Clinical Guideline

ACUTE RESPIRATORY DISTRESS SYNDROME

SETTING Paediatric Intensive Care Unit (PICU), Bristol Royal Hospital for Children
FOR STAFF Medical and Nursing Staff
PATIENTS Critically Ill Children

Definitions:

Acute Respiratory Distress Syndrome (ARDS)

- Acute onset
- Bilateral infiltrates consistent with pulmonary oedema
- No clinical evidence for an elevated left atrial pressure
- Mild: Ratio of the partial pressure of arterial oxygen to the fraction of inspired oxygen (PaO\textsubscript{2}/FiO\textsubscript{2}) between 200 and 300 mmHg, with > 5 cmH\textsubscript{2}O positive end-expiratory pressure (PEEP). The PaO\textsubscript{2} is measured in mmHg and the FiO\textsubscript{2} is expressed as a decimal between 0.21 and 1.00.
- Moderate: PaO\textsubscript{2}/FiO\textsubscript{2} between 100 and 200 with PEEP > 5 cmH\textsubscript{2}O.
- Severe: PaO\textsubscript{2}/FiO\textsubscript{2} < 100 with PEEP > 5 cmH\textsubscript{2}O

Acute Lung Injury

- Acute Lung Injury Now = Mild Acute Respiratory Distress Syndrome

General Strategies for Management Acute Respiratory Distress Syndrome

Optimising the initial ventilatory management is very important and should include the following:

1. Treat cause of respiratory failure where possible
2. Use of an appropriately fitting endotracheal tube with less than 20% leak (otherwise PEEP and mean airway pressure will not be effective).
3. Use of appropriate tidal volume, 6 ml/kg to avoid volu-trauma (Caution as tidal volumes displayed on ventilator may not be accurate (overread) in small children) 1.
4. Optimum PEEP (8-12 cmH\textsubscript{2}O).
5. I:E ratio approximately 1:1 to allow for a slightly longer inspiratory time.
6. Aim for \( \text{SaO}_2 \text{ 88-92\%} \); if \( \text{SaO}_2 >95\% \), automatically (without ABG) wean FiO\(_2\) by 5-10\% and try to achieve FiO\(_2\) <60\% as soon as possible to minimise oxygen toxicity \(^2\).

7. Permissive hypercarbia with \( \text{PaCO}_2 \text{ 8-10 kPa} \), pH >7.2 as this is associated with reduced mortality in ARDS \(^3\).

8. Optimum fluid balance. A positive fluid balance is associated with worsening oxygenation \(^4\). Consider early diuretics.

9. Trial of prone positioning to see if improves oxygenation. Prone positioning may improve outcome especially with early application and more prolonged duration of prone positioning (12-16 hours) \(^5\).

10. Frequent infection surveillance, consider bronchoalveolar lavage (BAL) to exclude untreated pulmonary infection.

11. Avoidance of prolonged muscle paralysis (think seriously about stopping after 72 hours \(^6\), or at minimum have daily muscle relaxant holiday with some movement and coughing).

If the above therapies fail to improve oxygenation and Oxygenation Index [(FiO\(_2\) (%) times mean airway pressure) divided by PaO\(_2\) in mmHg] is greater than 15 and or PaO\(_2\)/FiO\(_2\) Ratio < 200. (To convert kPa to mmHg = kPa x 7.5)

Then the following sequence of options should be tried:

1. **High Frequency Oscillatory Ventilation (HFOV):**
   Randomised trial of HFOV in paediatrics found that HFOV reduced the incidence of Chronic Lung Disease in survivors with no significant side-effects. \(^7\) There are 4 oscillators available in PICU. The Sensor Medics 3100A can be used for children up to 10kg and the Sensor Medics 3100B should be used for children >10kg.
   Start at mean airway pressure (MAP) 5-10 cm H\(_2\)O greater than MAP on conventional ventilation, Amplitude (delta P) 2 x the set MAP, Frequency 7-10 Hz and Inspiratory time of 33%.
   Adjust according to clinical response, ABG and lung inflation on CXR.

2. **Steroids:**
   Randomised trials using methylprednisolone have shown improved oxygenation, shorter duration of mechanical ventilation, reduced lung injury score and reduced multi-organ failure score (if used in first 2 weeks of illness), but increased incidence of neuromuscular weakness was found. \(^8, 9\)
   In infants, similar beneficial effects have been observed with dexamethasone.
   Treatment Regime:
   Usually start 5-7 days after onset of ARDS when likely in fibro-proliferative phase of ARDS.
   **Bolus dose:**
   Methylprednisolone 2 mg/kg (iv) followed by
   **Maintenance:**
   Methylprednisolone 0.5 mg/kg (iv) 6 hourly for 14 days
Alternatively, Dexamethasone 0.25 to 0.5 mg/kg iv/po 12 hourly may be used

**Then reduce to**
Methylprednisolone 0.5 mg/kg (iv) 12 hourly for 7 days
(or Dexamethasone 0.25 mg/kg daily iv/po)

**Then taper the dose over 4 days by**
Halving dose every 24 hours for 3 days before discontinuing treatment.
If disseminated fungal infection or septic shock develops Methylprednisolone should be discontinued by tapering over a two-day period.

Equivalent anti-inflammatory doses of corticosteroids (BNF for Children)
Methylprednisolone 4 mg= Dexamethasone 750 micrograms = Prednisolone 5 mg

**Local Practice Guidelines**

3. **Inhaled Nitric Oxide (NO)**
   
   No improvement in outcome parameters were found in any of the randomised trials when used for hypoxic respiratory failure except for some marginal improvement in oxygenation in the first 24 hours of treatment. It is also very expensive and costs £1000 per day for the first 3 days of treatment. Consider mainly in patients with documented echographic evidence of pulmonary hypertension. A 15-30 minute trial of inhaled Nitric Oxide can be tried to evaluate response (there is no charge from the supplier for usage under 30 minutes). However there is evidence that inhaled NO increases the risk renal dysfunction.

4. **Surfactant**
   
   Although earlier trials suggested benefit in paediatric ARDS, more recent trials have shown no improvement in oxygenation or outcome, and surfactant may be associated with adverse events such as transient hypoxia and increased the risk of pneumothorax. Surfactant should only be considered if all other therapies have failed, and must be discussed with a PICU consultant first.
   
   Dose: Curosurf 1ml/kg, maximum dose 12 mls, maximum 2 treatments.
   
   Cost per 3ml vial is £547

5. **Consider Permissive Hypoxia**

In severe ARDS resistant to therapy, consider permissive hypoxemia aiming for SaO2 82-88% to decrease risk of ventilator toxicity so long as global oxygen delivery can be maintained.

However need to optimise cardiac output, consider low dose Dopamine and keep haemoglobin levels > 100 g/L. Monitor lactate and mixed-venous oxygen saturations (SvO2)

6. **Consider early referral for ECMO**

   If all of the above fail, and oxygenation index remains greater than 20, early referral to an ECMO centre is advised, as ECMO is less likely to be beneficial if already ventilated for 7-10 days. (Discuss with ECMO centre early).
References:


11. Afshari A, Brok J, Møller AM, Wetterslev J. Use of inhaled nitric oxide in acute respiratory failure patients with low blood oxygen does not improve survival Cochrane Published Online: May 16, 2012


RELATED DOCUMENTS

- High Frequency Oscillation
- Nitric Oxide Protocol

AUTHORISING BODY

- PIC Governance

SAFETY

- Nil

QUERIES

- Contact Duty PICU Consultant Ext 28018.