THE ABCs OF VENTILATOR MODES

VENTILATOR MONITOR DISPLAY
VENTILATOR PARAMETERS

MAQUET
GETINGE GROUP

VENTILATION PARAMETERS
Ventilator Parameters

Respiratory Rate (frequency):

- Number of breaths per minute ventilator delivers
- Ventilator can provide all patient’s ventilation, or patient may be able to breathe spontaneously between ventilator breaths
- May titrate (adjust) rate to control carbon dioxide (CO₂) levels
VENTILATOR PARAMETERS

Tidal Volume (TV):

- Tidal volume is the volume of gas the ventilator will deliver to the patient with each breath
- Usual setting is 6 to 8 ml/kg (ideal body weight)
- Example: 100 kg patient = 600 ml tidal volume to 800 ml tidal volume

Ideal body weight (kilograms):

- Devine:
  - Men: 50 kg + 2.3 (height (in) – 60)
  - Women: 45.5 kg + 2.3 (height (in) – 60)
- Robinson:
  - Men: 52 kg + 1.9 kg for each inch over 5 ft
  - Women: 49 kg + 1.7 kg for each inch over 5 ft
- Miller:
  - Men: 56.2 kg + 1.41 kg for each inch over 5 ft
  - Women: 53.1 kg + 1.36 kg for each inch over 5 ft
- Hamwi:
  - Men: 48 kg + 2.7 kg for each inch over 5 ft
  - Women: 45.5 kg + 2.2 kg for each inch over 5 ft
Minute Volume (MV):

- Volume of gas the ventilator will deliver to the patient in one minute
- Minute volume = respiratory rate x tidal volume
- Example: RR 10 x 600 ml TV = 6 liter MV
**Indicates amount of oxygen ventilator delivers**
- Expressed as a percentage — room air is 21%
- \( \text{FiO}_2 \) varies widely depending on patient’s condition
- Arterial blood gases and pulse oximetry values will help determine \( \text{FiO}_2 \) settings
- Titrate to keep oxygen saturation \( \text{SpO}_2 \) >96%
- \( \text{FiO}_2 \) range is 21% to 100%
PEEP (Positive End-Expiratory Pressure):

- PEEP maintains small end-expiratory pressure to help prevent alveolar collapse and improve oxygenation
- Most patients are started on 5 cmH₂O of PEEP
- Range on SERVO-i® (0 to 50 cmH₂O)
**VENTILATOR PARAMETERS**

**P-Peak (Peak Inspiratory Pressure)**

- **Definition:** Reflects airway resistance and lung compliance (work required to move air through airways and into alveoli)
- **Elevated** with either increased resistance or decreased compliance
Ventilator parameters:

- Method or way a breath is delivered
- Mode of ventilation should be tailored to needs of the patient
- Controlled mode
- Supported (spontaneous) mode
- Combination mode
VENTILATOR PARAMETERS

CATEGORIES OF VENTILATION MODES
CATEGORIES OF VENTILATION MODES

- Controlled modes:
  - Volume Control
  - Pressure Control
  - PRVC

- Supported (spontaneous) modes:
  - Pressure support / CPAP
  - Volume support
  - NAVA®

- Combination modes:
  - SIMV (VC) + PS
  - SIMV (PC) + PS
  - SIMV (PRVC) + PS
  - Bi-vent

- Controlled modes:
  - Every breath delivered to patient is a mechanical breath (breath may be triggered by a timing mechanism or patient effort)

- Supported (spontaneous) mode:
  - Every breath is spontaneous (i.e., patient triggered and patient cycled) but supported by ventilator

- Combination modes:
  - Combination of both controlled and supported
Every breath delivered to patient is a mechanical breath (breath may be triggered by a timing mechanism or patient effort)
CONTROLLED MODES

Volume Control:

- A minute or tidal volume is preset
- Breaths are delivered at a preset frequency/rate
- Pressure is variable throughout the delivered breath
- Flow is constant throughout the breath
CONTROLLED MODES

Volume Control — vent settings:

1. Tidal Volume (ml)
2. Respiratory Rate (b/min)
3. PEEP (cmH₂O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Pause time (s)
7. Inspiratory rise time (s)
8. Trigg. Flow / Trigg. Pressure
CONTROLLED MODES

Ti (Inspiratory Time):
- Part or portion of the ventilatory cycle necessary for inspiration
- Setting:
  - 0.1 to 5.00 sec
  - Maintain an I:E of 1:2 or greater (1:3, 1:4, etc.)
CONTROLLED MODES

T pause:
- Time for no flow or pressure delivery (%)
- Setting: 0.0 to 30%, or 0.00 to 1.50 sec
**T insp rise (Inspiratory Rise Time):**

