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Research Article

Multidisciplinary Approach by Respiratory Care Support Team for Patients Receiving Prolonged Mechanical Ventilation

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Abstract

Introduction: The purpose of this prospective cohort study was to evaluate a multidisciplinary approach to ventilator weaning by a dedicated professional respiratory support team (RST) in tracheostomized patients undergoing prolonged mechanical ventilation.

Methods: Forty tracheostomized patients who had received prolonged mechanical ventilation were recruited from the intensive care unit of a single teaching hospital. The weaning protocol consisted of six steps and was implemented by the RST, which included medical doctors, nurses, physiotherapists, clinical engineers, dentists, and dental hygienists.

Results: Thirty-six (90%) of the 40 patients were successfully liberated from mechanical ventilation after a mean ventilated duration of 92.2 days. Of the remaining four patients, two were liberated from mechanical ventilation for 8 hours per day and the other two were deemed permanently ventilator-dependent. Of the 36 patients who were successfully weaned, 17 were discharged to home without care, four were discharged to home with care, and 13 were discharged to a nursing home. No serious problems were encountered by the RST when weaning patients from mechanical ventilation.

Conclusion: A multidisciplinary approach to ventilator weaning by an RST is safe and useful for liberation of tracheostomized patients from prolonged mechanical ventilation.

Keywords: multidisciplinary approach, prolonged mechanical ventilation, respiratory care support team, ventilator weaning

Introduction

In Japan, numerous dedicated medical respiratory care support teams (RSTs) aim to improve the quality of respiratory care, such as standardized ventilator weaning and prevention of ventilator-associated pneumonia. RSTs include medical doctors, nurses, physiotherapists, clinical engineers, clerical workers, dentists, and dental hygienists

who not only provide respiratory care directly for patients but also support general medical staff members who are not specialized in respiratory medicine.

Skilled technique and advanced knowledge are required when weaning patients from mechanical ventilation. A spontaneous breathing trial (SBT) has been recommended when weaning patients with acute respiratory disease from a ventilator [1-3]. Respiratory care when implementing SBT and early mobilization is important in patients with acute respiratory failure, and recent reports and guidelines recommend the ABCDE bundle [4-6]. However, there is no standard protocol for ventilator weaning in patients who have had long-term mechanical ventilation or in those with chronic respiratory failure. Further, it is common for patients to fail a trial of ventilator weaning after prolonged mechanical ventilation.

The purpose of this study was to evaluate a multidisciplinary RST approach to ventilator weaning in tracheostomized patients who have received prolonged mechanical ventilation.

Methods

Study design

This prospective cohort study was performed at a single teaching hospital (Tosei General Hospital, Seto, Aichi, Japan) from November 2008 to March 2013 with follow-up until December 2013. The study participants were tracheostomized patients who had received prolonged mechanical ventilation in the intensive care unit (ICU) and were then transferred to a general ward (Figure 1). The inclusion criteria were (i) patients were discharged from the ICU; (ii) tracheostomized patients who received prolonged mechanical ventilation; (iii) patients who failed an SBT; and (iv) patients who were reintubated after a successful SBT. The exclusion criteria were (i) patients who received the best support care; and (ii) patients who received home mechanical ventilation. The study protocol was approved by the ethics committee at Tosei General Hospital (approval number 571). The trial was also registered (UMIN000028285, http://www.umin.ac.jp/). Informed consent was obtained from all patients who participated in the study.

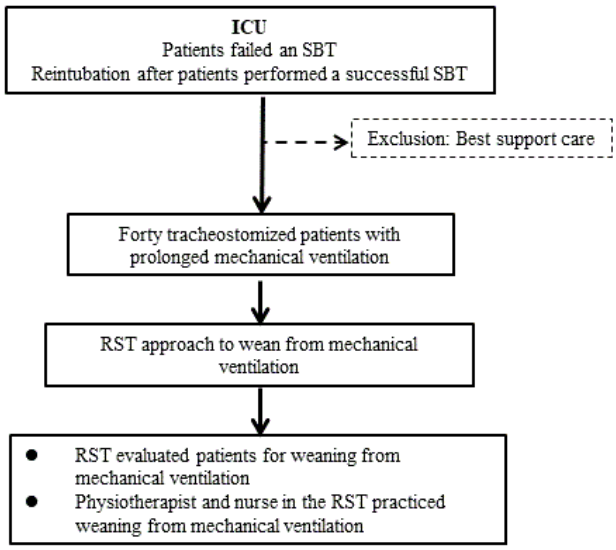

Figure 1: Flow chart showing the study protocol. ICU: Intensive Care Unit; RST: Respiratory Care Support Team; SBT: Spontaneous Breathing Trial

