

The Study on the Relationship Between the Duration of Chest Vibration prior to Endotracheal Suctioning and the Changes in Oxygen Saturation in Low – Birth – Weight Infants

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I. BACKGROUND OF PROBLEM

There has been a rapid increase in the population of surviving high risk infants including low-birth-weight (LBW) infants as a result of high technology and improvement of quality in care (Pinch & Spielman, 1989). The introduction of the ventilator from the 1960s substantially improved the outcome of LBW infants with respiratory distress syndrome (RDS) (Carlo & Martin, 1986 ; Hallman & Gluck, 1982).

High risk infants artificially ventilated due to a respiratory disorder require endotracheal suctioning (ETS), nasopharyngeal and/or oropharyngeal suctioning to remove secretions in order to maintain an optimal level of ventilation (Simbruner, Coradello, Fodor, Havelec, Lubec & Pollak, 1981). Mechanical ventilation as well as endotracheal intubation impairs an infant's natural ability to clear lung secretions because of an ineffective cough reflex resulting from an open glottis and a lack of normal mucociliary function in neonatal population (Thibeault & Gregory, 1986). In order to retrieve the maximum amount of secretions, chest vibration

(CV), type of the chest physiotherapy (CPT), has been advocated in infants with respiratory problems (Curran & Kachoyeanos, 1979 ; Tudehope & Bagley, 1980).

The benefits of CV include improvement of gas mixing by external oscillation, the liquidization of sputum by vibration, and the relaxation of chest muscle (Holody & Goldberg, 1981 ; Jensen, Harbitz & Smidsrod, 1978). The most frequent adverse effect of CV is hypoxemia (Holloway, Adams, Desai & Thambiran, 1969 ; Parker, 1993). The effects of CV have been investigated in patients who suffer from massive and thick lung secretions mostly from chronic obstructive pulmonary disease (COPD) or cystic fibrosis (Connors, Hammon, Martin & Rogers, 1980 ; Holody & Goldberg, 1981 ; Mohsenifar, Rosenberg, Goldberg & Koerner, 1985). CV may alter gas exchange inside airway and influence infants's oxygenation level (Curran & Kachoyeanos, 1979 ; Finer & Boyd, 1978). However, there is a profound lack of empirical studies on the clinical use of this technique in high risk infants, particularly LBW infants. Protocols of CV are inconsistent in both clinical settings and literature, clinical guideline on

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the application of CV needs to be developed through scientific research rather than blindly adapting adult care practices to the care of newborns.

PURPOSE OF STUDY

The purpose of this pilot study was : 1) to examine the effects of CV on oxygen saturation, 2) to investigate the relationship between the duration of CV and the changes in oxygen saturation immediately after CV when compared to baseline, and 3) to establish the optimal duration of CV related to the least decrease in oxygen saturation in LBW infants. In addition, data were collected on the nursing criteria used to initiate CV in LBW infants. The independent variable was the duration of CV performed before suctioning and the dependent variable was oxygen saturation monitored using a pulse oximeter.

Specific research questions related to the purpose of the study have been developed as follows :

- Q1: Are there significant differences in oxygen saturation after CV when compared to baseline in LBW infants?
- Q2: Is there a relationship between the duration of CV and the change in oxygen saturation in LBW infants?
- Q3: What is the optimal duration of CV prior to suctioning associated with the least decreases in oxygen saturation in LBW infants?

METHODS

SAMPLES

A non random sample of ten LBW infants has enrolled at level III neonatal intensive care unit (NICU) of Magee Womens Hospital(MWH). CV was performed before ETS or nasopharyngeal suctioning as a standard nursing procedure when appropriate. The staff nurse assessed a LBW infant's respiratory need for CV and initiated the procedure of CV. There was no additional intervention or direct contact to the infants for the study except routine nur-

sing procedure related to CV. Each infant at the NICU has his/her own pulse oximeter, Nellcor N-200, for the continuous monitoring of oxygen saturation and heart rate(HR).

