Joint Trauma System

Acute Respiratory Failure

Clinical Practice Guideline (CPG) Training

Joint Trauma System Trauma Care Educational Program

Disclosure/Disclaimer

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Agenda

- Purpose
- Summary
- Background
- Diagnosis
- Management
- Ventilation
- Transport of ARDS Patients
- Special Situations
- Performance Improvement (PI) Monitoring
- References
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- Contributors

Purpose

- These slides are based on the JTS Acute Respiratory Failure CPG which describes the associated risk factors, diagnosis, and management of Acute Respiratory Distress Syndrome (ARDS) in combat casualties in the forward deployed environment and the resources available for safe aeromedical transport of these patients.
- Date of CPG publication: 23 Jan 2017
- JTS CPGs are evidence-based guidelines developed by subject matter experts in the military and civilian communities. CPGs are compiled from DoD Trauma Registry data, health data abstracted from patient records and after action reports.
- Information contained in this presentation is only a guideline and not a substitute for clinical judgment.

Summary

- Lung protective strategies should be implemented for patients with ARDS along with minimizing intravenous fluids and blood product transfusions.
- Early consultation with available support staff and activation of Advanced Critical Care Evacuation team (ACCET) evacuation assets should be considered in patients with ARDS.

Background

- ARDS occurs between 26%-33% of combat casualties.
- Patients with ARDS had significant increased risk of death (12.8% vs 5.9%).
- 8% of preventable deaths occur due to multi-organ failure which includes ARDS.

Patient with ARDS chest X-ray
Source: Medical Aspects of Chemical Warfare, Borden Institute.

ARDS Definition

- ARDS is defined as follows:
  - New or worsening respiratory systems within a week of a known injury.
  - Bilateral opacities on chest imaging not fully explained by pulmonary edema, effusions/hemothorax, lobar collapse, or pulmonary nodules
  - Severity determined by degree of hypoxemia with a Positive End Expiratory Pressure (PEEP) or Continuous Positive Airway Pressure (CPAP) of at least 5 cm H2O.
- ARDS severity definitions:
  - Mild ARDS: PaO2 to FiO2 ratio (P:F) of > 200 and ≤ 300
  - Moderate ARDS: P:F of > 100 and ≤ 200
  - Severe ARDS: P:F of ≤ 100

Background

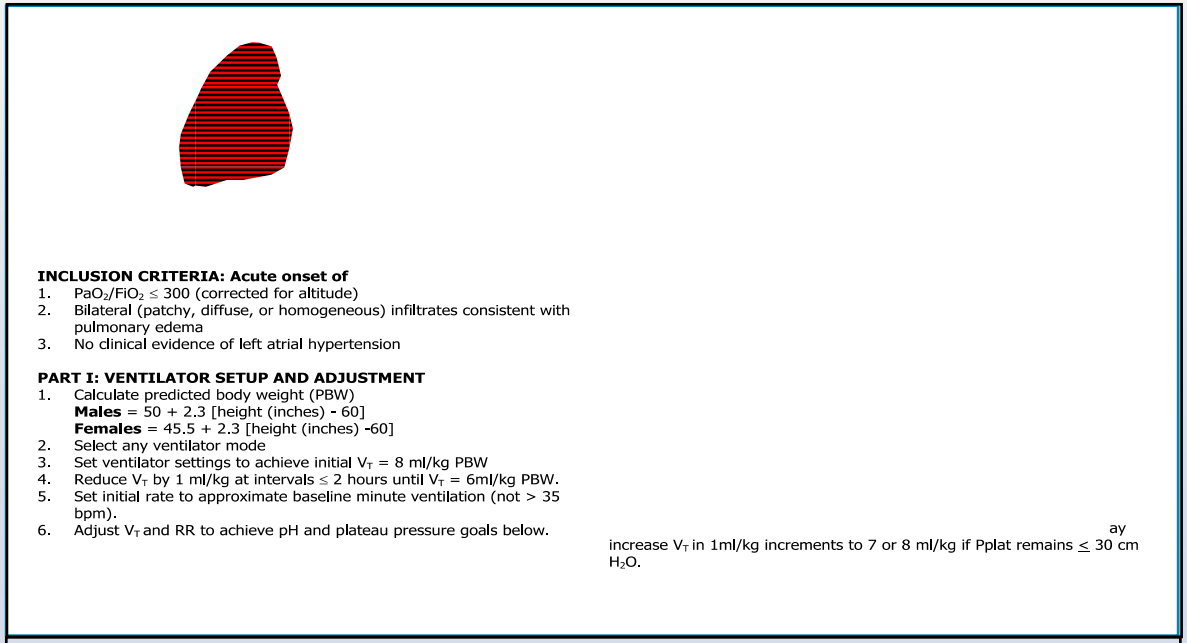
- ARDS develops from direct and indirect injury to the lungs.
  - **Direct injury examples**: pulmonary contusion, inhalation injury, pneumonia
  - **Indirect injury examples:** multiple transfusions, septic shock, severe acute pancreatitis
- Cardiac failure or fluid overload must be ruled out when considering ARDS.
- Several other diseases may mimic ARDS and may benefit from lung-protective ventilator management but require further interventions.
  - **Examples**: acute eosinophilic pneumonia, acute interstitial pneumonitis, diffuse alveolar hemorrhage

