Puritan Bennett™ 840 Ventilator

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The Link Between Sedation and ICU Outcomes

Keeping patients comfortable and at ease while they're in the ICU can be very challenging. Patients often have limited consciousness or ability to communicate.[1, 2]

A full 71% of patients show signs of agitation at least once during their stay.[1] Out of compassion, clinicians often turn to sedation to relieve distress.[1]

However, a growing body of research has confirmed a strong link between sedation and poor patient outcomes. When used inappropriately, sedation can lead to failure to wean, prolonged ICU stays and increased cost of care.[1]

The Challenging Reality of Mechanical Ventilation

Although a necessary intervention, conventional modes† of mechanical ventilation are limited in their ability to properly manage a patient's work of breathing.[3-5] In fact, in the ICU, 42% of increases in sedation are in response to patient-ventilator asynchrony.[1]

Without a way to better manage work of breathing, increasing sedation can seem like the best option. But, increased sedation can prolong time on the ventilator.[1, 2]

Vicious Cycle Affecting Outcomes

1. Patient is mechanically ventilated

2. Sedation is lightened

3. Patient becomes agitated

42% of all increases in sedation are in response to asynchrony.[1]

4. Patient is sedated to alleviate agitation

5. Patient is at increased risk for muscle atrophy

Respiratory muscle atrophy begins in as little as 18 hours.[6]

Although there are multiple reasons why atrophy of the diaphragm occurs, it appears that a significant factor is reduced activity, even in PSV and PSV based modes.[6]

†VC, VC+, PC, PS and PSV based modes

Clinical goal

Weaning comprises approximately 40% of the time spent on the ventilator.[9]

Most patients are extubated in <three days, but ~20% require prolonged support.[9]

ACUTE STAGE »

Offload work of breathing and treat the underlying condition

Controlled Modes

In controlled modes, a patient doesn't have to do any work. That's often desirable at this stage, but can cause limitations when trying to get the patient to breathe on their own.[10]

WEANING STAGE »

Facilitate patients breathing on their own and liberate from the ventilator

Spontaneous Modes

Multiple authors agree respiratory muscle weakness is an important risk factor for delayed weaning.[7, 11]

A study published in the *New England Journal of Medicine* found muscle atrophy occurred in as little as 18 hours of mechanical ventilation.[6]

Although there are multiple reasons why atrophy of the diaphragm occurs, it appears that a significant factor is reduced activity, even in spontaneous modes such as pressure support (PSV).[7]

FAILURE TO WEAN

In addition, conventional modes of ventilation are rigid in their delivery of a breath. This pattern can be at odds with the patient's natural breathing rhythm, facilitating the cycle of asynchrony, sedation and muscle weakness.[3, 4]

Volume Controlled

If a patient wakes up and tries to participate in breathing, work of breathing (WOB) and/or anxiety can increase:

- WOB – Vt limit is not high enough or the breath is too short. This can also cause anxiety.
- Anxiety – Breath is too long
- Patient may show signs of agitation and is sedated[3]

Pressure Controlled

Relatively comfortable mode, patient can receive variable flow, but the patient does not have to do any work leading to an increased risk of muscle atrophy.[7, 11]

Pressure Support

Spontaneous breathing is allowed, however, it's still a programmed breath. If the patient triggers the ventilator he or she receives the programmed breath.

The patient either has to work very hard or not at all if ventilator settings are not aligned.

- WOB – if the level of support is below patient demand, the WOB will increase
- Reduced activity – if the level of support exceeds patient demand, the patient may have periods of reduced activity leading to an increased risk of muscle weakness
- Ineffective triggers – found to be an independent predictor of longer mechanical ventilation duration,[4] ineffective triggers can result in an increase in WOB and/or anxiety
- Patient may show signs of agitation and is sedated[3]

To the patient, waiting for that next breath feels like they're suffocating, causing panic. Being forced to breathe too quickly, too shallowly, or too deeply is unsatisfying and extremely tiring, leading to distress.[5]

Promote Natural Breathing

At Covidien, we believe mechanical ventilation can and should be more natural.

