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Ventilator Management

A Systematic Approach to Choosing and Using New Modes

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Keywords

• Ventilator • Mechanical ventilation • Hypoxia • Dyssynchrony • ARDS

Key points

- Modern ventilators have many new modes but most go unused.
- Research has demonstrated that low tidal volumes in acute respiratory distress syndrome and early liberation for all patients are life-saving; other mode choices are made for short-term benefits.
- Guidelines have been shown to improve patient outcomes for ventilators and these should be implemented as a first step in ventilator mode selection.

INTRODUCTION

Modern ventilator management presents a dizzying array of choices in ventilators, modes, and advanced features. The new clinician is assaulted with a list of acronyms that sound impressively similar but can mean the difference between a calm, well-oxygenated patient and an agitated, hypoxic one struggling to breathe. New ventilators are developed with advanced microprocessors and artificial intelligence to reduce the workload of the physician and patient, but with very little data to back them up. What the data do show is that the sooner we rid the patient of the ventilator, the better they will do, and this is our ultimate and daily goal.

The new ventilator modes are often developed by industry and then assigned proprietary names on each ventilator. Some ventilators offer the same modes as other vents, some are unique. All ventilators have the basic modes of ventilation, which are discussed. We then address some common

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advanced modes of ventilation and then some less available types. We also discuss adjuncts to mechanical ventilation, such as extracorporeal membrane oxygenation. It is best to know what ventilators and resources your institution has to be able to plan a strategy for your patients' recoveries.

SIGNIFICANCE

The overwhelming number of unique modes of ventilation available is demonstrated in Table 1 taken from the article by Mireles-Cabodevila and colleagues [1] showing 47 unique mode names on only 4 different ventilators. These names are given by the ventilator manufacturer and do not necessarily represent differences in independent or dependent variables on the machine or differences in appropriate clinical scenarios. For example, the airway pressure release ventilation mode on the Dräger Evita XL (Draeger Medical, Telford, PA) has the same features as the Bi-Vent mode on the Maquet Servo-i (Maquet Getinge Group, Wayne, NJ). To discuss different types of ventilation between ventilators, Chatburn [2] developed a classification of ventilator modes. This separated modes first by pressure or volume as the control variable and then subclassifies them by the breath sequence type: continuous mandatory ventilation (CMV), intermittent mandatory ventilation (IMV), or continuous spontaneous ventilation (CSV). From there, the modes are further subdivided by breath-targeting scheme: set-point, dual, adaptive, optimal, biovariable, or intelligent. Table 2 demonstrates this and is taken from the article by Mireles-Cabodevila and colleagues [1] to demonstrate how the modes from Table 1 fit into an organized classification scheme.

Breath-targeting schemes are one of the key targets for innovation in mechanical ventilation. Early in the development of positive pressure ventilation, you could choose a set-point for your volume or pressure and the machine would hit it. New microprocessors and artificial intelligence allow for heuristics and auto feedback to adjust the vent between, and even within, breaths. Dual targeting switches between pressure control and volume control within a single breath to reach preset volume and pressure targets. Adaptive targeting changes the target between breaths based on the performance of the prior breaths. Optimal targeting bases targets on mathematical models from prior breaths. Intelligent targeting systems are the most complex and based on artificial intelligence modeling of prior breaths.

These breath-targeting schemes vary from completely clinician dependent to completely model dependent and there are problems with both ends of the spectrum. Data show that low tidal volume ventilation is clearly better for acute respiratory distress syndrome (ARDS) [3], but that this is not currently uniformly applied by practitioners [4]. Computerized systems would seem to solve this human problem; however, mathematical models and artificial intelligence systems are easily confused by the patient not behaving according to how the model predicts. The computer then provides inappropriate ventilator support.

We have a taxonomy for ventilation modes and a large variety of these modes to choose from. But, the only high-quality significant data we have to

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