Chapter 77
Approach to Acute Respiratory Distress Syndrome (ARDS) in the ICU

77.1 Introduction

Acute respiratory distress syndrome (ARDS) is a severe, life-threatening condition characterized by acute onset of hypoxemia and bilateral pulmonary infiltrates, not fully explained by cardiac failure or fluid overload. It often complicates critical illnesses such as abdominal trauma and requires prompt recognition and management to reduce morbidity and mortality. This algorithm provides a systematic approach to ARDS management in the intensive care unit (ICU), emphasizing personalized strategies based on ARDS phenotypes, evidence-based interventions, and emerging therapies [1, 2] [Ref: Algorithm 77.1].

77.2 Diagnosis

77.2.1 Diagnosis Based on Berlin Definition of ARDS

ARDS diagnosis is based on the following criteria:

- Acute Onset: Symptoms develop within 7 days of a known clinical insult.
- Bilateral Opacities: Detected on chest imaging (X-ray or CT scan), not fully explained by effusions, lobar/lung collapse, or nodules.
- Respiratory Failure Not Fully Explained by Cardiac Failure or Fluid Overload: Requires objective assessment (e.g., echocardiography) to exclude hydrostatic edema.
- Hypoxemia Severity (based on PaO_2/FiO_2 ratio with PEEP $\geq$5 cm H_2O):
- Mild: PaO_2/FiO_2 200–300 mmHg.

S. B. Mishra et al., *Mastering ICU Care*,
https://doi.org/10.1007/978-981-95-0179-3_77

- Moderate: PaO_2/FiO_2 100–200 mmHg.
- Severe: PaO_2/FiO_2 < 100 mmHg [3, 4]. Updated global definition: In non-intubated patients, ARDS can also be diagnosed when supported by HFNO at ≥30 L/min or NIV/CPAP with ≥5 cm H_2O of end-expiratory pressure. Modified definition for resource-limited settings: ARDS may be diagnosed if $SpO_2/FiO_2 \leq 315$ (when $SpO_2 \leq 97\%$), without requiring a minimum PEEP or oxygen flow rate.

Additionally, phenotyping ARDS into hyperinflammatory and hypoinflammatory types can guide therapeutic approaches, as different phenotypes may respond variably to treatments like corticosteroids or PEEP adjustments.

77.2.2 Lung Ultrasound (LUS) Diagnosis of ARDS: (LUS ARDS Score)

Combining LUS aeration score and LUS findings specific for ARDS (pleural abnormalities/subpleural consolidation).

LUS aeration score varies from 0 to 3.

Score 0: Presence of A-lines
Score 1: Presence of B-lines less than 50% of the pleura
Score 2: Presence of B-lines more than 50% of the pleura
Score 3: Presence of consolidation

LUS ARDS score is useful for assessing the severity of ARDS at admission for monitoring the response by lung aeration on a daily basis.

77.3 Management

77.3.1 Initial Stabilization with Noninvasive Ventilation (NIV)

Consider NIV or High-Flow Nasal Cannula (HFNC) in patients with mild to moderate ARDS:

- Goal: Improve oxygenation while avoiding intubation.
- Monitoring: Closely observe for signs of NIV failure, such as worsening hypoxemia or increased work of breathing.
- Risks: Delayed intubation can worsen outcomes; therefore, NIV should be used cautiously, especially in early and severe ARDS.

77.3.2 Tidal Volume Adjustment in Mechanical Ventilation

Initiate Lung-Protective Ventilation:

- Low Tidal Volume (LTV): Set at 6 mL/kg of predicted body weight.
- Adjustments for High Chest Wall Elastance or Obesity: May require modification of tidal volumes to ensure adequate ventilation without overdistension.
- Plateau Pressure: Keep $\leq$30 cm H_2O to minimize barotrauma.
- Driving Pressure Optimization: Aim to reduce driving pressure (plateau pressure minus PEEP) to lower the risk of ventilator-induced lung injury (VILI) [5].

