Ventilator Overview and Troubleshooting

Settings and Management Tip Sheet for Providers

VARIABLES TO CONSIDER FOR MECHANICAL VENTLIATION

Mode of Ventilation	Controlled: Breath size and Minimum RR set by vent Spontaneous: Breath size and RR set by patient
Ventilation Variables	
Respiratory Rate (RR)	Adjust to maintain pH > 7.2 Monitor for autoPEEP if RR high (esp > 35)
Tidal Volume (V_T)	Goal 6 or less cc/kg ideal body weight (IBW) for ARDS
Oxygenation Variables	
Fraction inhaled Oxygen (FiO2)	Ranges 30%-100% Avoid > 60% for prolonged time, risk of toxicity
Positive End Expiratory Pressure (PEEP)	Optimize PEEP using PEEP tables or driving pressure Risk of hypotension with high PEEP
Additional Variables	
Inspiratory Flow Rate (V̇)	Ventilator default ~60 LPM ↑V̇ will ↓ Inspiratory time and ↑Peak Pressure (PIP)
Flow delivery pattern	Ramp / Decelerating  Square Wave 
Trigger for spontaneous breath	Flow (standard) or pressure triggered (less sensitive)

Suggested Initial Ventilator Settings Post-Intubation

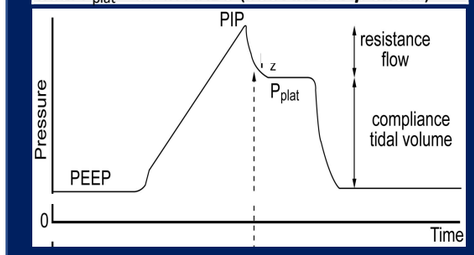
Mode: Assist Control-Volume Control (AC-VC)

Tidal Volume (V_T)	6 cc/kg (IBW)
Respiratory Rate (RR)	Match pre-intubation RR
FiO_2	100%
PEEP	10 cm H_2O (5 if hypotensive)

MANUEVERS FOR ASSESSING PULMONARY MECHANICS

Inspiratory Pause to Assess P_{plat}

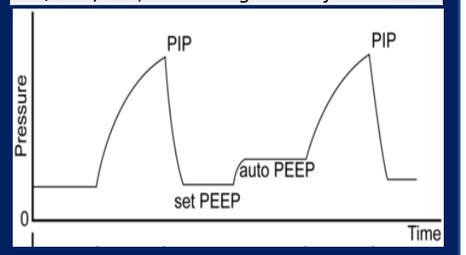
Plateau pressure (P_{plat}): Pressure felt by the lungs, determined by Vt and lung compliance; Goal P_{plat} < 30 in ARDS (See ***ARDS Tip Sheet***)



When to Check:
ARDS Management (see ***ARDS Tip Sheet***); Workup of Elevated Peak Inspiratory Pressure (PIP)

Expiratory Pause to Assess autoPEEP

autoPEEP: Hyperinflation as a result of incomplete emptying before next breath; Risk of ↓BPs /PEA; See *Management of autoPEEP*



When to Check:
Expiratory flow on ventilator not 0 at end of exhalation; h/o COPD/asthma; Workup of ↓BPs of unclear etiology

Please see dedicated ventilator cards (*QR Codes below*) for instructions on checking an inspiratory and expiratory hold maneuver for various ventilator brands.

Ventilator Specific Pocket Cards

PB 840 | PB 980 | Maquet | Hamilton C1 | OR Vent

TROUBLESHOOTING ON THE VENT

High Peak Pressure Alarm

Peak Pressure (Peak Inspiratory Pressure, or PIP)

- Reflects how hard the ventilator must work to deliver a breath
- Normal < 40 cm H2O

Function of:

- Inspiratory flow (V̇), flow pattern
- Airway resistance (including patient, ETT, and circuit)
- Compliance of patient's respiratory system

Initial approach to high peak pressure alarm…

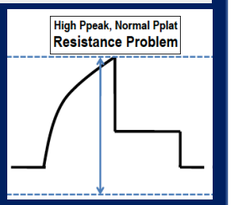
Step 1: Ask RT to temporarily increase the peak pressure alarm setting (to ensure patient receives full V_T)

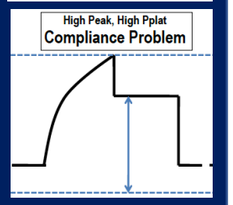
Step 2: Check inspiratory pause for P_{plat}

Is P_{plat} elevated?

