Case of successful Extracorporeal Life Support (ECLS) in a patient with refractory asthma – Importance of increasing awareness of the role of ECLS in the UK

A Tewari, T Ali, R Baba

Citation

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Abstract

Life threatening asthma is acute, severe and often unexpected. 1 Ventilation is not end stage management. Extracorporeal Life Support (ECLS) which traditionally has provided significant support for acute respiratory distress in infants and children and recently adults 2 is also enabling improved prognosis in those patients with severe refractory asthma .3 We describe the use of ECLS in a patient with acute severe asthma where despite all aggressive medical management and mechanical ventilation, a fatal outcome appeared likely. Following initiation of ECLS the patient showed a considerable clinical improvement within 24 hours. Thus we highlight the importance of ECLS in patients with severe refractory asthma and ask that clinicians be increasingly aware of this facility in the UK.

INTRODUCTION

In the UK asthma is an important cause of impaired quality of life, hospital admission and mortality across the whole spectrum of age, sex, ethnicity, socioeconomic status and geographical location.[4] The prevalence of asthma is increasing [5] and in the UK it currently affects 5.1 million adults (approximately 13%).[6] Interestingly the number of deaths attributed to asthma is decreasing; data on asthma deaths in the UK show that on average 1,400 people die from asthma each year, which equates to almost four people every day.[6]

Acute asthma is characterized by spasm of bronchial smooth muscle, mucosal oedema and increased bronchial mucous secretion.[7] Treatment options include inhaled bronchodilators for rapid control of bronchospasm, theophylline to relax smooth muscle by increasing intracellular cAMP, corticosteroids to decrease bronchial inflammation and magnesium which inhibits calcium influx by blocking voltage-dependent calcium channels thus relaxing smooth muscle airways.[8] Endotracheal intubation and positive pressure ventilation is reserved for patients with severe hypoxaemia or hypoventilation despite these measures.

We describe the use of Extracorporeal Life Support (ECLS) and positive outcome in a patient with severe asthma that was refractory to mechanical ventilation.

CASE REPORT

A 20 year old male with a medical background of bronchial asthma and no previous ITU admissions presented to accident and emergency with shortness of breath and wheeze over the last 12 hours. He showed no improvement with his regular medication (becotide, salbutamol). 2 weeks prior to admission he had developed a sore throat and cough productive of sputum.

On initial examination his GCS 15 but he was tachypnoeic with a respiratory rate of 28breaths/minute, blood pressure was 128/90mmHg and pulse 85 beats per minute. He was talking in broken sentences and there were bilateral inspiratory crackles to midzone and bilateral expiratory wheezes on auscultation. He was treated for acute infective exacerbation of asthma with nebulised bronchodilators, supplemental oxygen, intravenous magnesium sulphate and methylprednisolone. He was also started on tazocin 4.5g three times a day and gentamicin 300mg once a day. However, his clinical condition worsened and pulse oximetry showed Sp02 of 95% on 15L and 84% on room air. The arterial blood gas on air showed a pH of 7.38 pC02 5.00kPa, pO2 7.15kPa. ECG showed sinus tachycardia and

initial full blood count, electrolytes and liver function tests were normal. He was breathing with a respiratory rate of 50 breaths/minute and his saturations were deteriorating to 90% on 15 litres oxygen. He was starting to tire and the decision was made for intubation and further management on the intensive care unit.

He was induced with propofol 200mg, fentanyl 100mcg and suxamethonium 100mg and after intubation and ventilation he was maintained on propofol,and alfentanyl infusions. At peak pressure of 40cm H20 (PEEP at 0cmH20) he has tidal volumes of 200-300mls and autopeep 15cm H20. I:E ratio was 1:4 and respiratory rate10/minute. However he was proving very difficult to ventilate. Despite addition of a vecuronium infusion peak pressures were still reaching 45cm H2O though tidal volumes temporarily increased to 300-350mls/ breath. Arterial blood gas showed a PC02 of >20kPa, pH 7.1, pO2 12kPa on FiO2 .80. Despite adequate sedation and paralysis, airflow obstruction and dynamic hyperinflation worsened. Portable chest radiographs demonstrated evidence of a left sided pneumothorax and a chest drain was inserted immediately. 2 hours later the arterial blood gas showed pH of 6.82, pco2 still >20kPa, pO2 10kPa and BE incalculable. The patient also developed atrial fibrillation with a ventricular rate of 110 beats/minute.

