Ventilator Terminology & Classification of Mechanical Ventilation
Medical University of South Carolina
Division of Neonatology

Modes of Ventilation

Mode of ventilation: Refers to the pattern of breaths and its relationship to patient breaths	MUSC Ventilator
High Frequency Ventilation: Rates significantly above physiological respiratory rate	Jet Oscillator

Intermittent Mandatory Ventilation / Synchronized IMV (SIMV)
    Ventilation at a specified rate that approximates physiological rates
    May be synchronized to patient's inspiration
    May be synchronized to patients inspiratory time
	VIP Bird
	Avea

Assist Control Ventilation (AC)
    Initiation of each breath synchronized to patient's respiratory pattern;
    Every patient breath is assisted to the same degree
	VIP Bird
	Avea

Pressure Support Ventilation (PS)
    Initiation of each breath synchronized to patient's respiratory pattern;
    Every breath is assisted, though not necessarily to the same degree
    May be combined with SIMV or CPAP
    Usually flow cycled (see: Other Controls below)
	Avea

Airway Pressure Release Ventilation
    Pressure is maintained at a peak above FRC
    Very short intermittent releases allow ventilation
    Spontaneous breaths occur around a high MAP
	NA: Supported by Avea but not used in our unit

Biphasic Ventilation
    Utilizes alternating high and low MAPs in various ratios
    Spontaneous breathing (may be pressure supported) occurs around both high and low MAPs
    Longer duration of low MAP distinguishes biphasic from pressure release ventilation
	NA: Supported by Avea but not used in our unit

Mechanical Control of Ventilation

Control: (Breath Control) Refers to the mechanism the ventilator uses to adjust the amount of gas delivered		MUSC Ventilator

Volume Control:
    Ventilator delivers a preset volume
    Pressure varies as required to deliver the volume
		VIP Bird & Avea

Pressure Control
    Ventilator delivers a preset peak pressure (PIP)
    Volume varies
		VIP Bird & Avea

Mixed (Dual)
    Attempt to deliver specified volume using a pressure control
    Mechanism (and therefore effect) varies significantly between ventilators
    Includes (among others):		

	PRVC:
	    Tidal Volume is ordered
	    Ventilator calculates anticipated pressure required to deliver ordered volume
	    Pressure is recalculated each breath based on last several breaths and V_T's
	    Although volume is ordered, breath delivered is a pressure breath
	    Results in fluctuations in PIP as might V_T, to a degree
		Servo (by internal convention, limited use in NICU)
		
		Supported in adult mode on Avea

	Volume Guarantee
	    Pressure control ventilation with a minimum volume delivery
	    Pressure breath is delivered but may switch to volume breath if needed to ordered V_T
	    Both PIP and Minimum V_T (volume guarantee) are ordered
		Avea (dual mode ventilator of choice in our NICU)

Modes are sometimes listed as including breath control.

For example, the Avea lists 6 neonatal modes of ventilation on its display, which are essentially 2 modes each with 3 breath type controls:
- **Volume Assist Control**
- **Volume SIMV**
- **Volume Time Cycled Pressure Limited**
- **Pressure Assist Control**
- **Pressure SIMV**
- **Pressure Time Cycled Pressure Limited**

Other Controls:

I. Cycling (how the cycle time is determined; how the breath is terminated)
   a. Time cycled (respiratory cycle duration is determined by time)
   b. Volume cycled (respiratory cycle duration determined by delivered volume)
   c. Flow Cycled (respiratory cycle duration is determined by gas flow)
II. Triggering (how a patient effort is detected)
   a. Time
   b. Pressure
   c. Flow
   d. Temperature flux
III. Various controls that change the shape of the ventilator curve (rise time, inspiratory time, flow, etc)

Time Cycled Pressure Limited (TCPL) vs Pressure Control (PC) Ventilation

In general, all mechanical breaths are characterized by several variables:
- Trigger: what tells the ventilator to fire
- Control: determines the characteristics of the breath
- Cycle: primary mechanism determining how the breath is ended
- Limit: secondary mechanism of breath termination

The major difference between TCPL and PC ventilation is how the breath is delivered – gas flow is constant in TCPL, which allows limited gas flow on demand breaths (unassisted patient breaths). In PC ventilation, gas flow is decelerating / variable, which allows for fluctuation in flow according to patient demand. Because of this, PC might have adverse effects on volume delivery (shorter inspiratory plateau) but might also reduce barotrauma and need for sedation.

Terminology

Terminology is not standardized between manufacturers and might differ between institutions
By convention at MUSC, we use classical descriptors of the respiratory cycle rather than manufacturer specific terminology.

I. Pressures
- a. Positive End Expiratory Pressure
    - i. Avea and VIP Bird
    - ii. Pressure maintained during expiration
- b. PIP (our preferred terminology)
    - i. Maximal pressure generated during inspiratory phase of ventilatory cycle
    - ii. Set directly on VIP Bird
    - iii. Set indirectly in Avea as (PEEP + Inspiratory Pressure)
- c. Pressure Support (our preferred terminology)
    - i. Pressure (above PEEP) of assisted breaths in Pressure Support Ventilation
    - ii. Entered directly in Avea (PSV)
- d. Inspiratory Pressure (Not preferred - use PIP to order peak pressure – see above)
    - i. Pressure above PEEP generated in machine breaths
    - ii. AKA: ΔP, tidal pressure
    - iii. PIP = PEEP + IP

II. Rate
- a. Machine rate for mandatory breaths in IMV or SIMV
- b. Back-Up ventilator rate in AC
- c. Entered directly in Bird and Avea

III. Synchronization
- a. Inspiratory: senses beginning of patient inspiration
    - i. Flow Trigger (Avea)
    - ii. Assist Sensitivity (Bird)
- b. Expiratory (limits inspiratory time by sensing near complete inflation of lung)
    - i. Termination Sensitivity (VIP Bird)
    - ii. Percent Flow Cycle (Avea)

Example:
Goal PIP is 18 with PEEP of 4cm and SIMV rate of 45 (and Pressure Support of 6 cm above PIP)

Order: PIP=18, PEEP=4, Rate=45, (Pressure Support = 6 cm)

Settings:
       VIP Bird: PIP=18, PEEP=4, Rate=45, (Pressure support is not available on the VIP Bird)
       Avea: IP=14, PEEP=4, Rate=45, PSV=6