

# Differences in Muscle Activity of the Upper Extremities During Respiratory Assistance Techniques between Experienced and Inexperienced Physiotherapists - Observational Study

Sho Kumabe<sup>1</sup>, Tomoko Hirayama, PhD<sup>1</sup>, Akihiro Takada, MS<sup>1</sup>, Yui Kikuchi, MS<sup>1</sup>,  
Yumi Fukuyama, MS<sup>1</sup>, Yoshihiro Yamashina, PhD<sup>1</sup>

Aino University, Department of Physical Therapy.

\*Corresponding Author: Sho Kumabe, RPT, 4-5-4, Higashioda, Ibaraki City, Osaka, 567-0012, Japan.

## Abstract

**Purpose:** To compare upper extremity muscle activity and tidal volume during the breathing assist technique between experienced and inexperienced respiratory physiotherapists.

**Methods:** Nine physiotherapists with more than 10 years of experience in respiratory physiotherapy (experienced physiotherapists) and ten physical therapists with less than 1 year of experience in respiratory physiotherapy (inexperienced physiotherapists) participated in this study. A healthy adult male received the breathing assist technique while wearing an eye mask. The tidal volume at rest was calculated from the average value of the 1-minute resting breaths measured using an expiratory gas analyzer. In addition, the tidal volume during the breathing assist technique was measured six times, and the tidal volume during respiratory assistance was calculated from the average value. The measurement sites for muscle activity were the anterior deltoid, middle deltoid, posterior deltoid, biceps brachii, triceps brachii, flexor carpi radialis, flexor carpi ulnaris and opponens pollicis muscles of the upper limb from the caregiver side to the distal side.

**Results:** The tidal volume measured for the experienced participants tended to be higher than that for the inexperienced physiotherapists. According to the average electromyography values, experienced physiotherapists had significantly higher activity in the anterior deltoid and posterior deltoid muscles, while inexperienced physiotherapists showed activity in the biceps brachii and flexor carpi ulnaris muscles that was significantly higher compared to the experienced participants ( $p < 0.05$ ).

**Discussion:** In this study, experienced physiotherapists showed greater muscle activity related to shoulder joint movement, whereas inexperienced physiotherapists showed greater muscle activity related to elbow and wrist joint movements. Therefore, it is reasonable to assume that the experienced physiotherapists tried to assist breathing with the whole trunk and upper limbs, while the inexperienced physiotherapists tried to use only the upper limbs and hands.

**Key words:** Manual breathing assist, Muscle activity, Tidal volume

## INTRODUCTION

The breathing assist technique is a procedure performed by placing the palm on the patient's chest, applying pressure in the direction of physiological

motion during exhalation, and releasing the pressure during the following inhalation. The results of the procedure include increased tidal volume, improved ventilation, mitigated breathing difficulty, improved rib cage flexibility, and decreased functional residual

## Differences in Muscle Activity of the Upper Extremities During Respiratory Assistance Techniques between Experienced and Inexperienced Physiotherapists - Observational Study

---

volumes, among others<sup>1-6</sup>). This is one of the most popular and distinctive procedures for respiratory physical therapy in Japan<sup>5</sup>). The main purpose of the breathing assist technique is to improve respiration by manually assisting with respiratory movements. In addition, tidal volume has been reported to increase significantly even under artificial respiration control without adverse effects on the adaptation of the procedure<sup>7</sup>).

Not all the effects of the breathing assist technique, however, are good. In addition to the trachea and lungs, the thoracic cavity contains organs, such as the heart and aorta, which play a central role in blood circulation. Therefore, it is believed that not only the respiratory system but also the circulatory system is affected by the compression effect of the breathing assist technique. The breathing assist technique increases the inspiratory volume by releasing the pressure and rapidly making the intrathoracic pressure negative; however, simultaneously, the venous return volume may increase. Because an increase in venous return increases the load on the heart, the breathing assist technique should be avoided in patients with severe heart disease and unstable hemodynamics.

Thus, incorrectly performed breathing assist techniques may harm the body and should be corrected. Therefore, we investigated the difference in the muscle activity of the upper limbs between physiotherapists with more than 10 years of experience in respiratory physiotherapy and those with less than 1 year of experience during the breathing assist technique, with the aim of using the data to guide inexperienced physiotherapists.

