Key concept : Prematurity, Endotracheal suctioning, Chest vibration, Oxygenation

The Effects of Chest Vibration Prior to Endotracheal Suctioning on Oxygenation and the Amount of Lung Secretions in Premature Infants with Respiratory Distress Syndrome*

Ahn, Young Mee**

I. BACKGROUND OF STUDY

Since the ventilator was introduced in the 1960s, the outcome of premature infants with respiratory distress syndrome(RDS) was considerably improved(Carlo & Martin, 1986). The basic principle of the treatment in RDS, a major cause for mortality in premature infants, is to support ventilation and maintain adequate oxygenation, frequently through endotracheal intubation and mechanical ventilation. While on mechanical ventilation, the infants require endotracheal suctioning(ETS) to remove lung secretions, which facilitates the maintenance of an optimal level of ventilation.

However, the known negative effects of ETS in neonates include hypoxia, bradycardia, mucosal damage, and increased intracranial pressure(Bailey, Kattwinkel & Teja, 1988 ; Barnes, Assonye & Vidyasagar, 1981 ; Durand, Sangha, Cabal, Hoppenbrouwers & Hodgman, 1989 ; Fanconi & Duc, 1987). In order to maximize the beneficial effects of ETS, chest vibration(CV) has been advocated in infants with mechanical ventilation(Curran & Kachoyeanos, 1979 ; Tudehope & Bailey, 1980).

Theoretically, the purpose of CV is to thin lung secretions and to propel secretions from the smaller to the larger airways(Dulock, 1991). The physical force generated by CV may help to loosen and move lung secretions from smaller to larger airways, thereby making secretions more accessible for removal by ETS. As a result, there is a subsequent reduction in airway obstruction. This leads to a decrease in the resistance to the flow of inspired oxygen along with a greater exposure of the alveolar surface area, which enhances gas mixing inside the airways, reducing the work of breathing and improving oxygenation. Two physiologic parameters, oxygen saturation and heart rate(HR), are widely accepted clinically for evaluation of an infants oxygenation level(Kelly, Palisano & Wolfson, 1989).

In the clinical setting, CV prior to ETS in premature infants either has been used(Finer, Moriatey, Boyd, Phillips, Stewart, and Ulan, 1979 ; Tudehope & Bailey, 1980) or has questioned about the routine use(Fox, Schwartz & Shaffer, 1978 ; Raval, Yeh, Mora, Cuevas, Pyati & Pildes, 1987). The safety and efficacy of CV has been investigated in pediatric subjects with cystic fibrosis(Connors,

* This research was in partial fulfillment of the PhD in nursing at University of Pittsburgh, PA. USA.

** Inha University, Department of Nursing. (email)aym@inha.ac.kr

Hammon, Martin & Rogers, 1980 ; Rivington-Law, Epstein, Thompson & Corey, 1984), as well as, in adult subjects with chronic obstructive pulmonary disease(Mohsenifar, Rosenberg, Goldberg & Koerner, 1985) and other conditions in which subjects have copious amounts of lung secretions (Holody & Goldberg, 1981).

However, the safety and efficacy of CV has not been investigated in the neonatal population. Currently, the clinical application of CV in neonates appears to be based on adult care practices, rather than scientific validation. To date, there have been no methodologically sound studies on the effects of CV prior to ETS exclusively with detailed procedures and methodologies in neonates. The purpose of this study was to investigate the effects of CV prior to ETS on oxygenation(i. e., oxygen saturation and HR), along with the amount of lung secretions in premature infants with RDS.

Ⅱ. STATEMENT OF PROBLEMS

The specific aims of this study were : 1) to investigate the effects of CV prior to ETS on oxygen saturation(SpO_2) and HR, and 2) to evaluate the effects of CV prior to ETS on the amount of lung secretions retrieved during ETS, in premature infants with RDS. In a crossover design, ETS only, without CV(ETSO) served as the control conditions, and ETS with CV(ETSCV) served as the intervention conditions, per each subject. Three null hypotheses were developed as follows :

H1 : There is no difference in the changes of SpO_2 before, during, and after ETS, between ETSO and ETSCV in premature infants with RDS.

H2 : There is no difference in the changes of HR before, during, and after ETS, between ETSO and ETSCV in premature infants with RDS.

H3 : There is no difference in the amount of lung secretions retrieved at the end of ETS, between ETSO and ETSCV in premature infants with RDS.

