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Original Article

Comparison of ventilation parameters and blood gas analysis in mechanically-ventilated children who received chest physiotherapy and suctioning *vs.* suctioning alone

Monalisa Elizabeth, Chairul Yoel, Muhammad Ali, Munar Lubis, Gema Nazri Yanni

Abstract

Background Chest physiotherapy and suctioning are routine methods for airway clearance in mechanically-ventilated children. However, chest physiotherapy has not been confirmed to affect ventilation parameters, such as tidal volume (TV), peak inflation pressure (PIP), peak inspiratory flow (PIF), and peak expiratory flow (PEF), as well as blood gas analysis (BGA) values in pediatric intensive care unit (PICU) patients.

Objective To determine the efficacy of chest physiotherapy and suctioning vs. suctioning alone for improving the mechanical ventilation and BGA parameters.

Methods This randomized, single-blind, clinical trial was conducted from November 2012 to June 2013 in the PICU at Haji Adam Malik Hospital, Medan. A total of 40 mechanically-ventilated pediatric patients were enrolled and divided into either the chest physiotherapy and suctioning group (24 subjects) or the suctioning alone group (16 subjects). Subjects underwent treatment, followed by monitoring of their ventilation parameters and blood gas analyses. Data were analyzed by independent T-test and Mann-Whitney test.

Results Subjects comprised of 23 boys and 17 girls, with an age range of 1–204 months. After the respective treatments (chest physiotherapy and suctioning vs. suctioning alone), the ventilation parameters were as follows: median TV (60.0 *vs.* 56.5 mL, respectively; P=0.838), median PEF (10.4 *vs.* 10.8 l/s, respectively; P=0.838), median PIF (7.4 *vs.* 8.2 l/s, respectively; P=0.469), and mean PIP (17.3 *vs.* 15.6 cmH2O, respectively; P=0.23). The BGA values were: median pH (7.4 *vs.* 7.3, respectively; P=0.838), median pCO2 (38.4 *vs.* 36.2 mmHg, respectively; P=1.000), mean pO2 (136.6 *vs.* 139.2 mmHg, respectively; P=0.834), median HCO3 (20.4 *vs.* 22.7 mmol/L, respectively; P=0.594), median TCO2 (22.0 *vs.* 23.7 mmol/L, respectively; P=0.672), mean BE (-4.3 *vs.* -3.1 mmol/L, respectively; P=0.629), and median O2 saturation (98.5 *vs.* 98.3 %, respectively; P=0.967).

Conclusion In mechanically-ventilated children in the PICU, ventilation parameters and BGA values are not significantly different between subjects who received both chest physiotherapy and suctioning compared to those who received suctioning alone. **[Paediatr Indones. 2016;56:285-90. doi: 10.14238/pi56.5.2016.285-90]**.

Keywords: chest physiotherapy; suction; ventilator parameter monitoring value; blood

Endotracheal intubation with mechanical ventilation is an important component of intensive care treatment in critically ill children, however, it is also associated with compromised airway clearance.[1,2] Chest physiotherapy, including postural drainage and percussion, are typical airway clearance methods used by physiotherapists.[3] In most hospitals, intubated and mechanically-ventilated intensive care patients routinely undergo physiotherapy to reduce the occurrence of pulmonary

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From the Department of Child Health, University of Sumatera Utara Medical School/H. Adam Malik General Hospital, Medan, North Sumatera, Indonesia.

Reprint requests to: Monalisa Elizabeth, MD. Department of Child Health, University of Sumatera Utara Medical School/H. Adam Malik Hospital, Jl. Bunga Lau No.17, Medan 20136, North Sumatera, Indonesia. Phone +62-61-8361721/8365663; Fax. +62-61-8361721; Email: monalisaelizabeth@yahoo.com.

complications, such as nosocomial pulmonary and bronchopulmonary infections, as well as atelectasis.[4] However, an indication for chest physiotherapy as an adjunct treatment of children hospitalized with acute pneumonia remains controversial.[5,6]

Manual hyperinflation is believed to increase the passive inflation of the lungs and the expiratory flow rate, improve static and dynamic compliance, increase the volume of suctioned secretions, and decrease the risk of ventilator-associated pneumonia.[7] Vibration also directly leads to sensory stimulation of the respiratory mechanism so as to increase tidal volume and ventilation.[8]

The aim of this study was to compare mechanical ventilation parameters and BGA values in mechanically-ventilated children who underwent either chest physiotherapy and suctioning or suctioning alone.