Because this study observed routine nursing activity of CV with no additional intervention for the purpose of the study, and utilized already existing monitoring system, the study proposal was exempted by the internal review board(IRB) of the hospital. Therefore informed consent from parents or guidance was not obtained for the participation in the study.

The principal investigator(PI) made rounds or communicated daily with the charge or staff nurse of NICU to identify the existence of LBW infants who met the research criteria. If an infant was identified by selection criteria, routine schedules for CV and suctioning were identified from staff nurse and the chart. The staff nurse informed of the purpose of the study.

Inclusion criteria of infants were birth weight of 700 to 2,500 gram, the presence of mechanical ventilation and Nellcor N-200, and the need of CV prior to suctioning assessed by the staff nurse. Exclusion criteria were the presence of major congenital malformations, severe neurologic disorders, such as Grade>III periventricular /intraventricular hemorrhage(IVH), or seizure, the oscillatory ventilator, chronic pulmonary disease and/or bronchodilator therapy within the last 24 hours.

DATA COLLECTION

The staff nurse assessed respiratory need for CV and suction and performed them as a part of routine respiratory care in ventilated infants. PI observed nursing activity related to CV, and collected data on the changes in oxygen saturation and the duration of CV using the data collection sheet. CV was performed as applying a mini-vibrator(NC70209) to infant's chest. It included the optional use of one of four attachments, cap, ball, flat, and spot. Any use of these attachments was recorded on data collec-

tion sheet, as well as different application sites and the duration of CV.

Oxygen saturation was collected from a digital readout on the screen of the pulse oximeter (Nellcor N-200) during two phases. First phase was the five seconds for baseline oxygen saturation immediately before initiating the routine nursing practice of CV. Second phase was the five seconds immediately after CV and before suction. Any existing changes of oxygen saturation from the pulse oximeter monitor were recorded during these phases.

For the observation of the duration of CV, a calibrated stopwatch was used for PI to time the duration of CV when the staff nurse performed CV on the infants. When the staff nurse initiated CV to the infant, the researcher pressed the button on the stopwatch and the timing of CV was initiated. When the staff nurse stopped the administration of CV from the infant, the timing for the duration of CV was terminated by pressing the button on the stopwatch again. After the completion of the entire CV and suctioning procedure, the staff nurse was asked to describe the criteria for initiating CV prior to ETS.

In addition, demographic data including gestational age and weight at born, postnatal age and weight, and information on ventilator settings and medical history, were collected. Table 1 illustrated data collection plan.

Table 1

Data Collection Plan

Variables	Before CV (5 sec)	During CV	After CV (5 sec)
Oxygen Saturation	X		X
Duration of CV		X	

INSTRUMENTATION

CV was performed using a mini vibrator (NC70209) to infant's the chest. The mini - vibrator is 100g of weight and 4.2 cm x 3.3 cm x 13.5 cm in

size. Its power source is DC 1.5 V (1 x "C" cell) with approximately 5,500 cycle per minute and an amplitude of 0.06 mm.

Oxygen saturation is the percentage of total hemoglobin concentration that is in the form of oxyhemoglobin under any particular conditions (Schmidts & Thews, 1983). It was monitored using a pulse oximeter, Nellcor N-200. The Nellcor sensor was placed to one of the feet and detected every arterial pulse in infants. Oxygen saturation measured by this pulse oximeter has been reported with a strong correlation ($r = .98$) with arterial oxygen saturation in newborns (Anderson, 1987). The accuracy of Nellcor N-200 pulse oximeter is stated in the relationship to $\text{SaO}_2(\%) \pm 1$ standard deviation (SD) (Operator's Manual of Nellcor N-200 pulse oximeter, 1992, p. 49).

DATA ANALYSIS

Data management and analysis were the responsibility of the researcher in consultation with the research committee members. A coding book was developed and used to facilitate the data collection procedure and data entry (DE). A computer file matched with the sequence of the coding book was created into DE on SPSSPC. Data from the coding book including demographic information were double entered into this file. The primary variables of interest analyzed were the changes in oxygen saturation and the duration of CV.

