Introduction to various modes of mechanical ventilation

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APRV
Airway pressure release ventilation
ASB
Assisted spontaneous breathing
ASV
Assisted spontaneous ventilation
ATC
Automatic tube compensation
Automode
Automode
BIPAP
Bilevel Positive Airway Pressure
CMV
Continuous mandatory ventilation
CPAP
Continuous positive airway pressure
CPPV
Continuous positive pressure ventilation
EPAP
Expiratory positive airway pressure
HFV
High frequency ventilation
HFFI
High frequency flow interruption
HFJV
High frequency jet ventilation
HFOV
High frequency oscillatory ventilation
HFPPV
High frequency positive pressure ventilation
ILV
Independent lung ventilation
IPAP
Inspiratory positive airway pressure
IPPV
Intermittent positive pressure ventilation
IRV
Inversed ratio ventilation
LFPPV
Low frequency positive pressure ventilation
MMV
Mandatory minute volume
NAVA
Neurally Adjusted Ventilatory Assist
NIF
Negative inspiratory
NIV
Non-invasive ventilation
PAP
Positive airway pressure
PAV and PAV+
Proportional assist ventilation and proportional assist ventilation plus
PCMV (P-CMV)
Pressure controlled mandatory ventilation
PCV
Pressure controlled ventilation or PC
PEEP
Positive end-expiratory pressure
PNPV
Positive negative pressure ventilation
PPS
Proportional pressure support
PRVC
Pressure regulated volume controlled ventilation
PSV
Pressure Support Ventilation or PS
(IMV (Synchronized)
S-CPPV
Synchronized continuous positive pressure ventilation
S-IPPV
Synchronized intermittent positive pressure ventilation
TNI
Therapy with nasal insufflation
VCMV (V-CMV)
Volume controlled mandatory ventilation
VCV
Volume controlled ventilation or VCVS

Concepts and Modes of Mechanical Ventilation

Control Modes
– every breath is fully supported by the ventilator
– in classic control modes, patients were unable to breathe except at the controlled set rate
– in newer control modes, machines may act in assist-control, with a minimum set rate and all triggered breaths above that rate also fully supported.
SIPPV (or PTV or A/C) and SIMV

Terminology:

Triggered ventilation can be divided into patient triggered (PTV), otherwise known as synchronous intermittent positive pressure ventilation (SIPPV) or assist control (A/C), the infant being able to trigger a positive pressure inflation with each breath, and synchronized intermittent mandatory ventilation (SIMV), the infant being able to trigger only a pre-set number of positive pressure inflations.

IMV, SIMV, SIPPV (or A/C or PTV), PSV

Does the mode make the difference?
Conclusions: We found that SIMV was at least as efficacious as conventional IMV, and may have improved certain outcomes in BW-specific groups.


Baumer JH Arch Dis Child Fetal Neonatal Ed 2000;82:F5–F10

PTV (A/C) versus IMV

There was no observed benefit from the use of PTV, with a trend towards a higher rate of pneumothorax under 28 weeks of gestation. Although PTV has a similar outcome to IMV for treatment of RDS in infants of 28 weeks or more gestation, within 72 hours of birth, it was abandoned more often. It cannot be recommended for infants of less than 28 weeks’ gestation with the ventilators used in this study.

Baumer JH Arch Dis Child Fetal Neonatal Ed 2000;82:F5–F10

Synchronized mechanical ventilation for respiratory support in newborn infants (Review)

**Pressure Control vs. Pressure Support**

- **Constant inspiratory pressure**
- **Decelerating, variable inspiratory flow rate**

**Time cycled:** (A) Pressure Control
**Flow cycled:** (B) Pressure Support

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**Termination Sensitivity = Cycle-off Criteria**

- Peak Flow (100%)
- TS 5%
- Leak
- Tinsp. (eff.)
- Tinsp.