Diagnose

- Diagnosis is typically made in patients who have respiratory failure which requires intubation and mechanical ventilation.
- Diagnosis is confirmed by the following steps:
  1. Verify the patient is likely to have respiratory failure from either a direct or indirect pulmonary injury or the need for mechanical ventilation support.
  2. Consider diagnoses which can mimic ARDS.
  3. Obtain a good quality anteroposterior upright chest x-ray (CXR) or CT scan if possible and look for diffuse infiltrates.
  4. If unable to exclude cardiogenic pulmonary edema or fluid overload, consider placing a central venous pressure catheter and obtain trans-thoracic echocardiogram.
  5. Place patient on volume or pressure-control ventilation based on ARDSNet Card and obtain an arterial blood gas (ABG) 30 minutes later to calculate the patient's P:F ratio.

Diagnose

Once ARDS is confirmed, document the grade (mild, moderate, severe) in patient record along with diagnostic criteria used.



INCLUSION CRITERIA: Acute onset of

1. $PaO_2/FiO_2 \leq 300$ (corrected for altitude)
2. Bilateral (patchy, diffuse, or homogeneous) infiltrates consistent with pulmonary edema
3. No clinical evidence of left atrial hypertension

PART I: VENTILATOR SETUP AND ADJUSTMENT

1. Calculate predicted body weight (PBW)
   Males = 50 + 2.3 [height (inches) - 60]
   Females = 45.5 + 2.3 [height (inches) -60]
2. Select any ventilator mode
3. Set ventilator settings to achieve initial V_T = 8 ml/kg PBW
4. Reduce V_T by 1 ml/kg at intervals ≤ 2 hours until V_T = 6ml/kg PBW.
5. Set initial rate to approximate baseline minute ventilation (not > 35 bpm).
6. Adjust V_T and RR to achieve pH and plateau pressure goals below.

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increase V_T in 1ml/kg increments to 7 or 8 ml/kg if Pplat remains ≤ 30 cm H_2O.

Sample of ARDS Mechanical Ventilator Protocol card.
Source: ARDS Network

Management Goals

- Safely support gas exchange without further injuring the patient lung.
  - Limit barotrauma (PPLAT≤30 cm H2O or PIP ≤ 35 cm H2O)
  - Limit volutrauma (VT 6-8 mL/kg Predicted body weight (PBW))
  - Limit atelectrauma (moderate to high PEEP)
- Goals should include:
  - SpO2≥88-95%
  - pH≥7.3 (in TBI patients PaCO2 should be 35- 40 mm Hg)
- Early consultation with intensivist is encouraged for all patients and is available by phone if needed to either Landstuhl Regional Medical Center or San Antonio Military Medical Center.

