

Respiratory Care Pocket Reference

v1.15



Oxygen Sources & Delivery Devices

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| Nasal Cannula (NC) | <p>Pros: Ubiquitous; commonly used up to 6LPM</p> <p>Cons: Requires humidification if >4LPM (risk of epistaxis); no work of breathing support</p> <p>O₂: works with any pressure source via flow meter; FIO₂ increases 2-4% per LPM; variable FIO₂ delivery based on patient's minute ventilation & flow rate</p> |
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| Non-Rebreather/Facemask (NRB/FM) | <p>Pros: ~High FIO₂; can be more comfortable than NC</p> <p>Cons: Limited FIO₂ if high respiratory drive; no work of breathing support</p> <p>O₂: works with any pressure source via flow meter; simple FM 5-10 LPM (~FIO₂ 35-50%); NRB 10-15 LPM (~FIO₂ 60-80%); enough flow to prevent bag collapse</p> |
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| High Flow Nasal Cannulae (HFNC) | <p>Pros: Able to achieve high FIO₂ even with high minute ventilation; can titrate flow and FIO₂; heated and humidified for comfort; may improve outcomes in acute hypoxemic respiratory failure compared to NIPPV or low-flow O₂; small amount positive pressure assists with work of breathing</p> <p>Cons: Requires special device; consumes massive amounts of oxygen</p> <p>O₂: Requires high pressure/flow source; ~ >90% FIO₂ (variable with minute ventilation, entraining room air around cannulae) 3 types: 1) With blender to mix compressed air + O₂; 2) With port/Venturi effect to entrain room air and mix with compressed O₂; or 3) Without blender.</p> <p>Initial Settings: infant <1year = 8LPM; child 1-4 years = 10LPM; Child > 4 years = 20LPM; adolescents/adults = 40LPM flow and 100% FIO₂; can titrate flow and/or FIO₂ (max flow depends on cannula size; up to 60 LPM for adults and 100% FIO₂) if tolerated and O₂ source adequate.</p> |
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| Non-invasive Ventilation (NIV) or Positive Pressure Ventilation (NIPPV) Trade name "BiPAP" | <p>Pros: May avoid intubation in some pts (COPD, cardiogenic pulmonary edema, upper airway obstruction) by decreasing work of breathing and adding PEEP</p> <p>Cons: Risk of infectious aerosol generation (possibly less if helmet NIPPV); risk of aspiration if patient not alert / unable to protect airway or if inspiratory pressures ≥20cm H₂O; pt must be alert enough to remove mask if uncomfortable; skin breakdown with prolonged use; confusing terminology: IPAP (inspiratory pressure); EPAP (expiratory pressure = PEEP); PS of "5 over 5" is the same as PS delta 5 over 5, is the same as IPAP 10/EPAP 5</p> <p>O₂: requires high pressure/flow source to achieve high FIO₂</p> <p>Initial Settings: PS (DP) 5/PEEP (EPAP) 5-10; titrate DP up to 15 to reduce inspiratory work; use higher initial IPAP with obese pts; higher pressures may require sedation in peds</p> |
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| Continuous Positive Airway Pressure (CPAP) | <p>Pros: Delivered via face mask or multiple other potential interfaces to splint open the upper airway, increase lung volume & intrathoracic pressure</p> <p>Cons: Prolonged use is uncomfortable & causes skin breakdown; limited unloading of inspiratory muscles or provide complete respiratory support</p> <p>O₂: requires high flow/pressure source to achieve high FIO₂</p> <p>Initial Settings (adults/peds): CPAP or PEEP 5-10; adults: titrate as needed up to 15; peds ≤12; higher pressures may require sedation in peds</p> |
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Oxygen Delivery Device & Supply FAQ