Ⅲ. LITERATURE REVIEW

1. Prematurity and RDS

Respiratory distress syndrome referred to as hyaline membrane disease, usually affects premature infants with inadequate lung development. It is associated with 30% of normal neonatal death and with 50% to 70% of the death in premature infants (Avery & First, 1994). It occurs in greater than 60% of infants with less than 30 weeks gestational age(GA) and in about .05% with full term infants (Thibeault & Gregory, 1986). The more premature the infant the greater the likelihood of developing RDS.

The employment of mechanical ventilation along with surfactant replacement therapy has improved the survival of premature infants with RDS. Intubated infants have difficulty in clearing lung secretions with the suppression of the cough reflex and impairment of ciliary activity(Sackner, Landa, Greeneltch & Robinson, 1973). Thus, ETS may be an essential intervention to clear secretions from lung. However, immature ciliary function and abnormal respiratory movement in small and narrow airways of premature infants may contribute to difficulties in dislodging and movement of secretions into larger airways for the removal by ETS. Thus, CV may serve as a mechanism to facilitate the loosening and mobilizing of lung secretions prior to ETS in the neonatal population.

2. Chest vibration

Chest vibration, a type of CPT, has been employed by applying mechanical or manual fine, shaking movements to the chest of the premature infants. Vibration activity should progress from peripheral lung segments toward the trachea(Parker, 1993). Curran and Kachoyeanos(1979) investigated the effects of two different methods of CV against a control procedure, on oxygenation and respiratory function in twelve neonates. Chest vibration was administered with either an electrical toothbrush or a padded nipple for 1 minute. While no description of the method of grouping was cited, the group of neonates($\underline{n}$=6) who received CV using a toothbrush, showed significantly higher level of PaO_2 ($\underline{m}$=82.1 mmHg), clearer breath sound, and better skin color than the group($\underline{n}$=6) receiving using a padded nipple($\underline{m}$=41.1 mmHg) or than the control group without any CV($\underline{m}$=67.4 mmHg). These results supported the benefit of consistently controlled oscillation form mechanical vibration on oxygenation in neonates. However, the findings warrant further investigation because of the small sample size.

Holody and Goldberg(1981) studied the effects of CV alone without other types of CPT, on oxygenation in acutely ill adults with atelectasis or pneumonia. Mechanical vibration was applied for 30 minutes using a vibrator to the anatomical area of acute lung diseases, as determined by chest X-ray. The patient was suctioned once immediately following CV. There was an average improvement of 10 mmHg in PaO_2 at 30 minutes after CV and suctoining, and further improvement to an average increase of 15 mmHg in PaO_2 at 1 hours after CV and suctioning($\underline{p}<.001$). The CV appeared to improve ventilation/perfusion match within alveolar unit. The researchers concluded the external oscillation from CV improved gas mixing, liquidified lung secretions, and relaxed chest muscle in adults with pulmonary problems.

Wood(1987) reported on three cases of diffuse new periosteal bone formation in relation to CV, involving the ribs in infants who were hospitalized 4 months and 6 months with meconium aspiration. During hospitalization, these infants underwent routine CV with a padded toothbrush for 5 minutes six times daily over the entire chest. The rationale for such a vigorous protocol of CV was not described.

As the body of literature related to CV in the form of CPT lack both in the number of studies and in scientific rigor, the implications of CV remain inconclusively. Therefore, a empirical research is warranted.

Ⅳ. METHOD

A repeated measures within-subjects experimental design(crossover design) was used to investigate the effects of CV prior to ETS on SpO_2 and HR in 20 premature infants with RDS. The amounts of lung secretions retrieved during the ETS condition were also evaluated. The independent variable was the presence or the absence of CV prior to ETS(ETSCV versus ETSO) with random assignment, served by subject's own control. The dependent variables were : 1) SpO_2, and HR, which were measured with a pulse oximeter, and 2) the amount of lung secretions, measured by weight in grams(g) using a balance scale. The ETSO and ETSCV were initiated in accordance with the nursing assessment of the need for ETS and standard nursing practice at the data collection sites.

