

ICU Ventilation for Anesthesiologists

Noninvasive Ventilation (NIV)

Heated/humidified high-flow nasal cannula (HHFNC) or non-invasive positive pressure ventilation (NIPPV)

Although evidence exists for using in congestive heart failure, pulmonary edema, and chronic obstructive pulmonary disorder, these modalities are NOT useful in acute respiratory distress syndrome (ARDS), altered mental status.

AVOID NIV IN COVID. A high risk for aerosolization of the virus exists, and efficacy data are minimal. **A rare consideration is HHFNC with ICU consult and high-level personal protective equipment (PPE).**

HHFNC → high flow air/O₂ blend (≤ 60 L/min), allows titration of FiO₂ for hypoxemia. High flow may create positive end-expiratory pressure (PEEP).

Continuous positive airway pressure (CPAP) = PEEP via mask

Bi-level positive airway pressure (BIPAP) = PEEP + inspiratory support; BIPAP 10/5 = PSV 5/5 (BIPAP P above 0 not ΔP)

Decision to Intubate

Standard Indications: Hypoxia (P/F < 200), PCO₂ > 60, pH < 7.2, Airway protection

PaO₂/FiO₂ is the standard for classifying ARDS (<100 severe, 100-200 moderate, 200-300 mild)

EARLY INTUBATION IN COVID: ≥ 6 L for SaO₂ $\geq 92\%$ The goal is to avoid emergent intubation.

COVID Intubation: Personal protective equipment including aerosol precautions, limited number of people, employing the most experienced intubator.

Consider video laryngoscopy to increase distance from patient.

Consider rapid sequence intubation to avoid bag mask ventilation. If needed, bag will require expiratory filter.

+Place central venous catheter/a-line using same PPE. Obtain single CXR to confirm all.

Mechanical Ventilation

Volume Control (default): TV \leq 6mL/kg IBW, PEEP 8-12, RRF 16-20, FiO₂ prn

Lung Protective Ventilation Avoid hurting lungs with ventilator to make the numbers look good.

↓ TV(\leq 6mL/kg IBW), PEEP ↑normal OR, permissive hypercapnea (↑PCO₂ / ↓pH), PaO₂ 55-80

Ideal Body Weight (IBW) = (sex + height NOT weight)

OR Vent = Volume Control = Patient cannot exceed set volume or rate.

ICU Vent = Volume Control = Assist-Control = “control” like OR vent, or “assist” patient triggers breath but TV cannot vary from set. Minute ventilation can be increased by patient triggering.

Adjustments: ABG + airway pressures

↑RR → pH>7.2. Watch for auto-PEEP. **Do not need normal PCO₂.**

Auto-PEEP = incomplete exhalation, gas flow not 0 before next breath, tx = shorten i-time

Sodium Bicarbonate does not work when alveolar ventilation is limited, AVOID.

↓ FiO₂ → PaO₂ 55-80, **no benefit to a perfect SaO₂**

OK to stop here, advanced level below this line

✓/estimate **Plateau Pressure** and **Driving Pressure**

P_{plateau} < 30 (ideal <20), Driving Pressure <15

- 1. Recruitment + ↑PEEP = Improvement in P_{Plateau}/driving pressure suggests recruitable lung**
- 2. If not ↓, TV further to avoid injuring lung (to 4mL/kg IBW)**

Vent inspiratory pause → plateau pressure

Driving Pressure = plateau - PEEP

If unable/unsure of how to perform inspiratory pause = change to pressure control ventilation, adjust pressure to obtain the previous tidal volume → Driving Pressure = $P_{\text{insp}} - \text{PEEP}$.

Other modes such as airway pressure release ventilation should be managed with ICU consult.

Alarms: When to worry

- Volume alarms if TV not achieved → disconnect, leak → decruitment
- High pressure alarms → resistance problem (Obstruction in endotracheal tube) or poor compliance → trial of recruitment → if compliance improves then ↑ PEEP, if not then ↓ TV

Weaning: when improving, trial **Pressure support ventilation**; one method: mean airway pressure on VC → starting PS, keep PEEP the same, continue to decrease PS as ABG allows

- Initiate Spontaneous Breathing Trial (SBT) \geq qDay, institution specific PSV range 0/0→5/5 for 30-60 min to evaluate readiness to liberate from vent.
- Extubation: Wean from ETT (⊗ delirium, protect airway, decrease secretions.

Wean from vent using SBT, rapid shallow breathing index (RSBI), vital capacity, negative inspiratory force.

COVID 19 patients should be extubated with full PPE and precautions.

Extubation

- SBT Pass if hemodynamics, RR, ABG or SaO₂ ok after 30-60 minutes.
- RSBI RR / TV (liters) if <105 more likely to succeed w/extubation
- FVC forced vital capacity (full inspiration/expiration effort)
- NIF (deep inhale) looking for at least -15 or stronger

Anesthesia Machines as ICU Ventilators

Your expertise is essential.

Caution. This section describes an unintended use for anesthesia machines.

- Check or check-out machines daily. If not possible, check between patients
- Machines may power off after set period (e.g. GE after 49 days).
- Remove vaporizers. N₂O, flush as you would for Malignant Hyperthermia cases.
- Consider FGF > 50% of patient Minute Volume to avoid excess moisture.

- If Higher FGF → ↑ CO₂ absorber life but ↓ humidity, replace CO₂ absorber prn.
- Monitor ET_{CO}₂ on machine side of HME. Avoid moisture in gas analyzer.
- If \emptyset vacuum is available for waste gas, remove scavenging system (in addition to leaving scavenging system open to prevent unintentional PEEP).

COVID patients → inspiratory + expiratory filters to avoid contamination

Machine safety

- Adjust alarm volumes to ICU setting (louder).
- Anesthesia Machines do not have “apnea”/backup ventilation; maintain vigilance.
- Check with manufacturer before adding nebulizer.