Pressure Support Ventilation – Impact on Anaesthesia Practice

a report by
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Assisting the Spontaneously Breathing Patient

Though pressure support ventilation (PSV) has been available in the intensive care setting since 1981, it has only recently become available for use during general anaesthesia. Aside from technical issues relating to the basic differences between intensive care unit (ICU) and operating room (OR) ventilation, there have been few opportunities to employ spontaneous breathing during anaesthesia until the early 1990s and the introduction of the laryngeal mask airway (LMA). The LMA, coupled with newer inhalation anaesthetics, has encouraged clinicians to allow patients to breathe spontaneously through much, or all, of the anaesthetic. PSV can be used to assist those patients in whom spontaneous breathing is elected. The following Clinical Focus, produced by the Department of Clinical Affairs, will discuss PSV for anaesthesia.

What is PSV?

While many other names have been used, the basic idea behind PSV is to support spontaneous breathing by applying pressure to the airway in response to patient-initiated breaths. PSV is patient-triggered and either flow or time-cycled. For PSV to be of value during clinical anaesthesia, the patient must be breathing spontaneously. Other ventilation modes such as synchronous intermittent mandatory ventilation (SIMV), either alone or in combination with PSV, are available for patients who require a mandatory minute volume provided by a mechanical ventilator.

During PSV, once a breath is initiated, the ventilator pressurises the airway to a given inspiratory support pressure (Psupport). This pressure is usually from 5–10cm H_2O pressure and provides the additional ventilatory support required to offset the effects of general anaesthesia. Each PSV-assisted breath is terminated according to a preset decrease in flow or after a specific duration as a back-up.

By applying pressure to the airway immediately upon sensing a patient breathe, PSV enhances inspiratory flow and provides improved gas distribution within the lungs. This enhanced gas distribution results in a lower peak airway pressure, which is quite advantageous when LMAs are used; lower pressure results in less gas leakage around an LMA seal. If LMA seal leaks are present, PSV is able to better compensate for these leaks since the airway pressure is maintained irrespective of the volume, accounting for the delivered tidal volume and leak volume.

The advantage of PSV is its ability to assume some of the patient's increased work of breathing imposed by the patient breathing system used during anaesthesia. PSV can also counter the reduction in functional residual capacity as well as the decrease in muscle contraction produced when modern inhalation anaesthetics are used. In supporting a patient's spontaneous breathing, PSV provides for sustained or enhanced tidal volumes, maintains normal end-tidal CO_2 concentrations and provides for ventilator assistance even when using airway devices that may introduce leaks such as the LMA.

Inhalation Agents and PSV

While PSV can be used anytime in a patient that has the ability to initiate a spontaneous breath, it is best suited to anaesthetics where a normal, or near normal, respiratory rate is expected. Such cases may include agents like sevoflurane or desflurane. These two agents are well suited to permitting spontaneous breathing and, as a consequence, for the application of PSV. Sevoflurane is becoming the standard for use in children. Desflurane is increasingly common for rapid recovery in adults.

How to Implement PSV

While some parameters used during PSV are patient-controlled, a pressure support level (Psupport) must be adjusted on the ventilator. Since the volume, rate and timing of each breath are patient-controlled, there is no adjustment for these during PSV. If clinical conditions require, positive end-expiratory pressure may be added.

The initial level of Psupport will vary from patient to patient depending on the patient's pulmonary

physiology, compliance and other clinical issues. Since the patient's tidal volume is determined by individual lung characteristics and breathing efforts, the effect of the added support will be ventilator-augmented tidal volumes. Clinically, it is easiest to start with lower levels of pressure support, in the 5– 10cm H_2O range, gradually increasing the support pressure to a level where an adequate tidal volume is maintained.

Conclusion

The PSV mode is an invaluable addition to the practice of anaesthesia. The use of PSV allows patients to breathe spontaneously while reducing the patient's work of breathing. This can be a clinical benefit in both out-patient and same-day surgical anaesthesia.

The increased use of LMAs means more spontaneous breathing is permitted during anaesthesia. PSV offers significant benefits in patients breathing with LMAs because lower airway pressures are required, thereby decreasing leaks around the LMA seal.

PSV provides a new and clinically useful ventilation strategy that was only common in ICUs and for the extremely ill pulmonary patient. With PSV in anaesthesia, a larger patient population can be served. ■