Respiratory support team

The RST is a dedicated medical team that includes medical doctors, nurses, physiotherapists, clinical engineers, clerical workers, dentists, and dental hygienists and provides care for general medical patients with specific respiratory needs, including standardized ventilator weaning and prevention of mechanical ventilator-associated pneumonia. Each expert concurrently works for an RST. The RST directly cares for patients, supports general medical staff members who are not specialized in respiratory care, and takes measures to prevent ventilator-associated lung injury in general wards.

Multidisciplinary weaning approach

The ventilator weaning protocol consisted of the six steps outlined in Table 1. The patients received the training needed to come off the ventilator if they had no new exacerbation of infection or respiratory failure and their physical status were otherwise stable. Vital signs were monitored during training using the criteria shown in Table 2. Rehabilitation was carried out at the same time as the training to come off the ventilator and consisted of exercise and positioning when seated, sitting in a wheelchair, standing, stepping, and walking.

Table 1: Training protocol for ventilator weaning

Inclusion criteria	• The patient has no new exacerbation of infection or respiratory failure • Other than respiration, the patient's general physical condition is stable
Step-by-step approach	
Step 1	• Reduce the number of forced ventilations with SIMV + PS (over 20 minutes) • Both VCV and PCV are available
Step 2	• If the patient's ventilator is set at CPAP + PS, PEEP and support pressure are decreased (target CPAP 5 cmH_2O + PS 5 cmH_2O)
Step 3	• Extend training time with setting of CPAP (CPAP 5 cmH_2O + PS 5 cmH_2O) • Training time is extended from a few minutes to 30 minutes, a few hours, and if possible, to 4 hours; then proceed to step 4
Step 4	• Patient is weaned temporarily from the ventilator via the tracheostomy orifice • Time off the ventilator is extended from a few minutes to 30 minutes and then to 1 hour, 2 hours, 4 hours, and 8 hours • Patient receives ventilation in SIMV mode when asleep at night
Step 5	• When the patient can be weaned from the ventilator for more than 8 hours, CPAP mode ventilation is initiated • If there is no ventilation history to support ventilation at nighttime, go to step 6
Step 6	• Patient is fully weaned from the ventilator at nighttime • Patient is weaned completely from the ventilator
CPAP: Continuous Positive Airway Pressure; PCV: Pressure Control Ventilation; PS: Pressure Support; SIMV: Synchronized Intermittent Mandatory Ventilation; VCV: Volume Control Ventilation; PEEP: Positive End-Expiratory Pressure	

Table 2: Evaluation of vital signs during training for ventilator weaning

	Measurements
Respiration	RR/TV >80
	RR >40
	TV >30% change from baseline
Oxygenation	P/F ratio <200
	SpO_2 <90%
	FiO_2 increase by ≥10%
Other symptoms	Dyspnea (Borg scale >4)
	Bad complexion, abnormal sweating
	Increase of $PaCO_2$
	Increase in HR by ≥30 bpm
	Decreased level of consciousness
HR: Heart Rate; $PaCO_2$: Arterial Carbon Dioxide Pressure; P/F ratio: Arterial Oxygen Pressure/Fraction of Inspired Oxygen; RR: Respiratory Rate; SpO_2: Saturation Pulse Oxygen; TV: Tidal Volume; BPM: Beats Per Min	

Outcome measurements

The primary outcome was the proportion of patients who could be completely liberated from ventilation, i.e., for 24 hours per day. The secondary outcome was the proportion of patients who could be temporarily weaned, i.e., for more than 8 hours per day. The condition of the tracheostomy and the patient's overall health status at the time of discharge from hospital were also assessed.

Results

The demographic and clinical characteristics of the 40 patients recruited for this study are shown in Table 3. Sixty-five percent of the patients were male and the median patient age was 73.0 (interquartile range 61.5–84.5) years. Eighteen patients were receiving mechanical ventilation subsequent to cardiopulmonary resuscitation after a cardiac arrest and eight because of acute respiratory distress syndrome.