- Inspiratory Rise Time, or “T insp. Rise”, is the time taken to reach the peak inspiratory flow or pressure at the start of each breath.
- Inspiratory Rise Time (%) is applicable in Pressure Control, Volume Control, PRVC, SIMV-Volume Control, SIMV-Pressure Control, SIMV-PRVC. Setting can be in the range 0 to 20% of the respiratory cycle time.
- Inspiratory Rise Time, set in seconds, is applicable in Pressure Support, Volume Support and Bi-Vent.
- **Setting:** 0 to 0.40
  - Adults range is 0 to 0.40 seconds
  - Infants range is 0 to 0.20 seconds
Trigger:

- This determines the level of patient effort to trigger the ventilator to initiate inspiration
- Trigger sensitivity can be set in flow triggering (Trigg. Flow) or pressure triggering (Trigg. Pressure)
- Normally, flow triggering is typically preferable as this enables the patient to breathe with less effort
- The higher the number (above 0) the more sensitive the ventilator is to patient efforts
- The sensitivity is set as high as possible without self-triggering. This ensures that triggering is patient-initiated and avoids auto-triggering by the ventilator
- **Setting:** -20 to 0 (Pressure Trigger)
  Above 0 (Flow Trigger)

**Similar names for Volume Control:**

- IPPV/CMV
- VCV-A/C
- Volume A/C
- VC-CMV
- VC-AC
CONTROLLED MODES

Pressure Control:

- A pressure level is preset
- Breaths are delivered at a preset frequency / rate
- Pressure is constant throughout the delivered breath
- Tidal and minute volume are variable
- Flow is variable throughout the breath
CONTROLLED MODES

Pressure Control — vent settings:
1. PC (Pressure Control level) above PEEP (cmH₂O)
2. Respiratory Rate (b/min)
3. PEEP (cmH₂O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Inspiratory rise time (s)
PC (Pressure Control level) above PEEP (cmH₂O):
- The set inspiratory pressure level for each mandatory breath
- **Setting:**
  - Infant range is 0 to 80 cmH₂O
  - Adult range is 0 to 120 cmH₂O

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**Similar names for Pressure Control:**
- P-CMV
- PCV-A/C
- Pressure A/C
CONTROLLED MODES

PRVC:

- “Pressure Regulated Volume Control”
- An alternative to straight pressure control and/or Volume Control
- In this mode we attempt to obtain best of both volume and pressure control
- PRVC regulates pressure to changing compliance of lungs to adjust inspiratory flow and pressure to maintain a set tidal volume
- Breaths are delivered at a preset frequency (timing mechanism) and may also be patient-triggered
### CONTROLLED MODES

**PRVC — vent settings:**

1. Tidal Volume
2. Respiratory Rate (b/min)
3. PEEP (cmH\textsubscript{2}O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Inspiratory rise time (s)
CONTROLLED MODES

Similar names for PRVC:

- Adaptive Pressure Ventilation CMV
- PRVC A/C
- Autoflow
- Volume Control Plus (VC+)

SUPPORTED (SPONTANEOUS) MODE
Every breath is spontaneous (i.e. patient triggered and patient cycled) but supported by ventilator.

Pressure Support / CPAP:
- Pressure Support is a patient-initiated breathing mode in which ventilator supports patient effort.
- Provides a small amount of pressure during inspiration to help patient draw in a spontaneous breath.
- If PS above PEEP is set to 0, it then becomes CPAP.
- Reduces work of breathing.
SUPPORTED (SPONTANEOUS) MODES OF VENTILATION

**Pressure Support — vent settings:**
1. PS (Pressure Support level) above PEEP (cmH₂O)
2. PEEP (cmH₂O)
3. Oxygen concentration (%)
4. Inspiratory rise time (s)
5. Trigg. Flow / Trigg. Pressure
6. Inspiratory Cycle-off (%)

**Backup Ventilation**
1. PC (pressure control level) above PEEP (cmH₂O) in backup ventilation
2. Resp. Rate (b/min) in backup ventilation
3. Ti (Inspiratory Time) in backup ventilation
SPONTANEOUS (SUPPORTED) MODES

Similar names for Pressure Support / CPAP:

- Assisted Spontaneous Breathing
- Spontaneous Mode
- Pressure Support Ventilation
SPONTANEOUS (SUPPORTED) MODES

VOLUME SUPPORT — description:

- A patient-adapted constant inspiratory support is supplied when activated by patient effort
- Volume is continuously monitored and inspiratory pressure automatically adjusts to maintain targeted tidal volume
- Patient determines frequency
- Pressure pattern constant
- Flow pattern decelerating
SUPPORTED (SPONTANEOUS) MODES OF VENTILATION

VOLUME SUPPORT — vent settings:
1. Tidal Volume (ml)
2. PEEP (cmH₂O)
3. Oxygen concentration (%)
4. Inspiratory rise time (s)
5. Trigg. Flow / Trigg. Pressure
6. Inspiratory Cycle off (%)

