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Extra-Corporeal Membrane Oxygenation in the Management of 2009 Influenza A (H1N1) Refractory Respiratory Failure

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Abstract

Rapidly progressive acute respiratory failure attributed to 2009 H1N1 influenza A infection has been reported worldwide¹⁻³. Refractory hypoxaemia despite conventional mechanical ventilation and lung protective strategies has resulted in the use a combination of rescue therapies, such as conservative fluid management, prone positioning, inhaled nitric oxide, high frequency oscillatory ventilation and extracorporeal membrane oxygenation (ECMO)⁴. ECMO allows for pulmonary or cardiopulmonary support as an adjunct to respiratory and cardiac failure, minimising ventilator-associated lung injury (VALI). This permits treatment of the underlying disease process, while concurrently allowing for recovery of the acute lung injury. This case documents a previously healthy twenty-two year old Asian male patient with confirmed pandemic (H1N1) 2009 influenza A who was successfully managed with ECMO in the setting of severe refractory hypoxaemia and progressive hypercapnia.

Case Report

A 22 year old previously healthy Chinese student presented to the Emergency Department with a 6 day history of worsening dyspnoea, myalgia and general malaise. On examination he was found to be pyrexia (38.5°C), hypotensive (100/67 mmHg) and pulse oximetry recorded oxygen saturations of 78% on room air. His admission chest radiograph (Figure 1) showed bilateral middle and lower zone consolidation and arterial blood gas sample confirmed severe hypoxaemia (PaO₂ 5.9 kPa). The patient was promptly transferred to the Intensive Care Unit for invasive ventilatory and vasopressor support. Oseltamivir was commenced for confirmed pandemic H1N1 2009 influenza A infection, in addition to piperacillin/tazobactam, and clarithromycin for community-acquired pneumonia.

Figure 1: Admission Chest Radiograph



Over the course of 8 days, the patient developed progressive worsening multiorgan failure requiring a protective lung ventilator strategy for severe acute respiratory distress syndrome (ARDS), ongoing vasopressor support, in addition to continuous renal replacement therapy. In the setting of refractory hypoxaemia and progressive hypercapnia with conventional ventilatory support (Murray Score 3.25, pH 7.23), the patient was transferred to the Karolinska Institute, Stockholm, Sweden for ECMO. The patient was initially treated with veno-venous ECMO but subsequently converted to veno-arterial ECMO with nitric oxide secondary to venous stasis and right ventricular failure. Complications during the course of ECMO treatment included spontaneous haemothorax requiring a thoracotomy, and ongoing gastrointestinal bleeding prompting cessation of ECMO support on Day 11. The patient was gradually weaned off pressure support ventilation over a 16 day period, and transferred back to Dublin. The total length of ventilatory support including ECMO was 66 days and hospital stay was 78days. He recovered well with physical rehabilitation and retained full cognitive function.

Discussion

Since 2009 H1N1 influenza A was first described and identified in Mexico in April 2009 a total of 4,586 laboratory confirmed cases of pandemic (H1N1) influenza have been reported in Ireland (80% of cases aged ≤ 35 yrs)⁵. Of this patient group, 1,069 patients were hospitalized. 77 adult patients required admission to an Intensive Care Unit and there were 14 adult ICU deaths (18% ICU mortality). Observational studies published to date have recorded mortality rates ranging from 14.3%^{2,9} up to 41.4%³. ECMO is a treatment modality shown to be efficacious in the management of neonatal and paediatric cardio-pulmonary failure^{6,7} and is indicated in adults with acute severe respiratory failure refractory to advanced modes of mechanical ventilation. The Extracorporeal Life Support Organisation (ELSO) has reported survival rates of 85%, 74% and 52% in infants, children and adults respectively treated with ECMO for severe Acute Respiratory Distress Syndrome (ARDS)⁵. This treatment technique involves the use a veno-venous (preferred mode) or veno-arterial (required for cardiac support) life support circuit with a membrane oxygenator, and requires heparinisation. Mechanical ventilator settings can then be adjusted to allow for lung rest, with lower respiratory rates, fraction of inspired O₂ and plateau inspiratory pressures (< 25 cm H₂O) minimizing VALI⁸.

An observational study of patients (n=68) with 2009 influenza A-associated ARDS treated with ECMO in 15 ICU's in Australia and New Zealand demonstrated an overall mortality of 21%⁹. Peek et al evaluated the safety, clinical efficacy, and cost-effectiveness of ECMO and established that early transfer to an ECMO centre significantly improved survival without severe disability¹⁰. In the case that we have presented, transfer to the only Irish institution providing a fixed non-mobile ECMO service (Mater Misericordiae University Hospital) was not possible as this facility was at full capacity. Although an invasive and complex procedure, commencing ECMO in a specialised centre should be considered in patients with rapidly progressive acute respiratory failure as a lifesaving measure when conventional mechanical ventilation and adjunctive non-ventilatory strategies have failed.

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