Subjects Recruitment : The study condition was approved from the biomedical institutional review board of the University of Pittsburgh and data collection hospitals. Twenty premature infants were recruited using the criteria for inclusion, regardless of race or gender for 6 months. Once a potential subject was identified through daily rounds at neonatal intensive care unit(NICU), the parent of the infant was approached to obtain an informed consent

1. Subjects (Table 1 & 2)

A nonprobablistic convenience sample of 20 premature infants with RDS was recruited from Level III NICU of university affiliated hospital located in southwestern Pennsylvania, USA. The sample size was determnined mainly with power analysis. The inclusion criteria of the participants were as followed : 1) born before 37 weeks of GA with birth weight(BW) of 700-2,500g, 2) postnatal age at the study day>3 days, 3) no current steroid, surfactant, or bronchodilator at the study day, and 4) no congenital anomalies or severe neurologic disorders.

The subjects were comprised of 8(40%) females and 12(60%) males. The mean BW was 1,195.90 g (SD=422.05, range 700 to 2,244 g) with the mean GA of 28.3 weeks(SD=2.62, range 25 to 33 weeks). Most of the subjects were studied at the third days of life. Nineteen infants(95%) were treated with surfactant(Survanta) and an antibiotic(Gentamicin). Ten infants(50%) received the bronchodilator and nine infants(45%) were administered the steroid before the study. Therefore, none received steroid, bronchodilator, nor surfactant at the study day.

In table 2 for the ventilatory and medical considerations of the subjects, the mean ET size was 2.75 mm(SD=0.30). A 6.5 Fr. suction catheter was used in nineteen subjects, while a 5.0 Fr. catheter was used in one subjects due to a different type of ET adaptor. The ratio of the internal diameter of the ET to the external diameter of the suction catheter (ID/OD) ranged from 0.38 to 0.46 with the mean of 0.43(SD=0.05). The mean oxygen flow rate was 8.8 l/minute(SD=1.36) with the mean PEEP of 4.3 cmH_2O(SD=0.47) and a mean FiO_2 on the ventilator of 30.9%(SD=11.01). The mean RR and the mean systemic arterial pressure(SAP) was 53.15(SD=11.3) and 44.05 mmHg(SD=7.37), respectively. No infants were febrile on the study day.

Table 1. Descriptive Information of Subjects (N=20)

description	frequency (%)	M(SD)
Birth weight		1,195.90 g (422.05)
Gestational age		28.3 weeks(2.62)
Postnatal weight		1,189 g (446.48)
Postnatal days		3.10 days (0.91)
Sex female	8 (40)	
male	12 (60)	
Antibiotics no	1 (5)	
previously	4 (20)	
currently	15 (75)	
Surfactant no	1 (5)	
previously	19 (95)	
Steroid no	11 (55)	
previously	9 (45)	
Bronchodilator no	10 (50)	
previously	10 (50)	

2. the ETS conditions : ETSO(the control) and ETSCV (the experiment)

The procedure for ETS was based on and initiated in accordance with the standard suctioning procedures by staff nurse after an in-service education program with a structured guideline in the proposed NICUs. The order of either the control condition(ETSO), or the experimental condition (ETSCV) per each subject was determined by randomization. The duration for each condition was approximately 15 minutes. The conditions were performed at least 4 hours apart form each other.

There were six phases(P1 to P6) of data collection for SpO_2 and HR in both conditions(ETSO versus ETSCV, see table 3) ; P1-the phase of the last 1 minute from the entire 5 minutes baseline, P2-the phase of 1st hyperoxygenation(HO) using manual baggings, P3-the phase of 2nd HO after 0.5 cc normal saline instillation, P4-the phase of the ETS condition, which is divided into two subphases of P4a(the phase of CV) and P4b(the phase of

Table 2. Ventilatory and Medical Condition of the Subjects (N=20)

	ET size	ID/OD ratio	O_2 flow	PEEP	FiO_2	RR	SAP	temperature
M	2.75	0.43	8.80	4.30	30.90	53.15	44.05	36.85
SD	0.30	0.05	1.36	0.47	11.01	11.3	7.37	0.75
min.	2.5	0.38	8.0	4	21	35	33	35.2
max.	3.5	0.54	12.0	5	70	78	61	37.2

ETS), P5－the phase of 3rd HO after ETS, and P6－the phase of 1 minute post－condition.

CV : The CV involves the application of a mini－vibrator, NC70209, to the one low costal margin at one midaxillary line to the mid－sternum and from the low costal margin at the other midaxillary line to the mid－sternum during 30 seconds.

ETS : ETS involves the removal of secretions and debris from ET reached to the premeasured length using a suctioning catheter. At this point, 80 mmHg negative pressure was applied while the suctioning catheter was rotated and withdrawn from the ET over a 5 second period of time.