Table 3: Demographic and clinical patient characteristics

Male/female sex	26/14
Age (years), median (interquartile range)	73.0 (61.5–84.5)
Reason for mechanical ventilation	
Cardiopulmonary arrest	18
Acute respiratory distress syndrome	8
Sputum could not be expectorated	5
Heart failure	3
Sepsis	2
Thoracic aortic dissection	1
Acute hepatic encephalopathy	1
Multiple system atrophy	1
Subdural hematoma	1

Ventilator-off training was started by the RST on average 49 days after starting mechanical ventilation. The mean duration of mechanical ventilation until complete liberation from ventilation was 41.1 days. A high proportion of patients (n = 36/40, 90%) were successfully liberated from mechanical ventilation after a mean duration of 92.2 ± 141.6 days. Of the remaining four patients, two could be liberated for 8 hours and the remaining two failed to wean and were deemed ventilator-dependent. Of the 36 patients who were successfully weaned, 17 were discharged home without further respiratory care, four were discharged home with some degree of respiratory care, and 13 were discharged to a nursing home. Three of 4 patients who failed to wean from the mechanical ventilation died of deterioration of the disease condition. One patient could not be weaned due to sleep apnea syndrome. The tracheostomy was closed in 17 patients, and six patients' tracheostomy tube was changed to a speech cannula. No serious problems were encountered during weaning from mechanical ventilation by the RST.

Discussion

In this study, a multidisciplinary RST approach was implemented for ventilator weaning in 40 tracheostomized patients who had received prolonged mechanical ventilation. Thirty-six (90%) of the patients were successfully liberated from mechanical ventilation using a protocol that included ventilator-off training and physiotherapy. The high weaning rate in this study suggests the usefulness of this multidisciplinary approach when weaning patients from prolonged mechanical ventilation.

Implementation of the ABCDE bundle [4-6] requires that severe patients on a ventilator are awoken once at an early time so that their respiratory condition can be evaluated for liberation from mechanical ventilation using an SBT, and early mobilization and exercise can be initiated. Several studies [7-10] have reported difficulty in weaning some patients from prolonged mechanical ventilation. In a retrospective study by Shin et al. [8] only 41 (32.3%) of 127 patients requiring prolonged mechanical ventilation were successfully weaned. In another retrospective cohort study [7], only 55 (48.2%) of 114 patients were weaned after discharge from the ICU. A further retrospective study [9] reported a weaning success rate of 54% in 1419 patients requiring prolonged mechanical ventilation. Another study [11] retrospectively investigated 363 patients receiving prolonged mechanical ventilation and found that only 24% could be weaned successfully. In contrast, 90% of the patients in our study could be weaned completely from prolonged mechanical ventilation. We attribute this high success rate to our multidisciplinary RST approach to management of these patients, not only with regard to ventilator-off training and physiotherapy, but also the mental health support provided by the nurses and the swallowing training provided by dentists and therapists on the general wards. A weaning protocol implemented by an RST was less error-prone and could be carried out systematically. Jubran et al. [12] reported that weaning by unassisted breathing through tracheostomy had a shorter median weaning time compared with pressure support in patients who required prolonged mechanical ventilation. Although the weaning method of our study was based on the patient's ability to tolerate a decrease in pressure support, the weaning method of Jubran et al. [12] may be more effective. In the future, it may be better for the RST to choose unassisted breathing through tracheostomy than decreasing pressure support.

There are several limitations to our study. First is its single-center design and small sample size. Second, few of the patients included had chronic respiratory disease, which could explain the high proportion of patients who were successfully weaned. Third, this study was completed 5 years ago. In this study, not all patients experienced much early awakening time recommended by the ABCDE bundle [4-6] and actively used analgesics. If we treat patients based on the ABCDE bundle [4-6], the weaning of the patient's mechanical ventilation may be faster and safer than that in our study. Further research is needed in the future to determine how successful this multidisciplinary approach to ventilator weaning would be in patients with chronic respiratory disease.

Conclusion

Interprofessional team work by an RST allowed safe and effective implementation of a ventilator weaning protocol, which had a success rate of 90% in patients who had received prolonged mechanical ventilation.

Acknowledgement

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