Methods

We conducted a single-blind, clinical trial to the effects of chest physiotherapy and suctioning vs. suctioning alone on changes in mechanical ventilation parameters in the PICU at Haji Adam Malik Hospital, Medan from November 2012 to June 2013. Subjects were pediatric patients using mechanical ventilation who met the inclusion criteria. The power of the study was 80%. Inclusion criteria were mechanical ventilation on any modes or ventilator settings, and presence of any lung pathology, such as consolidation and atelectasis/effusion, as evaluated by chest x-ray. Exclusion criteria were chest trauma, or risk of clotting dysfunction. Subjects' parents provided informed consent. The study was approved by the Research Ethics Committee of the Faculty of Medicine at the University of Sumatra Utara.

Subjects were randomized into groups, the chest physiotherapy and suctioning group and the suctioning alone group. Subjects in the first group received 30 minutes of chest physiotherapy and suctioning, and the second group received suctioning alone. We monitored the TV, PIP, PIF, PEF, peak expiratory flow rate (PEFR), and peak inspiratory flow rate (PIFR) shown on the screen of the ventilator and performed BGA before physioteraphy and 30 minutes after chest physioteraphy. Blood gas analysis was assessed with B121 Cobass.

Data were processed and analyzed using *SPSS for Windows version 15.0* software. Independent t-test and Mann-Whitney test were used to compare ventilation parameters and BGA values between groups. Results were considered to be statistically significant for P values <0.05 with 95% confidence intervals.

Results

A total of 126 patients were treated in the PICU at Haji Adam Malik Hospital in Medan from November 2012 to June 2013, 58 patients underwent mechanical ventilation. Forty patients met the inclusion criteria and were assigned to either the physiotherapy and suctioning group or the suctioning alone group. A profile of the study is shown in **Figure 1**.

Table 1. Baseline characteristics of subjects

Characteristics	Physiotherapy + suctionin (n=24)	Suctioning alone (n=16)
Median age (range), months	10.5 (1-204)	14.5 (1-180)
Gender, n		
Male	12	11
Female	12	5
Mean body weight (SD), kg	7.9 (2.4-65)	9.5 (3.3-40)
Median body height (range), cm	76 (45-175)	75 (47-170)

Table 1 shows the subjects' mean ages of the physiotherapy and suctioning group as well as the suctioning alone group (10.5 *vs.* 14.5 months, respectively), as well as the number of males (12 *vs.* 11, respectively) and females (12 *vs.* 5, respectively). **Table 2** shows subjects mechanical ventilation parameters and BGA values before chest physioteraphy and suctioning and suctioning alone. Kolmogorov-Smirnov test revealed that there were no significant differences between the two groups prior to treatment.

Mann Whitney test and independent T-test revealed that there were no significant differences in all mechanical ventilation parameters between the two groups after treatment ($P>0.05$) (**Table 3**). In addition, **Table 4** shows that there were no significant differences in all BGA parameters between the two groups after treatment ($P>0.05$).