Ventilation

- Place patient on Lung-Protective Ventilation Settings according to ARDSNet ventilator management card.
- Two different PEEP tables on card and either is acceptable.
- Driving pressure (P_{PLAT} – PEEP) should be minimized.
- During initial management, a VT of 8 mL/kg may be used but should be reduced to 6 mL/kg within 2-4 hours.
- If P_{PLAT} remains above 30 cm H2O, the tidal volume can be further reduced to 4 mL/kg as long as oxygen delivery to peripheral tissues is normal (normal lactate and base deficit).
- Other modes of ventilation besides volume-assist-control can be used but only at the discretion of an intensivist experienced in ARDS management.

Rescue Oxygenation Therapies

- Limited options in austere environments.
- Low-level recruitment maneuvers performed by holding 40 cm H_2O for 40 seconds can be done but should be prepared to manage hemodynamic instability from decreased venous return.
- Inhaled Nitric Oxide or Prostacyclin not typically available in theater.
- Advanced ventilator modes such as inverse ratio ventilation or pressure release ventilation should be utilized under supervision of experienced intensivist.

ECLS & ECMO

Extracorporeal Life Support (ECLS)

- Should be considered early in patients that are failing attempts at lung-protective ventilation.
- Consider if gas exchange and perfusion goals are not met after 12 hours of lung-protective ventilation and the patient has been paralyzed and proned.
- Indications for initiating Extracorporeal Membrane Oxygenation (ECMO) for respiratory failure include:
  - P:F ratio < 100 or plateau pressure > 30 cm H_2O despite optimal ventilatory management.
  - Respiratory acidosis with pCO2>70 and a pH<7.25 despite optimal ventilator management.
  - Initiation of ARDS rescue therapies (PEEP>15, prone, iNO, paralysis).
  - Respiratory failure associated with significant barotrauma.

ECLS & ECMO

- ECMO consultation is available 24 hours a day through U.S. Army Institute of Surgical Research.
- Early notification and consultation is paramount given time to generate transport capability.

Patient placed on ECMO at Role 3 being prepared for transport

Source: Out of the Crucible: How the US Military Transformed Combat Casualty Care In Iraq and Afghanistan, Borden Institute

Neuromuscular Management

- Neuromuscular Blockade
  - A 48-hour course of neuromuscular blockade may facilitate use of lung protective strategy and eliminate problems such as ventilator dyssynchrony.
  - Survival benefit if used within 48 hours of ARDS.
  - Cisatricurium is the preferred neuromuscular blockade.
- Prone Positioning
  - Done if disease primarily in lower lobes (based on CXR or CT findings).
  - Initial trial of 2-6 hours with continuation if gas exchange improves.

