Mechanical Ventilation

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- **Noninvasive Ventilation:** HHFNC or NIPPV
  +Evidence: CHF/ pulmonary edema, COPD; ⃠ utility in ARDS, altered MS
  Both NIPPV and HHFNC have been used in COVID-19; balance risk of avoiding intubation with aerosolization of virus
  - **HHFNC** = heated high flow nasal cannula → high flow air/O_2 blend (≤60 L/min), allows titration of FiO_2 for **hypoxemia**, high flow may create PEEP
    - Several case series have described management of patients HHFNC.[1,2] There is some evidence that viral aerosolization from these technologies may be less of a concern than initially thought, but this remains controversial and appropriate isolation and PPE should be used.[3]
  - **NIV** = noninvasive positive pressure ventilation → commonly CPAP or BIPAP
    - NIV has also been described in the management of COVID-19,[4] including during prone positioning,[5] with positive effects on oxygenation and respiratory rate. The risk of aerosolization is unknown and overall NIV remains controversial in COVID-19; appropriate isolation and PPE should be used.
  - **CPAP** = PEEP via mask; **BIPAP** = PEEP + inspiratory support
    - BIPAP 10/5 = PSV 5/5 (BIPAP P above 0 not ΔP)

- **Decision to Intubate:** Hypoxia (P/F <200), PCO_2 >60, pH<7.2, ΔMS/airway protection
  - **PaO_2/FiO_2 = standard for classifying ARDS (<100 severe, 100-200 moderate, 200-300 mild)**

  Timing of intubation in COVID-19: Increased work of breathing and high RR, ≥6L for SaO_2 ≥92%
  - Goal = avoid emergent intubation (plan ahead if possible)
  - Ongoing controversy about timing of intubation[6,7]
  - Consider establishing an intubation team specifically for COVID-19[8]
  - **COVID Intubation**: PPE +aerosol, <people, +experienced intubator, RSI ⃠BMV **+Place CVC/a-line using same PPE**, single CXR to confirm all

- **Mechanical Ventilation:**
  - **Volume Control (default): TV≤6mL/kg IBW, PEEP 8-12, RR 16-20, FiO_2 prn**
    - **Lung Protective Ventilation = avoid volu- and barotrauma by using high TV or hi Pressures to achieve normal ABGs or saturation.**
    - **↓ TV (≤6 mL/kg IBW), PEEP ↑ normal OR, permissive hypercapnea (↑ PCO_2 / ↓ pH), PaO_2 55-80**
    - **IBW = Ideal Body Weight (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 once set, minute ventilation can be increased by patient trigger**

- **Driving pressure of <14 should be targeted by reducing lower TV and optimal PEEP**

- **Adjustments:** ABG + airway pressures
  - ↑ **RR** → **pH>7.2**, watch for auto-PEEP, **do not need normal PCO_2**
    - **Auto-PEEP = incomplete exhalation, gas flow not 0 before next breath, tx = shorten i-time, avoid disconnecting ETT!**
    - **Sodium bicarbonate = does not work when alveolar ventilation is limited, AVOID**
  - ↓ **FiO_2** → **PaO_2 55-80**, no benefit to a perfect SaO_2
    - OK to **stop here**, advanced level below this line
  - ✓/estimate **Plateau Pressure ($P_{plateau}$)** and **Driving Pressure**
    - **$P_{plateau}$ <25 (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, tolerate permissive hypercarbia for pH >7.2**
    - **Vent inspiratory pause → $P_{plateau}$**
    - **Driving Pressure = $P_{plateau}$ - PEEP**
    - **If unable/unsure of inspiratory pause, change to pressure control ventilation, adjust pressure to obtain the previous tidal volume → Driving Pressure = P_{insp} – PEEP**
    - **Proning improves V/Q mismatch and may need longer durations**
    - **Inhaled pulmonary vasodilator (epoprostenol vs. NO) may help; will need ICU consult**
  - **Other modes such as APRV should be managed with ICU consult**
    - **More vent learning can be found at https://slideplayer.com/slide/5830349/**
    - Reports indicate deep sedation may be required to achieve ventilator synchrony; short-acting agents should be used and weaned as soon as possible. Drug shortages must be prepared for in surge situations.

- **Alarms - when to worry:**
  - Volume alarms if TV not achieved → disconnect, leak → derecruitment
  - High pressure alarms → poor compliance, trial of recruitment → if compliance improves, then ↑ PEEP, if not then ↓ TV

- **Weaning:**
  - When improving, trial PSV; one method: mean airway pressure on VC → starting PS, keep PEEP the same, continue to decrease PS as ABG allows

- Initiate **SBT = Spontaneous Breathing Trial** ≥qd, institution-specific PSV range 0/0→5/5 for 30-60 min to evaluate readiness to liberate from ventilator, alert Intubation teams.

- **Extubation:**
  - Wean from ETT (⃠ delirium, protect airway, secretions)
  - Wean from ventilator (SBT, RSBI, VC, NIF)

  COVID-19 patients should be extubated with full PPE and precautions. BE READY FOR REINTUBATION, these patients often require prolonged vent support.
    - **SBT = pass if hemodynamics, RR, ABG or SaO_2 ok after 30-60 min**
    - **RSBI = RR / TV (liters); if <105, more likely to succeed w/ extubation**
    - **FVC = forced vital capacity (full insp/exp effort)**
    - **NIF = negative inspiratory force (deep inhale); looking for at least -15 or stronger**

References

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