Openventio PUBLISHERS

PULMONARY RESEARCH AND RESPIRATORY MEDICINE

ISSN 2377-1658 Open Journal http://dx.doi.org/10.17140/PRRMOJ-SE-2-107

Special Edition
"Recent Advances in Pulmonary Rehabilitation"

Review

Corresponding author
Ryuhei Sato, RN, PhD
Assistant Professor
Department of Critical Care Nursing
Kyoto University Graduate School of Human Health Science 53 Shogoin Kawahara-cho, Sakyo-ku
Kyoto 606-8507, Japan
Tel. +81-75-751-3947
Fax: +81-75-751-3947
E-mail: sato.ryuhei.2n@kyoto-u.ac.jp

Special Edition 2
Article Ref. #: 1000PRRMOJSE2107

Article History
Received: June 15th, 2017
Accepted: June 20th, 2017
Published: June 21st, 2017

Citation
Sato R, Ebihara S, Kohzuki M. Recent advances in pulmonary rehabilitation for patients in the intensive care unit (ICU). *Pulm Res Respir Med Open J*. 2017; SE(2): S50-S53. doi: 10.17140/PRRMOJ-SE-2-107

Recent Advances in Pulmonary Rehabilitation for Patients in the Intensive Care Unit (ICU)

Ryuhei Sato, RN, PhD[1*]; Satoru Ebihara, MD, PhD[2]; Masahiro Kohzuki, MD, PhD[3]

[1]Department of Critical Care Nursing, School of Human Health Science, Kyoto University Graduate School of Medicine, 53 Shogoin Kawahara-cho, Sakyo-ku, Kyoto 606-8507, Japan

[2]Department of Rehabilitation Medicine, Toho University Graduate School of Medicine, 6-11-1 Omori-nishi, Ota-ku, Tokyo 143-8541, Japan

[3]Department of Internal Medicine and Rehabilitation Science, Tohoku University Graduate School of Medicine, 1-1 Seiryo-machi, Aoba-ku, Sendai 980-8574, Japan

ABSTRACT

Pulmonary rehabilitation is important to prevent complications in critically ill patients in the intensive care unit (ICU) who are on mechanical ventilation. However, the effectiveness and adverse events related to pulmonary rehabilitation for patients in the ICU are largely unclear because of the diversity of diseases and various levels of severity in this situation. This review aims to clarify the evidence currently available for pulmonary rehabilitation in critically ill adult patients requiring mechanical ventilation, with a focus on positioning and early mobilization. Prone positioning (PP) does not seem to benefit adults with hypoxemia mechanically ventilated in the ICU. However, it improved survival among patient subgroups like those enrolled within 48 h of meeting the trial entry criteria, those treated with PP for ≥16 h per day, and those with severe hypoxemia at trial entry. PP using the protective lung ventilation strategy for patients with acute respiratory distress syndrome was associated with reduced mortality. On the other hand, PP may cause pressure sores and tracheal tube obstruction. The semi-recumbent position may prevent ventilator-associated pneumonia with no adverse events. Early mobilization (EM) enhances mobility status and muscle strength and increases days of life and out of the hospital for up to 6 months; it also shortens the duration of delirium. The main adverse events with EM are hemodynamic changes and desaturation. Therefore, medical staff should carry out pulmonary rehabilitation for patients in the ICU, given the effectiveness and adverse events. Future studies should identify diseases that would benefit from pulmonary rehabilitation and optimize the method.

KEY WORDS: Pulmonary rehabilitation; Intensive care unit (ICU); Positioning; Early mobilization

ABBREVIATIONS: ICU: Intensive Care Unit; PP: Prone Positioning; EM: Early Mobilization; RR: Risk Ratio; CI: Confidence Interval; ARDS: Acute Respiratory Distress Syndrome; VAP: Ventilator-associated pneumonia; OR: Odds Ratio; MRC: Medical Research Council; IL: Interleukin; COPD: Chronic Obstructive Pulmonary Disease.