### MATERIALS AND METHODS

#### Approval from the Ethics Committee

This study protocol was approved by the research ethics committee of Aino University

#### Participants

A total of 9 physical therapists with more than 10 years of experience in respiratory physiotherapy (experienced) and 10 physical therapists with less than 1 year of experience in respiratory physiotherapy (inexperienced) were included. A healthy adult male

received the breathing assist technique while wearing an eye mask to prevent him from identifying the respiratory assistance provider.

#### Measurement of Tidal Volume

The tidal volume at rest was calculated from the average value of the 1-minute resting breaths measured using an expiratory gas analyzer. In addition, the tidal volume during respiratory assistance was measured six times and the tidal volume during respiratory assistance was calculated from the average value.

#### Measurement of Muscle Activity

The measurement sites for muscle activity were the anterior deltoid, middle deltoid, posterior deltoid, biceps brachii, triceps brachii, flexor carpi radialis, flexor carpi ulnaris and opponens pollicis muscles of the upper limb from the caregiver side to the distal side. Muscle activities were measured using electromyography. To evaluate the muscle activity, the relative value was calculated from the maximum muscle contraction.

#### Statistical Analysis

For statistical analysis, tidal volume and muscle activity were compared using an unpaired t-test. A significance level <5% was used for all evaluations, and the analysis was performed using the StatView software (version 5.0; SAS Institute, Cary, NC, USA).

### RESULTS

Table 1 shows the physical characteristics of the participants. The age and years of experience in respiratory physiotherapy of experienced participants were higher than that of the inexperienced participants. Table 2 and 3 shows differences in Tidal Volume and muscle activity of the upper extremities during respiratory assistance techniques. The tidal volume of the experienced participants tended to be higher than that of the inexperienced participants. According to the average electromyography values, experienced participants had significantly higher activity in the anterior deltoid and posterior deltoid muscles, while inexperienced participants showed activity in the biceps brachii and flexor carpi ulnaris muscles that was significantly higher compared to the experienced participants ( $p < 0.05$ ).

## Differences in Muscle Activity of the Upper Extremities During Respiratory Assistance Techniques between Experienced and Inexperienced Physiotherapists - Observational Study

**Table 1.** The physical characteristics of the participants

	experienced physiotherapists	inexperienced physiotherapists	p value
Number	9	10	
Age (years)	35.6 ± 2.2	21.6 ± 0.7	p<0.05
Weight (kg)	60.2 ± 6.5	62.4 ± 8.1	p>0.05
Height (cm)	170.1 ± 4.7	169.3 ± 3.9	p>0.05
Years of experience in respiratory physiotherapy	13.1 ± 1.5	1.0 ± 0.0	p<0.05

Values are means ± SD.

**Table 2.** Differences in Tidal Volume during respiratory assistance techniques

	experienced physiotherapists	inexperienced physiotherapists	p value
TV (L) <sub>Quite breathing</sub>	414.4 ± 15.0	403.6 ± 8.4	p>0.05
TV (L) <sub>manual breathing assist</sub>	719 ± 53.9	699 ± 37.0	p>0.05

Values are means ± SD. Abbreviation: TV. Tidal volume.

**Table 3.** Differences in muscle activity of the upper extremities during respiratory assistance techniques

	experienced physiotherapists	inexperienced physiotherapists	p value
Anterior deltoid (%)	2.6 ± 0.6	1.8 ± 0.9	p=0.04
Middle deltoid (%)	2.1 ± 0.6	2.3 ± 0.4	p>0.05
Posterior deltoid (%)	4.7 ± 1.0	2.7 ± 1.2	p=0.003
Biceps brachii (%)	2.0 ± 0.7	3.1 ± 0.5	p=0.002
Triceps brachii (%)	2.7 ± 0.5	3.0 ± 0.5	p>0.05
Flexor carpi radialis (%)	1.8 ± 0.5	1.8 ± 0.5	p>0.05
Flexor carpi ulnaris (%)	1.6 ± 0.9	2.6 ± 0.6	p=0.006
Opponens pollicis (%)	0.9 ± 0.2	1.8 ± 1.0	p=0.004

Values are means ± SD.