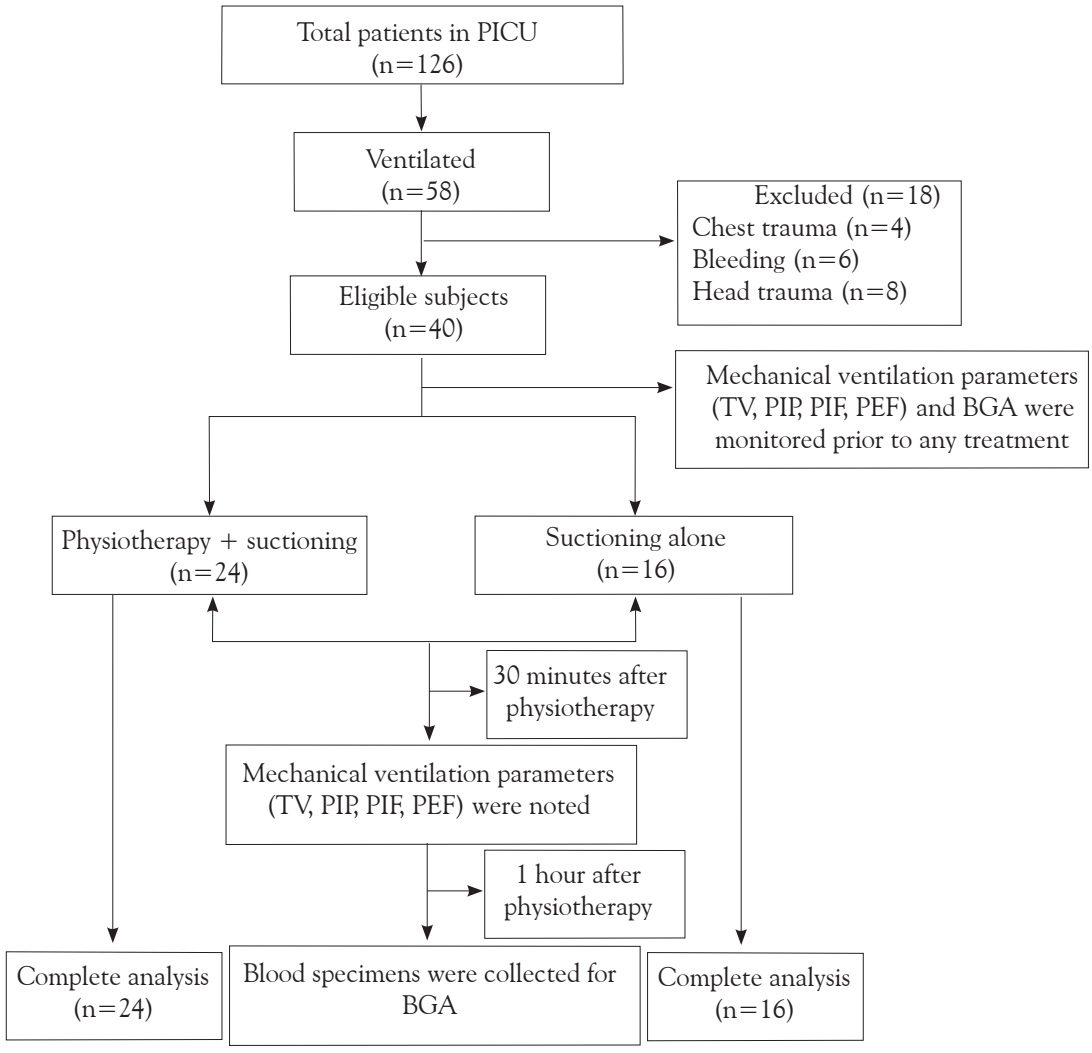

Figure 1. Study flow chart

Table 2. Mechanical ventilation parameters and blood gas analysis before chest physiotherapy and suctioning alone

Parameters	Physiotherapy suctioning (n=24)	Suctioning alone (n=16)
Ventilation parameters		
Median TV (range), mL	62.0 (15-380)	55 (20-326)
Mean PEF (SD), l/s	11.2 (8.79)	11.7 (8.08)
Mean PIF (SD), l/s	10.0 (8.38)	12.1 (9.46)
Mean PIP (SD), cm H_2O	17.2 (4.75)	15.7 (3.79)
BGA values		
Mean pH (SD)	7.3 (0.17)	7.3 (0.19)
Mean pCO_2 (SD), mmHg	43.4 (16.89)	52.7 (32.36)
Mean pO_2 (SD), mmHg	134.5 (39.74)	126.6 (47.69)
Mean HCO_3 (SD), mmol/L	21.7 (6.93)	22.3 (5.55)
Mean TCO_2 (SD), mmol/L	23.0 (7.21)	23.8 (6.13)
Mean BE (SD), mmol/L	-4.0 (7.46)	-3.1 (5.45)
Mean O_2 saturation (SD), %	97.2 (3.92)	96.2 (4.40)