Oxygen Supply & Demand Calculator

Respiratory Mechanics

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| Positive End Expiratory Pressure (PEEP) | <ul style="list-style-type: none"> Pressure within respiratory circuit at end of expiration Must be ≥5 cmH₂O in IMV to prevent derecruitment of alveoli This value is always set by ventilator operator |
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| Pressure_{Peak Inspiratory} (PIP) | <ul style="list-style-type: none"> Reflects pressure generated by airway/ETT resistance and compliance Range 10-40cmH₂O; target <40cmH₂O |
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| Pressure_{Plateau} (Pplat) | <ul style="list-style-type: none"> Reflects pressure in alveoli only If in volume control, perform inspiratory pause (when there is no flow, there is no effect of resistance; Pplat P at alveoli) Target <30cmH₂O (adults); <28 (peds); optimal ≤25 cmH₂O |
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| Pressure_{Driving} (Pdr) | <ul style="list-style-type: none"> Pdr = Pplat - PEEP Tidal stress (lung injury and mortality risk) if elevated Target ≤15cmH₂O; mortality risk if ≥20cmH₂O |
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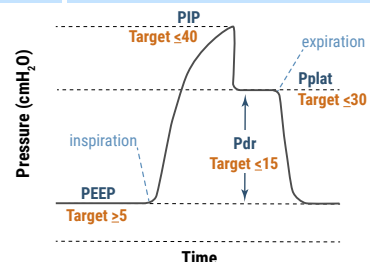
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| I:E and Inspiratory Time (T_i) | <ul style="list-style-type: none"> I:E = ratio of Inspiration to Expiration Normal 1:2 or 1:3; 1:1 is only tolerated when paralyzed (and rarely indicated); 1:4 or 1:5 may be better in asthma or COPD Normal T_i ~ 1-1.5s in non ARDS; Consider T_i 0.7-1 for ARDS |
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| Minute Ventilation (MV) | <ul style="list-style-type: none"> MV = V_t x RR; where V_t is the tidal volume (i.e. volume of each breath) and RR is the respiratory rate (breaths per minute) Normal 4-6 LPM; ~lower if obtunded, hypothermic, deeply sedated; ~higher 8-14 LPM in hypoxic respiratory failure Adjust for pCO₂ goal (e.g. permissive hypercarbia if ARDS); ~6-8 L/min in most intubated adults, may be ≥10-15 L/min in ARDS |
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| Peak Flow | <ul style="list-style-type: none"> Highest flow delivered by ventilator during inspiration 40-60 LPM common; ~50-80 LPM if patient triggered mode Sometimes increasing flow can improve patient-ventilator synchrony; caution this may cause elevation in PIP |
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| Compliance (C) | <ul style="list-style-type: none"> C = ΔV / ΔP = Tidal volume of breath / Pdr Dynamic compliance (VT/PIP-PEEP) or static compliance (VT/Pplat-PEEP) measured at end inspiratory pause Range is 60-80mL/cmH₂O in intubated patients; ARDS ≤40 |
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| Inspiratory Resistance (R) | <ul style="list-style-type: none"> R = PIP - Pplat/inspiratory flow Must be measured during constant flow Normal <10cmH₂O/L/sec; concern if ≥15cmH₂O/L/sec |
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Choosing a Ventilator Mode

- Assist Control (AC) Volume Mode** is default for non-spontaneous breathing patients or ARDS
- AC Pressure Mode & Dual Modes** can be used for non-spontaneous breathing patients or ARDS
- PSV** if spontaneous breathing and non-ARDS; **SIMV** and **APRV** have no data to support regular use

Volume Control

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| Other Names | AC-VC; Assist Control Volume Control; VCV; ~CMV (controlled mandatory ventilation = all modes with RR and fixed T _i); (S)CMV |
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| Controlled Variables | RR, V_t, PEEP, FIO₂, Trigger level, Flow pattern, I:E (either directly or via peak flow, T _i settings) |
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| Initial Settings Adult & Pediatric | <ol style="list-style-type: none"> Set V_t at 6-8 mL/kg predicted body weight (PBW) Set RR: Adults: set at pt's most recent RR (do not exceed 35); Peds: set at most recent RR (do not exceed 60 bpm in infants, 40 bpm in toddlers/preschoolers, 35 bpm in school-aged children or adolescents) Set T_i : Adults 0.70-1 sec; Peds based on RR to maintain a minimum ratio of 1:2 Select FIO₂ and PEEP (use ARDSnet grid if applicable; see next page) |
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| Flow | Square wave/constant/fixe; or Variable/decreasing ramp (potentially more physiologic); 40LPM healthy, 60LPM ARDS |
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| I:E | <ul style="list-style-type: none"> I:E of 1:2 or 1:3 is best for most patients; Normal T_i ~ 1-1.5s in non ARDS patients; Consider T_i 0.7-1 for ARDS I:E of 1:1 or >1:1 associated with PEEP1, decreased cardiac output (CO) and oxygen delivery Process for setting I:E may vary by ventilator make; commonly by changing T_i, inspiratory flow and flow pattern |
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| Pros | Guaranteed MV regardless of changing respiratory system mechanics; precise control of V _t to limit volutrauma |
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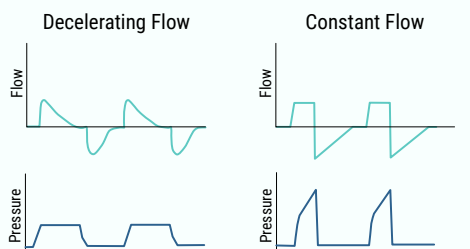
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| Cons | Will overcome high resistance or compliance to deliver set V _t (must set pressure limit & alarm); breath stacking (i.e. next breath delivered before exhalation of prior breath); fixed flow and T _i can increase asynchrony when V _t & flow demand > vent settings |
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| Breath Initiation | Control: Time trigger (60s/set RR): fixed VE Assist: Pt effort triggers full breath at set T _i , V _t , and flow rate |
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| If No Patient Trigger | Delivers full set V _t at set rate (i.e. guaranteed VE) |
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| Breath Termination | Time cycled = breath ends at set T _i ; alarms if V _t not achieved; flow is set, breath ends once V _t delivered Pressure cycled = safety mechanism; breath termination by clinician set high-pressure limit (10-15cmH ₂ O>avg PIP); "pop-off" |
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| Notes | <ul style="list-style-type: none"> Inspiratory pause (~0.3s) can be built into each breath, will increase mean airway pressure; can measure Pplat Alarms: high pressure 5-10 > PIP, VE 50% above+below actual Trigger: 2-5 Lpm for flow; -2 cmH₂O for pressure |
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Pressure Control