## DISCUSSION

This study clarified the differences in upper extremity muscle activity during the breathing assist technique between skilled and unskilled respiratory physiotherapists. First, there was no significant difference in tidal volume between skilled and unskilled respiratory physiotherapists. This suggests that even an inexperienced clinician can apply sufficient pressure to the chest. However, the activity of the anterior and posterior deltoid fibers was greater in the expert group than in the non-expert group, suggesting that the expert used the muscles around the shoulder joint. It is believed that this is because respiratory assistance can be performed in a stable posture by fixing the central part. In contrast, inexperienced participants had greater activity in the

biceps brachii, flexor carpi ulnaris, and the opposite pollicis muscles than experienced participants, suggesting that respiratory assistance was performed using only the upper extremities and hands. Additionally, sex should be considered. It is possible that this difference in muscle activity may cause patient discomfort during respiratory assistance. Although there was no difference in the ventilation volume during respiratory assistance, patient discomfort during respiratory assistance may lead to dyspnea; therefore, it is considered better to avoid this as much as possible. Our research could be used to instruct unskilled respiratory physiotherapists on breathing assistance methods. The present study, however, had some limitations, including the relatively small cohort comprising only healthy male participants. Additionally, in this study, we only measured muscle

## Differences in Muscle Activity of the Upper Extremities During Respiratory Assistance Techniques between Experienced and Inexperienced Physiotherapists - Observational Study

activity in the upper extremities; therefore, we were unable to explain any differences in trunk or lower extremity movements between skilled and unskilled providers. Therefore, these activities should be measured in future studies.

### CONCLUSION

In this study, the experienced respiratory physiotherapists showed greater activity in the muscles involved in shoulder joint movement, while inexperienced respiratory physiotherapists showed greater activity in the muscles involved in elbow and wrist joint movements. Given this, it would be reasonable to assume that the experienced providers tried to assist breathing using the entire trunk and upper limbs, while the inexperienced providers tried to use only the upper limbs and hands. It is possible that this difference in muscle activity may cause patient discomfort during respiratory assistance, which we hope to investigate in the future.

### Conflict of Interest

The authors declare no conflicts of interest in relation to this article.

### Acknowledgement

We are grateful to members of Aino University for their important contributions to this experiment.

We would like to thank Editage ([www.editage.jp](http://www.editage.jp)) for English language editing.

### Approval from the Ethics Committee

This study protocol was approved by the research ethics committee of Aino University(AINO2016-013).

### REFERENCES

1. Kurita, H., Nitta, O., Harada, M., & Mizukami, M. 2010. Ventilatory effects of manual breathing assist technique (MBAT) and shaking in central nervous system disease sufferers. *J. Phys. Ther. Sci.*, 22: 209-15.
2. Ihashi, K., Saitou, A., Yahata, J., & Ito, N. 1989. Effect of manual breathing assist technique on lung volumes. *J. Phys. Ther.*,16: 267-72.
3. Kihara, K., Mase, K., Nozoe, M., Okada, M., Murakami, S., Ogino, T., Matsushita, K., Kajisa, N., Wada, T., Mabuchi, S., Terayama, S., Hukuda, Y., & Doumen, K. 2015. Features of palm pressure distribution during the breathing assist technique. *J. Jap. Soci. Res. Reha.*, 25: 309-14.
4. Kolaczowski, W., Taylor, R., & Hoffstein, V. 1989. Improvement in oxygen saturation after chest physiotherapy in patients with emphysema. *Physi. Can.*, 41: 18-23.
5. Tanaka, T., Kozu, R., Kitagawa, C., Asai, M., & Senjyu, H. 2015. A manual breathing assist proficiency scale for therapists interrater reliability and elements which is related to tidal volume. *J. Jap. Soci. Res. Reha.*, 25: 95-98.
6. McCarren, B., Alison, JA.,& Herbert, RD. 2006. Manual vibration increases expiratory flow rate via increased intrapleural pressure in healthy adults: an experimental study. *Aust. J. Physiother.*, 52: 267-71.
7. Kolaczowski WL., Heck CS. 1999. The effect of expiratory assist and sustained chest compression techniques on ventilation in mechanically ventilated patients. *Proceedings. 13th International Congress of the World Confederation for Physical Therapy*:28

**Citation:** Sho Kumabe, Tomoko Hirayama, *et al.* Differences in Muscle Activity of the Upper Extremities During Respiratory Assistance Techniques between Experienced and Inexperienced Physiotherapists-Observational Study. *Archives of Physical Health and Sports Medicine.* 2021; 5(1): 08-11. DOI: <https://doi.org/10.22259/2639-362X.0501002>

**Copyright:** © 2022 Sho Kumabe, Tomoko Hirayama, *et al.* This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.