Practical Uses of Pressure-Controlled Ventilation

Sean Shortall RRT-NPS, RPFT
Dana Oakes BA, RRT-NPS

Introduction

This article is the second in a series describing the types and modes of ventilation available today on mechanical ventilators. Volume-control ventilation (VCV) is considered by some to be "the" conventional ventilation. Although pressure-control ventilation (PCV) is another option available on most critical care mechanical ventilators today, many respiratory care practitioners (RCP) may not be fully aware of its advantages. This article will describe the indications for using pressure control ventilation.

Throughout the last two decades, several new types of ventilation and modes have advanced by way of microprocessor ventilator technology. Among the new types of ventilation that have become common place is variable-flow, time-cycled, pressure-controlled ventilation. When used at its fullest potential, PCV may ventilate, oxygenate, and protect the patient's lungs from ventilator-induced lung injury (VILI) more efficiently than "conventional" volume ventilation.

To avoid confusion, it is best to think of PCV as a type of ventilation as opposed to a mode. PCV does much more than limit or control pressure; it gives a variable flow at a constant preset pressure for a fixed set inspiratory time. The resulting tidal volume is dependent on airway resistance, chest wall and lung compliance and the amount of auto-PEEP.

Advantages of PCV

There are several advantages that PCV has over VCV. The first is a variable decelerating inspiratory flow pattern. Three factors affecting flow are resistance, compliance, and patient effort. In VCV, even if the RCP selects a descending flow pattern, the flow is fixed and does not adapt and adjust to the patient's condition. Some patients may require a high inspiratory flow to meet the inspiratory drive. In VCV, increasing the flow will shorten the inspiratory time (T_I) which may make the patient dys-synchronous. In PCV, the inspiratory flow and the T_I are independent of one another. The RCP sets the inspiratory time according to the patient's particular needs and the decelerating inspiratory flow pattern provides a more even distribution of air to the alveoli regardless of the amount of compliance.

The square inspiratory pressure waveform that is produced during a PCV breath not only limits airway pressure, but gives constant pressure

throughout the inspiratory phase. Because of the initial high peak flow at the beginning of the breath, the preset pressure is achieved quickly and remains at this level until the set T_I is achieved. This allows the alveoli to potentially be kept open for the entire T_I, optimizing oxygenation.

The three main indications for choosing PCV over VCV are: high inspiratory flow demands, poor oxygenation, and/or high peak airway pressures.

PCV can deliver up to 200L/min depending on the particular ventilator. Therefore, the high variable inspiratory flows can satisfy most patient demands, such as with sepsis and neurological issues.

Meeting flow demands improves patient-ventilator synchrony. Patients on VCV with inadequate flow may show signs of flow starvation such as increased agitation and patient-ventilator dys-synchrony. Another advantage is patients who are switched to PCV secondary to high flow demands should require less sedation.

Patients with high F_IO_2 requirements are excellent candidates for PCV. It offers several benefits that the RCP can utilize. One such benefit is the previously mentioned set T_I. A longer T_I will increase gas mixing time and increase mean Paw, both of which can improve oxygenation. Keep in mind that if the T_I is extended beyond the point at which inspiratory flow has reached zero, very little, if any, further volume will be delivered. If an inverse I:E ratio therapy is needed, patients usually require more sedation. This is referred to as inverse ratio ventilation (IRV). Hemodynamics should be monitored closely. One study concluded that a fall in systolic and mean arterial blood pressure was problematic with IRV when an I:E of 2:1 or greater was used. Auto-PEEP can also be a product of IRV, further compromising the circulatory system.

When limiting pressure is the goal for your patient, PCV offers, just as the name implies, a pressure limited or control feature. Any patient who has a high plateau pressure (> 30 cm H_2O) in VCV should either have his tidal volume reduced or be switched to PCV. It is a safer way to ventilate a patient who has noncompliant lungs.

Disadvantages of PCV

The greatest disadvantage of PCV is not having a guaranteed tidal volume. It is for this reason that the RCP must set low volume alarms appropriately. Some ventilator manufacturers offer combination pressure and volume modes. The important fact to remember is that these combination modes actually deliver a pressure type breath with a set T_I and variable decelerating flow linked with a set tidal volume

Summary

The key to properly ventilating patients is assessing the needs of a particular patient and using the type of ventilation that best fits that patient. Frequent reevaluation may point to the need for a different mode or ventilation type. It is vital that every respiratory therapist be familiar with the aspects of PCV. The authors believe that every respiratory care practitioner should consider both volume and pressure control ventilation to be "conventional". The more tools available to us, the better we can ventilate and protect our patients.

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Information in these articles based on information contained within the book "Ventilator Management: A Bedside Reference Manual" by Dana Oakes and Sean Shortall.