Division of Acute Care Surgery Clinical Practice Policies, Guidelines, and Algorithms:
Acute Respiratory Distress Syndrome (ARDS) Management
Clinical Algorithm

| Original Date: 10/2019 | Purpose: To delineate the management of patients with acute respiratory distress syndrome (ARDS) |

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Memorial Hermann STICU/BICU ARDS Treatment Algorithm

Patient with ARDS

- Timing: within 1 week of known clinical insult or new or worsening respiratory symptoms
- Chest imaging: bilateral opacities not fully explained by effusions, lung collapse, or nodules
- Origin of edema: not explained by cardiac failure or fluid overload
- Hypoxia
  - Mild: PaO2/FI O2 200-300 mmHg
  - Moderate: PaO2/FI O2 100-200 mmHg
  - Severe: PaO2/FI O2 <100 mmHg

Lung protective ventilation (ARDS Network, volume or pressured controlled)³, ¹
1. Vt 4-6 cc/kg (start at 6 cc/kg of predicted body weight, see below)
2. Inspiratory Pplat <30 cm H2O
3. PEEP titration (see below, start with lower settings)

*** Consider driving pressure titration (Pplat: PEEP, goal <15 cm H2O)², ¹

Ventilator dysynchrony
1. Consider changing vent mode
2. Minor adjustments (flow rate/pattern, respiratory pause, assess for auto-PEEP, etc.)
3. Increase Vt up to 8 cc/kg (keep Pplat <30 cm H2O)
4. Increase sedation

Dysynchrony?

Pao2 < 60 and/or Spo2 <88% and/or PaO2/FI O2 <150 mmHg?

Reduce ventilator support

No

Yes

Consider the following strategies based on clinical situation. Decisions should be made with attending/fellow input.

Prone positioning⁴, ⁶-⁸ (reduced mortality)
- See prone protocol for details
- Carefully consider exclusion criteria

Neuromuscular blockades (with deep sedation)⁷, ⁸, ¹¹
- Initiate within 48 hours of ARDS diagnosis
- 0.4 mg/kg rocuronium bolus followed by 10 mcg/kg/min continuous infusion titrated to 2 twitches for 48 hours (dose may be decreased in the setting of liver failure)
- Discontinue if PEEP <8 cm H2O and FiO2 <40% x12 hours

Avoid derecruitment by increasing mean airway pressure and/or PEEP ("open lung concept")⁵, ¹³, ¹⁴
1. ARDS Network higher PEEP table (see below)
2. Recruitment maneuvers (e.g. CPAP 20-40 cm H2O x 30 sec or PCV 40/20 cm H2O x 2 min, watch for hemodynamic instability)
3. Incremental PEEP trial based on optimal oxygenation, driving pressure, and/or compliance

Airway pressure release ventilation (APRV)¹⁴, ¹⁵, ¹⁶
- Other non-rebreather pressure controlled modes of ventilation (e.g. PC-SIMV or PC-AC) should be tried before switching to APRV
- See tips below

Nitric oxide¹⁷, ¹⁸
- Consider only if no improvement with strategies listed above
- Improves oxygenation but does not improve mortality or ventilator-free days, associated with AKI, expensive
- Start at 10 ppm, increase to 40 ppm as needed, if FiO2 stable at <50% wean by 10 ppm/hr; consider temporary FiO2 increase to complete wean
- Check methemoglobin daily

Additional considerations
1. Use conservative fluid management strategies, diurete liberally¹³, ¹⁵
2. Asymmetric lung consolidation? Position good lung down to improve V/Q ratio
3. Rule out cardiac dysfunction (if not done already)

Pao2 < 60 and/or Spo2 <88% and/or PaO2/FI O2 <150 mmHg?