Discussion

The median age of subjects was 10.5 months in the physiotherapy and suctioning group and 14.5 months in the suctioning alone group. In addition, there were 12 males and 12 females in the physiotherapy and suctioning group and 11 males and 5 females in the suctioning alone group. A previous study on chest physiotherapy in children had subjects aged one month to 12 years (median age 44 months)5 and subjects aged 1 week to 15.9 years (median 1.3 years).[2]

In most hospitals in developed countries, physiotherapy is considered to be an integral part of

Table 3. Comparison of the mechanical ventilation parameter results in the two groups after treatment

Mechanical ventilation parameters	Physiotherapy + suctioning (n=24)	Sunctioning alone (n=16)	95% CI of differences	P value
Median TV (range), mL	60.0 (16-382)	56.5 (22-370)		0.838[a]
Median PEF (range), l/s	10.4 (3-19.6)	10.8 (3-28.6)		0.838[a]
Median PIF (range), l/s	7.4 (3.1-31.6)	8.2 (3-29)		0.469[a]
Mean PIP (SD), cm H_2O	17.3 (4.80)	17.3 (4.80)	-1.17 to 4.71	0.23[b]

[a] Mann-Whitney; [b] independent T-test

the management of ICU patients. The precise role that physiotherapists play in the ICU varies considerably, depending on factors such as the country in which the ICU is located, local traditions, staffing levels, training, and expertise.[2] In some hospitals, physiotherapy is routinely performed on all intubated ICU patients receiving mechanical ventilation, with the aim of decreasing the incidence of pulmonary complications (e.g., nosocomial pneumonia, bronchopulmonary infection, and atelectasis).[4] In Indonesian hospitals, physiotherapy is often done, but not officially recorded. We found no significant differences in ventilation parameters between patients who received both chest physiotherapy and suctioning and those who received suctioning alone. An American study showed that chest physiotherapy was more effective to facilitate airway clearance compared to not having physiotherapy or simply relying on spontaneous coughing in patients with cystic fibrosis.[9] Chest physiotherapy in paediatric practice has been believed in the potential benefits of this modality in evacuating inflammatory exudates and tracheobronchial secretions, removing airway obstruction, reducing airway resistance, enhancing gas exchange, and reducing the work of breathing.[5] However, a previous study suggested that chest physiotherapy as an adjunct to standard treatment did not hasten clinical resolution in children hospitalized with acute pneumonia.[5] In our study, in addition to bronchopneumonia, patients also had pleural effusions, tuberculosis, lung edema, atelectasis, aspiration pneumonia, and other comorbidities.

A prospective study of 47 patients during mechanical ventilation who underwent chest physiotherapy and blood test done after physiotherapy.[10] In our study, monitoring parameter of ventilator before and further monitoring is done 30 minutes after physiotherapy and blood sample were collected for BGA 1 hour after physioterapy. A study assessing the effect of vibration physiotherapy on the respiratory system showed no differences in peak inspiratory, end expiratory or lung volume after either vibration or manual physiotherapy.[11] Capacity of lung compliance differs according to age, so responses to chest physiotherapy may vary. Chest physiotherapy in mechanically ventilated children should be evaluated in terms of the process of weaning from mechanical ventilator support, atelectasis, and hospital stay.[6] In our study, we did not assess for the potential effect of chest physiotherapy in terms of hospital stay or duration of mechanical ventilation.

