Using Proportional Assist Ventilation to Wean a Prolonged Mechanically Ventilated Patient with Chronic Obstructive Pulmonary Disease

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ABSTRACT

Long-term mechanical ventilation (MV) increases heath care cost. Difficult-to-wean patients represent a challenge to health care providers and patient’s family. Patient with chronic obstructive pulmonary diseases (COPDs) are usually difficult to wean off mechanical ventilators for many pathophysiological reasons. Modes of ventilation used in MV weaning have produced variable results. The main shortcoming of currently available modes of weaning is inability to meet patient’s changing ventilator demand. Proportional assist ventilation (PAV) is a new mode of ventilation designed to keep up with patient’s breathing demand and unload work of breathing. In this case report, we have shown that PAV was able to wean off a patient with COPD who had been on the ventilator for 37 days.

Key words: Chronic obstructive pulmonary disease, mechanical ventilation, modes of weaning, prolonged mechanical ventilation, weaning

INTRODUCTION

Mechanical ventilation (MV) of patients with chronic obstructive pulmonary diseases (COPD) has been a challenge for critical care clinicians. This is because COPD is characterized by airflow limitation, respiratory muscles weaknesses, and abnormal lung mechanics. This may explain why COPD patients represent around 40% of patients in the long-term acute care facilities receiving prolonged MV.[1] Prolonged mechanical ventilation (PMV) has been defined as the need for MV for 3 weeks or more.[2] In a recent United Kingdom based study, the incidence of PMV was 6.3/100 ventilated admissions.[3] The mean intensive care unit (ICU) stay for PMV was 37 days consuming about 50% of ICU bed days, and as a result, increasing cost of care. Time spent in weaning from MV takes about 40-50% of MV time.[4] For COPD patients, weaning time may take as much as 59% of MV time.[3]

Weaning from MV has been carried out using different methods. The most common methods of weaning are:
Spontaneous breathing using T-piece, pressure support ventilation, and synchronized intermittent mandatory ventilation (SIMV). Weaning success using these methods has been variable, depending on the clinical condition and method applied. One possible explanation of weaning failure could be attributed to the fact that these methods of weaning, by design, do not appropriately respond to the ever-changing patient’s ventilatory demand. Proportional assist ventilation (PAV) is a new mode of ventilation that is purported to keep up with changing patient’s demands and lung mechanics. In this article writing, we report a case of weaning a COPD patient using PAV.

CASE REPORT

A 62-year-old female known case of COPD with diabetes mellitus and hypertension was admitted to the hospital complaining of severe headache and elevated blood pressure (232/89). Patient lost consciousness and was intubated and connected to a mechanical ventilator. Brain computed tomography (CT) revealed intraventricular hemorrhage, most likely a result of uncontrolled hypertension. Patient was ventilated using SIMV mode at a rate of 14 b/min, pressure support (PS) of 12 cm H2O, and fraction of inspired Oxygen (FiO2) of 50% with acceptable arterial blood gases. Patient was sedated with Fentanyl 50-150 mcg/kg. Patient was kept on the same ventilator settings for 13 days as her blood pressure was unstable and level of consciousness was low (Glasgow Coma Scale, 8-10/15). On day 14, sedation was stopped to prepare the patient for possible weaning of the ventilator. Patient was switched to PS of 12 cm H2O but developed tachypnea and increased work of breathing (WOB) and placed back to full MV support. Four days later, patient’s level of consciousness improved with good cough and gag reflexes. Another trial of weaning using PS was attempted. After 24 h of weaning using PS with marginal extubation criteria, patient was extubated. Nebulized Racemic Epinephrin and Salmbutamol were given for stridor. Oxygen saturation dropped to 70%. Bilevel positive airway pressure (BiPAP) was instituted in an attempt to prevent re-intubation. After 2 h on BiPAP, patient developed bradycardia and desaturation which required intubation and cardiopulmonary resuscitation for 10 min. Patient regained normal pulse and placed back on controlled MV. Five days later, a weaning attempt was done, but patient developed tachypnea and tachycardia. Due to difficulty weaning and anticipated prolonged ventilation, a tracheostomy tube size 7.5 mm was inserted. After 1 day on tracheostomy tube, several attempts of weaning have been tried for a period of 1 week with no favorable responses, after which a decision was made to try patient on PAV (PAV+, Puritan Bennet 840, Galawy, Ireland). Proportional Assist level (PA) of 80% was initiated with FiO2 of 25% and positive end expiratory pressure of 5 cm H2O. Patient’s vital signs, blood gases, respiratory mechanics, and WOB were monitored closely. WOB improved gradually, and the patient was able to communicate better. On PAV+, patient spent more time sleeping than on SIMV. PA support level was weaned by 5-20% daily until PA of 10% was reached with no apparent signs of respiratory distress. Aerosol and hyperinflation therapy with lavage and suctioning were performed twice a day to clear airways. After 7 days on PAV+, patient was successfully disconnected from the ventilator and placed on aerosol trach mask of 35% FiO2. After 2 weeks of monitoring and receiving lung clearance and aerosol therapy, patient was transferred from our ICU to the ward. Ten days later, patient was discharged home on home care program.

DISCUSSION

During PAV, the ventilator delivers inflation pressure in proportion to measured flow, volume, resistance, and compliance of the respiratory system. Unlike traditional modes of ventilation, ventilator assistance during PAV follows the changing patients’ demand. Grasso et al. have shown that PAV adjusts well to changing WOB. This neuro-mechanical coupling during PAV has been shown to improve patient-ventilator synchrony. Purro et al. studied the physiological determinants of weaning failure and found that muscles weakness, abnormal pulmonary mechanics, and increased respiratory drive are the main reasons for patients to stay longer on the ventilator.

Patients with COPD usually suffer from chronic respiratory muscles weakness as a result of long-lasting breathing against airflow limitation and dynamic hyperinflation. COPD patients also exhibit considerable amount of patient-ventilator asynchrony. This results in increased respiratory drive and WOB. We believe that the high reported weaning failure rate in COPD (about 50%) is related to the fact that traditional methods of weaning do not provide sufficient recovery and preserve of respiratory muscles.

The main advantage of PAV is its ability to unload respiratory muscles and improve the matching between patient and ventilator. The level of muscle loading during PAV can be visually monitored by inspecting WOB bar in the ventilator panel. This graph provides calculation of total and patient’s WOB. The level of PAV assistance can be adjusted so that total and patient’s WOB are not excessive. Therefore, over-and under-assistance are avoided. Over-assistance aggravates dynamic hyperinflation while under-assistance imposes...
unnecessary load on respiratory muscles. In both cases, weaning process will be hampered. We believe that the success of weaning lies on clinicians’ ability to adjust ventilator to give the “just right” level of assistance. In this report, we have successfully used PAV to wean a COPD patient who has been on the ventilator for 37 days.

REFERENCES


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