bottle feeding during bedtime might cause chronic respiratory symptoms in infants.

However, a correlation between bedtime bottle feeding and chronic respiratory symptoms in infants has not yet been examined. In this prospective study, we hypothesized bedtime bottle feeding could be the cause of chronic respiratory symptoms in infants, and attempted to examine whether respiratory symptoms improved following the discontinuation of bedtime bottle feeding in infants who exhibited chronic respiratory symptoms.

## MATERIALS AND METHODS

### Patients

We recruited patients more than 6 months old who visited Samsung Medical Center due to chronic respiratory symptoms that lasted longer than 8 weeks. Forty-four patients who had been bottle-fed during bedtime were included in the study. Bedtime bottle feeding was defined as a feeding that was performed with use of a baby bottle within 1 h before sleep or while infants were asleep during the night. Those infants who had a congenital anomaly, a history of serious medical events or the presence of any other illness, evidence of an acute respiratory infection, a parental history of allergy or a history of allergy, a history of passive smoking, below the 10th percentile of weight for age, premature birth, low birth weight or lack of written informed consent were excluded in this study.

### Methods

We used a questionnaire to obtain data about the volume and frequency of bedtime bottle feeding, the position for bedtime bottle feeding and respiratory symptoms (cough, sputum, rhinorrhea, nasal obstruction, wheezing and dyspnea). Respiratory symptoms were graded with a four-point scale (Table 1), which was modified from the scoring system in the previous study [11]. Guardians of the patients were given instructions about the detrimental effects of bedtime bottle feeding as well as the

**Table 1.** Scoring for respiratory symptoms during 3 months (at months 0, 1, 2, and 3)

Respiratory symptoms	Frequency	Points
Cough	4–7 days a week	3
	1–3 days a week	2
	Less than once a week	1
	Not at all	0
Sputum	4–7 days a week	3
	1–3 days a week	2
	Less than once a week	1
	Not at all	0
Rhinorrhea	4–7 days a week	3
	1–3 days a week	2
	Less than once a week	1
	Not at all	0
Nasal obstruction	4–7 days a week	3
	1–3 days a week	2
	Less than once a week	1
	Not at all	0
Wheezing	4–7 days a week	3
	1–3 days a week	2
	Less than once a week	1
	Not at all	0
Dyspnea	4–7 days a week	3
	1–3 days a week	2
	Less than once a week	1
	Not at all	0

correct method of bottle feeding. The parents were also given information about the optimal frequency of bottle feeding according to the age-related developmental stage, the optimal amount of feeding associated with the increased gastric volume of each developmental stage and the use of weaning. The daily feeding amount was allocated to be used from the time when the infant woke up in the morning to 1 h before the infant went to bed. Bottle feeding was discontinued within 1 h before sleeping or during the night when the infant woke up during sleeping. Providing a small amount of water during the nighttime was allowed in order to provide a level of psychological satisfaction. It was also recommended that when the infants wake up and cry at night, parents should wait for several min for the infants to stop crying and spontaneously go back to sleep as opposed to running to comfort the infants or provide the infants with milk [12, 13]. After education, those infants were followed up at 1, 2 and 3 months after discontinuation of bedtime bottle feeding. Following

the distribution of educational materials, respiratory symptoms scores were compared between infants whose bedtime bottle feeding was discontinued and infants whose bottle feeding was maintained.

The institutional review board at Samsung Medical Center in Seoul approved this study and written informed consent was obtained from guardians of each patient prior to participation in this study.

### Statistical analysis

A mixed model and pairwise T test with Bonferroni's correction were used to identify a correlation between persistent bedtime bottle feeding and respiratory symptoms. All statistical analyses were performed using SPSS software version 17.0 (SPSS, USA). *p* values < 0.05 were considered as significant.