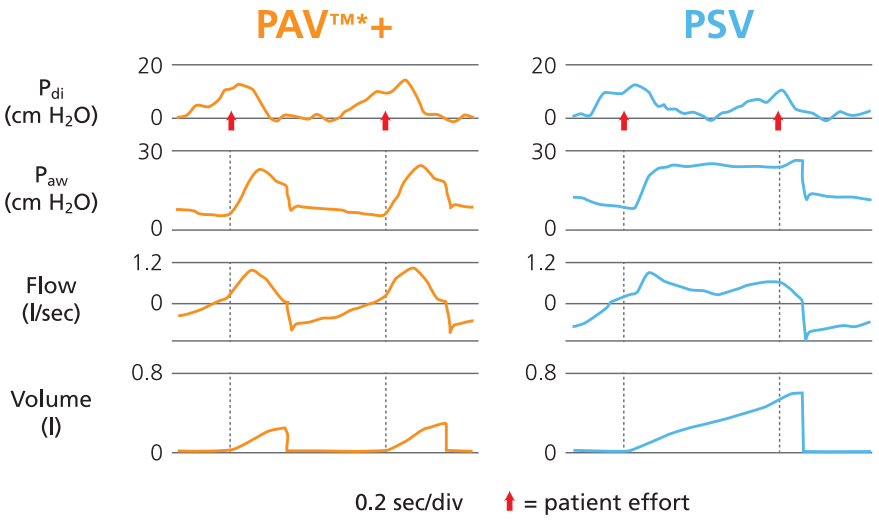
Our PAV™*+ software for the Puritan Bennett™ 840 ventilator is a breath type that better manages the patient's work of breathing and promotes natural breathing compared to conventional mechanical ventilation†.[8]

PAV™*+ software manages the patient's work of breathing differently than other current modes of mechanical ventilation† in the following ways.[12]

With PAV™*+ mode the patient defines rate, depth and timing.

- Flow is an indicator of demand. It tells us when the patient wants to begin inspiration, how deep the breath should be, when to end the breath and how often to breathe.
- PAV™*+ mode continuously measures patient demand by measuring flow and volume every 5 milliseconds.
- As patient demand changes, PAV™*+ mode changes support within the same breath.

Enabling the patient to define rate, depth and timing helps reduce excessive workload or patient agitation, potentially reducing the need for unnecessary sedation.[13-17]



Ineffective Efforts (min)

Assist Level	PAV™*+	PSV
Min.	0.3	1.0
	0.6	4.0
	1.0	10.0
Max.	1.2	13.0

PAV™*+ mode provides better synchrony with a patient's breathing than pressure support ventilation modes (PSV)

Year	Author	Results
2011	Costa et al[13]	"PAV+ improves patient-ventilator interaction, significantly reducing the incidence of end-expiratory asynchrony and increasing the time of synchrony."
2009	Xirouchaki et al[14]	"Compared to PS, PAV+ is associated with fewer interventions in terms of ventilator settings and sedative dose changes."
2008	Xirouchaki et al[15]	"Compared to PS, PAV+ increases the probability of remaining on spontaneous breathing, while it considerably reduces the incidence of patient-ventilator asynchronies."
2007	Bosma et al[16]	"PAV+ resulted in better quality of sleep compared to PSV."

When the %Support is set, the patient and the ventilator are sharing the work of breathing as defined by the clinician.

- Work of breathing can be calculated using the equation of motion.[18]
- When R and E are known, it's possible to calculate patient-generated pressure (Pmusc) and work of breathing in real time using the equation of motion.[16, 18-21]

  $P_{MUSC} + P_{VENT}$ = (flow x resistance) + (volume x elastance)
- PAV™*+ mode measures resistance and compliance every 4-10 breaths.
- Once %Support is set, clinicians can use the work of breathing (WOB) bar for real-time feedback on how much work the patient is doing.
- The work of breathing bar displays both total work of breathing (WOBtot) and the patient work of breathing (WOBpt).
- Associated fatigue values for work of breathing are shown as being outside the green zone.

The work of breathing bar, when coupled with good clinical assessment, can help take the guesswork out of determining the appropriate level of mechanical ventilation support.

