

RTBoardReview
Simulation 24: 22 Year-Old Woman with Atypical Viral Pneumonia
Condition/Diagnosis: ARDS, Pulmonary Hypertension

Take Home Points

The acute respiratory distress syndrome (ARDS) is a rapidly progressive form of respiratory failure characterized by *noncardiogenic* pulmonary edema causing a severe hypoxemia that is refractory to usual oxygen therapy. Defining characteristics include the following:

- Bilateral infiltrates/opacities on chest X-ray or CT
- PF ratio < 300 on at least 5 cmH₂O PEEP/CPAP
- Decreased lung compliance, increased deadspace

Common pulmonary causes include pneumonia (viral or bacterial), pulmonary contusion, aspiration of gastric contents, and submersion injury (non-fatal drowning). Common non-pulmonary causes include sepsis, shock/trauma, burns, and pancreatitis

Assessment/Information Gathering

- Assess for history of abrupt onset of new/worsening respiratory symptoms
- Assess for signs of respiratory distress, i.e., tachypnea, use of accessory muscles of respiration, thoracoabdominal paradox, diaphoresis
- Assess for diffuse crackles on auscultation (based on underlying cause, other adventitious sound may occur, e.g. wheezing with aspiration pneumonia)
- Evaluate for hypoxemia: tachycardia, cyanosis, SpO₂ < 90% on > 30% O₂, P/F < 300
- Judge severity by P/F ratio
 - Mild: 200-300
 - Moderate: 100-200
 - Severe: < 100
- Confirm absence of findings suggesting cardiac failure or fluid overload, e.g., NO cardiomegaly or pleural effusions on chest X-ray)
- Recommend ABG (for objective assessment of PaO₂, P/F ratio, acid-base balance)
- Recommend X-ray or CT scan (looking for characteristic bilateral infiltrates/opacities)
- Recommend brain natriuretic peptide (BNP) – to help rule-out CHF/cardiogenic edema
- Recommend echocardiography – to rule-out cardiogenic pulmonary edema and assess for pulmonary hypertension (estimated peak PA systolic pressure > 45 mm Hg)
- Recommend CVP (to help rule-out overhydration, adjust fluid balance and assess ScvO₂)
- Recommend additional evaluation relevant to suspected cause(s), e.g., if sepsis is suspected cause, assess for fever, hypotension, and related lab data such as the presence of bacteria (in blood, lungs), CBC (leukocytosis), blood lactate (tissue hypoxia), etc

Treatment/Decision-Making

Implement a lung-protective ventilation protocol, as below (slightly modified from ARDSNet):

- Start in any ventilator mode with initial VT of 7-8 mL/kg predicted kg body weight
- Aim to keep the plateau pressure (P_{plat}) at or below 30 cm H₂O
- Set an initial respiratory rate sufficient to the patient's minute ventilation requirements (generally 7-9 L /min for adults)

