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Case Report

Sevoflurane administration initiated out of the ED for life-threatening status asthmaticus[☆]

Abstract

Status asthmaticus is both a common and dangerous cause of acute dyspnea in the emergency department (ED) setting. Although most cases respond favorably to standard treatment, there are rare cases in which therapy beyond traditional treatment is needed. One of these treatment modalities includes inhalational anesthesia. We present a case in which inhaled sevoflurane was initiated out of the ED for a life-threatening asthma exacerbation refractory to conventional treatment. To our knowledge, this is only the second case to report the use of inhaled anesthetics initiated out of the ED for status asthmaticus and is the first report of its kind to thoroughly detail the respiratory response noted while inhalation anesthesia was being implemented. A brief review of other case reports involving the use of sevoflurane for asthma is included. This case, as well as the others reviewed, illustrates the significant beneficial effect inhaled anesthetics can have on asthma, making this a treatment modality that must be recognized and appreciated by all emergency medicine providers.

Acute asthma exacerbations are among the most common clinical scenarios encountered by the emergency medicine provider. Some estimates report that a total of 1 to 2 million patients per year present to emergency departments (EDs) for asthma-related complaints, with approximately 450,000 per year being admitted [1]. It is, therefore, expected that emergency physicians must be intimately familiar with the management of acute asthma exacerbations. Death from asthma is rare, with estimations of around 5000 per year in the United States [2]. Although 5000 deaths per year is a considerable amount, this accounts for approximately 0.003% to 0.005% of total patients presenting to EDs. In these few patients, therapies beyond the mainstays of inhaled bronchodilators and systemic corticosteroids are often initiated. Some of these therapies include but are not limited to intravenous epinephrine, magnesium, ketamine, or inhaled anesthetics. Here, we present a case of a young adult male in status asthmaticus who presented in acute respiratory distress, with severe acidosis refractory to traditional therapies. He was transferred from the ED directly to the operating room for initiation of inhaled anesthetics. To our knowledge, this is only the second description of inhalational anesthesia being initiated directly out of the ED for treatment of a severe asthma exacerbation and is the first report of its kind to detail the improvement in respiratory parameters (peak pressure, tidal volume, end-tidal CO₂, pH, and Pco₂) observed while inhalation anesthesia was being administered.

A young male in his early twenties presented to an urban ED with severe shortness of breath. On arrival, he was unresponsive, and his

friends were unable to provide any collateral history. However, an albuterol inhaler was found in his possession. Initial examination revealed frothy airway edema, prominent bilateral wheezes, strong radial pulses, and a depressed level of consciousness, with a Glasgow Coma Scale of 8. The patient was immediately started on nebulized albuterol, intravenous methylprednisolone, a single dose of intramuscular epinephrine, and intravenous magnesium. During the initial resuscitation, he was provided with positive pressure ventilation with a bag valve mask but was already becoming progressively more difficult to ventilate with the bag valve mask. He was then intubated after induction and paralysis with etomidate and succinylcholine, respectively. His chest radiograph was consistent with hyperinflation, but no pneumothorax or other abnormality was noted. After intubation, he remained hypoxic, with oxygen saturations as low as 60%, and he remained difficult to ventilate with the bag valve mask despite external manual chest decompression. Oxygenation improved with ventilator adjustments; however, he began demonstrating elevated peak pressures, with pressures around 50 cm H₂O. His peak pressures improved with disconnection from the ventilator followed by manual external decompression; however, this procedure had to be repeated multiple times for recurrences of elevated peak pressures. This progressed to the patient becoming hypotensive if not repeatedly disconnected and manually decompressed.

The emergency medicine physician then contacted the anesthesia department for initiation of inhalational anesthesia, and arrangements were made to transport the patient to the operating room for initiation of inhaled sevoflurane. Within 30 to 60 minutes of sevoflurane therapy, the patient demonstrated significant improvements in tidal volumes, peak pressures, pH, partial pressure of carbon dioxide, and end-tidal carbon dioxide (Figs. 1–5). The attached figures illustrate the remarkable improvements made to his respiratory status in a relatively short period. He was then transferred to the intensive care unit and extubated later that day. He was discharged home on his third hospital day in baseline, normal condition.

This case represents a rare but important scenario in which inhaled anesthetics were used as a rescue therapy for a patient with severe respiratory distress refractory to conventional therapy. Although the use of inhalational anesthesia for status asthmaticus has been described in case reports, it is in reality very rarely used. Because its use is so infrequent, the current existing body of literature regarding inhalational anesthesia for refractory asthma is limited to case reports and series.