## RESULTS

### Characteristics of subjects

The mean age of the 44 infants was  $15.8 \pm 7.8$  months (age range, 6–39 months). The subjects consisted of 24 males and 20 females. The mean sleeping time was  $9.1 \pm 1.2$  h (mean  $\pm$  SD). The amount of liquid food provided by bedtime bottle feeding was  $180.6 \pm 32.1$  mL. The frequency of bedtime bottle feeding was  $1.7 \pm 0.7$  times and the duration of bedtime bottle feeding was  $20.5 \pm 12.3$  min. The time point for bedtime bottle feeding was 'after wake-up from sleep at dawn' in 29 patients (65.9%), 'immediately before sleep' in 25 patients (56.8%), '30 min before sleep' in 19

patients (43.1%) and '1 h before sleep' in 6 patients (13.6%). The reasons for bedtime bottle feeding included 'because the infants seem to be hungry and fretful' in 29 infants (65.9%), 'to put infants to bed' in 10 infants (22.7%) and 'out of habit' in 5 infants (11.4%). The posture for bedtime bottle feeding was 'the lying position' in 42 infants (95.5%) and 'the sitting position' in 2 infants (4.5%). Infants who were fed in the sitting position fell asleep in the lying position within 1 h following the feeding. After education of parents about the detrimental effects of bedtime bottle feeding and the correct method of bottle feeding, 28 infants (63.6%) (16 males and 12 females) discontinued bedtime bottle feeding and 16 infants (36.4%) (12 males and 4 females) continued bedtime bottle feeding. There were no significant differences in the clinical characteristics between the infants whose bottle feeding was maintained and infants whose bottle feeding was discontinued (Table 2).

### A comparison of respiratory symptoms for infants that maintained bottle feeding and infants that discontinued bottle feeding

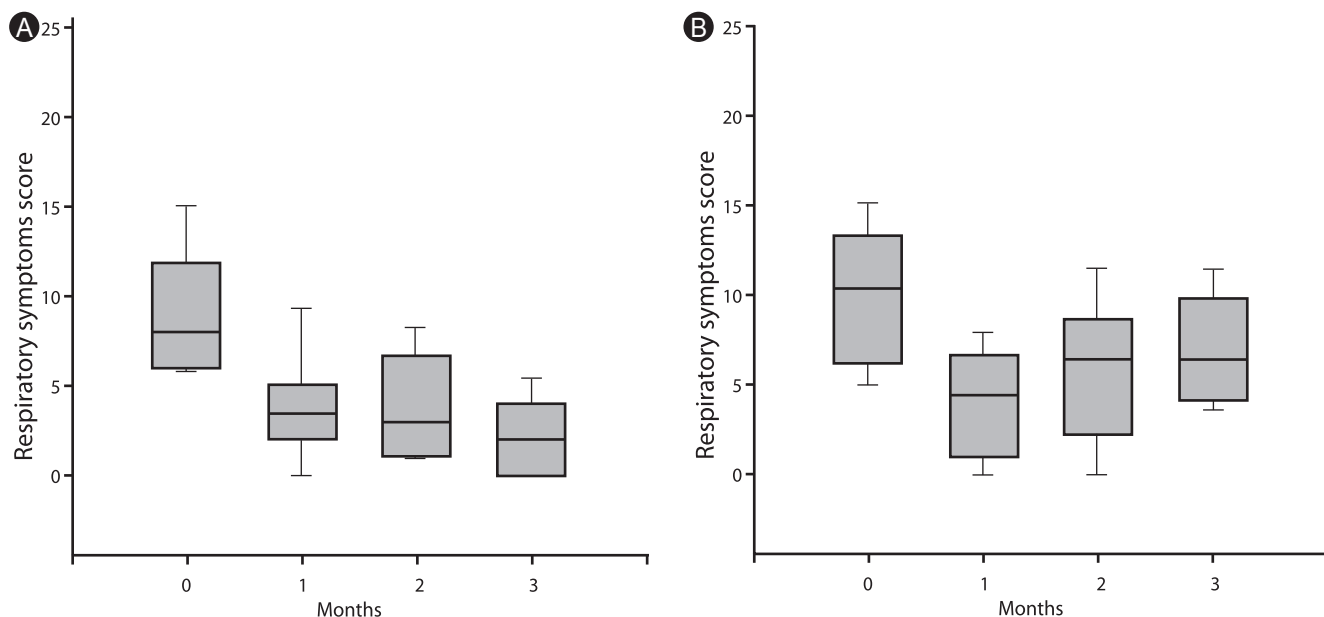
The median values of respiratory symptom scores at 0, 1, 2 and 3 months were 8 points (range, 5–23 points), 3.5 points (range, 0–12 points), 3 points (range, 0–11 points) and 2 points (range, 0–10 points) in the infants who discontinued bottle feeding, respectively. The corresponding values were 10.5 points (range, 3–16 points), 4.5 points (range, 0–8 points), 6.5 points (range, 0–13 points) and 6.5 points (range, 3–13 points) in the infants whose bottle feeding was maintained, respectively.

