

Respiratory Therapy - Unit Practice Manual
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GUIDELINES FOR: Pressure Support Ventilation with the EVITA XL

POLICY: Pressure support ventilation (PSV) is a pressure limited flow cycled mode that is triggered by the infant's spontaneous breath and all breaths are supported to a preset pressure. The pressure support breath is designed to give every spontaneous breath a "boost" of pressure on inspiration terminating each breath when the inspiratory flow declines to a preset threshold. This feature managed through the flow triggering sensor eliminates inspiratory hold and provides optimal patient-ventilator synchrony. PSV functions primarily as a weaning mode to enable full or partial unloading of respiratory musculature during mechanical ventilation. PSV can be used alone (endotracheal CPAP/PSV) or as an adjunct to synchronized intermittent mandatory ventilation (SIMV) or Pressure Control Ventilation Plus (PCV+) with the EVITA XL ventilator. Work of breathing created by the endotracheal tube and ventilator circuit can be overcome through the use of pressure support.

RATIONALE: When the infant initiates a breath there is a rapid delivery of flow which peaks and then decelerates. Inspiration ends when the inspiratory flow declines to 25% of peak flow. If the flow cycling criterion is not met, the inspiratory time limit (T_{insp}) will end the inspiration phase and begin the expiration phase (Fig.1) in all PS modes (PCV+, SIMV, CPAP/PS). The infant decides the start of inspiration and start of expiration and therefore controls the inspiratory time, respiratory rate and peak inspiratory flow of the spontaneous breath.

INDICATIONS:

- Weaning for spontaneously breathing patients.
- Compensation for inspiratory work of breathing associated with the ventilator circuit and endotracheal tube.
- When the ventilator strategy includes the assistance of spontaneously triggered breaths.
- Full ventilator support in patients with ventilator drive and normal to moderately abnormal lung function.

ADVANTAGES:

- Complete patient-ventilator synchrony during inspiration and expiration.
- Allows for less sedation to be used.
- Allows the patient to establish their own respiratory pattern, the patient can control onset and duration of the inspiratory cycle.
- Depending upon the set level of pressure support, PSV can overcome the resistive forces primarily related to the ventilator and endotracheal tubing, or both the resistive and elastic forces (elastic forces are secondary to decreased lung compliance).
- Decreased work of breathing with the same tidal volume delivered.
- With PSV the diaphragm maintains tone, which may minimize basilar atelectasis.

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**CONTRA-
INDICATIONS:**

- Inability to initiate a breath due to neuromuscular blocking agents, deep sedation, neurological diseases affecting the medulla, or peripheral nerve disease/injury such that the patient cannot breathe.
- High level of anxiety or tachypneic respiratory states.
- Patients with low respiratory drive that result in periods of hypoventilation.
- Low compliance states and conditions requiring high level of inspired oxygen and mean airway pressure support.

LIMITATIONS:

- The EvitaXL in the PS mode has **limited** ability to compensate for leak flow and detect patient effort/trigger above the leak. When the leak is not compensated autocycling will occur. Autocycling is when the leak flow exceeds the trigger threshold resulting in a breath being triggered without spontaneous activity. To verify that autocycling is not occurring, the infant's spontaneous rate should be the same as the pressure supported breaths seen on the pressure curve and in measured values.
- The Evita XL can compensate for leaks when the MVleak (minute ventilation leak) is less than 3L/min. This information is found by selecting the data key and then selecting table 1.

VARIABLES IN

PSV: There are three variables which determine how PSV will affect the work of breathing and patient-ventilator synchronization:

1. **Triggering of inspiration:** Flow triggering is used in the PSV mode to initiate the inspiratory flow. Triggering should begin at 0.5L/min with the EVITA XL.
2. **Inspiratory pressure rise time:** The rise time (slope in the EVITA XL) determines how quickly the ventilator reaches the preset pressure. The rise time should be set at zero when PSV is used in conjunction with SIMV and when used with endotracheal CPAP/PSV.
3. **End of inspiration:** PSV is terminated:
 - when the inspiratory flow declines to 25% of peak flow.
 - when the inspiratory flow returns to zero i.e., the infant exhales or fights the ventilator.
 - when the inspiratory time (T_{insp}) limit has been reached.