Preliminary data analysis was done on SPSSPC to identify measures of central tendency and to visually screen all variables for initial familiarization with data set. The skewnesses of the variables of interest were examined to evaluate the central tendencies of the distribution of data. The skewness was -1.074 for oxygen saturation before CV, -1.485 after CV, and 0.804 for the duration of CV. Due to small sample size and no guarantee of the normal distribution of data set, nonparametric statistics was employed to answer research questions.

RESULTS

SUBJECTS

The study was performed in ten LBW infants with respiratory problems (table 2). All infants showed an appropriate intrauterine growth weight for gestational age, even though they were prematurely born. The mean body weight was 1305.0 g (SD=580.6) at birth and 1270.1 g (SD=518.1) at the study day. The mean of gestational age was 28.6 weeks (SD=3.1) with the postnatal age of 14.3 (SD=11.52) days of life. Every infant was diagnosed having respiratory problems, such as RDS (60%), atelectasis (30%), or pneumonia (10%). 60% of them had received surfactant therapy due to the prematurely developed lungs. They were mechanically ventilated with intermittent mechanical ventilation (IMV) or continuous positive airway pressure (CPAP) with the mean respiratory rate (RR) of 37.2 (SD=14.37). Mean FiO₂ was 42.3 (SD=21.2) when CV was performed.

in oxygen saturation was standardized to its baseline value (pre-value), i. e.,

$$\% \text{ change} = [(\text{post value} - \text{pre value}) / \text{pre value}] \times 100,$$

yielding percentage change values. Any changes in oxygen saturation during CV were also recorded. The number of the observation during CV among infants varied according to the duration of CV and the physiologic response to CV of infants. Table 3 illustrates the duration of CV and the mean values of oxygen saturation before, during and after CV.

In order to answer the first and second research questions related to the CV and the changes in oxygen saturation, null hypotheses were developed due to the lack and inconsistency of the empirical evidence to direct hypotheses within the literature for each of the variables of interest.

H1: There are no significant differences in oxygen saturations after CV when compared to baseline in LBW infants.

The median value of oxygen saturation was 94 before CV and 92.5 after CV. Matched Paired

Table 2

Demographic Information and Medical History (n = 10)

Ident	Wt at birth (g)	GA at birth (wk)	Wt at the study (g)	Postnatal age (day)	Surfactant history	Medical diagnosis	FiO ₂ at CV	Ventilation
1	1,967	32	1,960	6	Previously	Pneumonia	24	CPAP
2	840	28	881	7	currently	RDS	45	IMV
3	745	26	748	20	None	RDS	30	IMV
4	1,472	28	1,285	6	previously	RDS	38	CPAP
5	704	24	700	19	previously	RDS	35	IMV
6	1,087	28	1,094	11	none	RDS	42	CPAP
7	1,921	32	1,760	7	none	atelectasis	40	IMV
8	937	27	799	17	previously	RDS	30	IMV
9	1,048	27	1,375	43	previously	atelectasis	100	IMV
10	2,329	34	2,099	7	none	atelectasis	31	CPAP
<u>M</u>	1,305.0	28.6	1,270.1	14.3			42.3	
<u>SD</u>	580.63	3.10	518.14	11.52			21.2	

Oxygen Saturation and Chest Vibration

There were two phases of data collection in oxygen saturation immediately before and after CV lasting 5 seconds. Each mean of the changes observed

Wilcoxon test was employed to examine whether or not there is the difference in oxygen saturation before and after CV. The result showed a statistically significant difference of 3% decrease in oxygen saturation immediately after CV (p<.05), even

though 3% decrease in oxygen saturation within 5 seconds immediately after CV is not considered as a meaningful desaturation clinically.

H2: There is no relationship between the changes in oxygen saturation before and after CV and the duration of CV in LBW infants.