Much of the current literature regarding inhalational anesthesia's effect on the pulmonary system is aimed at describing pharmacology and pharmacokinetics. A detailed description of the pharmacology of inhaled anesthetics is beyond the scope of this article. Briefly, inhaled anesthetics are used in asthma due to their ability to cause bronchodilation. The mechanism of this bronchodilation is not fully understood, but

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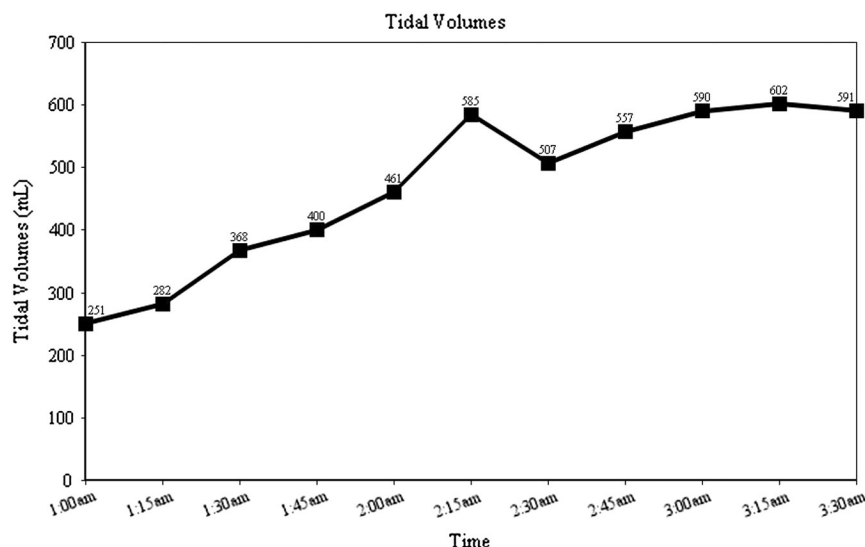


Fig. 1. Tidal volumes during sevoflurane administration.

proposed mechanisms include direct β -adrenergic receptor stimulation, smooth muscle relaxation, inhibition of bronchoactive mediator release, histamine antagonism, and nitric oxide release by an epithelial dependent mechanism [3].

The use of inhalational anesthetics for status asthmaticus was first reported in the 1930s, with agents such as tribromethanol, cyclopropane, and ether. Of the more modern inhaled anesthetics, halothane was the first to be described, with the earliest reports being described in the late 1970s and early 1980s [3]. To date, halothane remains the most commonly described inhaled anesthetic in regard to its use for treating refractory status asthmaticus. Numerous case reports have been described, but it should be noted that all of these case reports describe the initiation of halothane in patients who are already in the intensive care unit.

It should be reiterated that the case currently being described stands out in that it involved the use of sevoflurane and had this initiated out of the ED. Sevoflurane has lower blood-gas solubility compared to other inhaled anesthetics; this lower solubility affords greater control of anesthetic depth as well as allowing for more rapid recovery after general anesthesia [4]. In regard to its pulmonary effects, sevoflurane provides bronchodilation, inhibition of hypoxic vasoconstriction, and minimal

airway irritation. Compared to all other inhaled anesthetics, sevoflurane is reportedly the least irritating to the airway [5]. It has also been proposed that sevoflurane may be more effective in decreasing airway resistance when compared to other inhaled anesthetics [6].

Despite the benefits conferred by the use of sevoflurane, reports of its use in status asthmaticus are less prevalent than that of other inhaled anesthetics, namely, halothane. This is likely more of a reflection of the availability, cost, and familiarity with halothane, rather than a difference in efficacy. A brief summary of all case reports, written in English, involving the use of sevoflurane as a rescue therapy for life-threatening asthma will be summarized below.

A 2012 case report described a 10-year-old boy with asthma who presented critically ill and improved only after initiation of sevoflurane [7]. This patient was treated with terbutaline, salbutamol, ipratropium bromide, intravenous prednisolone, magnesium, and ketamine, with minimal improvement in his bronchoconstriction. After initiation of sevoflurane, the patient began to show improvement in his respiratory parameters and eventually made a full recovery. A similar case described an 8-year-old child with status asthmaticus who was treated with a multimodal regimen, including inhaled sevoflurane, who also made a full recovery [8]. A recent case series of 7 pediatric patients