77.3.3 Positive End-Expiratory Pressure (PEEP) Strategy

Individualize PEEP Settings:

- Use of Esophageal Manometry: To estimate transpulmonary pressure and tailor PEEP accordingly.
- Avoid Routine Lung Recruitment Maneuvers: Unless guided by expert opinion or in cases of refractory hypoxemia.
- Balance: Adequate PEEP improves alveolar recruitment, but excessive PEEP can cause hemodynamic instability and overdistension [6].

77.3.4 Neuromuscular Blockade

Consider Early Neuromuscular Blockade in severe ARDS:

- Timing: Early administration (within 48 h) can improve patient-ventilator synchrony.
- Benefits: Reduces VILI by preventing asynchrony and high transpulmonary pressures.
- Duration: Use the minimal effective duration to reduce risks associated with prolonged paralysis [7].

77.3.5 Corticosteroid Therapy

Assess the Use of Corticosteroids:

- Role: Can reduce inflammation and ventilator days in certain ARDS phenotypes.
- Risks: Monitor for secondary infections, hyperglycemia, and other side effects.
- Evidence: Recent studies suggest benefits in early administration but require careful patient selection.

77.3.6 Prone Positioning

Implement Early Prone Positioning in severe ARDS (PaO_2/FiO_2 < 150 mmHg):

- Duration: At least 16 h per day.
- Mechanisms:
- Improves ventilation-perfusion matching.
- Promotes more homogeneous distribution of stress and strain.
- Enhances alveolar recruitment.
- Monitoring: Watch for potential complications like pressure sores, dislodgement of tubes, or hemodynamic changes [8].

77.3.7 Refractory Hypoxemia and Consideration of ECMO

Evaluate for Extracorporeal Membrane Oxygenation (ECMO):

- Criteria:
- Severe hypoxemia (PaO_2/FiO_2 < 80 mmHg) despite optimal mechanical ventilation and adjunctive therapies.
- Hypercapnia with acidosis (pH <7.20) refractory to conventional management.
- Contraindications: Uncontrolled bleeding, irreversible organ failure, or contraindications to anticoagulation.
- Resource Considerations: ECMO requires specialized equipment and trained personnel; consider transfer to a specialized center if necessary.

77.3.8 Conservative Fluid Management

Implement Strategies to Reduce Pulmonary Edema:

- Maintain a Negative Fluid Balance:
- Use diuretics if hemodynamically stable.
- Restrict fluid intake while ensuring adequate tissue perfusion.
- Monitor Parameters:
- Urine output.
- Hemodynamic status (e.g., via central venous pressure or echocardiography).
- Lactate levels as a marker of perfusion

77.3.9 Adjunctive Measures and Emerging Therapies

Investigate Emerging Therapies:

- Mesenchymal Stem Cells: Potential anti-inflammatory effects; currently under clinical trials.

- Extracorporeal CO_2 Removal: May allow ultra-protective ventilation strategies.
- Immunomodulators: Therapies targeting specific inflammatory pathways.
- Note: These therapies are experimental and not recommended for routine use outside of clinical trials.

77.3.10 Lessons from COVID-19 and ARDS Management

Apply Insights from COVID-19 ARDS:

- Lung-Protective Ventilation: Remains cornerstone therapy.
- High-Flow Nasal Cannula (HFNC): Effective in certain patients to improve oxygenation and reduce the need for intubation.
- Awake Prone Positioning: Can enhance oxygenation in spontaneously breathing patients.
- Adaptation: Tailor interventions based on individual patient response and emerging evidence.