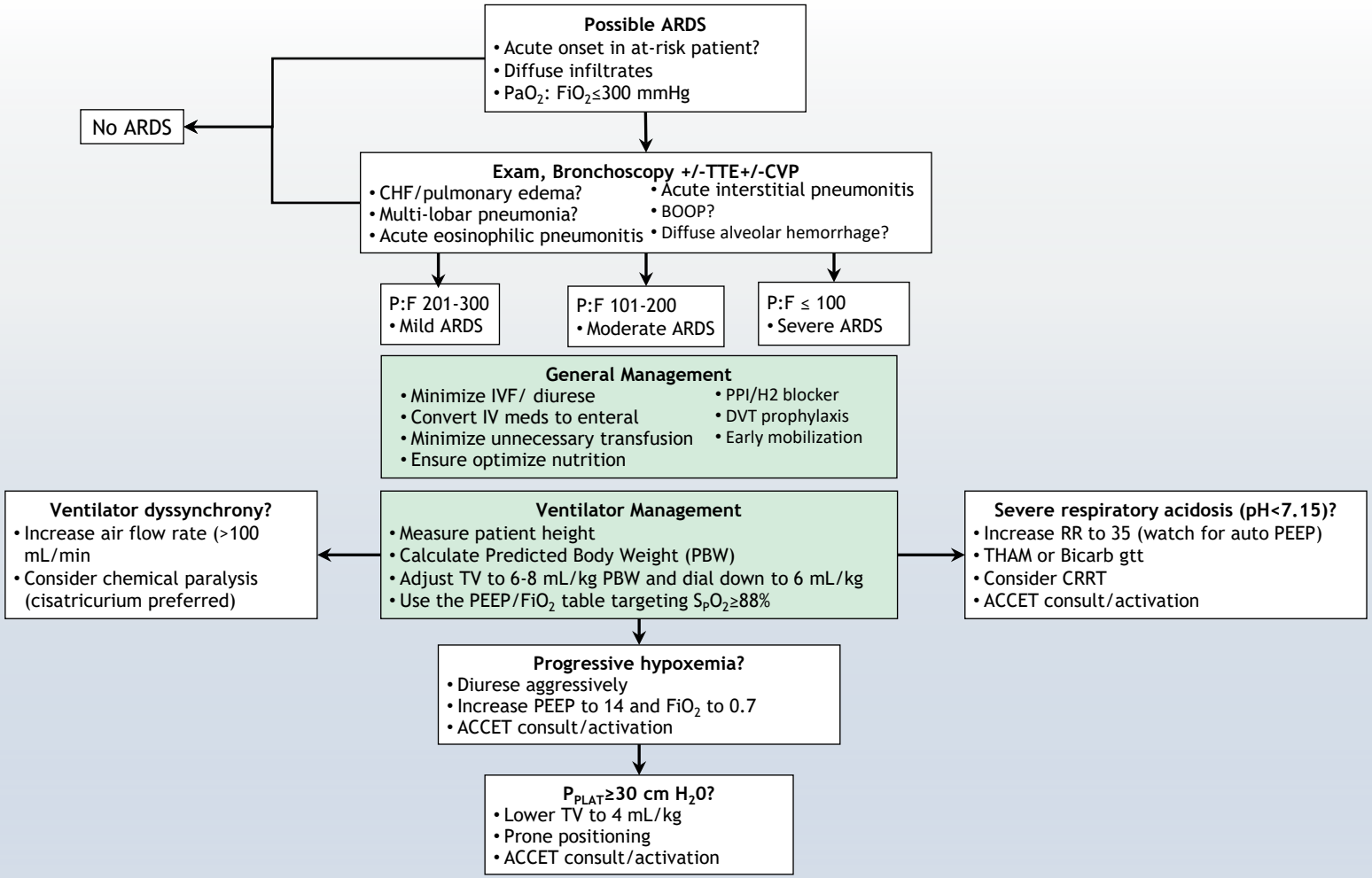
Fluids & Transfusions

- Fluid Management
  - Minimize volume infusion as soon as possible.
  - Aggressive diuresis is recommended if patient can tolerate it.
  - Continuous Renal Replacement Therapy (CRRT) can be used to eliminate intravascular volume.
  - Albumin infusions combined with diuresis should be considered if the patient has hypoproteinemia.
- Blood Product Transfusions
  - There is risk of initiating or exacerbating respiratory failure with each unit – especially plasma (7% per unit).
  - Always balance the risk and benefit of blood products.

Other Factors/Considerations

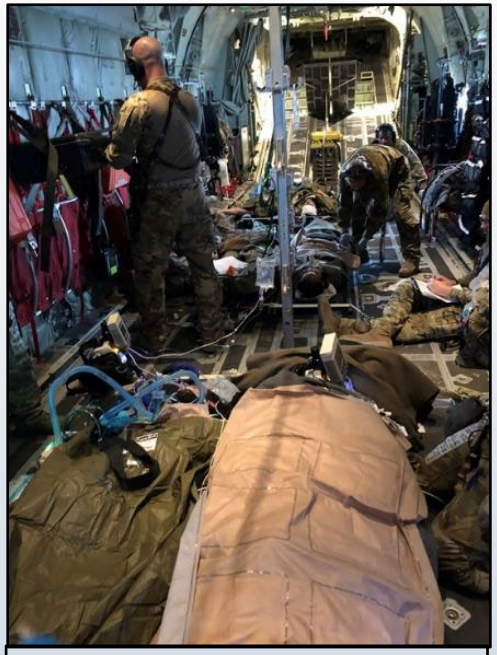
- Corticosteroid administration
  - No benefit in the initial treatment of ARDS.
  - Only consider beginning administration in patients with ARDS between day 7 and 13 of onset.
- Nutrition and venous thromboembolism prophylaxis
  - Enteral feeding preferred with nasojejunal feeding tubes ideally over nasogastric feeding tubes.
  - Stress ulcer and chemical venous thromboembolism should be considered in all patients.
- Sedation management and physical therapy
  - Patients should undergo daily awakening trials and mobilization as early as possible, even while intubated.