At this stage his case was discussed with a tertiary respiratory centre. The patient was accepted for treatment for acute lung injury via veno-venous extra corporeal life support (ECLS). At this point, peak inspiratory pressures were ranging between 45-50 cm H2O, with an auto peep of 12-14cm H2O. Prior to cannulation for ECLS a right sided apical chest drain was inserted. ECLS was initiated. Less than 24 hours later, whilst receiving ECLS, the patient was ventilating with a peak pressure of 21cm H20. On an Fi02 0.40, he had a pH of 7.43, pC02 5.5kPa, p02 10.8kPa. He was transferred back to our hospital 48 hours later where he was weaned off respiratory support and extubated approximately 36-48 hours later. Recovery and discharge following this was uneventful.

DISCUSSION

Extracorporeal life support (ECLS) has traditionally been used in infants and children with acute respiratory distress syndrome due to reversible pulmonary disease such as meconium aspiration, idiopathic respiratory distress syndrome, sepsis with pneumonia and persistent pulmonary hypertension of the newborn.[2] It also provides significant support for acute respiratory distress in adults.[9] The first successful use of ECLS was described by Hill and colleagues in 1972 [10] in a 24 year old male who developed post traumatic acute respiratory distress syndrome. By 1986, Gattinoni and colleagues had demonstrated that use of extracorporeal carbon dioxide removal in patients with ARDS was safe and associated with a survival advantage.[11]

The earliest reports of the successful application of ECLS to asthma were described in 1981 [13] and 1993.[14] The therapeutic principle in asthma is to ensure adequate oxygenation by partially or totally replacing the lungs' function in gas exchange, giving time for the acute lung injury to heal and also allowing minimization of mechanical ventilation and its risks of O2 toxicity as well as barotraumas and volutrauma. ECLS is indicated for patients with respiratory failure of a reversible aetiology and who are not responding to standard medical management. Patients in whom ECLS is initiated within five days of mechanical ventilation tend to be most likely to respond whereas those in whom ECLS is begun after 10 days do very poorly.[12]

Our patient had acute severe asthma which did not improve despite maximum medical management and ventilatory support. This patient continued to deteriorate and developed severe dynamic hyperinflation with peak pressures ranging between 45-50mm H20 with resultant bilateral pneumothoraces, and severe respiratory acidosis. However following initiation of ECLS as an adjunct to medical and mechanical ventilation, his respiratory function normalised within 24 hours of therapy. ECLS is uniquely suited to the management of severe asthma attacks that are refractory to control with conventional treatment by virtue of the membrane lung's extremely efficient clearance of CO2. Rapid normalisation of PCO2 and correction of respiratory acidosis enables lower airway pressures to be used and lower concentrations of oxygen which helped to minimise oxygen toxicity and effects of volutrauma and barotraumas.[12] In this case the short burst of this treatment helped ensure a rapid recovery from respiratory support and then a steady medical recovery leading to discharge. There is currently no long term data on the statistics for repeat requirement of ECLS for respiratory failure due to refractory asthma.

There are other case reports [1314151617][18] and one case series [19] in the literature procuring findings that ECLS is a useful method for preventing death in patients with near-fatal status asthmaticus.

The indications for ECLS in the case reports included

cardiovascular compromise and/or cardiac arrest [131517] and severe hypercapnic acidosis.[141618] The indications for ECLS in the 3 patients in the case series [19] included severe, refractory hypercapnia and acidosis, hypoxemia and eventual shock, and dynamic hyperinflation demonstrated by peak inspiratory pressure up to 50–60 cm H2O. All patients benefits from 21 to 86 hours of ECLS. In our case the patient was referred for ECLS because of increasing hypoxaemia and hypercapnia during mechanical ventilation, recurrent pneumothoraces and acidosis. He benefited from 24 hours of ECLS.

In their case series, Kukita and colleagues [19] provided an algorithmic approach to mechanical ventilation in patients with status asthmaticus. We ask that clinicians consider ECLS if despite institution of hypoventilation and while tolerating increased peak inspiratory pressure, pH is still less than 7.2, PaCO2 is greater than 100 mm Hg, or life-threatening conditions of hypoxaemia, hypotension, or barotrauma develop.

In conclusion, this case illustrates the effective use of ECLS for acute, severe, reversible respiratory failure due to status asthmaticus. We ask that clinicians be increasingly aware of this facility in the UK as we believe that ECLS should be considered early in the treatment of patients with status asthmaticus whose gas exchange cannot be satisfactorily maintained by conventional aggressive medical therapy and mechanical ventilation.

CORRESPONDENCE TO

angela.tewari@yahoo.co.uk, Intensive Care Unit, Mayday Hospital, 503 London Road, Croydon CR7 4YE

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Author Information

A. Tewari
Specialist Registrar, Mayday Hospital

T. Ali
Specialist Registrar, Mayday Hospital

R. Baba
Consultant Intensivist, Mayday Hospital