3. Data Collection

During each phase(P1 to P6), data on SpO_2 and HR were collected from the pulse oximeter, Nellcor N－200, placed on the heel of the infants foot. As a result of the ETS condition, two lung secretions were collected into the catheter with mucus trap. Each of them was measured before and after the conditions using a balance scale. By subtracting the weight of excretions previously measured before the condition from those after the condition, the amount of lung secretions was obtained.

4. Data Analysis

All data were analyzed using SPSS 7.5 for Windows. To test the null hypotheses on the effects of CV prior to ETS on SpO_2 and HR(H1 to H2), multivariate analysis of variance for repeated measures(RM－MANOVA) was performed after the testing of assumptions of sphericity and homogeneity of variance. A paired t－test was employed to test the effects of CV on the amount of lung secretions(H3). No order effect was found between the two conditions in this crossover study.

V. RESULT

1. Hypothesis Testing on Oxygen Saturation and Heart Rate (H1 and H2)

A. SpO_2 and HR Response to the ETS condition

As presented in table 4, the mean baseline SpO_2 was 94.9%($\underline{SD}$=3.26) in ETSCV and 94.5%($\underline{SD}$=2.96) in ETSO. Compared to the baseline SpO_2, there was a 4.6% of decrease in SpO_2 during ETS at ETSCV, as compared to a 2.5% of decrease in SpO_2 at ETSO. During the intervention of CV, SpO_2 decreased from 94.9% to 92.4%. The decreases in SpO_2 with CV and/or ETS returned to the baseline within 1 minute after the condition by showing no difference in SpO_2 between baseline and 1 minute post condition in both ETSCV($\underline{t}$=1.63, $\underline{p}$=.120) and ETSO($\underline{t}$=.54, $\underline{p}$=.593).

Also, the mean baseline HR was 147.7 bpm($\underline{SD}$=13.15) in ETSCV and 147.2 bpm($\underline{SD}$=10.97) in ETSO. Compared to the baseline, there was a 7.7 bpm decrease in HR during ETS at ETSO, as compared to a 4.7 bpm of decrease at ETSCV. When CV was applied, HR increased from 147.70 to 149.9 bpm. The changes in HR with CV and/or ETS returned to the baseline within 1 minute post condition. There was no difference in the mean value of HR between baseline and 1 minute post－condition in both ETSO($\underline{t}$=.52, $\underline{p}$=.607) and ETSCV($\underline{t}$=.44, $\underline{p}$=.662). Considering the normal range of HR is 120 to 160 bpm in neonatal population, any changes in HR that remain within this range lack

Table 3. Design of the Study and Data Collection Phases (N=20)

phase condition	P1 baseline	P2 1st HO	P3 2nd HO	P4a CV	P4b ETS	P5 3rd HO	P6 post－condition
ETSO ($\underline{n}$=20)	x	x	x		x	x	x
ETSCV($\underline{n}$=20)	x	x	x	x	x	x	x

Note : x=data collection point

Table 4. SpO_2 and HR Responses between ETSO and ETSCV (N=20)

		baseline	1st HO	2nd HO	CV	ETS	3rd HO	post-condition
SpO_2								
ETSCV	M	94.9	94.0	95.1	92.4	90.3	90.4	93.1
	SD	3.26	3.88	3.56	5.26	5.75	6.92	5.15
ETSO	M	94.5	94.4	95.6	N/A	92.0	91.3	94.0
	SD	2.96	3.41	3.00		5.26	5.86	4.29
HR								
ETSCV	M	147.7	145.8	146.5	149.9	142.3	143.5	146.8
	SD	13.15	13.37	16.77	14.35	20.48	18.27	13.00
ETSO	M	147.2	145.2	145.4	N/A	139.6	144.4	146.4
	SD	10.97	9.19	11.48		12.54	13.43	9.27

Note) N/A=not applicable.

clinical significance. Figure 1 illustrated the SpO_2 responses and figure 2 compares the HR responses between ETSO and ETSCV throughout the ETS procedure.