ARDS Treatment Algorithm



Transport

- Limitations are imposed by transportation ventilators. Providers should expect PaO_2 will decrease.
- Transportation out of theater is routinely done by the Critical Care Air Transport Team (CCATT).
- ACCET are available for patients with severe ARDS with or without ECLS.



Transportation of intubated patient on fixed wing aircraft

Transport

- Indications for ACCET transport Include:
  - P:F < 100
  - Inhalation Injury
  - FiO_2 > 0.7 or pH < 7.25 on lung-protective ventilation
  - PEEP > 15 cm H_2O w/ PPLAT > 30 H_2O
  - Severe brain injury with $PaCO_2$ > 40 mm Hg on a transport ventilator
  - Cardiogenic shock refractory to maximal medical therapy
  - Anatomic derangement (i.e. pneumonectomy)
  - Use of advanced ventilator modes such as air pressure release ventilation
  - Acute pulmonary embolism with cardiac arrest or with persistent hypoxemia
  - Multi-system organ failure
- Transport by ACCET initiated by local chief of Trauma or ICU Director by contacting U.S. Transportation Command.

Special Situations

- Pediatric trauma patients are at risk of ARDS.
- Diagnosis of ARDS uses Oxygenation Index (OI) rather than P:F ratio to grade severity of ARDS.
- OI calculated by [100 x Mean Airway Pressure (MAP)]/[P:F]
  - Mild ARDS: OI of 4 to < 8
  - Moderate ARDS: OI of 8 to <16
  - Severe ARDS: OI ≥16

PI Monitoring

- Population of Interest

  All patients who receive mechanical ventilation

- Intent (Expected Outcomes)
  - Patients with Acute Respiratory Distress Syndrome (ARDS) are treated with lung protective ventilation.
  - Advanced airway support team consultation occurs within 4 hours when criteria are met (ex. PaO2:FiO2 <100, FiO2> 70%, PEEP > 15 cmH_2O with P_{PLAT} > 30 cm H_2O, severe TBI with PaCO2 > 40 mmHg, etc).

PI Monitoring

- Performance/Adherence Metrics
  - Number and percentage of patients diagnosed with ARDS who receive initial tidal volume 6-8 mL/kg.
  - Number and percentage of patients who have advance airway support team consultation within 4 hours when criteria are met (ex. PaO2:FiO2 < 100, FiO2> 70%, PEEP > 15 cmH2O with P_{PLAT} > 30 cm H_2O, severe TBI with PaCO2 > 40 mmHg, etc.) and patient is eligible for Evacuation (US Or Coalition Casualties).
- Data Source
  - Patient Record
  - Department of Defense Trauma Registry

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Appendices

- **Appendix A:** Diagnosis and Management of ARDS
- **Appendix B:** ARDSNET Ventilator Management for Patients with ARDS
- **Appendix C:** Prone Positioning in Patients with ARDS
- **Appendix D:** Additional Information Regarding Off-label Uses in CPGs

Contributors

- LtCol Jeremy Cannon, USAF, MC
- LTC Jeremy Pamplin, MC, USA
- LtCol David Zonies, USAF, MC
- LtCol Phillip Mason, USAF, MC
- MAJ Christy Sine, USAF, MC
- COL (ret) Leopoldo Cancio, MC, USA
- Col Jeffrey McNeill, USAF, MC
- LTC Christopher Colombo, MC, USA
- LTC Erik Osborn, MC, USA
- CAPT Robert Ricca, MC, USN
- Patrick Allan, MD
- MAJ Jeff DellaVolpe, USAF, MC
- LTC Kevin Chung, MC, USA
- CAPT Zsolt Stockinger, MC, USN

Slides: Lt Col Andrew Hall, USAF, MC

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