INTRODUCTION

All mechanically-ventilated critically ill patients in the intensive care unit (ICU) may experience difficulty coughing and excreting secretions. This in turn predisposes them to severe lung complications, decreases ventilator-free days, increases the length of ICU and hospital stay, and may consequently increase in mortality rates.[1,2] Pulmonary rehabilitation is a major step in the management of patients in the ICU, in order to prevent complications.[3] Physical therapy including pulmonary rehabilitation in the ICU has been shown to improve quality of

ISSN 2377-1658 http://dx.doi.org/10.17140/PRRMOJ-SE-2-107

life (QoL), physical function, and respiratory muscle strength; increase ventilator-free days; and decrease the length of hospital and ICU stay.[4] However, limited information is available on the effectiveness of pulmonary rehabilitation and associated adverse events in patients who are in the ICU for different diseases or conditions of varying severity.[5] The objective of this review is to confirm the evidence currently available for pulmonary rehabilitation of critically ill adult patients on mechanical ventilation, with a focus on positioning and early mobilization (EM).

POSITIONING

Positioning refers to the use of body position as a specific treatment technique. Positioning strategies used in the ICU include prone positioning (PP), semi-recumbent positioning, upright positioning, and lateral positioning.[3] This review describes PP and semi-recumbent positioning.

A recent systematic review of clinical trials showed that PP did not appear to be beneficial for adults with hypoxemia mechanically ventilated in the ICU, but certain subgroups may show improved survival with the use of this position: those enrolled within 48 h of meeting the entry criteria (risk ratio [RR], 0.75; 95% confidence interval [CI], 0.59-0.94), those placed in PP for ≥16 h per day (RR, 0.77; 95% CI, 0.61-0.99), and those with severe hypoxemia at trial entry (RR, 0.77; 95% CI, 0.65-0.92).[6] Additionally, subgroup analyses of short- and long-term mortality showed an RR of 0.79-0.85 for PP among patients with acute respiratory distress syndrome (ARDS), although the findings were not statistically significant. It has also been reported that compared with supine positioning, PP along with a protective lung ventilation strategy (tidal volume <8 mL/kg) significantly reduced mortality among patients with ARDS (RR, 0.74; 95% CI, 0.59-0.95).[7] PP is considered to improve survival rate by reducing the extent and duration of severe hypoxemia, propensity to ventilator-induced lung injury, or occurrence of nosocomial or ventilator-associated pneumonia (VAP).[6] Because recent studies showed that the incidence rate of pneumonia in patients with acute respiratory failure was not significantly different between the prone and supine position groups,[2,6] the main mechanism of improvement in mortality rates might not be prevention of pneumonia. However, PP may have some adverse effects, namely, pressure sores (RR, 1.37; 95% CI, 1.05-1.79) and tracheal tube obstruction (RR, 1.78; 95% CI, 1.22-2.60).[6]

The semi-recumbent position, in which the head of the bed is elevated by tilting, might prevent VAP. The results of a recent meta-analysis showed that the semi-recumbent position (30º to 60º) significantly reduced the risk of clinically suspected VAP compared to the 0º to 10º supine position (RR, 0.36; 95% CI, 0.25-0.50), although the number of studies with this finding and quality of evidence were low.[8] A randomized crossover study using radiolabeled gastric contents showed that reflux of contaminated gastric contents and aspiration were reduced in patients on mechanical ventilation placed in the semi-recumbent position.[9] The results of this crossover study prove that to prevent clinically suspected VAP, patients should be placed in the semi-recumbent position. This position might not have adverse effects, although some effects such as pressure ulcers, thromboembolism, and heart rate or blood pressure effects have been noted.[8]

EARLY MOBILIZATION

Mobilization strategies include passive and active turning and moving in bed, active-assisted and active training, cycling pedals in bed, sitting on the edge of the bed, standing, stamping, transferring from the bed, chair exercises, and walking.[10] EM is the application of physical therapy within the first 2-5 days of critical illness.[11] EM has received substantial attention because of the increasingly recognized sequelae of polyneuropathy and myopathy in critically ill patients.