Reduce ventilator support

No

Yes

ECHO²⁰, ²¹
- Consider early consult for patients with refractory severe ARDS

Levels of evidence:

- Strong recommendation
- Conditional recommendation
- Evidence is limited
APRV tips

- APRV is an inverse ratio pressure control type setting (designated as Bi-Level PC/PS on Puritan Bennett 980 ventilator)
- Set P_{High} (use desired plateau pressure, typically 25-30 cm H2O)
- Set P_{Low} (default = 3 cm H2O)
- Set T_{Low} to create desired auto-PEEP and V_T
  - Auto-PEEP is created by cutting expiration short
  - T_{Low} typically 0.2-0.8 sec (0.8 sec is good starting point)
  - Observe expiratory flow graphic to target an expiratory flow cutoff of 50-75% of peak expiratory flow
  - Assess auto-PEEP (via an expiratory hold) and adjust T_{Low}/expiratory flow cutoff to achieve desired auto-PEEP
  - Assess V_T (goal ~ 6 cc/kg predicted bodyweight) and adjust T_{Low}/expiratory flow cutoff to achieve desired V_T
- Set respiratory rate (typically 10-15/min). This is the easiest way to manipulate T_{High} and the I:E ratio.

2. The ARDS Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. NEJM. 2000;342(19):1301-1308 {Seminal RCT, showed reduced mortality with V\textsubscript{T} < 6 cc/kg predicted body weight and P\textsubscript{Plat} < 30 cm H\textsubscript{2}O}

3. Amato MB, et al. Driving pressure and survival in the acute respiratory distress syndrome. NEJM. 2015;372:747–55 {Secondary analysis of data from 9 RCTs showing driving pressure more strongly associated with survival than V\textsubscript{T} and P\textsubscript{Plat}}

4. Guerin C, et al. Prone Positioning in Severe Acute Respiratory Distress Syndrome. NEJM. 2013;368:2159-2168 {RCT, showed prolonged (>16 hr/day) early (<48 hrs after diagnosis) proning decreases mortality in ARDS patients with P/F <150}


7. Papazian et al. Neuromuscular Blockers in Early Acute Respiratory Distress Syndrome. NEJM. 2010;363:1107-1116 {ACURASYS RCT, early administration of NMB decreased mortality and ventilator time without causing weakness in ARDS patients with P/F <150}


10. Cavalcanti AB, et al. Effect of Lung Recruitment and Titrated Positive End-Expiratory Pressure (PEEP) vs. Low PEEP on Mortality in Patients with Acute Respiratory Distress Syndrome: A Randomized Clinical Trial. JAMA. 2017;318:1335–45 {ART RCT, showed increased mortality in ARDS patients with P/F <200 managed with recruitment maneuvers and PEEP titration}

11. Van der Zee, et al. Recruitment Maneuvers and Higher PEEP, the So-Called Open Lung Concept, in Patients with ARDS. Crit Care. 2019;23(1):73 {Review of the open lung concept including recruitment maneuvers and PEEP}


13. Hess D. Recruitment Maneuvers and PEEP Titration. Respir Care. 2015;60:1688-1704 {Comprehensive review of recruitment maneuvers and PEEP}


19. The ARDS Network. Comparison of Two Fluid-Management Strategies in Acute Lung Injury, NEJM. 2006;354:2564-2575 {RCT, conservative fluid management strategy increased days free from ventilator, mean difference of 7 liters over 7 days}

20. Peek G, et al. CESAR: Efficacy and Economic Assessment of Conventional Ventilatory Support Versus Extracorporeal Membrane Oxygenation for Severe Adult Respiratory Failure. A Multicenter Randomised Controlled Trial. Lancet. 2009;374:1351-1363 {CESAR RCT, showed that transfer to an ECMO center improved mortality, does NOT necessarily show that ECMO is superior to lung protective ventilation, only ¾ of patients randomized to ECMO went on}

21. Combes A, et al. Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome. NEJM. 2018;378:1965-1975 {EOLIA RCT, in patients with very severe ARDS no statistically significant mortality difference with ECMO (35 vs. 46%, p=0.09), crossover to ECMO in 28% in control group}

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