

Mechanical Ventilation

Working with patients requiring mechanical ventilation (MV) can be intimidating at first. PT intervention can produce an enormous impact for patients requiring MV, and mobilizing these patients is an established care standard.

Ventilation can be invasive (e.g., the patient is endotracheally intubated), or non-invasive (e.g., BiPAP).

When patients require MV, often some sedation is used to facilitate ventilator tolerance while maintaining alertness within the desired range – typically, **RASS** between **0** and **-1**. Sedating agents affect much more than alertness, and **propofol**, a common first-line sedating drug, significantly reduces **systemic vascular resistance** and **stroke volume**.

Because of this, pressors may be used to maintain mean arterial pressure (MAP) within goal range. **Norepinephrine**, or **levophed**, is a frequently-used alpha-1 agonist which **produces peripheral vasoconstriction**, but also has **an inotropic effect** (it increases contractility of the myocardium). Determination of readiness for mobility is guided by trend in pressor requirement, not absolute values.

Two commonly-encountered ventilator modes for intubated patients are Volume Control/ Assist Control (**VC/AC**) and Pressure Support (**PSV**).

VC/AC ensures that patients receive the desired **tidal volume (Vt)** during each inspiratory phase. This is based on the patient's body size. **Respiratory rate (RR)** is also set, so a desired **Minute Ventilation** is achieved ($Vt \times RR$). **PEEP**, or positive end expiratory pressure, is the pressure on the airway at the end of the expiratory phase which prevents atelectasis. **FiO₂** is fraction of inspired Oxygen, and this format for this value is used because it enables easy calculation of the **P/F ratio**, which defines Acute Respiratory Distress Syndrome (**ARDS**) severity, guiding treatment approach.

Ventilator settings are documented like this: Mode/RR/Vt/PEEP/FiO₂; e.g. VC/AC/24/440/10/0.50.

Pressure Support Ventilation assists the patient's inspiratory effort, meaning the patient initiates the inspiratory phase actively. The vent adds a set amount of pressure during the inspiratory phase but does not guarantee that a set tidal volume is attained. This mode requires inspiratory muscle activity and is often better-tolerated by patients that are alert and mobilizing actively.

Typically for ventilator **weaning**, a setting of PSV 5/5 is trialed for 30 minutes, meaning that a patient breathes actively through the endotracheal tube (ETT) with 5 cm H₂O of pressure support during inspiratory phase, and 5 cm H₂O of PEEP. Patients may require greater than 5 PS to maintain Vt during active mobilization.

MV is used to facilitate gas exchange. Arterial Blood Gas draws reveal **pH** (normal is 7.4; less is acidosis, more is alkalosis); **PaO₂** and **PaCO₂** (partial pressures of O₂ and CO₂, respectively), and HCO₃⁻ (bicarbonate). Kidneys produce HCO₃⁻ to help regulate homeostasis, and when a metabolic derangement produces an acidotic state, HCO₃⁻ is used to buffer the rate of pH decrease.

MV affects more than just gas exchange. Positive pressure ventilation, invasive or not, increases **intrathoracic pressure** which reduces venous return. Because of this reduction in **preload** at the Right Atrium, **cardiac output** is reduced, which can affect all organ systems. AHRQ used to recommend deferment of mobilization until **PEEP < 10** is tolerated, and though patients are mobilized on higher PEEPs, this cardiopulmonary impact is important to keep in mind.

Patients who are endotracheally intubated often benefit from **airway clearance techniques** for mobilization of secretions. **Active mobilization** (e.g., walking, or at least standing to transfer to a chair) is encouraged.

Monitor vital sign response closely, particularly during position changes.

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