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| Other Names | AC-PC; Assist Control Pressure Control; ~CMV - PC |
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| Controlled Variables | RR, P_{insp} (or PC level), PEEP, FIO₂, Flow trigger, Rise time, I:E (set directly or by Inspiratory time, T _i) |
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| Initial Settings Adult & Pediatric | <ol style="list-style-type: none"> Set inspiratory pressure (P_{insp}) at 8-20cmH₂O, or set equal to previous Pdr, P_{lit} or ~1/2 of PIP if transitioning from VC (goal 6-8 m./Kg PBW) Set RR: Adults: set at pt's most recent RR (do not exceed 35); Peds: set at most recent RR (do not exceed 60 bpm in infants, 40 bpm in toddlers/preschoolers, 35 bpm in school-aged children or adolescents) Set T_i : Adults 0.70-0.85 sec; Peds based on RR to maintain a minimum ratio of 1:2 Select FIO₂ & PEEP (use ARDSnet grid if applicable; see next page) |
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| Flow | <ul style="list-style-type: none"> Variable/decreasing ramp (potentially more physiologic) Peak Flow determined by: 1) P_{insp} level, 2) R, 3) T_i (shorter = more flow), 4) Pressure rise time (↓ Rise time → ↑ Peak flow), 5. Pt effort (↑ Effort → ↑ Peak flow) |
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| I:E | <ul style="list-style-type: none"> I:E of 1:2 or 1:3 is best for most patients; T_i 0.7-1s for ARDS I:E 1:1 or >1:1 associated with PEEP1, decreased CO & O₂ delivery Determined by set T_i and RR (Volume and flow variable) |
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| Pros | <ul style="list-style-type: none"> Avoids high PIPs Variable flow (↑ pt effort causes ↑flow to maintain constant airway pressure = potentially better synchrony: ↑ pt effort → ↑ flow and ↑ V_t) "Automated/active expiratory valves" (transiently opens expiratory valve to vent off pressure with coughing, asynchrony); ↑ comfort and ↓ barotrauma risk |
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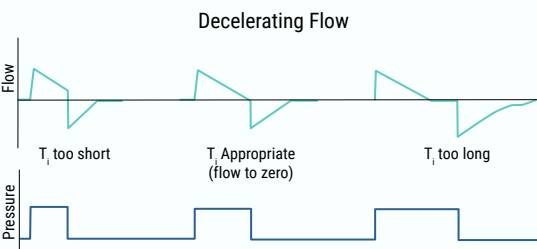
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| Cons | V _t and MV not guaranteed; V _t determined by C and R (might be bigger or smaller than is optimal) |
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| Breath Initiation | Control: Time trigger - (60s/set RR) Assist: Pt trigger delivers P _{insp} for inspiratory time cycle |
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| If No Patient Trigger | Delivers P _{insp} at set rate and T _i |
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| Breath Termination | Time cycled = I:E or T _i set, breath ends at set time |
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| Notes | <ul style="list-style-type: none"> Pplat is the set inspiratory pressure Alarms: high pressure 5-10 > PIP, VE 50% above+below actual Trigger: 2-5 Lpm for flow; -2 cmH₂O for pressure Unlike in VC, in PC the ventilator cannot compensate for volume lost to circuit compliance (i.e. V_t delivered may be less than V_t measured and may be significant especially in pediatrics) |
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Pressure Support