The changes in oxygen saturation and the duration of CV were listed in table 3. The median value duration of CV was 41 seconds. To examine the relationship between the changes in oxygen saturation before and after CV and the duration of CV, Spearman rho correlation coefficient of nonparametric statistics was used. The result showed there is no significant relationship between those two variables of interest ($p > .05$).

Table 3.

Oxygen Saturation and the Duration of CV ($n = 10$)

Ident	Oxygen Saturation			Duration of CV
	Before CV	After CV	Changes(%)	
1	96	94	-2	39
2	93	90	-3	37
3	98	92	-6	38
4	92	72	-22	41
5	93	93	0	100
6	97	94	-3	60
7	97	94	-3	60
8	95	96	1	41
9	91	86	-5	85
10	96	96	0	74
<u>Mdn</u>	94	82.5	-3%	41

For the third research question on the duration of CV, the optimal duration of CV was defined in the relationship with the least decrease in oxygen saturation. According to no relationship between the duration of CV and oxygen saturation, the optimal duration of CV could be arbitrarily selected among any period of CV shown in the study. The minimum duration of CV was 22 seconds and the maximum was 100 seconds with the range of 78 seconds.

In addition, HR was collected before and after CV

using a pulse oximeter in the same manner of data collection in oxygen saturation. The median value of HR was 162 before CV and 160 after CV (table 4). HR was increased in 70% of the subjects, whereas decreased in 30% of them. There was no significant change in HR before and after CV examined with Matched paired Wilcoxon test. As well as, the changes in HR had no relationship with the duration of CV examined with Spearman' rho correlation coefficient.

Table 4

The Relationship between Heart Rate and CV ($n = 10$)

HR	Before CV	After CV	Changes (%)
<u>Mdn</u>	162	160	-0.6

The application sites of CV vary by the nurses. 70% of the subjects received CV on both side of chest and 30% of them received CV on either right or left side of the chest in which the ailment was existed. The mini-vibrator has four attachment, cap, ball, flat, and spot. Half of the nurses performed the CV used ball, flat, or spot attachment for minimum contact with the surface of the chest, while the rest of them used cap attachment with a wide area of contact.

The criteria to perform CV in LBW infants were asked the nurses after performing CV and suctioning. The criteria for CV addressed by the staff nurses were "due to atelectasis, secretions or medical order". In fact, every infant who received CV was ordered to routinely receive CV prior to suctioning by physician because of their respiratory problem, such as RDS, atelectasis or pneumonia. Some of the infants showed large amount of secretions with dusky color. It revealed that nursing criteria of CV is based on respiratory assessment for CV confirmed by medical prescription given from the physician. However, the fact that no infants received CV without prescription raises a question on the independent nursing assessment from the order of the physician on the criteria of CV.

DISCUSSION

Infants with artificial ventilation have difficulty removing lung secretions due to the suppression of the cough reflex and the impairment of ciliary activity (Sacker, Landa, Greeneltch & Robinson, 1973). These difficulties could become the obstacles of detachment and movement of secretions in LBW infants with small and narrow airways. Thereby, CPT has been advocated to prevent respiratory complications in neonates with respiratory problems (Curran & Kachoyanos, 1979; Holody & Goldberg, 1981).

CPT consists of several discrete techniques, such as postural drainage, percussion, vibration, coughing, forced expiratory technique, in addition to hyperventilation, hyperinflation, hyperoxygenation, and oropharyngeal, nasopharyngeal and/or tracheal suctioning (Thibeault & Gregory, 1986). Postural drainage is one method to drain lung secretions from various lung segments into the large airway using gravity (Pfleger, Theissl, Oberwaldner & Zach, 1992). However, this technique needs considerable cautions in patients at risk for intracranial hypertension and/or intraventricular hemorrhage, such as premature infants. Percussion is believed to alter the pressure within airways to help dislodge mucous plugs with an air pocket between the chest wall and the cupped hand or percussion tool (Dulock, 1991). However, it is difficult to deliver consistent pressure with consonant frequency even with a percussion tool in neonates. Furthermore, any pressure on infants's chest could alter intrathoracic pressure, which is reported in the relation to ICH and/or IVH in infants (Durand, Sangha, Cabal, Hoppenbrouwers & Hodgman, 1989). Coughing or forced expiratory technique is not possible for the intubated premature infants with respiratory problems. Procedures, such as hyperventilation, hyperinflation, and/or hyperoxygenation prior to ETS in these population, need careful consideration due to their prematurity and insecurity of the respiratory mechanism, the vulnerability of terminal airway sac and the oxygen