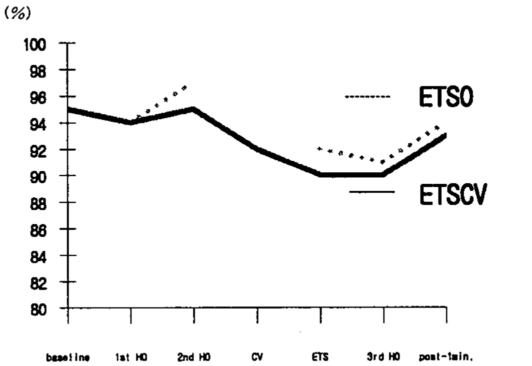

Fig. 1. Oxygen saturation response to the ETS condition

There was no significant difference in SpO_2 responses across the phases by the two conditions (ETSO and ETSCV) (F=.62, p=.682). Thus, H1 was not rejected.

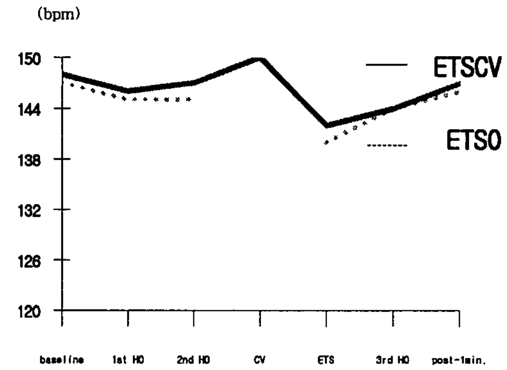

Fig. 2. HR response to the ETS condition

B. Hypothesis Testing on SpO_2(H1)and HR(H2) (See table 5 & 6)

H1 : There is no difference in the changes of SpO_2 before, during, and after ETS between ETSO and ETSCV in premature infants with RDS.

H2 : There is no difference in the changes of HR before, during, and after suctioning between ETSO and ETSCV in premature infants with RDS.

There were no significant differences in the HR responses across the phases by the type of the ETS

Table 5. MANOVA Table for SpO_2 (%) Responses by the ETS condition (N=20)

Source	SS	df	MS	F	p	Effect size	Power
Within subjects							
(P)hase of condition	704	14.5	140.89	11.59	.000*	.379	1.000
(T)ype of condition	24.70	18.1	24.70	.70	.414	.035	.152
Interaction(PxT)	25.17	14.5	5.03	.62	.682	.032	.219

Note : significance at p<.01

conditions($\underline{F}$=.42, $\underline{p}$=.833). Thus, H2 was not rejected.

C. Hypothesis Testing on the Amount of Lung Secretions (H3) (see Table 7)

H3 : There is no difference in the amount of lung secretions retrieved during suctioning between ETSO and ETSCV in premature infants with RDS.

The amount of lung secretions retrieved during suctioning ranged from 0.03 to 1.35 g with a mean of 0.49 g in ETSO and ranged from 0.25 to 1.39 g with a mean of 0.68 g in ETSCV. Differences in the amount of lung secretions between ETSO and ETSCV were compared using a paired t-test. There was a significant difference in the amount of lung secretions retrieved during suctioning between the two conditions($\underline{t}$= −3.5, $\underline{p}$=.003).

Ⅵ. DISCUSSION

1. The Effects of the ETS condition on Oxygen Saturation and HR

The CV has been used in combination with ETS in the neonatal population. In this crossover design with 20 premature infants with RDS, CV was employed prior to ETS in the experimental condition(ETSCV), while the control condition(ETSO) did not include CV, per each infant. Significant changes(i. e., general decreases) in SpO_2 and HR were observed across the phases of the conditions regardless the type of the ETS condition. However, as H1 and H2 were not rejected, overall, there were no significant differences in the changes of SpO_2 and HR responses between ETSO and ETSCV. Changes in SpO_2 and HR in this study remained within a normal range(i. e. SpO_2 between 90 to 100%, and HR between 120 to 160 bpm). Any changes in SpO_2 and HR returned to the baseline within 1 minute post condition.

These findings relating to primarily decreases in SpO_2 and HR(*although not considerable*) were consistent with those of Gunderson, Stone & Hamlin (1991) which reported that ETS resulted in decreases in PaO_2 and HR. They concluded that the decreases in HR were due to mechanical and vagal stimulation rather than hypoxia. However, in this study, the direct stimulation of the carina was avoided by regulation of the catheter length as per the ETS condition. Therefore, decreases in SpO_2 and HR during ETS in this study may not have been caused by vagal stimulation, but rather from any possible secondary effects of suctioning on cardiopulmonary system, including hypoxia. Kerem, Yatsiv & Goitein(1988) reported that hypoxia was the most frequent adverse effect of suctioning.

