

EMV + VENTILATOR REFERENCE SHEET

Modes of Ventilation		
MODE	Description	Additional Information
Assist Control (Volume)	During this mode of ventilation, the patient receives either controlled or assisted breaths based on a preset Tidal Volume. During inhalation, the ventilator senses negative pressure created by the patient and delivers an assisted breath at a predetermined volume.	Patient: Apnea or Patients with the Reflex for Spontaneous Breathing Stages of a Mechanical Ventilation Patient: Stage 1-Apnea Assist Control (Volume) delivers a set tidal volume at a set ventilatory rate; for instance, AC(V) delivers 500ml Vt at a rate of 12/minute. Stages of a Mechanical Ventilation Patient: Stage 2-Spontaneous Respiratory Reflex If the patient has a spontaneous breathing reflex and AC is the mode, as soon as the ventilator recognizes an increase in the negative intra-thoracic pressure of -2 cmH2O, the entire set Vt is delivered to the patient. Because the patient has a spontaneous breathing reflex, time between breaths is automatically recalculated by the EMV to maintain the set ventilatory rate to prevent breath stacking. The patient's efforts are assisted. The patient does not work. This is a rest and heal mode.
Assist Control (Pressure)	During this mode of ventilation, the patient receives either controlled or assisted breaths based on a preset Peak Inspiratory Pressure (PIP). During inhalation the ventilator senses negative pressure created by the patient and delivers an assisted breath at the preset pressure target.	Patient: Apnea or Patients with the Reflex for Spontaneous Breathing Stages of a Mechanical Ventilation Patient: Stage 1-Apnea Assist Control (Pressure) delivers the necessary tidal volume to achieve the pre-set pressure at a set ventilatory rate; for instance, AC(P) delivers a 472ml Vt (variable Vt per ventilation) to achieve a set pressure of 30cmH2O at a rate of 12/minute. Stages of a Mechanical Ventilation Patient: Stage 2-Spontaneous Respiratory Reflex If the patient has a spontaneous breathing reflex and AC is the mode, as soon as the ventilator recognizes an increase in the negative intra-thoracic pressure of -2 cmH2O, the EMV delivers the necessary Vt to achieve the pre-set pressure. Because the patient has a spontaneous

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		breathing reflex, time between breaths is automatically recalculated by the EMV to maintain the set ventilatory rate to prevent breath stacking. The patient's efforts are assisted. The patient does not work. This is a rest and heal mode.
Synchronized Intermittent Mandatory Ventilation-SI MV (Volume or Pressure)	SIMV delivers mandatory breaths that are synchronized to the patient's spontaneous but intermittent respiratory efforts. The patient receives controlled breaths based on the set breathing rate. Spontaneous intermittent breaths are unsupported. What ever the patient breathes in is what he gets-- nothing more. This is a work and wean mode.	Patient: Spontaneous Breathing Effort Stages of a Mechanical Ventilation Patient: Stage 4- Spontaneous Breathing Effort Requiring a Mandatory Minute Rate SIMV allows the ventilator to sense the patient's own breathing and permit spontaneous breaths between mechanical ventilation while assuring sufficient mandatory breaths should the patient's own rate fall below a mandatory preset ventilator rate per minute. Spontaneous intermittent breaths are unsupported. What ever the patient breathes in is what he gets-- nothing more. This is a work and wean mode. For instance, if the patient only has a spontaneous Vt of 200ml, the ventilator will not provide the remainder of the preset tidal volume. SIMV will recalculate the time between ventilations for each of the patient's spontaneous intermittent breaths to prevent breath stacking.
Synchronized Intermittent Mandatory Ventilation-SI MV (Volume or Pressure) with Pressure support	SIMV delivers mandatory breaths that are synchronized to the patient's spontaneous respiratory efforts. The patient receives controlled breaths based on the set breathing rate. Spontaneous intermittent breaths are supported if Pressure Support is used.	Patient: Spontaneous Breathing Effort Requiring Inhalation Assistance through Pressure Support Stages of a Mechanical Ventilation Patient: Stage 3-Inadequate Spontaneous Breathing Effort Requiring Assistance SIMV allows the ventilator to sense the patient's own breathing and permit spontaneous intermittent breaths between mechanical ventilation while assuring sufficient mandatory breaths should the patient's own rate fall below a mandatory preset ventilator rate per minute. Pressure Support is the amount of additional pressure support expressed in cmH2O designed to supplement a spontaneous intermittent breath during inspiration. For some patients in SIMV

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		mode, spontaneous intermittent breaths need assistance overcoming the resistance of the lungs. Pressure Support is like blowing up the balloon a little bit, which is the most difficult part. It is extra pressure on the front end only. To add Pressure Support: Press and hold the PIP parameter button, press the Confirm/Select button to highlight the PS value, then select the desired value. Remember to select Confirm/Select to enable the value.
	CPAP maintains positive pressure in the lungs during spontaneous respiration. Pressure Support provides additional positive pressure at a higher pressure setting upon spontaneous inspiration. The higher Pressure Support is released when the patient completes the inspiratory cycle and begins to exhale. During exhalation, the positive pressure is maintained at the set PEEP/CPAP level. Because there are 2 levels of pressure, this is BiPAP. The patient must be spontaneously breathing and will determine their own rate, depth, and I:E Ratio. The CCT Paramedic will need to set the FIO₂.	Patient: Adequate Spontaneous Breathing Stages of a Mechanical Ventilation Patient: Stage 5-Adequate Spontaneous Breathing Effort and Volume with Inspiratory Assistance and PEEP Assurance (BiPAP)
CPAP	CPAP maintains positive pressure in the lungs during spontaneous respiration. The patient must be spontaneously breathing and will determine their own rate, depth, and I:E Ratio. The CCT Paramedic will need to set the FIO₂ along with PEEP.	Adequate Spontaneous Breathing Stages of a Mechanical Ventilation Patient: Stage 6-Adequate Spontaneous Breathing Effort and Volume with PEEP Assurance (CPAP) halation, CPAP maintains a constant positive airway pressure so the alveoli do not collapse (i.e. it keeps the balloon blown up a little bit so you don't have to exert as much energy). Pay attention to your ETCO₂; the patient is exhaling