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**SIMV versus SIMV + PSV**

- **Minimal ventilator settings:**
  - PIP 16 cm H2O
  - FiO2 0.30
  - PEEP 5 cm H2O
  - SIMV rate 15 breaths per minute
- and remained on these settings for 48 hours

 Reyes ZC et al. Pediatrics 2006;118:1409-1417

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**PSV improves respiratory function in VLBW infants when compared to SIMV**

<table>
<thead>
<tr>
<th>TABLE 1 - Results Concerning Spontaneous Respiratory Rate (RR), Total Volume (Vt), Minute Volume (Vt), and Mean Airway Pressure (MAP) During Four Ventilation Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>First ventilation cycle</td>
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<tr>
<td>--------------------------</td>
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<tr>
<td>Test phase 1: SIMV (4 hr)</td>
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<tr>
<td>RR min-max (mean)</td>
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<tr>
<td>Vt min-max (mean)</td>
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<tr>
<td>MAP min-max (mean)</td>
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<tr>
<td>TS 5%</td>
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<tr>
<td>Set (max) Tinsp.</td>
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</tbody>
</table>

**RESULTS:**

- PSV improves respiratory function in VLBW infants when compared to SIMV.

**CONCLUSIONS:**

For this study, it was found that the addition of PS as a supplement to SIMV during the first 28 days may play a role in reducing the duration of mechanical ventilation in extremely VLBW infants, and it may lead to a reduced oxygen dependency.

Reyes ZC et al. Pediatrics 2006;118:1409-1417
Compliance Changes During Pressure Controlled Ventilation

Volume Ventilation

Tidal volume is not affected by the rapidly changing pulmonary mechanics

Compliance ↓

Pressure Ventilation:
Decreased Tidal Volume

Volume Ventilation:
Increased Pressure

Combination “Dual Control” Modes

Combination or “dual control” modes combine features of pressure and volume targeting to accomplish ventilatory objectives which might remain unmet by either used independently.

Combination modes are pressure targeted
Partial support is generally provided by pressure support
Full support is provided by Pressure Control

Volume Assured Pressure Support (Pressure Augmentation)

Volume Support (Variable Pressure Support)

Pressure Regulated Volume Control (Variable Pressure Control, or Autoflow)

Airway Pressure Release (Bi-Level, Bi-PAP)

PRVC (Pressure regulated volume control)

A control mode, which delivers a set tidal volume with each breath at the lowest possible peak pressure.

Delivers the breath with a decelerating flow pattern that is thought to be less injurious to the lung…… “the guided hand”.

Combination “Dual Control”Modes

Volume Assured Pressure Support (Pressure Augmentation)

Volume Support (Variable Pressure Support)

Pressure Regulated Volume Control (Variable Pressure Control, or Autoflow)

Airway Pressure Release (Bi-Level, Bi-PAP)
PRVC: Advantages

Decelerating inspiratory flow pattern
Pressure automatically adjusted for changes in compliance and resistance within a set range
Tidal volume guaranteed
Limits volutrauma
Prevents hypoventilation
PRVC: Disadvantages

Pressure delivered is dependent on tidal volume achieved on last breath

Intermittent patient effort \( \Rightarrow \) variable tidal volumes

Volume Targeted Ventilation

Concept: deliver the set Vt at the lowest airway pressure possible

Volume targeted ventilation: A Self Weaning Mode

Methods:

PSV group: The weaning strategy consisted of reducing the pressure support level progressively over time, so that the work of breathing was shifted from ventilator to the patient.

PSV-VG group: Weaning was a more automatic process once appropriate levels of Vt had been established.

Similar blood gas goals (e.g., pH > 7.25; pO2, 50–75 mmHg; pCO2, 40–65 mmHg) were achieved during weaning from mechanical ventilation in both groups.
Pressure-Regulated Volume Control Ventilation vs. Synchronized Intermittent Mandatory Ventilation for Very Low-Birth-Weight Infants


Conclusion:
In mechanically ventilated infants with birth weights of 500 to 1249 g, using PRVC ventilation from birth did not alter time to extubation.

A total of 24 RCTs and 3 systematic reviews comparing various CMV modes and settings and 2 RCTs investigating permissive hypercapnia reported no differences in mortality or bronchopulmonary dysplasia.