NO → | → YES

Increased Resistance	Decreased Compliance
Airway secretions	Abdominal distention
Bronchospasm	Pleural effusions
Kinks in circuit tubing	Pneumothorax
Patient biting on ETT	**Pulmonary edema / ARDS**





AutoPEEP Evaluation

Step 1: Check hemodynamics
autoPEEP → hyperinflation → decreased preload → ↓BPs → PEA
If ↓BPs due to autoPEEP, disconnect ETT from from vent to ↓hyperinflation (requires airborne PPE in COVID+/PUI)
Step 2: Check an expiratory pause and assess expiratory flow at end of expiration
Step 3: Improve I:E ratio (↓RR, ↓VT, ↑flow rate, square wave)

Overview of Select Modes of Mechanical Ventilation

	MODE OF VENTILATION		SET BY PROVIDER	DETERMINED BY PATIENT FACTORS	ADDITIONAL NOTES
MANDATORY	**Assist-Control Volume-Cycled*** **Preferred Mode for ARDS*	**AC-VC**	V_T, Minimum RR, PEEP, FiO2, and Inspiratory Flow (V̇) *or* Inspiratory:Expiratory ratio (I:E)	Peak Inspiratory Pressure (PIP) and Plateau Pressure (P_{plat}) Actual RR	○ Delivers set V_T (with a minimum RR) ○ Fixed V̇ and low V_T can lead to vent dyssynchrony ○ Must monitor for barotrauma (P_{plat})
MANDATORY	**Pressure Control Ventilation** (Assist-Control Pressure Cycled)	**PCV/AC-PC**	Inspiratory Pressure (P_{insp}), PEEP, Minimum RR, FiO2, and I:E (through rise time and inspiratory time, T_I)	V_T and Inspiratory Flow (V̇) Actual RR	○ Delivers set P_{insp}, PEEP (with a min RR) ○ Variable V̇ with improved comfort and vent synchrony ○ Risk of ↑↑ V_T (>6cc/kg)
SPONTANEOUS	**Spontaneous Intermittent Mechanical Ventilation**	**SIMV**	*For mandatory breaths*: V_T, RR, PEEP, FiO2, Inspiratory Flow (V̇) *For spontaneous breaths*: P_{insp}, PEEP, and FiO2	*For mandatory breaths*: PIP and P_{plat} *For spontaneous breaths*: V_T, RR, I:E, Inspiratory Flow (V̇)	○ Delivers set V_T (for controlled breaths) ○ Allows for additional spontaneous breaths (providing pressure support) ○ Risk of ↑↑ V_T (>6cc/kg) with spontaneous breaths ○ May prolong weaning
SPONTANEOUS	**Pressure Support Ventilation**	**PSV**	Inspiratory Pressure (P_{insp}), PEEP, and FiO2	V_T, RR, I:E, Inspiratory Flow (V̇)	○ **WEANING MODALITY** ○ Delivers set P_{insp} and PEEP ○ Variable V̇ and low V_T per patient effort ○ No minimum RR, requires resp drive

VENT ADJUSTMENTS

	Ventilation	Oxygenation
	pH and PaCO2	**PaO2 and SpO2**
ACVC	**V_T, RR**	**PEEP, FiO2**
PCV	**P_{insp} I:E (↓T_I, ↑rise time), RR**	**PEEP, FiO2**
SIMV	**V_T, RR**	**PEEP, FiO2**
PSV	**P_{insp}**	**PEEP, FiO2**

WEANING FROM THE VENT

Ensure you have fixed underlying respiratory problem first

Proceed with a Spontaneous Breathing Trial (SBT) and Spontaneous Awakening Trial (SAT)

PSV 7/5 with FiO2 40% with sedation discontinued
(Consider 5 / 0 for COVID +)

Assess for Failure of SAT/SBT

↑WOB? ↑ HR? ↓ SpO2? ↓ V_T with ↑ RR?

Ensure No Other Barriers to Extubation

Secretions < Q3H and normal mental status
If AMS: Good cough, gag, withdraws to pain

Visit the Penn COVID-19 Learning Center Site

Check out the ARDS Tip Sheet