Table 6. MANOVA Table for HR Responses by the ETS condition (N=20)

Source	SS	df	MS	$\underline{F}$	$\underline{p}$	Effect size	Power
Within subjects							
(P)hase of condition	1096.42	14.5	219.28	2.3	.050*	.108	.720
(T)ype of condition	33.0	18.1	33.0	.08	.782	.004	.052
Interaction(PxT)	68.92	14.5	13.78	.42	.833	.022	.157

Note : significance at p<.05

Table 7. Amount of lung secretions between ETSCV and ETSO (N=19)

condition	Amount of Lung Secretions (g)				$\underline{t}$	$\underline{p}$
	M	SD	min.	max.		
ETSCV(experiment)	.68	.32	.25	1.39	−3.5	.003*
ETSO(control)	.49	.37	.03	1.35		

Note : significance at p<.01

However, the degrees of decrease in SpO_2 and HR were not considered to be clinically significant in this study.

In the current study, SpO_2 slightly decreased from baseline to CV in both conditions. It is a consistent result of Holloway et al. (1969), who reported the small drop of PaO_2 (no number reported) immediately after a combined form CPT including CV in neonates. However, this is the contrast finding of Holody and Goldberg(1981), who reported increases in PaO_2 as a result of CV for 30 minutes in adult patients with atelectasis or pneumonia. However, the differences in age and diagnostic conditions of the subjects, the duration of CV, and the data point disallow the concordant conclusion of CV on oxygen level between their studies and this study.

Raval et al. (1987) reported that a combined form of CPT, consisting postural drainage, percussion, and vibration had no effects on PaO_2 and PaO_2/FiO_2 ratio in neonates. However, the combined use of the multiple CPT techniques made it impossible to compare the independent effects of CV on oxygenation between their study and this study. Fox, Schwartz & Shaffer(1978) reported a decrease in PaO_2 with CV and ETS in neonates. However, those decreases in PaO_2 did not reflect the independent effect of CV separately from suctioning. Without a control group with suctioning only, it is not possible to make valid comparison of the specific effects of CV on oxygen level in current study with their findings.

With respect to HR, there was a slight increase in HR during CV within normal range. Even though the degree of increase has neither statistical nor clinical meaning, it may be a response to the physiologic stimulation of the CV procedure. This is similar to the study finding by Kelly et al. (1989), who reported the slight increase in HR without changes in SpO_2 with developmental physical therapy in premature infants. This may indicate that premature infants tolerated CV without compromising their oxygenation level.

2. The Effects of the ETS Condition on the Amount of Lung Secretions

During 48 hours of postnatal age, there are minimal lung secretions in normal conditions. No previous study reported the amount of secretions retrieved during suctioning in premature infants. In this study, the mean amount of lung secretions retrieved during one time ETS were .49 g without CV and .68 g with CV. None had any secondary pulmonary conditions which might influence the amount of secretions.

Bateman, Newman and Daunt(1979), in a study of adult subjects reported that CPT enhanced mucociliary action to remove secretions from lower to larger airways, and increased the amount of secretions retrieval in a crossover design. However, their CPT protocol included various types of CPT, such as postural drainage, CV, percussion, and shaking. Thus, due to both a difference in subject population and method of CPT employed in the Bateman's study and the current study, appropriate comparisons of the findings are limited. At best, it can be suggested that CV may be a contributor to the amount of lung secretions retrieval.

Gallon's study(1991) on the effect of the speed of percussion on lung secretions production with adult subjects found the evidence of a significantly greater amount of lung secretions retrieved during ETS with fast percussion than slow percussion. In fact, the use of percussion was considered to be inappropriate for the patients who had minimal lung secretions production(Connors et al., 1980). Since normal premature infants generally have small amounts of lung secretions production, percussion may by also be suggested to perhaps be inappropriate with this population. Therefore, CV, which generates an even faster speed of vibration than percussion, may have been, in part, responsible for the greater removal of the relatively small amounts of lung secretions during ETSCV than during ETSO in this study.

Premature infants have narrow airways and tend to develop atelectasis due to less developed pulmonary structures and a deficiency of surfactant. All efforts should be implemented to prevent the obstruction of pulmonary airways in the management of RDS. The findings of this study supported that the administration of CV may serve as a therapeutic maneuver for lung secretion removal by ETS, thus preventing the potential risk for atelectasis in premature infants with RDS.