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| Other Names | PS; PSV; Spontaneous |
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| Controlled Variables | P_{insp}, PEEP, FIO₂, Flow trigger, Rise time |
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| Initial Setting Adult & Pediatric | Use for Spontaneous Breathing Trial (SBT): <ol style="list-style-type: none"> Set P_{insp} 5-10 cmH₂O accounting for ETT size (3.0/3.5mm = 10 cmH₂O; 4.0/4.5mm = 8 cmH₂O; ≥5mm = 5 cmH₂O) Set PEEP 5-8 cmH₂O FIO₂ ≤0.40 (Peds) or ≤0.50 (Adults) per SBT initiation criteria |
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| Flow | <ul style="list-style-type: none"> Decreasing ramp (potentially more physiologic) Determined by 1) PS level; 2) Airway resistance (R_{aw}); 3) Rise time (↑ Rise time --> ↓ Peak flow) and 4) Pt effort |
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| I:E | Determined by patient effort and flow termination ("E _{sens} " - see below "Breath Termination") |
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| Pros | Synchrony: allows pt to determine peak flow, V _t , and T _i |
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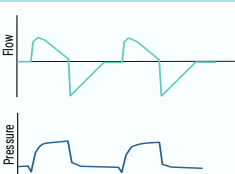
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| Cons | <ul style="list-style-type: none"> No guaranteed MV; V_t determined by pt (big or small); high PS and/or low E_{sens} in COPD can incr air-trapping asynchrony; muscle weakness/fatigue: ↓ effort or ability to sustain effort --> hypoventilation, ↑ fatigue |
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| Breath Initiation | Pt flow or pressure triggered; Flow (3-5LPM) more sensitive than pressure trigger (~2cmH ₂ O) |
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| If No Patient Trigger | Apnea (Most vents will have backup rate; all have alarm) |
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| Breath Termination | Flow cycled: Delivers P _{insp} until flow drops to predetermined % of initial peak flow ~E _{sens} (Standard setting ~25%; ~40-50% if obstructive pulmonary disease to prevent air trapping) |
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| Notes | PS mode is not necessarily equivalent to a spontaneous breathing trial (SBT) |
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Dual (Control) Mode

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| Other Names & Function | <ul style="list-style-type: none"> Pressure regulated volume control (PRVC); VC+; AutoFlow ~PC with a target V_t & variable P_{insp} (Δ1-3cmH₂O per breath) to meet goal V_t despite changing C and R; |
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| Pros | <ul style="list-style-type: none"> ↓ likelihood of hypo/hyperventilation associated with PC. If R or C changes, P_{insp} automatically adjusts to keep target V_t. Active expiratory valve (unlike AC-VC) promotes synchrony |
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| Cons | <ul style="list-style-type: none"> C & R can change significantly without notification Vent can't discern if V_t>target is due to ↑ pt effort or ↑ C; vent response to both = ↓ P_{insp}; Can lead to closed-loop "runaway" (↓ P_{insp}--> ↑ Pt Effort--> ↓ P_{insp})= ↑ Pt work; must carefully set alarms |
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Respiratory Care, Setup, & Monitoring

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| Ventilator Setup (prior to connecting patients) | <ul style="list-style-type: none"> Inspect all equipment for cleanliness or damage Review circuit orientation, filters, & heat & humidification system Ensure gas supply connected Perform machine self-test with new patient and per manufacture (ensure leak test included) Confirm initial settings and alarms |
| Ventilator Performance | <ul style="list-style-type: none"> Perform Full Status Check q4h: (PIP, Pplat, V_T, F_{IO2}, Alarms, SpO₂, ETCO₂ in addition to routine ICU monitoring) Evaluate vent & patient within ~1h of ventilator settings changes Wipe down ventilator with approved disinfection qShift |
| Pulmonary, Endotracheal Tube & Circuit Hygiene | <ul style="list-style-type: none"> Check cuff pressure and auscultate q12h to avoid over-inflation/leak (<25 cmH₂O); consider 'minimal occluding volume' in pedis Check inflation of pilot balloon to ensure it remains inflated Reposition & secure endotracheal tube with skin checks q12h Check ventilator circuit qShift for moisture accumulation (drainage); change circuit only if damaged or gross contamination (VAP PPx) Head of bed 30 degrees elevated for pneumonia prophylaxis (VAP PPx) Oral hygiene with mouthwash & suctioning TID (VAP PPx) Consider continuous subglottic suctioning or q12h oropharyngeal suctioning (VAP PPx) |
| Filters | <ul style="list-style-type: none"> All external filters should be inspected ≥daily (and after nebs) Replace viral filters as frequently as supplies allow in accord with the manufacturer's recommendations or if damaged/soiled (may last >1 week) For turbine and compressor ventilators, external inlet filters and fan filters must be cleaned at least monthly. For ventilators that allow, bacterial/viral filters should be placed proximal to external intake filters |
| Heat & Humidification | <ul style="list-style-type: none"> Active system: must use distilled or sterile water (~>500mL daily) to avoid infectious risk and device damage; can be made on site or purchased; check H2O supply q12-24h Passive heat moisture exchanger (HME): Only some HME include pathogen filter capability; Many manufacturers suggest change q24h, but studies show that an unsoiled HME in some circumstances can be used for several days. Nebs decrease lifespan (and must be given via bypass or with HME removed from circuit). Monitor for signs of an increased resistance (e.g. increase in PIP but no change in Pplat, or a prolonged exp flow) |
| Respiratory Specific Monitoring | <ul style="list-style-type: none"> Continuous pulse oximetry, if unable then spot check as frequently as possible Continuous capnography, if unable then spot check as frequently as possible, especially after major ventilator settings changes Auscultation performed routinely with checks Skin/Mucosal Assessments qShift |
| Contingency Planning | <ul style="list-style-type: none"> Ensure manual (i.e. bag valve resuscitator) ventilation device is operational and at bedside along with a facemask and PEEP valve |

Disclaimer: This card is intended to be educational in nature and is not a substitute for clinical decision making based on the medical condition presented. It is intended to serve as an introduction to terminology. It is the responsibility of the user to ensure all information contained herein is current and accurate by using published references. This card is a collaborative effort by representatives of multiple academic medical centers.