We compared the scores of respiratory symptoms at 0, 1, 2 and

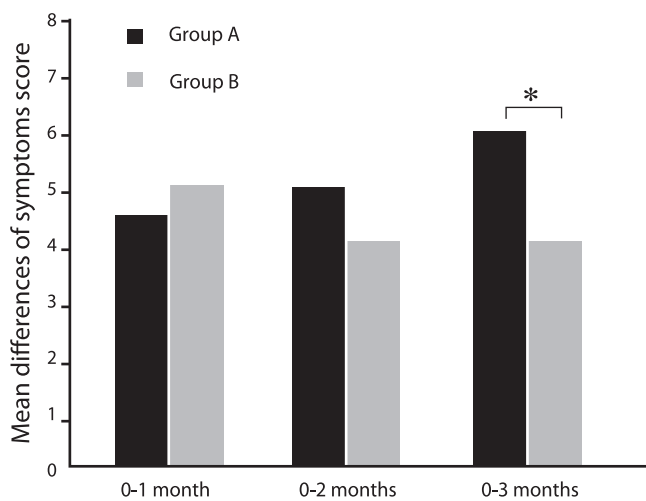
**Table 2.** The clinical characteristics of patients in this study

	Group A* (mean $\pm$ SD)	Group B† (mean $\pm$ SD)	<i>p</i> value
Gestational age (weeks)	38.5 $\pm$ 1.2	39.0 $\pm$ 1.7	0.43
Birth weight (g)	3,210 $\pm$ 590	3,105 $\pm$ 750	0.88
Mean age (months)	15.5 $\pm$ 8.1	16.0 $\pm$ 7.3	0.73
Weight (kg)	10.4 $\pm$ 4.1	11.0 $\pm$ 3.9	0.34
Height (cm)	77.8 $\pm$ 8.2	76.3 $\pm$ 7.5	0.22
Sleep time at night (h)	8.8 $\pm$ 2.1	9.1 $\pm$ 4.3	0.15
Maternal age (years)	29.2 $\pm$ 3.3	30.4 $\pm$ 4.6	0.32
Sibling, n	0.8 $\pm$ 0.6	1.0 $\pm$ 0.2	0.22
Maternal education (%)			0.87
College	22 (78.5)	12 (75.0)	
High school	5 (17.9)	3 (18.7)	
Less than high school	1 (3.6)	1 (6.3)	

\*Group A: patients where bedtime bottle feeding was discontinued. †Group B: patients where bedtime bottle feeding was maintained.



**Fig. 1.** Box plots are shown to compare the respiratory scores of the two groups (patients who had bedtime bottle feeding discontinued (A) and patients who had bedtime bottle feeding maintained (B)). Horizontal lines indicate medians. Boxes represent the 25th and 75th percentiles. Bars represent the 10th and 90th percentiles.  $p < 0.05$ .



**Fig. 2.** Comparisons of the mean difference of the total scores between groups. Scores 0 to 3 months of group A versus group B is shown. Group A: patients whose bedtime bottle feeding was discontinued; Group B: patients whose bedtime bottle feeding was maintained. \* $p < 0.05$

3 months between the 2 groups. Respiratory symptoms were significantly decreased in the infants whose bottle feeding was discontinued as compared to infants whose bottle feeding was maintained ( $p = 0.0003$ ) (Fig. 1). The differences in the mean scores of respiratory symptoms between 0 and 3 months were

significant ( $p = 0.009$ ) in infants whose bedtime bottle feeding was discontinued, but not in infants whose bedtime bottle feeding was maintained (Fig. 2).

