Use of inhalational anesthesia in the pediatric intensive care unit for patients with severe asthmatic bronchospasm prevents need for ECMO

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INTRODUCTION

Asthma is becoming more prevalent in our population (1). There are several treatment modalities available for asthma, however the treatment of severe bronchospasm may be limited. Near fatal severe bronchospasm in asthmatic patients has been associated with standard extracorporeal membrane oxygenation (ECMO) with successful outcomes (2), as well as pumplex ECMO therapy (3), however there are substantial risks associated with this procedure, which include a high risk of mortality (4). Patients presenting with severe intractable asthma unfortunately have few effective therapeutic options (5).

We describe two cases of patients with severe refractory bronchospasm that were successfully managed with inhalation anesthesia in the pediatric intensive care unit and successfully avoided ECMO therapy.

CASES

CASE 1

An 11 year old Caucasian female patient was transferred from an outside hospital (OSH) with status asthmaticus. The patient was intubated and sedated on arrival at our facility. With no family present, her chart indicated a history of asthma, and related that the onset of symptoms was approximately one week prior to presentation; with coughing, congestion, and rhinorrhea. The patient was afebrile throughout this period. On initial presentation she was in respiratory distress and was treated with multiple doses of albuterol, however she deteriorated into respiratory failure and was intubated. The patient’s peak pressures on the ventilator at the outside hospital were approximately 60 mmHg with a tidal volume of 400 mL. Upon arrival of the airway team (air ambulance service), she was started on continuous albuterol treatments and given 2mg/kg solumedrol and transported to our PICU. The airway pressures were weaned to some degree by the aircare team en route. ABG on arrival was pH 6.96, pCO2 >115, pO2 285 FiO2: 100%. The patient was then intubated and sedated with some improvement prior to being transferred to a higher level of care. He was using accessory muscles and noted to be tachypneic and in respiratory distress, with decreased breath sounds bilaterally. Arterial blood gas at this time revealed a pH of 7.15, a pCO2 of 75 mmHg and a pO2 of 58 mmHg. The patient was then intubated as he continued to show increasing signs of respiratory failure. The patient’s initial ventilator settings were pressure control with a peep of 10, rate of 16, and a peak pressure of 30mmHg. The patient tolerated these settings with oxygen saturations in the high 90s. The patient subsequently deteriorated further to a pH of 6.89 and a pCO2 of >115 mmHg. The patient had a history of prior hospitalizations for his asthma, without any prior intubations. Similar to our earlier patient, there was an unsuccessful response to standard beta agonist, steroid and ketamine infusions in the PICU with continued inability to ventilate with the patient’s pCO2 remaining >115 mmHg. The ECMO team was consulted, and after consultation with anesthesia again, a decision was made to also initiate a trial of inhalational Intensive Care in the PICU with ECMO on standby. The patient also responded very favorably to this therapy and was maintained on an end tidal value of 0.6 MAC of isoflurane for 16 h in the PICU; during which time his pCO2 gradually decreased as well as peak airway pressures. At this time, the patient was transitioned to the ICU ventilator and nebulizer treatments were restarted and he was eventually extubated successfully on day two of his PICU stay. The patient was discharged after a 10 day hospital stay, in stable condition.

Figure 1: Case one chest radiograph on admission, PaCO2 and pH trends.

The ECMO team was consulted very early into the patient’s hospital course to assess the patient’s potential need for ECMO, as there was no improvement in the patients respiratory status with standard therapy; repeat ABGs showed a continued pH<115 with a pH of 6.90 and P02, 234 (FiO2: 80%). The ECMO team was placed on standby at that time, and anesthesia was consulted for a possible trial of isoflurane prior to the initiation of ECMO. The patient also received amiphyline, ceftriaxone and paralyzed with cisatracurium.

Prior to the initiation of isoflurane therapy the patient became hypotensive requiring dopamine and phenylephrine infusions. The patients physical exam at that time showed little air movement on exhalation evident on auscultation, and peak inspiratory pressures of 45mmHg (plateau pressures were > 25-29mmHg) required were with volume control 400mL, RR: 12 FiO2: 100% PEEP 12mmHg. The patient responded very favorable to isoflurane and was maintained on an end tidal value of 0.6 MAC of isoflurane for 24 hours with ventilation progressively improving, PaCO2 decreasing, and peak airway pressures decreasing. The patient was extubated after 24 hours, transitioning to albuterol nebulisation and eventually was discharged home 6 days after admission in stable condition.

Figure 2: Case two chest radiograph showing evidence of pneumomediastinum with curvilinear lucency along the left heart border and tracking along the superior mediastinum, with extensive subcutaneous emphysema in the bilateral supraclavicular regions and no definite pneumothorax, PaCO2 and pH trends.

DISCUSSION

Severe intractable bronchospasm induced in asthmatic patients is challenging to treat. Therapeutic options after failure of traditional therapy include ECMO and inhalational anesthesia, neither of which have a standardized system in place in regards to pediatric patients in severe bronchospasm. ECMO as a rescue therapy has been well documented as a treatment for status asthmaticus, in multiple case reports as well as retrospective reviews of the literature, but despite its success, ECMO therapy should remain a therapy of last resort (6) as the morbidity and mortality with its use, remain high (3,4). Inhalational anesthetics, specifically isoflurane have also been viewed as a potential therapeutic option for severe bronchospasm (7,9). They are powerful bronchodilators (10,11), making them a potential rescue therapy prior to placement of patients on ECMO (12,13). They have been studied in animal models as well as through retrospective case series and reports showing potential for more routine use as a rescue therapy prior to placement of patients on ECMO (12,13).

In our two patients we choose to use isoflurane for multiple reasons, including success in its past in comparison to volatile agents (7) and better profile for longer-term use (14). Inhalation anesthesia use outside the operating room has been limited due to a variety of factors, including clinical expertise and issues of scavenging (13,15-16) and other operational difficulties outside the operating room. In order to be able to present clinicians the therapeutic modality of inhalational anesthesia as a viable treatment for pediatric patients, it may be necessary to standardize dosage and endpoints of treatment as inhalational anesthetic effects on pulmonary resistance show a multifactorial and complex mechanism of action (11).

In the two cases described; patients were imminently to be treated with ECMO therapy for severe bronchospasm due to inability to ventilate. Inhalation anesthesia therapy rescue in the PICU was successful in both cases to prevent this lead to a favorable outcome. As the morbidity and mortality of ECMO is high, pediatric intensive care physicians could consider inhalation anesthesia as an additional modality to utilize in consultation with their anesthesia colleagues.

REFERENCES