toxicity (Chulay & Craeber, 1988).

Considering possible risks and technical difficulties of these other methods of CPT, CV appears likely to be more appropriate technique for the respiratory care of the intubated infants. CV is performed by applying fine, shaking movement to the infant's chest. The purpose of CV is to propel secretions from smaller bronchi to large airways and to thin lung secretions (Dulock, 1991).

In last decades, CV was delivered using hand, toothbrush, or a paddled nipple by applying fine, shaking movements to infant's thorax. Recently, the technique of CV for the high risk infants improved with the use of mini-vibrator. The employment of mini-vibrator allows the possibility of the consistent administration of CV on the application sites, frequency, power, and the duration of vibration. The mini-vibrator used in this study is 100 g of weight and 4.2 cm x 3.3 cm x 13.5 cm in size.

However, the clinical observation of CV in this study demonstrated inconsistent application of this technique without any scientific rationale for the site (s) and the duration, and the use of optional attachments. Some nurses applied CV on both sides of chest, while other did on affected site. Some nurses performed CV with circular motions, while others applied CV from lower to upper part of anterior chest wall. Considering the physical principle of CV in moving lung secretions, CV needs to be performed in the manner to apply a mini-vibrator from the 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. In addition, the ball or spot type attachment of vibrator might reduce any excessive vibration due to small surfaces between vibrator and skin, even though there is no clear criteria for the use of various optimal attachments. When CV is applied using a mechanical vibrator, the cycle and/or power delivered from the vibrator could be consistently controlled. However, the duration of CV can vary by performers and give an immense influence to the outcome of it. The duration of CV using a vibrator

may probably be the only variable controlled in terms of two philosophical issues on CV, its efficacy and safety. However, no empirical study was identified on the duration of CV.

In this research, the amount of decrease in oxygen saturation was not related to how long CV was administered. It was observed that nurse clinicians were aware of the changes in oxygen saturation during CV, while some degree of decrease in oxygen saturation is normally expected with CV. The administration of CV needs to be terminated if there is a significant desaturation. Only one infant dropped oxygen saturation to the level of desaturation (to 72%) with 41 seconds of CV, even it returned to baseline by routine manual breaths using a Laerdal bag prior to suctioning. Since there was no relationship between the duration of CV and the changes in oxygen saturation, one may be able to subjectively designate the duration of CV with the durations observed in the study. Those who received the longest CV, 74 seconds and 100 seconds, showed no changes in oxygen saturation after CV. Those who had the shortest CV of 22 seconds, had experienced low saturation level before the initiation of CV with 7% decrease in oxygen saturation after CV. One literature recommended about 30 seconds of CV for neonatal population (Thibeault & Gregory, 1986). 50% of the LBW infants received 30 to 40 seconds of the duration of CV in this study. Therefore, 30 to 40 seconds appears to be an optimal duration of CV, according to this study with LBW infants.

Literature review on the effects of CV showed inconsistent outcome in neonates. Curran and Kachoyanos(1979) investigated the effects of two different types of CV on oxygenation. The infants received CV using a toothbrush, or a paddled nipple during 1 minute. The group of neonates who received CV using a toothbrush showed significantly higher levels of PO₂ (82.1 mmHg) with clearer breath sounds and better skin color, than the group with a paddled nipple for CV (41.1 mmHg), or the group without CV (67.4 mmHg). These results

support the benefits of consistently controlled oscillation from mechanical vibration on gas exchange and oxygenation.