Backup Ventilation
1. Tidal Volume in backup ventilation
2. Resp.Rate (b/min) in backup ventilation
3. I:E / Ti (s) in backup ventilation (depending on configuration)
SPONTANEOUS (SUPPORTED) MODES

Similar names for VOLUME SUPPORT:
- No other names for this mode

NAVA® — description:
- Patient-initiated synchronized breathing mode
- Breathing support is triggered by the electrical activity of the diaphragm (Edi)
- Patient controls the respiratory rate, inspiratory time, and the tidal volume with assist from the ventilator
- Operator sets the NAVA level (support)
- NAVA level is multiplied by the measured Edi signal to provide a pressure which is proportional and synchronized to the patient’s effort
SPONTANEOUS (SUPPORTED) MODES

NAVA® — objectives:

- NAVA ventilation delivers ventilatory assist in proportion and synchronized to the patient’s Edi (the electrical activity of the diaphragm).
SPONTANEOUS (SUPPORTED) MODES

Similar names for NAVA®

- No other vendor has a similar mode
Combination of both controlled and supported
COMBINATION MODES

SIMV (VC) + PS:

- “Synchronized Intermittent Mandatory Ventilation (Volume Control) + Pressure Support”
- Mandatory breaths are Volume Control breaths (controlled)
- Spontaneous breaths are pressure support (supported)
- Ventilator provides mandatory breaths which are synchronized with patient’s spontaneous efforts at a preset rate
SIMV (VC) + PS — vent settings:
1. Tidal Volume (ml) / Minute Volume (l/min)
2. SIMV rate (b/min)
3. PEEP (cmH₂O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Pause time (%/s)
7. Inspiratory rise time (%/s)
8. Breath cycle time (s)
10. Inspiratory Cycle-off (%)

Supported Breath
1. PS (Pressure Support) above PEEP (for supported breath)
COMBINATION MODES

SIMV (PC) + PS:

- "Synchronized Intermittent Mandatory Ventilation (Pressure Control) + Pressure Support"
- Mandatory breaths are pressure control breaths (controlled)
- Spontaneous breaths are pressure support (supported)
- Ventilator provides mandatory breaths which are synchronized with patient's spontaneous efforts at a preset rate
SIMV (PC) + PS — vent settings:
1. PC (Pressure Control level) above PEEP (cmH₂O)
2. SIMV rate (b/min)
3. PEEP (cmH₂O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Inspiratory rise time (s)
7. Breath cycle time (s)
8. Trigg. Flow / Trigg. Pressure
9. Inspiratory Cycle-off (%)

Supported Breath
1. PS (Pressure Support) above PEEP (for supported breath)
COMBINATION MODES

SIMV (PRVC) + PS:

- “Synchronized Intermittent Mandatory Ventilation (Pressure Regulated Volume Control) + Pressure Support”
- Mandatory breaths are PRVC breaths (controlled)
- Spontaneous breaths are pressure support (supported)
- Ventilator provides mandatory breaths which are synchronized with patient’s spontaneous efforts at a preset rate
COMBINATION MODES

Other name for SIMV Modes:

- VCV-SIMV
- Volume SIMV
- P-SIMV
- PCV-SIMV
- Pressure SIMV
- SIMV + Autoflow
- Adaptive Pressure Ventilation SIMV
- PRVC SIMV

Bi-Vent — description:

- Pressure controlled breathing that allows the patient the opportunity of unrestricted spontaneous breathing
- Two pressure levels are set together with the individually set duration of each level
- Spontaneous breathing efforts can be assisted by pressure support
- Decelerating flow pattern
- Constant pressure pattern
1. Pressure high (PHigh) for the higher pressure level (cmH₂O)
2. PEEP for the lower pressure level (cmH₂O)
3. Oxygen concentration (%)
4. Time at the higher pressure (THigh) level (s)
5. Time at the lower pressure (TPEEP) level (s)
6. Inspiratory rise time (s)

Supported Breath
1. Pressure Support level above Phigh (cmH₂O)
2. Pressure Support level above PEEP (cmH₂O)
3. Inspiratory Cycle-off (%)
COMBINATION MODES

Similar names for Bi-Vent:

- APRV
- BiLevel
- BiPhasic
- DuoPAP
CATEGORIES OF VENTILATION

- Controlled modes:
  - Volume Control
  - Pressure Control
  - PRVC

- Supported (spontaneous) modes:
  - Pressure support/CPAP
  - Volume support
  - NAVA®

- Combination modes:
  - SIMV (VC) + PS
  - SIMV (PC) + PS
  - SIMV (PRVC) + PS
  - Bi-Vent

THANK YOU

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