- Set an initial I:E ratio of 1:2 or 1:3
- Titrate PEEP and FIO₂ to maintain a SaO₂ of 88-95% (PaO₂ 55-80 torr)*
- Aim for FIO₂ ≤ 60% as soon as possible; use higher PEEP to keep FIO₂ in safe range
- Over the initial 4 hours, reduce VTs in steps to 7 mL/kg, and then to 6 mL/kg
- If P_{plat} cannot be kept ≤ 30 cm H₂O with VT 6 mL/kg consider alternative strategies
 - Further reduce the VT to as low as 4 mL/kg in 1 mL/kg steps (allows rates of 30-35/min to maintain pH/PaCO₂)
 - Unless contraindicated (e.g., high ICP) and as long as the pH can be kept at or above 7.20, allow the PaCO₂ to rise ("permissive hypercapnia"); exception is if pulmonary hypertension present and compromising right heart function (high PCO₂s constrict the pulmonary arterial circulation)
 - Sedate the patient to minimize dyssynchrony or allow permissive hypercapnia
 - As a last resort, consider eliminating patient effort, dyssynchrony and opposing force of muscle tone using a neuromuscular blocking agent such as cisatracurium (Nimbex)
- Adjunct therapies to recommend
 - Fluid-conservative therapy using diuretics to maintain neutral fluid balance/prevent fluid overload (contraindicated if signs of tissue hypoperfusion or patient in shock)
 - Elevate the head of the bed 30-45° to prevent ventilator-associated pneumonia OR place the patient in the prone position for at least 16 hours daily
- "Rescue" therapies to consider if life-threatening hypoxemia persists
 - Ventilator modes: HFOV or APRV
 - Extracorporeal Membrane Oxygenation (ECMO)
 - Pulmonary vasodilators (especially if pulmonary hypertension, right heart failure)
 - i. Inhaled nitric oxide (start at 5 ppm and titrate to a maximum of 20 ppm)
 - ii. Continuous aerosol therapy with epoprostenol (Flolan) via controlled drip to jet nebulizer; starting doses 20 to 50 ng/kg/min, wean as tolerated
- Do not recommend (ineffective in treating acute phase of ARDS):
 - Corticosteroids
 - Surfactant therapy
 - IV beta-agonists
 - IV N-acetylcysteine
- Unless essential to monitor/manage pulmonary hypertension, do not recommend insertion of a pulmonary artery ('Swan-Ganz') catheter - fluid balance can be adjusted using a CVP line; CVP O₂ parameters also provide an indication of cerebral perfusion and O₂ uptake.

*One of several methods can be used to titrate PEEP: 1) using a PEEP/FIO₂ lookup table (as per ARDSNet); 2) adjusting PEEP to a maximal acceptable plateau pressure while maintaining a safe VT, or 3) using a decremental PEEP approach where a recruitment maneuver is followed by titration of PEEP to the minimum required to prevent alveolar derecruitment.

Follow-up Resources:

Useful Web Links:

Viral Pneumonia

Rello, J & Pop-Vicas, A. (2009). Clinical review: Primary influenza viral pneumonia. *Crit Care*, 13:235. <http://ccforum.com/content/13/6/235>

ARDS

National Heart, Lung and Blood Institute, ARDS Clinical Network. (2008). Mechanical Ventilation Protocol Summary.

http://www.ardsnet.org/system/files/6mlcardsmall_2008update_final_JULY2008.pdf

Esan, A. (2010). Severe hypoxemic respiratory failure: Part 1—Ventilatory strategies. *Chest* 137, 1203-

1216. <http://journal.publications.chestnet.org/data/Journals/CHEST/22084/chest.09-2415.pdf>

Koh, Y (2014). Update in acute respiratory distress syndrome. *J Intens Care*, 2,

2. <http://www.jintensivecare.com/content/2/1/2>

Raof, R et al. (2010). Severe hypoxemic respiratory failure: Part 2—Nonventilatory strategies. *Chest* 137, 1437-

1448. <http://journal.publications.chestnet.org/data/Journals/CHEST/22085/chest.09-2416.pdf>

Saguil, A & Fargo, M. (2012). Acute respiratory distress syndrome: Diagnosis and

management. *Am Fam Phys*, 85, 353-358. <http://www.aafp.org/afp/2012/0215/p352.pdf>

Epoprostenol (Flolan)

Lusardi, P & Brown, V. (2003). Inhaled Epoprostenol: An approach to the treatment of pulmonary hypertension in patients with ARDS. *AJN*, 103, 64AA-64HH.

<http://sitel.org/wp-content/uploads/sites/9/2014/02/inhaled-epoprostenol-2003.pdf>

National Institutes of Health, Critical Care Therapy and Respiratory Care Section Prostacyclin therapy procedure.

http://www.cc.nih.gov/ccmd/cctrcs/pdf_docs/Aerosol%20Therapy/06-Prostacyclin%20Therapy.pdf

Siobal, M. (2007). Pulmonary vasodilators. *Respir Care*, 52, 885-899.

<http://rc.rcjournal.com/content/52/7/885.full.pdf>