## DISCUSSION

According to the American Academy of Pediatrics, when infants fell asleep with a feeling of fullness, the infants can sleep for approximately 9–10 h without waking-up at 6 months of age [12, 13]. It is therefore recommended to stop bedtime feeding at 6 months of age and to undergo complete weaning by 15 to 18 months of age. Inappropriately continued bottle feeding can affect the sleep cycle, cause the formation of dental caries due to increased oral flora, affect oro-facial development and affect respiratory diseases such as otitis media and wheezing [14-17].

The findings of this study imply that persistent bedtime bottle feeding has a detrimental effect on chronic respiratory symptoms in infants, which is in agreement with a previous report by Celedón et al. [18] These investigators showed that the incidence of asthma and wheezing within 5 years after birth were 1.5 times higher in infants who were given bedtime bottle feeding as compared to infants who were not. The mechanism was explained that tracheal irritation from micro-aspiration and/or

GER in the lying position might increase the incidence of asthma and wheezing in infants who continued to receive bedtime bottle feeding.

There are several possible explanations for the detrimental effects of bedtime bottle feeding on respiratory symptoms. The first explanation is due to immaturity in the coordination of sucking, swallowing and breathing in a supine position. Safe and successful oral feeding depends upon the proper development of sucking, swallowing, and breathing, and their coordination in order to minimize aspiration and enhance feeding efficiency. During sucking and swallowing in the supine position, GER and micro-aspiration are increased in infants who have an immature degree of respiratory control [5, 6]. Another explanation is related to the autonomic nervous system. The control of the autonomic nervous system is decreased during sleep. While sleeping, even normal healthy adults are observed to microaspirate a small amount of oropharyngeal secretion [19]. In infants, the rate of pharyngeal contraction is decreased during sleep, resulting in a decrease of swallowing of the oropharyngeal secretion and increased GER and microaspiration [9, 10].

In infants, GER and microaspiration produce not only gastrointestinal symptoms such as regurgitation and vomiting, but also respiratory symptoms including nocturnal cough, otitis media, sinusitis, chronic cough, recurrent bronchiolitis and pneumonia [20, 21]. Microaspiration repeatedly irritates the airways resulting in inflammation that causes bronchospasm and airway remodeling. Irritation of the vagus nerve due to GER increases the incidence of bronchospasm and hyper-responsiveness [20, 22]. An animal study has also demonstrated that GER and microaspiration are major risk factors in developing respiratory symptoms [23]. If the patients had been tested with the use of 24-h pH monitoring or gastric scintigraphy, our present study would have provided the mechanisms for the detrimental effects of bedtime bottle feeding on respiratory symptoms. We did not perform the invasive procedures, as parents of young children refused. Nevertheless, this prospective study is significant as it showed that the discontinuation of bedtime bottle feeding can improve chronic respiratory symptoms in infants aged 6 months and older.

In the current study, the respiratory symptoms were alleviated for both infants that discontinued bedtime bottle feeding and for infants where bedtime bottle feeding was maintained after one month. It is highly probable that even though we tried to exclude infants with acute respiratory infections from the current analysis, infants with subclinical infections might have been included.

Infants whose bottle feeding was maintained had risk factors for relapse of respiratory diseases, such as GER or microaspiration, which could aggravate the respiratory symptoms from a long-term aspect, despite the presence of temporary alleviation.

In conclusion, the discontinuation of bedtime bottle feeding may alleviate respiratory symptoms in infants with chronic respiratory symptoms. For infant patients with chronic respiratory symptoms, it is recommended to conduct a meticulous history and to provide parents with relevant education about the correct methods of feeding, including the discontinuation of bedtime bottle feeding in infants who are aged 6 months or older.

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