Lung-Protective Ventilation (LPV)


| When to Use LPV? | <p>All ARDS patients and most intubated non-ARDS patients will benefit from LPV, though there are some instances where departures from LPV are justified (i.e. mechanical ventilation <24h).</p> <p>ARDS Berlin Definition for Adult ARDS with Kigali Modification</p> <ol style="list-style-type: none"> Acute (within 1 week of new symptoms or insult) Bilateral opacities on CXR or Chest CT or chest US P:F ≤300 or S:F <315 with or without ≥5 cmH₂O PEEP Not fully explained by cardiac failure or fluid overload on exam <p>Pediatric ARDS (pARDS) Definition</p> <ol style="list-style-type: none"> Acute (within 1 week of new symptoms or insult) Infiltrate(s) on chest imaging consistent with acute lung disease Non-Invasive Ventilation: P:F ≤300 or S:F ≤264 with CPAP ≤5 cmH₂O Invasive Ventilation: Oxygen Index (OI) ≥4 or Oxygen Saturation Index (OSI) ≥5 Not fully explained by cardiac failure or fluid overload on exam; exclude perinatal related lung disease | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|---|---|-----|-----|-----|--------------------------|----------------|------|-----------------------------|---------------------|----------|-----------------------------|-------------------------|--------|--------------------------|-----------------|---|---|---|---|----|----|----|----|----|----|----|----|-------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|---|---|----|----|----|----|----|----|----|----|----|----|----|
| Acute Respiratory Distress Syndrome (ARDS) | <table border="1"> <thead> <tr> <th colspan="3">Severity Grading of ARDS (Correct for altitude)</th> </tr> <tr> <th></th> <th>Adult: P:F (PaO2 ÷ FIO2)</th> <th>Peds: OI & OSI</th> </tr> </thead> <tbody> <tr> <td>Mild</td> <td>P:F 200-300, ~27% mortality</td> <td>OI 4-7.9; OSI 5-7.4</td> </tr> <tr> <td>Moderate</td> <td>P:F 100-200, ~32% mortality</td> <td>OI 8-15.9; OSI 7.5-12.2</td> </tr> <tr> <td>Severe</td> <td>PF: <100, ~45% mortality</td> <td>OI>16; OSI>12.3</td> </tr> </tbody> </table> <p>If P:F <150 and worsening ARDS, consider adjunctive therapies</p> | Severity Grading of ARDS (Correct for altitude) | | | | Adult: P:F (PaO2 ÷ FIO2) | Peds: OI & OSI | Mild | P:F 200-300, ~27% mortality | OI 4-7.9; OSI 5-7.4 | Moderate | P:F 100-200, ~32% mortality | OI 8-15.9; OSI 7.5-12.2 | Severe | PF: <100, ~45% mortality | OI>16; OSI>12.3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Severity Grading of ARDS (Correct for altitude) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Adult: P:F (PaO2 ÷ FIO2) | Peds: OI & OSI | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mild | P:F 200-300, ~27% mortality | OI 4-7.9; OSI 5-7.4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Moderate | P:F 100-200, ~32% mortality | OI 8-15.9; OSI 7.5-12.2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Severe | PF: <100, ~45% mortality | OI>16; OSI>12.3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tidal Volume (V_T) | <ul style="list-style-type: none"> Measure height & calculate predicted body weight (PBW) (See table) Set initial V_T 6 mL/kg PBW(AC-VC) Check V_T at least every 4h (PC or if weaning PS mode) Titrate V_T by pressure goals & pH (below) If pH < 7.15 consider increase V_T toward 8mL/kg regardless of Pplat | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pressures | <p>Check Pplat (0.5s inspiratory pause) & Pdr (deltaP=Vt/C_{rs} = Pplat-PEEP) ~q4-6h and after each change in PEEP or V_T</p> <ul style="list-style-type: none"> If adult Pplat >30 cmH₂O (>28 Pediatrics), optimize sedation (±paralysis) and decreasing V_T by 0.5-1 cc/kg toward ~4 mL/kg If Pplat <30 cmH₂O and severe patient-ventilator dyssynchrony that cannot be addressed pharmacologically, consider increase V_T in 1 mL/kg steps up to 8 mL/kg If Pplat <25 cm H₂O and V_T <6 mL/kg, increase V_T to 6 mL/kg If PEEP ≥20 then use Pdr goal <15 (rather than Pplat goal) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Respiratory Rate (RR) & Inspiratory Time (Ti) | <p>Set RR at ~pre-intubation RR don't exceed ~35 breaths/minute (Adults)</p> <p>Set Ti 0.70-0.85 sec (may be longer if low RR) (avoid Ti <0.70 sec)</p> <ul style="list-style-type: none"> When changing V_T, adjust RR to keep target VE by goal pH (~8-12 L/min in acute ARDS) Consider lower RR if evidence of obstructive ventilatory defect Increase RR if pH <7.30 and decrease RR if pH >7.45 Keep duration of inspiration ≤ expiration | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PEEP & FIO2 (Goal to minimize) | <ul style="list-style-type: none"> Start at 5 cmH₂O PEEP for 2min, if stable hemodynamics, then select one of the following PEEP / FIO₂ titration strategies for goal PaO₂ 55-80 mmHg or SpO₂ 88-95% (In ARDS, PEEP usually ~10-14 cmH₂O). When ↑ PEEP; if Pplat ↑ more than Δ PEEP, think over-distension | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Lower PEEP/higher FIO₂ Strategy (*Default - May consider if low Pdr or pediatrics)</p> <table border="1"> <thead> <tr> <th>FIO₂</th> <th>0.3</th> <th>0.4</th> <th>0.4</th> <th>0.5</th> <th>0.5</th> <th>0.6</th> <th>0.7</th> <th>0.7</th> <th>0.7</th> <th>0.8</th> <th>0.9</th> <th>0.9</th> <th>1.0</th> </tr> </thead> <tbody> <tr> <td>PEEP</td> <td>5</td> <td>5</td> <td>8</td> <td>8</td> <td>10</td> <td>10</td> <td>10</td> <td>12</td> <td>14</td> <td>14</td> <td>16</td> <td>18</td> <td>18-24</td> </tr> </tbody> </table> <p>Higher PEEP/lower FIO₂ Strategy (May consider if PaO2/FIO2 is <100, high Pdr, or BMI>40)</p> <table border="1"> <thead> <tr> <th>FIO₂</th> <th>0.3</th> <th>0.3</th> <th>0.3</th> <th>0.3</th> <th>0.3</th> <th>0.4</th> <th>0.4</th> <th>0.5</th> <th>0.5</th> <th>0.5</th> <th>0.8</th> <th>0.9</th> <th>1.0</th> </tr> </thead> <tbody> <tr> <td>PEEP</td> <td>5</td> <td>8</td> <td>10</td> <td>12</td> <td>14</td> <td>16</td> <td>16</td> <td>18</td> <td>20</td> <td>22</td> <td>22</td> <td>22</td> <td>24</td> </tr> </tbody> </table> | | FIO ₂ | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | PEEP | 5 | 5 | 8 | 8 | 10 | 10 | 10 | 12 | 14 | 14 | 16 | 18 | 18-24 | FIO ₂ | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.8 | 0.9 | 1.0 | PEEP | 5 | 8 | 10 | 12 | 14 | 16 | 16 | 18 | 20 | 22 | 22 | 22 | 24 |
| FIO ₂ | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PEEP | 5 | 5 | 8 | 8 | 10 | 10 | 10 | 12 | 14 | 14 | 16 | 18 | 18-24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FIO ₂ | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.8 | 0.9 | 1.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PEEP | 5 | 8 | 10 | 12 | 14 | 16 | 16 | 18 | 20 | 22 | 22 | 22 | 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Adjunctive Therapies for ARDS Hypoxemia