A meta-analysis conducted in 2017 found that active mobilization in the ICU increased the probability of walking without assistance at hospital discharge (odds ratio [OR], 2.13; 95% CI, 1.19-3.83), greater muscle strength at ICU discharge as measured using the Medical Research Council (MRC) Sum Score (mean difference, 8.62 points; 95% CI, 1.39-15.86), and more days of life and out of hospital for 6 months (mean difference, 9.69; 95% CI, 1.7-17.66), although no impact on short- or long-term mortality was evident.[12] This meta-analysis also showed that early low-dose rehabilitation defined as commencing within 3 days of admission for less than 30 min per day favored days alive and out of the hospital for 6 months. Further, the results of randomized controlled trials showed that EM led to a shortened duration of delirium.[13,14] The mechanisms underlying the effects of EM have been examined in a few studies.[15,16] For example, it has been reported that the average ratio of interleukin-6 (IL-6) to IL-10 improves after low levels of passive physical activity in patients with prolonged critical illness.[15] However, we must take into account the peculiarities of the patient population and the time to the first mobilization. In patients with stroke (infarct or intracerebral hemorrhage), very early mobilization intervention started at a median of 18.5 h after onset and was associated with a reduction in favorable outcomes 3 months after stroke.[17] Similarly, in patients with acute exacerbation of chronic obstructive pulmonary disease (COPD), EM started within 48 h of hospital admission was associated with an increase in mortality at 1 year (OR, 1.74; 95% CI, 1.05-2.88).[18] The main adverse events during active mobilization include hemodynamic changes (pooled incidences per 1,000 mobilization/rehabilitation sessions, 3.8; 95% CI, 1.3-11.4) and desaturation defined as oxygen saturation of 80-90% (pooled incidences per 1,000 mobilization/rehabilitation sessions, 1.9; 95% CI, 0.9-4.3).[19]

CONCLUSION

Our review presents an overview of positioning and EM examined in high-evidence studies. Positioning and EM in critically ill

ISSN 2377-1658 http://dx.doi.org/10.17140/PRRMOJ-SE-2-107

Table 1: Effectiveness of and Adverse Events Related to Pulmonary Rehabilitation for Patients in the ICU.

Pulmonary rehabilitation	Effectiveness	Adverse events
Prone positioning	Reduced mortality	Pressure sores
	Patients with acute hypoxemia: those enrolled within 48 h of meeting entry criteria; those treated with PP for ≥16 h per day; and participants with more severe hypoxemia at trial entry.	Tracheal tube obstruction
	Patients with ARDS: using protective lung ventilation strategy (tidal volume <8 mL/kg)	
Semi-recumbent position	Prevented VAP	No adverse events
Early mobilization	Improved mobility status and muscle strength and increased days alive and out of the hospital for up to 6 months	Hemodynamic changes
	Shortened the duration of delirium	Desaturation

ICU: Intensive care unit; PP: Prone positioning; ARDS: Acute respiratory distress syndrome; VAP: Ventilator-associated pneumonia.

adult patients have both positive and negative effects. Similarly, certain patient populations may or may not benefit from pulmonary rehabilitation in the ICU, although research on this topic is not extensive. Thus, medical staff should carry out pulmonary rehabilitation for patients in the ICU, given the effectiveness and adverse events. Studies should be conducted to identify the conditions that benefit from these treatment strategies and the optimal parameters of the method (e.g., time of initiation, intensity, frequency, and duration) (Table 1).

CONFLICTS OF INTEREST

All authors declare that they have no competing interests.

REFERENCES

1. Rello J, Ollendorf DA, Oster G, et al. Epidemiology and outcomes of ventilator-associated pneumonia in a large US database. *Chest.* 2002; 122(6): 2115-2121. doi: 10.1378/chest.122.6.2115

2. Ayzac L, Girard R, Baboi L, et al. Ventilator-associated pneumonia in ARDS patients: The impact of prone positioning. A secondary analysis of the PROSEVA trial. *Intensive Care Med.* 2016; 42(5): 871-878. doi: 10.1007/s00134-015-4167-5

3. Stiller K. Physiotherapy in intensive care: Towards an evidence-based practice. *Chest.* 2000; 118(6): 1801-1813. doi: 10.1378/chest.118.6.1801

4. Kayambu G, Boots R, Paratz J. Physical therapy for the critically ill in the ICU: A systematic review and meta-analysis. *Crit Care Med.* 2013; 41(6): 1543-1554. doi: 10.1097/CCM.0b013e31827ca637