77.3.11 Long-Term Outcomes and Post-ARDS Care

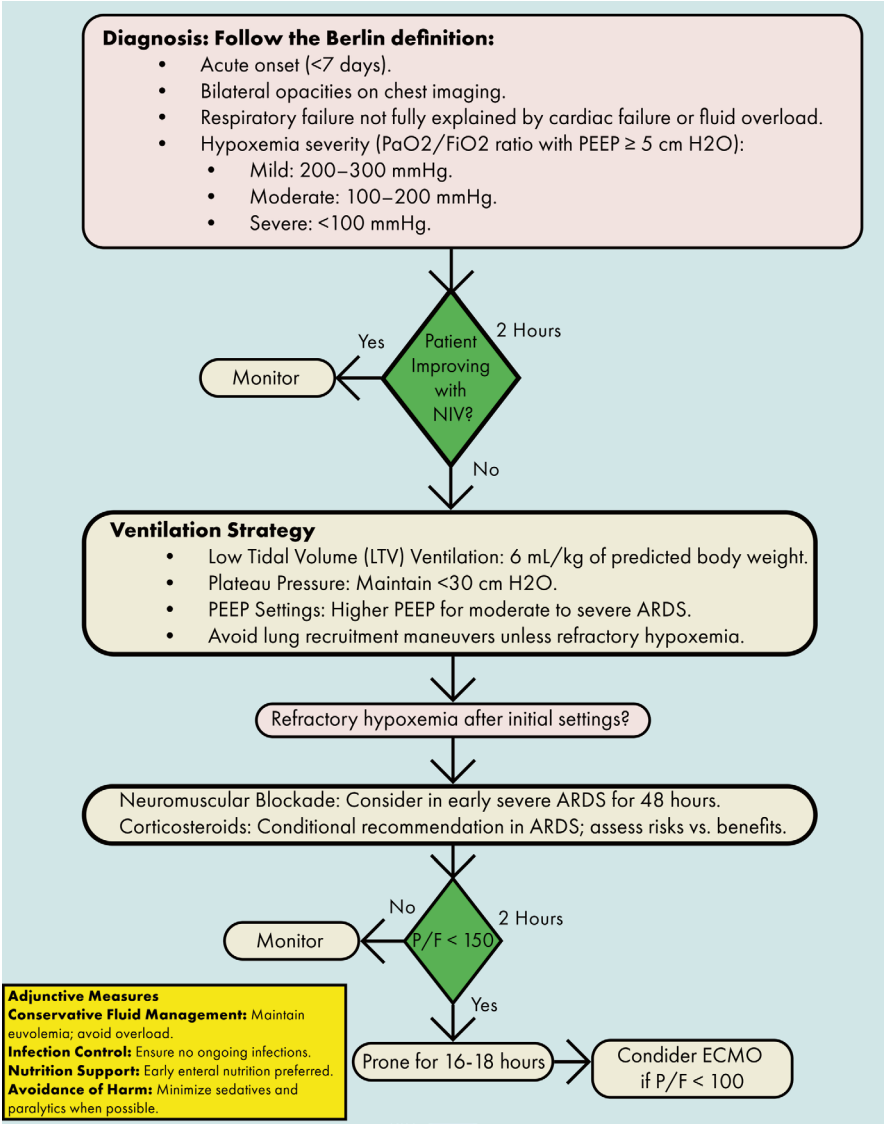
Recognize Post-ARDS Syndrome:

- Pulmonary Fibrosis: Can result in long-term respiratory dysfunction.
- Cognitive Dysfunction: Monitor for delirium and long-term cognitive deficits.
- Quality of Life Issues: Address physical weakness, psychological impact, and social reintegration.
- Follow-Up Care: Implement multidisciplinary rehabilitation programs to support recovery.

77.4 Conclusion

Management of ARDS in the ICU requires a comprehensive and individualized approach. By incorporating ARDS phenotyping, optimizing ventilatory strategies, and utilizing adjunctive therapies judiciously, clinicians can improve patient outcomes. Emerging therapies offer hope but require further research. Lessons learned from the COVID-19 pandemic have enriched our understanding and management of ARDS. Attention to long-term outcomes is crucial for supporting patients beyond the ICU.

Algorithm 77.1: Approach to acute respiratory distress syndrome (ARDS) in the ICU



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