Providing real-time feedback on work of breathing enables the clinician to keep the patient at a sustainable level of work—reducing the risk for respiratory muscle atrophy, but off-loading enough work to avoid fatigue.[7, 9, 11]

The work of breathing bar shows total work of breathing (WOB_{TOT}) and patient work of breathing (WOB_{PT})

Clinician sets "%Supp" to define the patient's WOB%age

A Good Fit for Your Institution

In addition to PAV™* software, the Puritan Bennett™ 840 ventilator features a full suite of software options, safety features and accessories to fit a variety of patients, from infant to adult.

Software Options

Leak Compensation: To help ensure patients are receiving the flow and volume they need, Leak Compensation software immediately detects and rapidly adjusts to changes caused by patient or airway interface movement, leaks and other barriers to targeted breath delivery. This helps prevent auto-triggering and as a result can help minimize patient-ventilator asynchrony.

In studies, the Puritan Bennett™ 840 ventilator with Leak Compensation software was shown to:[5, 12]

- Synchronize to increasing and decreasing leaks in both obstructive and restrictive lung models and with PEEP 5 cm H_2O and 10 cm H_2O
- Require fewer breaths to synchronize, under all test conditions
- Perform equally in both invasive and noninvasive ventilation settings

NeoMode 2.0 Software: This software enables the clinician to adjust ideal body weight (IBW) without disconnecting the patient, thereby avoiding the additional risks associated with patient disconnection. The ventilator is also able to detect and compensate for patient leaks, reducing the number of nuisance alarms and improving patient safety.

Bi-Level Software: Permits spontaneous breathing at all times, reducing patient-ventilator asynchrony. This software supports biphasic or airway pressure release ventilation for extra flexibility. An active exhalation valve improves patient comfort and reduces ICU costs associated with continuous sedation.

Volume Control Plus: This controlled breath type enables the patient to take spontaneous breaths, and pressure is automatically adjusted to encourage the patient to pull the targeted tidal volume.

Trending Software: Shows time-stamped displays of ventilator settings up to 53 parameters of monitored patient data and specific events for intervals up to 72 hours.

Respiratory Mechanics Software: Enables monitoring of key respiratory parameters for easy assessment of patient status.

Tube Compensation Software: Accurately overcomes the work of breathing imposed by the artificial airway. Helps clinicians better recognize when a patient is ready to extubate.

Features Designed for Safety

- **Circuit disconnect detection:** Monitors circuit pressure and effective patient volume to promptly detect circuit disconnection.
- **Automatic patient detection:** Helps prevent inadvertent changes from existing ventilator settings to standby modes that do not provide ventilation.
- **Ongoing background checks:** Assesses the proper function of the ventilator's electronics and pneumatics hardware continuously during ventilation.
- **Heated expiratory filters:** Traps 99.97% of pathogens to shield patients, clinicians and visitors from exposure to viruses and bacteria from exhaled gases.[18, 19]
- **Puritan Bennett™ 803 extended backup power source (BPS):** Minimizes risks during power outages by providing up to four hours of continuous battery backup power.[20]

Accessories

- **Puritan Bennett™ 840 ventilator pole cart:** Enables the ventilator to fit into confined spaces when a compressor is not required. Features dual-wheel castors and an ergonomic 360-degree handle system to improve maneuverability.
- **Puritan Bennett™ 840 compressor mount cart:** Offers a sturdy compressor mount plus either a one-hour or four-hour backup power supply.
- **Puritan Bennett™ 806 compressor:** Fits the compressor mount cart to provide a safe alternative air source if bottled or wall air are not available.
- **Puritan Bennett™ 840 ventilator cart:** Offers lightweight, easy maneuverability in a cost-effective package.