5. Stiller K. Physiotherapy in intensive care: An updated systematic review. *Chest.* 2013; 144(3): 825-847. doi: 10.1378/chest.12-2930

6. Bloomfield R, Noble DW, Sudlow A. Prone position for acute respiratory failure in adults. *Cochrane Database Syst Rev.* 2015(11): CD008095. doi: 10.1002/14651858.CD008095.pub2

7. Sud S, Friedrich JO, Adhikari NK, et al. Effect of prone positioning during mechanical ventilation on mortality among patients with acute respiratory distress syndrome: A systematic review and meta-analysis. *Can Med Assoc J.* 2014; 186(10): E381-E390. doi: 10.1503/cmaj.140081

8. Wang L, Li X, Yang Z, et al. Semi-recumbent position versus supine position for the prevention of ventilator-associated pneumonia in adults requiring mechanical ventilation. *Cochrane Database Syst Rev.* 2016(1): CD009946. doi: 10.1002/14651858.CD009946.pub2

9. Torres A, Serra-Batlles J, Ros E, et al. Pulmonary aspiration of gastric contents in patients receiving mechanical ventilation: The effect of body position. *Ann Intern Med.* 1992; 116(7): 540-543. doi: 10.7326/0003-4819-116-7-540

10. Gosselink R, Bott J, Johnson M, et al. Physiotherapy for adult patients with critical illness: Recommendations of the European Respiratory Society and European Society of Intensive Care Medicine Task Force on Physiotherapy for Critically Ill Patients. *Intensive Care Med.* 2008; 34(7): 1188-1199. doi: 10.1007/s00134-008-1026-7

11. Hodgson CL, Berney S, Harrold M, Saxena M, Bellomo R. Clinical review: Early patient mobilization in the ICU. *Crit Care.* 2013; 17(1): 207. doi: 10.1186/cc11820

12. Tipping CJ, Harrold M, Holland A, Romero L, Nisbet T, Hodgson CL. The effects of active mobilisation and rehabilita-

ISSN 2377-1658 http://dx.doi.org/10.17140/PRRMOJ-SE-2-107

tion in ICU on mortality and function: A systematic review. *Intensive Care Med.* 2017; 43(2): 171-183. doi: 10.1007/s00134-016-4612-0

13. Schaller SJ, Anstey M, Blobner M, et al. Early, goal-directed mobilisation in the surgical intensive care unit: A randomised controlled trial. *Lancet.* 2016; 388(10052): 1377-1388. doi: 10.1016/S0140-6736(16)31637-3

14. Schweickert WD, Pohlman MC, Pohlman AS, et al. Early physical and occupational therapy in mechanically ventilated, critically ill patients: A randomised controlled trial. *Lancet.* 2009; 373(9678): 1874-1882. doi: 10.1016/S0140-6736(09)60658-9

15. Winkelman C, Higgins PA, Chen YJ, Levine AD. Cytokines in chronically critically ill patients after activity and rest. *Biol Res Nurs.* 2007; 8(4): 261-271. doi: 10.1177/1099800406298168

16. Franca EE, Ribeiro LC, Lamenha GG, et al. Oxidative stress and immune system analysis after cycle ergometer use in critical patients. *Clinics (Sao Paulo, Brazil)*. 2017; 72(3): 143-149. doi: 10.6061/clinics/2017(03)03

17. AVERT Trial Collaboration group. Efficacy and safety of very early mobilisation within 24 h of stroke onset (AVERT): A randomised controlled trial. *Lancet*. 2015; 386(9988): 46-55. doi: 10.1016/S0140-6736(15)60690-0

18. Greening NJ, Williams JE, Hussain SF, et al. An early rehabilitation intervention to enhance recovery during hospital admission for an exacerbation of chronic respiratory disease: Randomised controlled trial. *Br Med J.* 2014; 349: g4315. doi: 10.1136/bmj.g4315

19. Nydahl P, Sricharoenchai T, Chandra S, et al. Safety of patient mobilization and rehabilitation in the intensive care unit. Systematic review with meta-analysis. *Ann Am Thorac Soc.* 2017; 14(5): 766-777. doi: 10.1513/AnnalsATS.201611-843SR