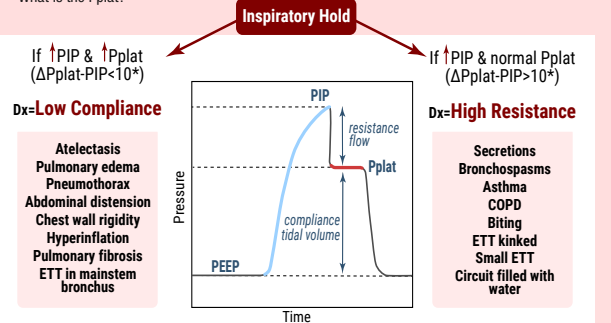
| | |
|--------------------------------------|--|
| Fluid Management | <ul style="list-style-type: none"> Concentrate IV medications and consider diuresis once hemodynamically tolerated with goal of euvolemia FACTT Trial of conservative vs. liberal fluid strategy showed conservative fluid strategy improved oxygenation, more ventilator-free & ICU-free days, no increased shock. However, no mortality benefit. |
| Paralysis | <ul style="list-style-type: none"> Check adequate sedation, then consider paralysis no longer than needed Choice of agent (each with pros & cons, may vary by setting): cisatracurium, atracurium, rocuronium, pancuronium, or vecuronium Monitor degree of paralysis with serial train-of-four (TOF) & wean as able ACURASYS Trial showed mortality benefit; ROSE Trial did not Short term paralysis eliminates work of breathing and can be helpful to accurately assess respiratory mechanics |
| Prone Positioning | <ul style="list-style-type: none"> Prone patient for ~16h at a time, continue proning until P:F >150 with PEEP remaining <10 cmH₂O while patient is supine for >4h Alternate with supine positioning which allows for patient care Do not need special bed; manually proning requires a team If unable to prone, could put less diseased lung down to improve V/Q match PROSEVA Trial showed mortality benefit |
| Pulmonary Vasodilator Therapy | <ul style="list-style-type: none"> No data demonstrate mortality benefit with pulmonary vasodilators Inhaled Prostacyclin Initial Dose: 50 ng/kg/min PBW (range 10-50 ng/kg/min); should be weaned (10 ng/kg/min increments q30min; once at 5ppm consider wean by 1ppm) to avoid hemodynamic compromise Inhaled Nitric Oxide (iNO) Initial Dose: ~20ppm; should be weaned (5 ppm increments q30min) to avoid potential hemodynamic compromise Caution if reduced left ventricular function, pulmonary hemorrhage, platelets <50, or anticoagulation |

