Healthcare providers and patients throughout the world depend on Covidien for state-of-the-art ventilation therapy. Whether your needs include acute care for critically ill patients with chronic respiratory failure or a solution to transition patients to home care, we have the right system for the task at hand.

Healthcare professionals know all too well the range of issues that impact ventilation outcomes today. At Covidien, our innovations are systematically tackling the issues that truly matter—patient safety, medical efficacy and healthcare efficiency. The Volume Ventilation Plus software option is another example of how we’re helping medical professionals improve ventilation outcomes and quality of life for their patients.
THREE DIMENSIONS OF EXCELLENCE BUILT INTO THE VOLUME VENTILATION PLUS SYSTEM

- **Patient Safety**—Three specific alarms come with the VC+ and VS options that alert the clinician of changes in patient condition and provide lung protection.

- **Clinician Support**—The VV+ option offers the patient enhanced comfort and synchrony (clinician support) while offering clinicians a way to maintain targeted tidal volume.

- **Healthcare Efficiency**—The VV+ system expands the therapeutic range options for clinicians. It is also effective in weaning patients from anesthesia, resulting in less time and money spent on postoperative recovery.

A BRIEF OVERVIEW OF VOLUME VENTILATION

Standard volume ventilation has been associated with increased work of breathing, flow starvation and prevention of spontaneous breathing or coughing during the inspiratory phase.\(^1\)\(^2\) If higher sedation is used to treat ventilator asynchrony, the increased sedation or paralysis could lead to increased time on the ventilator.\(^3\)\(^-\)\(^7\) In contrast, recent research has indicated that limiting damage believed to be caused by over distention of the lungs in acute respiratory distress syndrome (ARDS) may play an important role in improving survival. Lower tidal volume and lower lung pressure have been associated with improved survival.\(^8\)\(^-\)\(^10\) Whether volume or pressure strategies are best for achieving this lung protection goal remains undetermined.

This clinical paper describes two new breath delivery strategies with significant improvements in spontaneous breathing and preset volume delivery.
PRESSURE-BASED AND VOLUME-BASED BREATHS

The phrase “dual modes” of ventilation has caused some confusion regarding when to employ one kind of breath type or another kind of breath type. Dual modes are not actually modes but, rather, breath types. A breath type is defined as the means by which either a mandatory or spontaneous breath is delivered (i.e., Pressure Support, Pressure Control, Volume Control).

A Pressure breath type (whether mandatory or spontaneous) is determined by presetting the delivered peak pressure, while allowing flow and or tidal volume to vary.

A Volume breath type is determined by presetting a tidal volume, allowing pressure to rise and fall as lung impedance changes. Volume breath goals include maintaining consistent ventilation, maintaining low volumes for lung protection and eliminating CO₂.

VOLUME VENTILATION PLUS

Volume Ventilation Plus (VV+) is an option that combines two different dual mode volume-targeted breath types—Volume Control Plus (VC+) for delivery of mandatory breaths in A/C and SIMV, and Volume Support (VS) for delivery of spontaneous breaths in SPONT only.

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**VOLUME CONTROL PLUS**

Volume Control Plus (VC+) utilizes a clinician-set inspiratory time and clinician-set target tidal volume. The ventilator initially delivers a single standard volume test breath with a decelerating flow pattern and plateau to determine the relative lung compliance. If the delivered tidal volume is either greater or less than the preset value, the target pressures for subsequent breaths are adjusted to correct any discrepancies.

The volume-targeted mandatory breath delivered in VC+ is designed to address problems sometimes encountered with standard volume ventilation. When volume ventilation is desired, VC+ can help assure a high level of synchrony.

**VC+ CLINICAL ADVANTAGES**

Common uses of VC+:

- The clinician sets only the target volume and inspiratory time. The flow rate is then delivered in a descending ramp pattern, with a maximized initial inspiratory flow. VC+ reduces the potential for inappropriately low flow settings and inadvertent flow starvation.\(^1\text{-}^{13}\)

- A pressure control style of breath allows active spontaneous breathing during the inspiratory phase of the mandatory breath. Breathing, coughing or splinting is then allowed by venting excess pressure.