ORDERING INFORMATION

Standard Accessories	Catalog Number
Flex arm	4-032006-00
Inspiratory bacteria filter	
Disposable filter (D/Flex, carton of 12)	4-074601-00
Expiratory bacteria filter and collector vial	
Disposable filter (D/X800, carton of 12)	4-076887-00
Test hose	4-018506-00
Test lung	4-000612-00
Oxygen hose assembly, DIS (U.S.)	4-001474-00
Air hose assembly, DIS (U.S.)	4-006541-00
Power cord (North America)	4-071420-00
Operator's and technical reference manual	
English	4-075609-00
Spanish	4-070147-00
Software Options	
NeoMode 2.0 Software Option	10051492
Leak Compensation Software Option	10035870
Tube Compensation Software Option	4-076371-00
Bi-Level Software Option	4-076064-00
Volume Ventilation Plus Software Option	4-078126-00
PAV™*+ Option Kit	4-078203-00
Respiratory Mechanics Option Kit	10019218
Trending Software Option	10020408
Optional Accessories	
Service manual, English	4-070089-00
Puritan Bennett™ 840 Ventilator Cart and Accessories	
Puritan Bennett™ 840 Ventilator Cart with 1 Hr BPS	10000193
Puritan Bennett™ 840 Ventilator Cart with 4 Hr BPS	10000194
Wall-Air Water Trap Kit	4-075315-00
Fisher & Paykel Humidifier Mounting Kit for Black Carts	4-075313-00
Puritan Bennett™ 803 Backup Power Supply (BPS)	10030274
Battery Replacement Kit	4-070523-SP
Puritan Bennett™ 840 Ventilator Compressor Mount Cart and Accessories	
Puritan Bennett™ 840 Ventilator Compressor Mount Cart with 1 Hr BPS	10046822
Puritan Bennett™ 840 Ventilator Compressor Mount Cart with 4 Hr BPS	10046823
Cylinder Mount Bracket Kit	10045586
Wall-Air Water Trap Kit	10045588
Universal Humidifier Mounting Bracket for White Carts	10045589

Puritan Bennett™ 840 Ventilator Pole Cart and Accessories	
Puritan Bennett™ 840 Ventilator Pole Cart and 1 Hr BPS	10046826
Puritan Bennett™ 840 Ventilator Pole Cart and 4 Hr BPS	10046827
Cylinder Mount Bracket Kit	10045578
Wall-Air Water Trap Kit	10045588
Humidifiers and Breathing Circuits	
Reusable, adult, with heated wire, for Fisher & Paykel	G-061235-00
Reusable, adult, without heated wire	G-061208-SP
Reusable, pediatric, with heated wire, for Fisher & Paykel	G-061237-00
Reusable, pediatric, without heated wire	G-061223-00
Humidifiers and Breathing Circuits (continued)	
Humidifier Base	4-MR850-00
Puritan Bennett™ MR 850 Starter Kit	4-070773-00
Fisher & Paykel Mount Kit for Universal Bracket	10081874
Hudson Mount Kit for Universal Bracket	10081875
Kendall A2000 Mount for Universal Bracket	10081876
Fisher & Paykel Shroud Kit	10081877
Mounting Plate - Fisher & Paykel Shroud	10081785
Inspiratory bacteria filter	
Reusable filter (Re/Flex, each)	4-074600-00
Neo filter and adapter	
Neo disposable filter (carton of 12)	4-076408-00
Neo filter adapter	4-076405-00
Expiratory bacteria filter and collector vial	
Reusable filter (Re/X800, each)	4-070305-00
Reusable collector vial (Re/X800, each)	4-074647-00
Drain Bag and Drain Bag Accessories	
Drain bag, disposable (package of 25)	4-048491-00
Drain bag tubing, disposable (package of 10)	4-048493-00
Clamp, reusable (package of 5)	4-048492-00
Drain cap	4-074613-00
Filters and Sensors	
Seal, expiratory filter	4-070311-00
Filter, foam, compressor inlet	4-074374-00
Oxygen sensor††	4-072214-00
Nebulizer	
Aeroneb®* Pro Nebulizer	4-AP6000-US
Preventive Maintenance Kits	
10,000-hour preventive maintenance kit††, BDU/GUI	4-078179-00
15,000-hour preventive maintenance kit††, compressor	4-076805-00

††Oxygen sensor to be replaced every two years or as necessary by a qualified service technician. Preventive maintenance kits must be installed by a qualified service technician.

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