In infants, CV can be very effective in moving lung secretions due to their complaint chest wall (Parker, 1993). The amount of upper airway secretions removed by oropharyngeal or endotracheal suctioning was compared in two groups of neonates between with and without CPT (Etches & Scott, 1978). CPT consisted of postural drainage, manual vibration and percussion and resulted in the increase in the secretions, compared to the suction only. This result supported Lorin and Denning(1971)'s study on the evaluation of postural drainage with percussion and CV, compared to cough only, on the sputum volume and consistency in 17 children and young adults. Boeck(1984) studied the effects of percussion and vibration on the amount of sputum in pediatric patients and concluded the advantage of CPT on the removal of sputum.

Long term effects of CV and percussion following postural drainage have been investigated in premature infants (Finer, Moriatey, Boyd, Phillips, Stewart & Ulan, 1979). The eight of 21 infants without CPT developed postextubation atelectasis and none of them with CPT developed atelectasis after extubation. 38% of the infants only with postural drainage developed atelectasis. Lobar collapse, atelectasis following by extubation of tube occurs as a result of retained secretions and mucosal edema. CPT may improve the clearance of accumulated secretions and prevent airway obstruction that leads to atelectasis. The results showed CV and percussion is more effective than postural drainage alone in order to prevent the occurrence of postextubation atelectasis in neonates.

However, CV like any other therapeutic interventions, is not without side effects. The most common one is hypoxemia (Dulock, 1991 ; Holloway, et al., 1969 ; Parker, 1993). Fox and colleagues (1978) measured PaO₂ at four time points related to CV and ETS in order to examine the effects of CV

on oxygenation in neonates. There was a decrease of PaO₂ from 70 mmHg to 43 mmHg after ETS with CV and an increase to 78 mmHg after hyperventilation following ETS. Two hours later, PaO₂ returned back to baseline. However, CV and ETS were administered as a unit and the effects of each element was not measured separately, thereby, the degree of the association of hypoxemia with CV could not be evaluated.

Raval and colleagues(1987) compared the effects of CPT in 20 premature infants randomly assigned into two groups during the first 24 hours of life. CPT consisted of postural drainage, percussion and CV. The results showed the addition of CPT to the suctioning procedure made no significant difference in arterial blood gases, PO₂/FiO₂ ratio, or the weight of secretions removed. However, 50% of the group receiving CPT and suctioning developed grade III and IV of IVH, compared to none in the group receiving suctioning only. This finding suggests that CPT during first 48 hours of life may contribute or increase the occurrence of IVH in those infants already at increased risk. In fact, there is little lung secretions within first 48 hours of life, thereby routine CPT at these days should be avoided.

Wood(1987) reported three cases of diffuse periosteal new bone formation involving the ribs related to CV in infants with 4 to 6 months of hospitalization. During hospitalization, they underwent routine vibration with a padded toothbrush for 5 minutes six times daily over the entire chest. Even though follow up evaluations showed no abnormalities or associated bone disease, the author was convinced that the periosteal new bone formation in the rib is an undescribed and uncommon complication of prolonged vibration of infant.

The outcomes of CPT including CV in various health related literature are very inconsistent and difficult to compare each other. To critically review of the effects of one element independently, such as CV, from other type of CPT, several issues on CPT must be acknowledged in clinical setting and re-

