Extracorporeal Membrane Oxygenation (ECMO) in a child with near-fatal bronchial asthma

P S L M Waidyasekara, K Withanaarachchi, DVT Harischandra, A K K A Mihiran, RK Firmin

National ECMO Centre, Teaching Hospital Karapitiya, Galle, Sri Lanka

Correspondence : *Dr Suranga Waidyasekera; swaidyasekara@gmail.com*
Competing interests : *None declared*

Key words : *ECMO, severe bronchial asthma, paediatric asthma, near-fatal asthma*

Introduction

Asthma is one of the commonest chronic illnesses in children and an acute asthma attack is one of the commonest paediatric emergencies. Near-fatal asthma is defined as acute asthma associated with respiratory arrest or an arterial carbon dioxide tension (PaCO2) of more than 50mmHg, with or without altered consciousness and requiring mechanical ventilation.

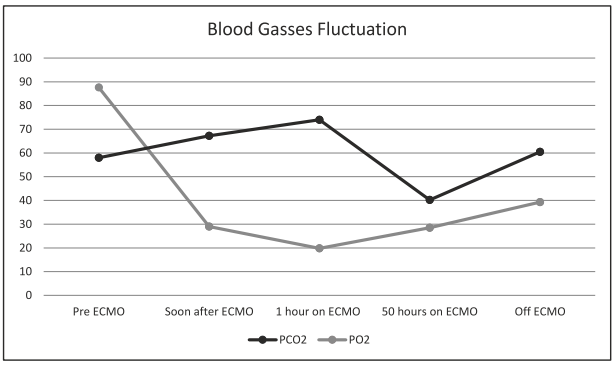
Mechanical ventilation may be problematic as acute asthma is associated with airway obstruction and air-trapping that may prevent effective carbon dioxide clearance. Hypoxia may be an issue in these patients but typically carbon dioxide retention and respiratory acidosis dominate.

Extra-corporeal Membrane Oxygenation (ECMO) is an alternative or complimentary technique that can be used in such situations. As the oxygenator can clear carbon dioxide as efficiently as it can add oxygen, the PaCO2 can be returned to normal whilst other supportive measures such as bronchodilators, steroids and antibiotics are given a chance to work. Veno-venous Extra-corporeal Membrane oxygenation (VV ECMO) is the modality of choice here, as cardiac function is usually normal. If, however, circulatory support is required, Veno-arterial ECMO should be used.

Case report

A six-year-old boy with poorly controlled bronchial asthma presented with an acute severe exacerbation which had poorly responded to inhaled bronchodilator therapy and oral steroids. It was complicated with broncho-pneumonia and arterial desaturation. He had poorly responded to second line therapy with intravenous magnesium sulphate, salbutamol, aminophylline and ketamine and was started on high flow nasal oxygen therapy. Despite these measures, his condition worsened with significant respiratory distress and type 2 respiratory failure. Mechanical ventilation was attempted with low ventilator rates and low inspiratory time. As the condition did not respond to pressure and volume control ventilation, high frequency oscillatory ventilation (HFOV) was attempted but this had minimal improvement.

ECMO was initiated due to the steep rise in carbon dioxide levels (PaCO2 = 90mm Hg) and poor oxygenation (PaO2 = 60 mm Hg) and acidosis (pH = 7.10). Following partial heparinisation, VV ECMO was established using femoral venous drainage and jugular return cannulation. ECMO was continued for 96 hours with heparin anti-coagulation running the Activated Clotting Time (ACT) between 180 and 200 seconds. Low pressure, low frequency and low oxygen ventilator support were also provided. Intravenous steroids and broad-spectrum antibiotic therapy were continued. The PaCO2 and pH were rapidly normalised and the arterial saturation and PaO2 were more gradually normalised (fig 1). VV ECMO was weaned gradually and the child was decannulated after 96 hours of support. He recovered completely and was discharged home after 10 days of hospitalisation. He remains well to date.



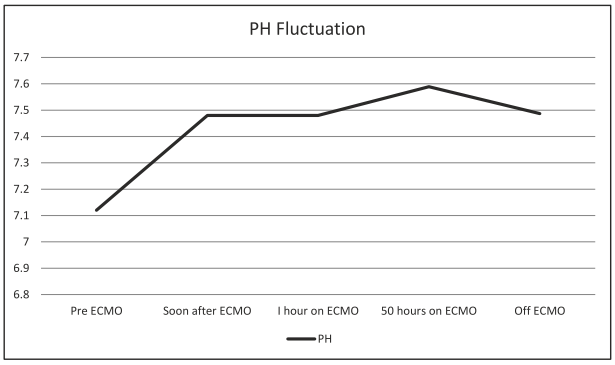


Fig 1 : Arterial blood gas changes over time

Discussion

Near-fatal asthma is a serious condition, which may require the use of mechanical ventilation and, if that fails, extra-corporeal life support techniques such as VV or VA ECMO [1]. Globally this condition carries a significant mortality. According to the Center for Disease Control (Atlanta, USA) data, near-fatal asthma bears a nearly 30% of mortality risk in that country [2]. Traditionally, mechanical ventilation was the mainstay of treatment of near-fatal asthma. Unfortunately, positive pressure ventilation often makes the air-trapping that is a feature of severe asthma worse, causing the PaCO2 to rise and the pH to fall further. It also tends to cause ventilator-induced lung injury (VILI) because of the pressures necessary to overcome airway resistance. As a result, ECMO is being increasingly used as a rescue therapy for bronchial asthma. With the institution of ECMO, control of PaO2, PCO2 and pH are rapidly achieved and then maintained until the resolution of the increased airway resistance and inflammation [3]. The risks are the same as for those on any extra-corporeal circuit: mainly cannulation risk, bleeding, heparin induced thrombocytopaenia and infection [4].

The use of ECMO in paediatric near-fatal asthma is a novel experience in the Sri-Lankan paediatric intensive care setting. Although the recovery of paediatric near-fatal asthma using ECMO is reported to be between 66% and 83% in the developed world, data is lacking in the lower and middle-income settings [5]. Therefore, this is an encouraging historical achievement for a developing country like Sri Lanka.

1. McFadden Jr, E. R. "Acute severe asthma." *American Journal of Respiratory and Critical Care Medicine* 168.7 (2003): 740-759.
DOI: 10.1164/rccm.200208-902SO

2. https://www.cdc.gov/asthma/most_recent%20data.htm.Accessed%2018%20July%202017

3. Di Lascio, Gabriella, et al. "Extracorporeal membrane oxygenation support for life-threatening acute severe status asthmaticus." *Perfusion* 32.2 (2017): 157-163.
https://doi.org/10.1177/0267659116670

4. Yeo, Hye Ju, et al. "Low-dose heparin during extracorporeal membrane oxygenation treatment in adults." *Intensive care medicine* 41 (2015): 2020-2021.

5. https://www.elso.org/registry.aspx