Ⅶ. CONCLUSIONS AND SUGGESTIONS

The crossover design was conducted to investigate the effects of CV prior to ETS on oxygenation (i. e., SpO_2, and HR) along with the amount of lung secretions in order to evaluate its safety and efficacy in 20 premature infants. The results showed that CV prior to ETS had no significant adverse effect on oxygenation, as compared with ETS without CV. However, there was a significantly greater amount of lung secretions at ETS with CV, as compared to ETS without CV. This concluded that CV may facilitate to loosen lung secretions and to move them from the smaller to larger airways for the removal by ETS in premature infants with RDS.

The findings related to oxygenation and lung secretions in this study suggest that an appropriately developed clinical protocol of CV with ETS minimizes the possible detrimental effects, rather than maximizes the beneficial effects of ETS in this population. This statement is made with the additional caution that a protocol to produce the desired effect without excessive stimulation must be followed.

With these conclusions, the followings were suggested for further study.

1. The study is needed to replicate for the reliability and validity check of SpO_2 data using comparisons of blood gas analysis with SpO_2.
2. Further study is needed to investigate the long term effects of routine CV in ventilated premature infants.
3. The study should be replicated in ventilated neonates with various pathophysiological conditions.

References

Avery, M. E. & First, L. R. (1994). Pediatric medicine (2^{nd} Ed.). Williams & Willkins.

Bailey, C., Kattwinkel, J. & Teja, K. (1988). Shallow versus deep ETS in young rabbit : Effects on the tracheobronchial wall. Pediatrics, 82(5), 746-751.

Barnes, C. A., Asonye, U. O. & Vidyasagar, D. (1981). The effects of bronchopulmonary hygiene on $PtcO_2$ values in neonates. Critical Care Medicine, 12(9), 819-822.

Bateman, J. R., Newman, S. P. & Daunt, K. M. (1979). Regional lung clearance of excessive bronchial secretions during physical therapy. Lancet, 10, 294-297.

Carlo, W. A. & Martin, R. J. (1986). Principle of neonatal assisted ventilation. Pediatric Clinics of North America, 33(1), 221-231.

Connors, A. F., Hammon, W. E., Martin, R. J. & Rogers, R. M. (1980). Chest physiotherapy. Chest, 78(4), 559-564.

Curran, C. L. & Kachoyeanos, M. K. (1979). The effects on neonates of two methods of chest physical therapy. Maternal Child Nursing, 4, 309-313.

Dulock, H. L. (1991). Chest physiotherapy in neonates : A review. American Association of Critical Nursing, 2(3), 446-450.

Durand, M., Sangha, B., Cabal, L. A., Hoppenbrouwers, T & Hodgman, J. E. (1989). Cardiopulmonary and ICP changes related to ETS in preterm infants. Critical Care Medicine, 17(6), 506-510.

Fanconi, S. & Duc, G. (1987). Intratracheal suctioning in sick preterm infants : Prevention of intracranial pressure. Pediatrics, 79(4), 538-543.

Finer, N. N., Moriatey, R. R., Boyd, J., Phillips, H. J., Stewart, A. R. & Ulan, O. (1979). Postextubation atelectasis : A retrospective review and a prospective controlled study. Journal of Pediatrics, 94(1), 110−113.

Fox, W. W., Schwartz, J. C. & Shaffer, T. H. (1978). Pulmonary physiotherapy in neonates : Physiologic changes and respiratory managements. Journal of Pediatrics, 92(6), 977−981.

Gallon, A. (1991). Evaluation of chest percussion in the treatment of patients with copious lung secretions production. Respiratory Medicine, 85, 45−51.

Gunderson, L. P., Stone, K. S. & Hamlin, R, L. (1991). Endotracheal suctioning-Inducing heart rate alterations. Nursing Research, 40(3), 139−143.

Holloway, R., Adams, E. B., Desai, S. D. & Thambiran, A. K. (1969). Effects of chest physiotherapy on blood gases of neonates treated by intermittent positive pressure respiration. Thorax, 24(4), 421−426.

Holody, B & Goldberg, H. S. (1981). The benefit of mechanical vibration physiotherapy on arterial oxygenation in acutely ill patients with atelectasis or pneumonia. American Review of Respiratory Disease, 124, 372−375.