A recent study predicts that physiotherapy secretions; effective against a trill process of the air, and TV. Vibration physiotherapy done at the end of the study after chest physiotherapy.[8] In addition, another study found that vibration-compression physiotherapy significantly increased peak expiratory

Table 4. Comparison of blood gas analysis results in the two groups after treatment

Blood gas analysis parameters	Physiotherapy + suctioning (n=24)	Sunctioning alone (n=16)	95% CI of differences	P value
Median pH (range)	7.4 (7.0-7.7)	7.3 (1.4-7.5)		0.838[a]
Median pCO_2 (range), mmHg	38.4 (19.7-102.90	36.2 (25-98)		1.000[a]
Mean pO_2 (SD), mmHg	136.6 (35.21)	139.21 (41.76)	-27.36 to 22.21	0.834[a]
Median HCO_3 (range), mol/L	20.4 (10.7-41.5)	22.7 (11.7-40.9)		0.594[a]
Median TCO_2 (range), mmol/L	22.0 (11.3-43.5)	23.7 (12.5-43.6)		0.672[a]
Mean BE (SD), mmol/L	-4.3 (7.60)	-3.1 (7.08)	-5.99 to 3.67	0.629[b]
Median O_2 saturation (range), %	98.5 (89.3-99.7)	98.3 (91.8-100)		0.967[a]

[a] Mann-Whitney; [b] independent T-test

flow and peak expiratory to inspiratory flow ratio [peak inspiratory flow:peak expiratory flow ratio (PIF/PEF ratio) > 1.1] and the increased volume and pressure the following tidal volume and the chest manual.[2] In our study, we did not perform vibration physiotherapy after chest physiotherapy.

A cross-over, randomized, clinical study compared the effect of chest physiotherapy with endotracheal suctioning of patients who were paralyzed, using sedation and ventilation. After 15 minutes of chest physiotherapy, base excess (BE), bicarbonate, saturated oxygen, and respiratory resistance significantly decreased. Thirty minutes after chest physiotherapy, physiological dead space was increased. However, for patients who received only endotracheal suctioning, after 15 minutes there were no changes in expired tidal volume, lung compliance, blood gas analysis values, or physiological dead space.[12]

An Australian study reported increased TV, peak inspiratory flow rate e (PIFR), peak expiratory flow rate (PEFR), and inspiration-expiration ratio after physiotherapy. All patients were given similar PIP values.[13] In our study, physiotherapy was performed by different physiotherapists and patients' PIP values were not the same.

A study which evaluated respiration in patients using mechanical ventilation, found that PEF, PIP, and inspiration volume increased during manual chest physiotherapy with or without chest vibration physiotherapy compared to when they first started on the ventilator.[14] In contrast, we found that chest physiotherapy and suctioning vs. suctioning alone did not yield significantly different ventilation parameters or BGA results in PICU patients. A previous study on cystic fibrosis patients with positive expiration mechanical pressure ventilation and chest physiotherapy using a manual chest pressure technique, showed increases in saturated oxygen, peak flow expiration, and better radiology photos. But there was no significant difference in spirometry.[15]

An Indian study found that chest physiotherapy was crucial in intubated patients. This randomized clinical test had two groups, those who received manual hyperinflation with suction (86 patients) as a control group and those who received chest physiotherapy twice daily (87 patients). The authors showed a significant improvement in mechanical ventilation parameters in the chest physiotherapy group and reported more complications in the control group. However, the chest physiotherapy group had longer treatment time but better weaning ratio.[16]

A neonatal study compared the effects of chest physiotherapy and suctioning on blood gas analysis, and secrete discharge in neonatus which connected to mechanical ventilation. Authors found that chest physiotherapy and suction did not improve oxygen pressure, but caused decreased $PaCo_2$ and PaO_2.[17]

Limitations of this study were that the cause of illness was not similar among patients and the physiotherapy procedure was not conducted by the same therapist. In conclusion, in mechanically-ventilated children in the PICU, mechanical ventilation parameters and blood gas analysis values are not significantly different between patients who received chest physiotherapy and suctioning, compared to those who received suctioning alone.

Conflict of Interest

None declared.

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