search environment. Starr(1992) addressed factors related to these issues. First, the combined use of various techniques of CPT leads to difficulty in evaluating independent effects of one element. Often, postural drainage, percussion, and/or vibration are applied as a unit according to routine custom of the institution or individuals. The compounding effects of these techniques remain unanswered and need to be investigated. The diversity of the population for CPT can be one factor to make difficulties in comparison of the outcomes of CPT. Difference in age and diversity of diagnostic conditions of subjects need to be taken into account for interpretation. The lack of standardization in the performance of various techniques in CPT is one of the factors to be considered. The qualification and quantification of each element of CPT, such as its frequency, duration, or application sites, is rarely addressed in literatures. Clinical application of techniques varies by institution and individuals. A standard use of mechanical device, such as a mini-vibrator, may help to control these problems. The final barrier is the different time point collected in order to measure the outcomes of CPT. The time elapse between the application of the technique and the outcome measurement could mislead the conclusion on the effects of CPT. Immediate, short, and long term effects should be separately interpreted, particularly independently from the effects of suctioning. In addition, the presence of control group to compared the outcomes between intervention group and control group would be essential to evaluate the effects of intervention of CPT, such as CV.

In this pilot study, a pre-experimental design research was carried 1) to examine the effects of CV on oxygen saturation, 2) to investigate the relationship between the duration of CV and the changes in oxygen saturation immediately after CV when compared to baseline, and 3) to establish the duration of CV related to the least decrease in oxygen saturation in LBW infants. Within 10 LBW infants in the NICU, the variance of demographics was be-

tween 700g to 2,099g for birth weight (BW) and between 24 weeks to 34 weeks for gestational age (GA). These limits of BW and GA represented the range of target population in NICU. A small drop (3%) of oxygen saturation was observed after CV. The median value of the duration of CV was 41 seconds. The degree of the decrease in oxygen saturation related to CV had no relationship with the duration of CV. This leaves arbitrary selection of the seconds of CV observed in this study. Half of the infants experienced 30 to 40 seconds of CV. It is reasonable to assume 30 to 40 seconds of CV would be clinically safe in LBW infants. The application of CV varied by nurse clinicians who performed CV without the scientific criteria. Many open discussion on the clinical protocol of CV with neonatologists, nurse clinicians and respiratory therapists supported and confirmed the results of the study. Therefore, in spite of small sample size, the generalizability of the result could be extended to the whole population of ventilated LBW infants in NICU. Further study needs to investigate the independent effects of CV from suctioning on oxygenation and the sputum in LBW infants.

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- 국문초록 -

저체중아에 있어 기관내 흡인전 흉부진동법의 기관과 산소포화 변화간의 관계 연구

안 영 미*

1960년대 이후 인공호흡기(mechanical ventilator)의 보급과 최근 의료과학의 발달, 간호의 질적 향상의 결과로 저체중출생아를 포함한 고위험 신생아의 생존율이 높아져왔다. 호흡장애증후군(RDS)은 일차적으로 폐포의 완전한 확장을 위해 필요한 계면활성물질(surfactant)의 부족, 미발달된 심폐기능에 의한 병리적 현상으로 저체중아의 가장 큰 원인이 되어왔다. RDS로 인해 인공호흡기에 의존해 있는 저체중아의 경우 적절한 산소공급과 이를 위한 호흡의 유지는 치료의 가장 큰 핵심이 되며, 이를 위한 기관내 혹은 비인두 흡인(nasopharyngeal suction)은 산생아 중환자실(NICU)의 가장 중요한 간호행위가 되어 왔다. 인공 호흡기를 위한 기관삽관은 그 자체가 기도의 섬모운동을 방해하고 기침반사를 억제시켜 폐 분비물의 효과적 배출을 억제하며, 특히 저체중아의 경우 조산과 관련하여 미발달된 흉곽운동과 심폐기능은 폐분비물의 이동을 저해하는 요소이다. 따라서 기도내의 분비물의 이동을 효과적으로 하여 흡인 시에 최대한의 효과를 돕기 위해 흉곽 물리요법(chest physiotherapy : CPT)의 한 형태인 흉곽

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진동법(Chest Vibration : CV)가 행해져 왔다. 그러나 저체중아를 위한 CV의 임상적 적용은 그 대상의 생리적 특성, CV의 적용부위(site)와 기간(duration)에 대한 과학적 근거 없이 만성감염이나 폐질환을 가진 성인이나 cystic fibrosis환자를 위한 CV protocol을 무분별하게 채택하여 저체중아에게 행하여져 왔다. 이에 본 연구자는 저체중아에 대한 CV의 안전성을 평가하고, 이에 기초하여 저체중아에게 바람직한 CV의 형태를 알아보고자 본 연구를 시작하였다.