Jenson, A. O. Harbitz, O & Smidsrod, O. (1978). Viscometric and chemical characterization of sputum from patients with chronic obstructive lung disease. Scandinavian Journal of Respiratory Disease, 59, 141−153.

Kelly, M. K., Palisano, R. J. & Wolfson, M. R. (1989). Effects of a developmental physical therapy program on oxygen saturation and heart rate in premature infants. Physical Therapy, 69(6), 467−474.

Kerem, E. Yatsiv, I. & Goitein, K. J. (1990). Effect of ETS on arterial blood gases in children. Intensive Care Medicine, 16(2), 95−99.

Mohsenifar, Z., Rosenberg, N., Goldberg, H. S. & Koerner, S. K. (1985). Mechanical vibration and conventional chest physiotherapy in outpatients with stable chronic obstructive lung disease. Chest, 87(4), 483−485.

Parker, A. (1993). Neonatal problems and the neonatal unit, In P. M. Eckersley (ed), Elements of Pediatric Physiotherapy, 1024−1029.

Raval, D., Yeh, T. F., Mora, A., Cuevas, D., Pyati, S. & Pildes, R. S. (1987). Chest physiotherapy in preterm infants with RDS in the first 24 hours of life. Journal of Perinatology, 7(4), 301−304.

Rivington-Law, B. A., Epstein, S. W., Thompson, G. L. & Corey, P. N. (1984). Effects of chest wall vibration on pulmonary function in chronic bronchitis. Chest, 85(3), 378−381.

Sackner, M. A., Landa, J. F., Greeneltch, N & Robinson, M. J. (1973). Pathogenesis and prevention of tracheobronchial damage with suction procedures. Chest, 64(3), 284−290.

Thibeault, D. W. & Gregory, G. A. (1986). Neonatal pulmonary hygiene. Appleton-Century-Crofts.

Tudehope, D. I. & Bailey, C. (1980). Techniques of physiotherapy in intubated babies with the respiratory distress syndrome. Austrian Paediatric Journal, 16,226−228.

Wood, B. P. (1987). Infants ribs : Generalized periosteal reaction resulting from vibrator chest physiotherapy. Radiology, 162, 811−812.

-국문초록-

주요개념 : 미숙아, 기관지 흡인술, 흉곽진동, 산소화

호흡곤란증 미숙아에 있어 기관지 흡인술전의 흉곽진동법이 산소화와 기관지 분비물의 양에 미치는 영향

안 영 미*

미숙아에 있어 주로 표면활성제의 부족으로 인한 호흡곤란증은 미숙아 사망의 주원인이 된다. 호흡곤란증의 치료목적은 적절한 환기를 통해 체내 산소화를 유지시키는 것이다. 인공호흡기 치료를 받는 미숙아에게 필수적인 간호중재인 기관지 흡인술은 그 효과를 극대화하기 위해 흉곽진동법과 같이 사용될 수도 있다. 그러나 미숙아를 대상으로 하는 흉곽진동법은 그 중재의 안전성이나 효과에 대한 과학적 검증 없이 시행되고 있는 실정이다. 이에 본 연구는 호흡곤란증 미숙아에 있어 기관지 흡인술 이전에 행하여지는 흉곽진동법이 산소화와 기관지 분비물에 미치는 영향을 연구하기 위해 실시되었다.

이를 위해 20명의 호흡곤란증 미숙아를 대상으로 대상자내 반복실험연구가 설계되었다. 독립변수는 기관지흡인술이전에 흉곽진동이고 종속 변수는 산소 포화도, 심박동수, 그리고 기관지 분비물의 양이었다. 각 대상자는 무작위 순서에 따라 한번은 흉곽진동없이 흡인을, 나머지 한번은 흉곽진동과 흡인의 두 가지 형태의 흡인을 경험하였다.

연구 결과, 기관지 흡인술이전에 흉곽진동을 실시하든, 안하든 산소포화도와 심박동수의 변화양상에는 차이가 없었다. 그러나, 흉곽진동법을 실시한 경우가 실시안한 경우에 비해 더 많은 양의 기관지 분비물을 흡인하였다. 이는 기관지 흡인술 이전에 실시하는 흉곽진동법이 미숙아의 체내에 부가적 산소소모를 초래하지 않는 반면, 기도로부터 더 많은 분비물을 흡인하는데 효과적임을 시사한다.

* 인하대학교 의과대학 간호학과