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		against pressure. If the patient cannot adequately exhale, the ETCO ₂ will rise.
Additional Mechanical Ventilation Parameters		
Parameter	Description	Additional Information
PEEP	Positive end expiratory pressure (PEEP) refers to holding pressure above the atmospheric pressure in the lungs at the end of exhalation. The alveoli are maintained open to allow for greater gas exchange, allowing for better oxygenation.	PEEP, EPAP, and CPAP are synonymous terms. They all refer to the pressure in the lungs at the end of exhalation. The higher the PEEP the higher the intrathoracic pressure. Use caution with PEEP greater than 10cmH₂O due to the increased potential for hypotension. High PEEP settings are common in ARDS patients.
Pressure Support	This is the amount of additional pressure support expressed in cmH ₂ O designed to supplement a spontaneous breath in both SIMV and CPAP modes. When performing CPAP with Pressure Support, Pressure Support is the pressure difference between IPAP (Inspiratory Positive Airway Pressure) and EPAP (Expiratory Positive Airway Pressure).	The literal definition of Pressure Support is “pressure above PEEP.” PS + PEEP = IPAP (Inspiratory Positive Airway Pressure)
I:E Ratio	This is the inspiratory time and the expiratory time expressed in seconds and as a ratio. For example, if the I:E Ratio is 1:2, the expiratory time-the time to exhale-is 2 times longer than the inspiratory time-the time to inhale.	Pediatric- 1:1 to 1:2 Healthy Adult: 1:2 COPD/Air Trapping: 1:3 to 1:5
V _t	Tidal Volume; amount of air delivered in a single breath measured in ml. Average adult V _t is 6-8 ml/kg based on ideal body weight.	Ideal Body Weight is based on gender and height. Male: 52 kg + 1.9 kg per inch over 5 feet Female: 49 kg + 1.7 kg per inch over 5 feet iPhone App: MV Start is beneficial.
T _i	Inspiratory Time; amount of time (in seconds) that the ventilator provides an inspired breath.	Commonly called “I-time” and is the duration of time allowed for the ventilator to deliver the set tidal volume.

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		Rarely, tidal volume needs to be delivered according to an Inspiratory Time (Ti) instead of I:E Ratio. These cases are typically limited to pediatric patients.
PIP	Peak Inspiratory Pressure; the greatest inspired pressure level delivered by a ventilator or by a spontaneous breath	On the EMV, a PIP value of greater than 60 requires confirmation. A PIP value of greater than 40 cmH ₂ O can cause increased intrathoracic pressure enough to change the patient's hemodynamic status.
Vmin	Volume of air (in Liters) breathed in and out of the lungs during 60 seconds.	
BPMt	Total combined breaths by patient or delivered by the ventilator over 60 seconds.	In AC (V) mode, pay particular attention to the BPMt vs. the set BPM. If there is a large difference in the two values, eventually the ventilator will begin alarming. The alarms vary, but typically include Fresh Air Intake Fault/Failure, Oxygen Fault/Failure, and High Respiratory Rate. These alarms are triggered by the patient's increased spontaneous respiratory rate as opposed to the rate set in AC (V). For these patients, check to assure the tidal volume and rate are appropriate for the patient; adjust accordingly. Additionally, SIMV + PS may be a more appropriate setting for the patient.

Average Peak Inspiratory Pressures		
	Normal Lung	Diseased Lung
Infant	15-30 cm H ₂ O	30-40 cm H ₂ O
Child	20-30 cm H ₂ O	30-40 cm H ₂ O

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Adult	25-35 cm H2O	30-40 cm H2O
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Troubleshooting

The ventilator is designed to monitor many aspects of the patient's respiratory status, and there are many different alarms that can be set to warn healthcare providers that the patient isn't tolerating the mode or settings. The following are common ventilator alarms and their most frequent causes.

High Pressure Limit -The high-pressure alarm should be set @ 10 cmH ₂ O above the patient's peak inspiratory pressure.	
Common causes:	Action:
Secretions in ETT/airway or condensation in tubing	Suction
Airway obstruction/gagging or trying to talk	Check tube placement, suction, and check vent tubing for kinks
Increased airway pressure from bronchospasm or pneumothorax	Follow protocol
Patient out of phase with ventilator	Calm and make patient comfortable. If patient is alert, ask if he/she is getting enough air and make adjustments accordingly to RR, TV, I:E ratio. Consider sedation.
Patient coughing as ventilator delivers a breath	Adjust tube depth if necessary. Disconnect vent and ventilate via BVM. Calm patient and attempt to re-introduce the ventilator
Water in tubing	Drain tubing
Decreased lung compliance	Consider applying PEEP, confirm tube placement
Low Pressure -A low pressure alarm should be set at 5 cmH ₂ O	
Common causes:	Action:
Vent tubing not connected	Connect vent tubing
Displaced ET tube	Verify placement