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Note: The software program for VV+ includes the VC+ and VS options (part #4-078126-00).
SPONTANEOUS BREATHING DURING VC+

- Spontaneous breathing is allowed during the inspiratory phase through the use of the active exhalation valve.
- Flow is determined automatically, thereby reducing the potential for inappropriately low flow rates.
- A higher or lower initial flow rate is allowed, increasing the potential for patient synchrony during splinting or aggressive flow demands.

VC+ OPERATING FEATURES

The Puritan Bennett™ 840 Ventilator’s VC+ option allows easy substitution for standard volume ventilation breaths in A/C or SIMV modes, since VC+ is a volume breath type.

Operating features:
- The ventilator quickly attains target tidal volume through its short series of test breaths. Intelligent recognition of adequate plateau helps protect against incorrect target values.
- Pressure is incrementally adjusted during start up. Pressure adjustment minimizes risk of large pressure and tidal volume swings caused by sudden and momentary changes in compliance.
- Tidal volume limits can be set to terminate breaths, should the tidal volume rise above desired levels before subsequent pressure targets are automatically lowered to deliver breath at preset volumes.
- Any disconnect is recognized and alarmed specifically as a circuit disconnect. Reconnection results in immediate resumption of previous target pressure and volume levels, assuring immediate resumption of mean airway pressure.
VOLUME SUPPORT

Volume Support (VS) utilizes a breath delivery control algorithm similar to the one used in the VC+ option. However, VS utilizes pressure support, instead of pressure control, to adjust flow. The clinician still sets the target volume but does not set the inspiratory time or ventilator rate. The ventilator then delivers a spontaneous pressure support style of breath and varies the pressure up or down to guarantee the preset tidal volume. As the patient assumes more of the work of breathing, the ventilator senses increased tidal volumes and decreases pressure. Should the tidal volume decrease, the ventilator will automatically increase VS to protect the patient from hypoventilation.

Patient triggering determines the ventilatory rate; patient demand determines the inspiratory time.

VS CLINICAL ADVANTAGES

The VS option is a spontaneous breath type utilizing a varying pressure support strategy to maintain a target tidal volume.

Common uses for VS:

Weaning from anesthesia. Clinicians set a target level of volume. As patients breathe above or below the preset volume, the support is increased or decreased to restore set volume. When patients begin to awaken and take larger and more frequent spontaneous breaths, the ventilator decreases its VS. However, if the patient's level of consciousness and respiratory drive decrease, VS increases. The VS option includes an apnea ventilation safety back up, should the patient cease breathing altogether.

The problems associated with targeting minute volume arise when patients satisfy the minute volume criteria by breathing rapidly and shallowly. VS focuses on tidal volume, instead of minute volume.

Control tidal volume and increase patient comfort. Although the literature about the efficacy of VS as a primary mode is scant, the VS option has also been used successfully as a primary mode of ventilation, especially in infants and pediatric patients. The clinician sets the patient's tidal volume. The ventilator will limit pressure without terminating breaths, if pressure rises to within 5 cm H₂O of the upper pressure limit. As compliance improves and the pressure falls, the patient can be ventilated with a minimal tidal volume at the lowest possible pressure. The higher setting allows patients more control over the support they are receiving (control of inspiratory time, control of respiratory rate and control of flow rate).
VOLUME SUPPORT AND PRESSURE SUPPORT

The VS option has advantages and limitations compared to Pressure Support (PS). The VS option may help keep patients in less danger of over- or under-ventilation, unless the patient’s respiratory drive and effort exceed the set tidal volume. PS will not decrease support, even if patient demand increases. The choice of VS or PS depends on the institution’s protocols, the disease entity, the acuity of the patient being treated and the clinician’s therapeutic goals.

SUMMARY

New flexibility in breath delivery can increase comfort for patients breathing spontaneously on mechanical ventilation. The Puritan Bennett™ 840 Ventilator, with its VC+ and VS options, expands the therapeutic range for clinicians and patients alike. The VC+ option offers clinicians the opportunity to take advantage of these new capabilities while maintaining control of tidal volume. VS may be useful in improving patient comfort and/or in weaning from anesthesia. Both options represent a breakthrough in ventilatory care of patients.