연구설계는 CV의 안전성을 평가하기 위한 실험연구이다. CV의 안전성은 RDS치료의 가장 일차적 목표인 oxygenation변화에 의해 평가될 수 있으므로, 본 실험 연구에서는 Pulse oximeter에 의해 계속적으로 측정된 산소포화 변화(oxygen saturation change)를 측정하였다. 실험대상은 미국동부에 위치한 대학병원의 NICU에 입원하여 RDS와 관련된 호흡장애로 인공호흡기에 의존해 있는 10명의 저체중아였다. 인공호흡기에 의존된 모든 저체중아는 Pulse oximeter와 심폐기능 측정기(cardiopulmonary monitor)에 의해 산소공급과 호흡상태가 계속 측정되고 있었다. 실험대상의 평균 출생시 몸무게는 평균 1,3050gm(SD=580.6)이었고, 임신월령은 평균 28.6주(SD=3.1)였다. RDS가 그들의 일차적 진단명이었고, 그중 4명은 pneumonia, atelectasis의 합병증을 가지고 있었다. 10명중 6명은 intermittent mandatory ventilation(IMV)의 형태로, 4명은 continuous positive airway pressure(CPAP)의 형태로 인공호흡기에 의존되어 있었고 CV시의 FiO_2 는 평균 42.3(SD=21.2)였다. CV는 중환아용 소형진동기(minivibrator)를 이용해 각각 10명의 간호사에 의해 행하여졌고, 최소 22초에서 최대 100초 동안 실시되었다. 50%의 간호사는 30초에서 40초간 CV를 실시하였으며,

CV의 적용 부위도, 진동 후 흉곽부위, 혹은 병변이 있는 좌우측, 혹은 양쪽 흉벽 등으로 다양했고, 적용방법도 원형으로 돌려가며(circular motion), 혹은 아래에서 위로, 혹은 아무런 기준없이 간호사의 기호에 따라 다양하게 적용되었다. 산소포화의 변화는 CV가 행해지기 전 · 후로 5초동안 관찰되었다.

연구의 결과, 산소포화 변화는 비 모수통계(non parametric statistics)의 일종인 Matched Paired Wilcoxon test로 분석한 결과 CV후에 3%의 감소가 보였다($P<.05$). 저체중아에 있어 산소포화의 3%감소는 임상적으로 중요한 의미가 없다고 사료되어지며, 실제 흡입전의 과도호흡에 의해 CV를 행하기 이전의 산소공급수준으로 돌아 왔다. CV실시 기간과 산소포화와의 상관관계는 비 모수통계인 Spearman rho correlation coefficient를 이용하여 분석하였는데, 이 두 변수는 서로 관계가 없는 것으로 나타났다($P>.05$)

또한 CV와 흡인 후에 각각의 간호사들에게 CV를 필요로 한 저체중아의 기준, 적용부위, 기간, 방법등에 대한 기준을 물었으나 대상의 특성에 따른 간호사정에 의존하기보다는 간호사 각자의 선호하는 방법이나 습관에 따라 행하는 것으로 나타났다.

결론적으로 CV와 산소포화 변화와의 관계, NICU에서 관찰된 CV의 임상적 적용을 기초로 저체중아에게 안전 CV protocol은 신생아용 소형 진동기를 이용하여, 양쪽 흉곽의 늑골하측 변연 부위(low lateral costal margin)에서 시작하여 흉골 중앙부위 방향으로 30초 동안 진동기를 적용하는 것이 좋은 것으로 나타났다. 이에 CV의 효과를 평가하기 위한 보다 과학적인 접근방법으로, CV와 흡인의 결과인 가래(sputum)에 대한 연구를 제언하는 바이다.