**CLINICAL
MANAGEMENT:**

1. PSV may be used alone in infants with a consistent respiratory drive (endotracheal CPAP/PSV) or in conjunction with Synchronized Intermittent Mandatory Ventilation (SIMV) or in Pressure Control Ventilation Plus (PCV+) with the EVITA XL. The pressure support level can be adjusted to deliver either a full tidal volume or a lower tidal volume for partial support.

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PCV+/PSV

FIO2 = 50% P_{insp} = 22
 Rate = 18 PS = 5.1cm (30%ΔP) to target a spont. V_t 4-7cc/kg
 T_{insp} = 0.4 sec PEEP = 5

ENDOTRACHEAL CPAP/PSV

FIO2 = 50%
 PS = 5.1cm to target a spont. V_t 4-7cc/kg
 PEEP = 5
 T_{insp} = 0.5 sec - 0.6 sec (Inspiratory time limit will terminate inspiration if flow criterion of 25% is not met.)

* The pressure support level when using endotracheal CPAP/PSV can be derived from the previous P_{insp} level (30%ΔP) or by beginning at a PS level of 5, verifying the targeted spontaneous tidal volume and increasing the PS in increments of 1 until the targeted spontaneous tidal volume has been reached.

PRESSURE TARGETED MODE (PCV+): When the PEEP is increased or decreased the pressure support breath is adjusted accordingly.

P _{insp} = 20 ΔP = 15 PEEP = 5 PS = 4.5 PS + PEEP = PIP spont 4.5 + 5 = 9.5
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Increase PEEP

P _{insp} = 20 Δ P = 14 PEEP = 6 PS = 4.2 PS + PEEP = PIP spont 4.2 + 6 = 10.2
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- The inspiratory pressure for the mechanical breath remains at the set pressure (P_{insp}) when the PEEP is increased or decreased.
- There will be a decrease in Δ P with the mechanical breath and an increase in the PIP of the spontaneous breath when increasing PEEP.

VOLUME TARGETED MODE (SIMV): The tidal volume is targeted so the P_{insp} will fluctuate according to the compliance of the infant's lungs to a maximum of the high pressure alarm limit. When the PEEP is increased or decreased the pressure support breath is adjusted accordingly.

PS = 4.5 PEEP = 5 PIP spontaneous = 9.5

Increase PEEP

PS = 4.5 PEEP = 6 PIP spontaneous = 10.5
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- The inspiratory pressure (PIP) will fluctuate according to the compliance of the infant's lungs.
- The Δ P will be maintained until the high pressure alarm is reached.

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WEANING:

SIMV/PSV or PCV+/PSV

1. Decrease the mechanical rate allowing an increase in the pressure supported spontaneous rate. The SIMV rate should go no lower than 8-10 breaths/min. This minimum rate will offer support to those patients with a potential for hypoventilation and/or less than adequate tidal volumes.
2. Once at the minimum rate, gradually decrease the pressure support level (PS) generally one to two, allowing the infant to take over a greater percentage of the work of breathing while maintaining spontaneous tidal volume of 4-7cc/kg.
3. The level of pressure support is titrated to achieve a tidal volume and respiratory rate that leads to patient comfort and acceptable work of breathing.
4. The level of pressure support should not be lower than that needed to overcome the work of breathing of the endotracheal tube and ventilator circuit; typically 4-5 cm H₂O pressure.
5. Maintain minimum PEEP until extubation to prevent derecruitment and/or atelectasis.
6. Extubate when the pressure support level delivers 5ml/kg tidal volume, the infant is not tachypneic, comfortable and meets all other clinical criteria for extubation.
7. Continue to monitor the infant for work of breathing and fatigue.

ENDOTRACHEAL CPAP/PSV

1. Decrease the pressure support level to deliver a tidal volume of 4-7 ml/kg while maintaining a minimum respiratory rate of 30 breaths/minute. The level of pressure support should not be lower than that needed to overcome the work of breathing of the circuit and endotracheal tube; typically 4-5 cm H₂O pressure.
2. Extubate when the pressure support level delivers 5 ml/kg and the infant meets all other clinical criteria for extubation.
3. Maintain minimum PEEP until extubation to prevent derecruitment and/or atelectasis.

APPROVAL:

EFFECTIVE DATE: 5/08

REVISION DATES: