

Refractory Hypoxaemia in Critical Care

Aim: To provide a stepwise strategy for managing refractory hypoxaemia in critical care patients.

Scope: Ventilated adults with hypoxaemic respiratory failure due to parenchymal lung disease. Patients with predominantly obstructive respiratory failure (e.g. bronchospasm) or pulmonary embolism are outside the scope of this document.

Critical Care Tips and Tricks for junior doctors

Step 1
ARDS Net lung protective ventilation

ARDS Net Goals (GRADE 1A)

- PaO₂ 8kPa or P/F ratio >13.3 (may tolerate lower PaO₂ if not acidaemic)
- Pplat < 30 cmH₂O
- Vt 6-8ml/kg IBW
- Accept high pCO₂ if pH > 7.2
- Optimise PEEP

Ideal Body Weight (kg)

Male = 50 + 2.3 x ((height_{cm}/2.54)-60)

Female = 45.5 + 2.3 x ((height_{cm}/2.54)-60)

Step 2
Additional Measures

In order to achieve the above goals consider:

- Increase FiO₂ where possible, aim < 0.8.
- Paralysis (GRADE 2A)
- Conservative fluid management (GRADE 2B)
- Bronchoscopy (GRADE 2C)
- Recruitment manoeuvres (GRADE 2C)
- Prone positioning for 16hrs (GRADE 2A); see Prone Position Ventilation SOP
- Inhaled prostacyclin (GRADE 2C)

Consider tracking the Murray Score at all stages

Points	0	1	2	3	4
P/F ratio (kPa)*	≥40	30-39.9	23.3- 29.9	13.3- 23.2	<13.3
PEEP (cmH ₂ O)	≤5	6-8	9-11	11-14	≥15
Compliance (ml/cmH ₂ O)**	≥80	60-79	40-59	20-39	≤19
CXR quadrants infiltrated	0	1	2	3	4

Murray Score = Total Points / 4

*P/F ratio = PaO₂(kPa)/FiO₂(decimal)

**Compliance = Vt(ml) ÷ (Pplat – PEEP)

Step 3
Consider ECMO Referral

If still unable to achieve ARDS Net goals, consider ECMO referral (GRADE 1B)

Criteria include:

- Murray Score > 3
- Potentially reversible acute lung disease
- Uncompensated hypercapnoea with pH < 7.2

Senior consensus discussion is recommended at this stage

This guideline has been adapted from an original document by the Academic Department of Critical Care, Queen Alexandra Hospital, Portsmouth, UK www.portsmouthicu.com

This document describes a standard strategy only and is not prescriptive. It is the clinical judgement of the treating physician to decide which strategy to employ and when.

Conservative fluid management¹

This can be achieved using diuretics/ fluid restriction/ haemofiltration/ SCUF aiming for at least neutral balance and ideally negative fluid balance if tolerated.

Paralysis²

An atracurium or rocuronium bolus followed by an infusion of cis-atracurium should be considered with the goal of reducing the 'Train of Four' on peripheral nerve stimulation to 2/4.

Recruitment manoeuvres³

In patients with 'recruitable' alveoli, this can be a lifesaving procedure if tolerated. Beware causing cardiovascular collapse, particularly in hypovolaemia.

Prone Positioning⁴

This has been shown to improve oxygenation and can possibly improve mortality in severe ARDS. It can be difficult to identify those in which benefit will be gained. It is labour intensive requiring at least five staff members to perform. Beware tube/line displacement and pressure areas.

Bronchoscopy

Caution should be exercised, particularly in severe hypoxaemia. Bronchoscopy can treat bronchial plugging but can also worsen infiltrates and cause de-recruitment from suctioning.

ECMO⁵

The strength of evidence for ECMO is disputed and senior consensus discussion is recommended. See Guys and St Thomas' referral criteria and contact details published online:

<http://www.guysandstthomas.nhs.uk/our-services/critical-care/referrals.aspx>

Prostacyclin⁶

May improve oxygenation but lacks quality evidence in severe ARDS and has mostly been used in patients with increased pulmonary artery pressures and hypoxia.

References

1. Wiedemann HP, Wheeler AP, Bernard GR, et al; National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network. Comparison of two fluid-management strategies in acute lung injury. *N Engl J Med.* 2006;354(24):2564-2575.
2. Papazian L, Forel JM, Gacouin A et al. Neuromuscular blockers in early acute respiratory distress syndrome. *N Engl J Med.* 2010; 363(12):1107-1116.
3. Fan E, Wilcox ME, Brower RG; et al. Recruitment maneuvers for acute lung injury: a systematic review. *Am J Respir Crit Care Med* 2008 178:1111-1116
4. Guérin C, et al. Prone positioning in severe acute respiratory distress syndrome. *N Engl J Med.* 2013. 368(23):2159-2168.
5. Peek GJ, Mugford M, Tiruvoipati R, et al; CESAR Trial Collaboration. Efficacy and economic assessment of Conventional Ventilatory Support Versus Extracorporeal Membrane Oxygenation for Severe Adult Respiratory Failure (CESAR): a multicentre randomised controlled trial. *Lancet.* 2009;374(9698):1351-1363
6. Meyer J, Theilmeier G, Van Aken H, et al. Inhaled prostaglandin E1 for treatment of acute lung injury in severe multiple organ failure. *Anesth Analg.* 1998;86(4):753-758.