Q How can I and my colleagues ensure we are using new mechanical ventilator modes the most effective way?

A John J. Gallagher, DNP, RN, CCNS, CCRN-K, TCRN, RRT, replies:

Modern mechanical ventilators have modes previously unavailable when mechanical ventilation was first established as a support therapy more than 50 years ago. Regardless of the manufacturer trade names assigned to these modes, all modes fall into 1 of 2 categories: volume control and pressure control. In volume-control mode, a flow of gas is delivered to achieve a set volume (ie, tidal volume [Vt]) with each ventilator breath. Although the set Vt may be guaranteed with each breath, the pressure generated in the pulmonary system varies depending on airway resistance, lung compliance, and lung elastance. Pressure-control modes deliver a flow of gas to achieve a set inspiratory pressure. In these modes, Vt may vary depending on airway resistance, lung compliance, and lung elastance. A wide array of pressure-control modes is available, including pressure control, pressure support, bilevel, and airway pressure release ventilation. Volume-control and pressure-control modes may be combined with breath-delivery options such as control mechanical ventilation, assist control, synchronized intermittent mandatory ventilation, or spontaneous mode.

Dual-control modes, available on some ventilators, combine qualities of volume-control and pressure-control modes. Dual-control modes are primarily pressure control in design; however, these modes also allow the practitioner to set a minimum Vt target with each breath and to achieve that Vt within a desired set pressure limit. Dual-control modes include pressure-regulated volume control, volume control plus, and volume support, among others. Other modes such as adaptive support ventilation, proportional assist ventilation, and neurally adjusted ventilatory assistance provide variable levels of ventilatory support (ie, full or partial) depending on clinician settings and patient effort. Some refer to these as closed-loop ventilation modes.

Ventilation modes are often combined with the application of positive end-expiratory pressure (PEEP) to prevent alveolar collapse during exhalation. PEEP may be applied at lower levels to prevent atelectasis or at higher levels to assist recruitment of collapsed alveoli. Since the Acute Respiratory Distress Syndrome Network trial in 2000, much emphasis has been placed on achieving lung protection by reducing Vt to prevent alveolar overdistention (aka, volutrauma). Survival advantage was demonstrated in the Acute Respiratory Distress Syndrome Network trial when a lower Vt was used (ie, 6 mL/kg predicted body weight compared with
12 mL/kg predicted body weight), thereby reducing ventilator-induced lung injury.\(^9\) Recently, the lung protective benefits of low Vt ventilation have been extended to patients without Acute Respiratory Distress Syndrome but who are at potential risk for lung injury.\(^10\-12\)

The application of low Vt combined with PEEP to prevent end-expiratory alveolar collapse has been the foundation of lung-protective ventilation. It is important to remember that in addition to protecting normal alveoli, collapsed alveoli must be recruited and stabilized. Collapsed alveoli are at risk for shear injury from repeated, although brief, inflation and collapse with each ventilator breath,\(^13\) which can result in additional alveolar injury unless sustained recruitment is achieved and maintained to stabilize the alveoli.\(^14\-20\) Use of intermittent recruitment maneuvers, as well as switching to modes with sustained breath-inflation patterns such as pressure-control, bilevel, or airway pressure release ventilation, along with application of PEEP, may aid sustained recruitment of collapsed alveoli, improved oxygenation, and, ultimately, improved ventilation.\(^8,21,22\)

Achieving effectiveness with any mode of ventilation requires familiarity and experience with the chosen mode. Familiarity and experience with the chosen mode involves understanding its desired applications and limitations across various disease states. In addition, the prescriber, respiratory care practitioner, and nurse must have a working knowledge of the technical aspects of the mode to optimize patient outcomes and prevent potential complications.

When initiating any ventilation strategy (ie, mode), it is important that all team members understand the goals for initiating the mode, as well as the end points or time frame for determining success or failure of the chosen strategy. Goals may include achieving ventilator liberation, lung protection, and/or lung recruitment. End points of success might be improvements in oxygenation, ventilation, or lung compliance. Potential adverse effects or complications of ventilation, such as dynamic hyperinflation, hypotension, and barotrauma-related pneumothorax, should also be anticipated.\(^21,23,24\)

Once a mode is initiated, desired improvements may take time to achieve. Depending on the degree of alveolar collapse, many hours may be required to recruit collapsed alveoli before improvements in oxygenation and ventilation are realized. Patience is required because improvement may not be immediate. Rapidly changing from one mode to another may not result in more desirable improvements.

Modern ventilators provide many options. There are limited data to support superiority of one mode over another. Rather, these modes should be viewed as tools to achieve common goals of oxygenation, ventilation, lung protection, lung recruitment, and, ultimately, ventilator liberation. Becoming familiar with the operation and application of modes available on the ventilators at your facility may be the most important factor in using them effectively and achieving desired patient outcomes.


References
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5. Branson RD, Chatburn RL. Controversies in the critical care setting. Should adaptive pressure control modes be utilized for virtually all patients receiving mechanical ventilation? \(\text{Respir Care.} 2007;52(4):478-487\).


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