Additional LPV Reference Calculations



| Predicted Body Weight (PBW) (kg) | | Scan for PBW Calculator | | | | |
|---|--------------|---|------------|------------|------------|------------|
| Males = 50 + 2.3 [height (inches) - 60] | |  | | | | |
| Females = 45.5 + 2.3 [height (inches) - 60] | |  | | | | |
| Height | PBW f/m | 4mL/Kg f/m | 5mL/Kg f/m | 6mL/Kg f/m | 7mL/Kg f/m | 8mL/Kg f/m |
| 58" (147cm) | 40.9/45.4 kg | 164/182 | 205/227 | 245/272 | 286/318 | 327/363 |
| 60" (152cm) | 45.5/50 kg | 182/200 | 228/250 | 273/300 | 319/350 | 364/400 |
| 62" (157cm) | 50.1/54.6 kg | 200/218 | 251/273 | 301/328 | 351/382 | 401/437 |
| 64" (163cm) | 54.7/59.2 kg | 219/237 | 274/296 | 328/355 | 383/414 | 438/474 |
| 66" (168cm) | 59.3/63.8 kg | 237/255 | 297/319 | 356/383 | 415/447 | 474/510 |
| 68" (173cm) | 63.9/68.4 kg | 256/274 | 320/342 | 383/410 | 447/479 | 511/547 |
| 70" (178cm) | 68.5/73 kg | 274/292 | 343/365 | 411/438 | 480/511 | 548/584 |

| Imputed Values for P:F Ratio | | Scan for Imputed P:F Calculator | |
|---|--------------------------|---|-------------|
| Use when blood gas analysis unavailable (Link to source data) | |  | |
| SpO₂ Values Corresponding to P:F ≤150: | | | |
| Measured SpO ₂ | Imputed PaO ₂ | FIO ₂ | Imputed P:F |
| 96% | 82 mmHg | ≥0.6 | ≤137 |
| 95% | 76 mmHg | ≥0.5 | ≤152 |
| 94% | 71 mmHg | ≥0.5 | ≤142 |
| 93% | 67 mmHg | ≥0.5 | ≤134 |
| 92% | 64 mmHg | ≥0.5 | ≤128 |
| 91% | 61 mmHg | ≥0.4 | ≤153 |
| 90% | 59 mmHg | ≥0.4 | ≤148 |
| <89% | ≤57 mmHg | ≥0.4 | ≤150 |

High Pressures, Desaturations & Dyssynchrony

| | |
|---|---|
| General Considerations | <ul style="list-style-type: none"> Is the ventilator set to FIO₂ 100% while you troubleshoot? Is the patient hemodynamically unstable? If so, consider pressors & urgent evaluation for pneumothorax or severe auto-PEEP. Is the ventilator circuit connected & set correctly? Are breath sounds bilateral? If unilateral, consider mainstem ETT, lobar collapse, and pneumothorax. |
| High Pressures | <ul style="list-style-type: none"> Is the patient agitated or asynchronous? Can a suction catheter pass easily through the endotracheal tube? If no, consider kinked tube, biting/bite block, secretions/suction, or replace ETT. What is the Pplat? |
|  | |
| Troubleshooting low compliance: | Decrease V _T & evaluate for breath stacking (auto-PEEP). Consider ↓ PEEP or adjunct therapies for hypoxemia if decrease in PEEP causes desaturations. |
| Troubleshooting high resistance: | Work outside (machine) to inside (alveoli); circuit problem, ETT kink/occlusion/biting, ETT obstructed/mainstem, large airway obstruction (mucous plug), small/medium airway obstruction (bronchospasm); auscultation & passing a suction catheter can quickly eliminate many of these. |
| Desaturations | <ul style="list-style-type: none"> Is the endotracheal tube in good position? (consider CXR) Is the pulse oximetry waveform good quality? Is there acute hypotension? Evaluate for tension pneumothorax, air trapping and pulmonary embolism Is the source of oxygen faulty or is there an air leak? Check each connection/element sequentially from source of oxygen to the patient. Are there concomitant pressure elevations? If so, see "High Pressures" (next column) Is P:F <150 in setting of worsening ARDS? If so, consider adjunct therapies (above). Are there signs of infection? Consider ventilator-associated pneumonia. |
| Patient-Ventilator Dyssynchrony | <ul style="list-style-type: none"> Detect signs of dyssynchrony: coughing, paradoxical breathing, ventilator alarms (low tidal volumes or high pressures), breath stacking. Treat underlying causes: 1) Ineffective triggering (patient or ventilator); 2) Inappropriate triggering (patient inspires while ventilator expires); 3) Auto-triggering (non-respiratory muscle movement triggers ventilator); 4) Flow dyssynchrony (too fast or too slow) |
| General Approach | <ul style="list-style-type: none"> Treat pain or anxiety if present If ineffective ventilator triggering change trigger sensitivity, decrease VT or pressure Increase V_T to 8 mL/kg and increase flow rate if pressures allow. Consider change to decelerating flow delivery if setting available. If still dyssynchronous, paralyze patient; (and sedate patient to RASS goal -5) |

Discomfort & Delirium

| | |
|---|--|
| Discomfort (pain, agitation, anxiety) & Delirium | <ul style="list-style-type: none"> Ensure appropriate analgesia & sedation to minimize ICU/IMV duration & risk of long-term neuropsychiatric impact. Reassess every <4 hours using a standardized scale <ul style="list-style-type: none"> Goal RASS -4 to 0 in intubated patients If RASS -4 tor -5 consider lightening sedation unless patient is paralyzed or dyssynchronous with ventilator. Target RASS -5 for paralyzed patients. Never paralyze without sedation Perform Daily Sedation Interruptions (DSIs) in non-paralyzed patients to reassess sedation & analgesia needs, which can guide weaning these medications. <p>Delirium: Prevention & treatment of delirium reduces mortality and ICU/IMV duration</p> <ul style="list-style-type: none"> Screen every 12h using standardized tool (i.e. CAM-ICU) Treat delirium by addressing underlying causes (pain, agitation, anxiety, or physiologic derangements) |
| <p>Richmond Agitation Sedation Scale (RASS)</p>  | |
| <p>Confusion Assessment Method for the ICU (CAM-ICU)</p>  | |

Ventilator Weaning & Extubation

| | |
|--------------------------------|---|
| SBT Initiation Criteria | <ul style="list-style-type: none"> FIO₂ ≤ 0.50 and PEEP ≤8 No ↑ in PEEP/FIO₂, requirements over past 24hrs pH > 7.30. VE < 15 L/min ~MAP > 60 mmHg (minimal pressors) ICP: non-labile and < 20 mmHg w/ CPP > 60 mmHg No MI in previous ~48hr |
| Weaning Strategies | <ul style="list-style-type: none"> Once daily SBT PS Pinsp 7-8/PEEP 5-8 cmH₂O x 2hr (2nd daily trial permissible if failure was sedation-related or caused by some other transient issue) SBT x 30min ~probably as good as SBT x 2hr if <48h intubated SBT x 2hr better predictor if intubated >48h If cardiogenic pulmonary edema risk: Consider 15min T-piece (i.e. d/c PS & PEEP) RSBI (rapid Shallow Breathing Index) = f/V_T is unreliable; <80 goal for extubation; sensitive, not specific (if > 105, good predictor of failure) Daily sedation interruption = faster extubation, shorter LOS |
| Extubation Criteria | <ul style="list-style-type: none"> Have you fixed the original problem and no upcoming procedures? Adequate oxygenation? (PaO₂ > ~60 on PEEP< 8 cmH₂O, FIO₂ <0.50) Adequate ventilation without excessive work of breathing? (ΔPaCO₂ ↑ of < 10 mmHg with remaining pH > 7.30 during SBT) Secretions? (assess cough strength, suction frequency & secretion volume) Airway protection? (assess gag, spontaneous cough and GCS) <ul style="list-style-type: none"> Assess risk of post-extubation airway obstruction: Consider cuff leak test if: intubation >6d, trauma, multiple intubations, prolonged prone, flat, volume overload, head/neck trauma, among others Cuff Leak Test: 1. pt must be sedated (interaction with vent = incr PIP= incr leak = false reassurance); 2. Suction oropharynx; 3. Initiate AC-VC V_T 8 mL/kg, RR 12, Ti: 1.5sec, Flow 50 LPM; 4. Measure expired V_T; 5. Deflate cuff and wait 6 breaths; 6. Measure expired V_T, expired V_T (goal is ↓ by >110mL in measure expired V_T); 7. Reinflate cuff Decrease aspiration risk by holding tube feeds for safe interval (~6-8h) Extubation criteria/goals for neuro patients may be different (e.g. visual tracking, swallowing, GCS-<10, <40y) Hemodynamics - re-intubation of an unstable patient can be lethal |