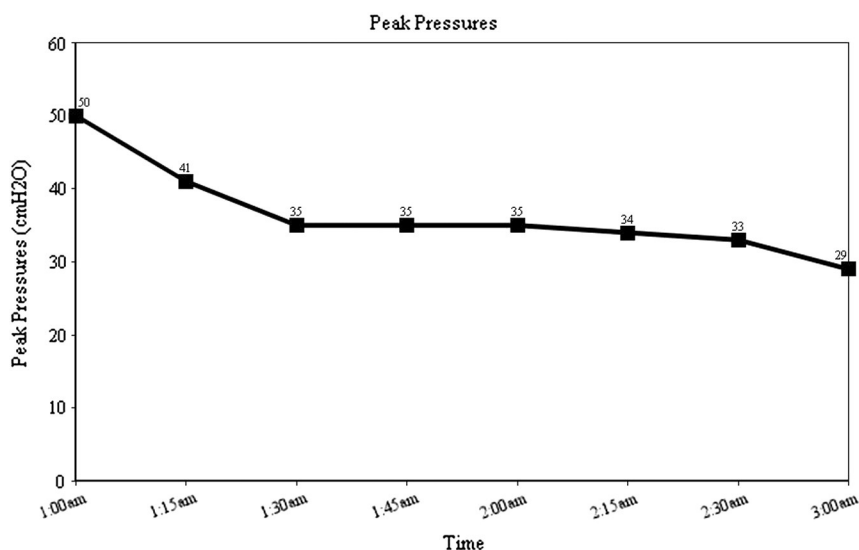


Fig. 2. Peak pressures during sevoflurane administration.

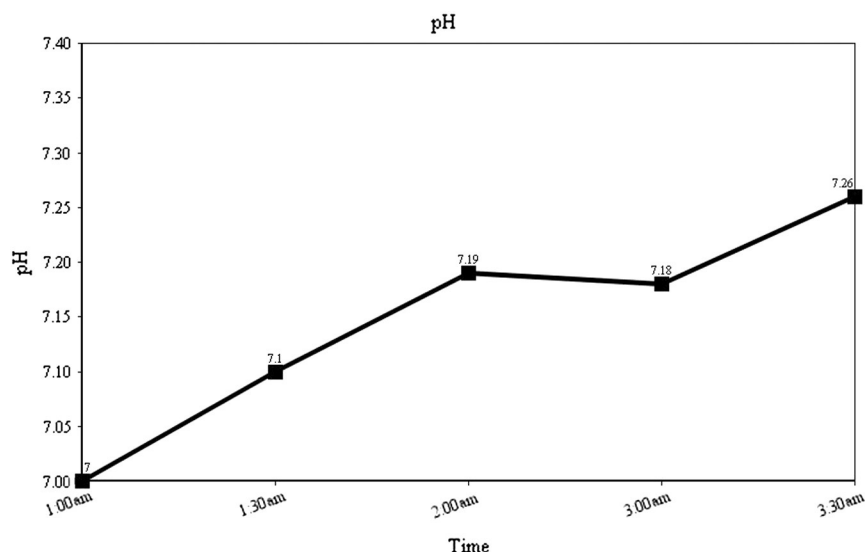


Fig. 3. pH during sevoflurane administration.

similarly reported successful use of sevoflurane for status asthmaticus [9]. In this series, all 7 patients with near fatal asthma were treated with sevoflurane, demonstrating improvements in their P_{CO_2} and pH and eventual discharge from the hospital. A 2008 case report [10] describes a 3-month-old infant who required more than 90 hours of sevoflurane because of status asthmaticus, highlighting that the patient did not develop any adverse reactions to such a prolonged course on sevoflurane. Similarly, it has also been demonstrated that adults can tolerate prolonged courses of sevoflurane for refractory status asthmaticus without development of adverse effects, specifically nephrotoxicity [11].

Schultz [12] described a case of a 26-year-old woman presenting to a rural ED in status asthmaticus. This patient required immediate intubation due to unresponsiveness and was treated with nebulized albuterol, subcutaneous epinephrine, intravenous methylprednisolone, and intravenous magnesium sulfate. After persistent hypoxia despite these measures, sevoflurane was initiated with the help of the anesthesia department. The patient's oxygenation improved with sevoflurane, and she required it for 2 hours before transport to a tertiary care facility. It should be noted that this report is very similar to our report in that it involved an adult with status

asthmaticus who only improved after initiation of sevoflurane. It also bears similarity in that inhaled anesthetics were initiated out of the ED, not from the intensive care unit. To our knowledge, Schultz's 2005 report and this current case report are the only 2 reports describing initiation of inhaled anesthetics out of the ED. Notable differences, however, exist. First, our case report was in an urban teaching hospital. Second, our report provides a detailed sequence of changes in respiratory parameters over the time that sevoflurane was being administered.

The use of inhalational anesthesia can be lifesaving in patients with asthma exacerbations failing traditional therapy. Although previously described, most cases describing this phenomenon have been in intensive care unit settings. This case report highlights the use of sevoflurane, initiated out of the ED, as a rescue therapy for a patient with a life-threatening asthma exacerbation. As noted in the attached figures, response to inhalational anesthesia can be dramatic within a short period. Although likely to be rarely used, emergency medicine physicians should be aware that starting inhaled anesthetics out of the ED is a viable and possibly lifesaving option for patients with near-fatal asthma exacerbations failing conventional therapy.

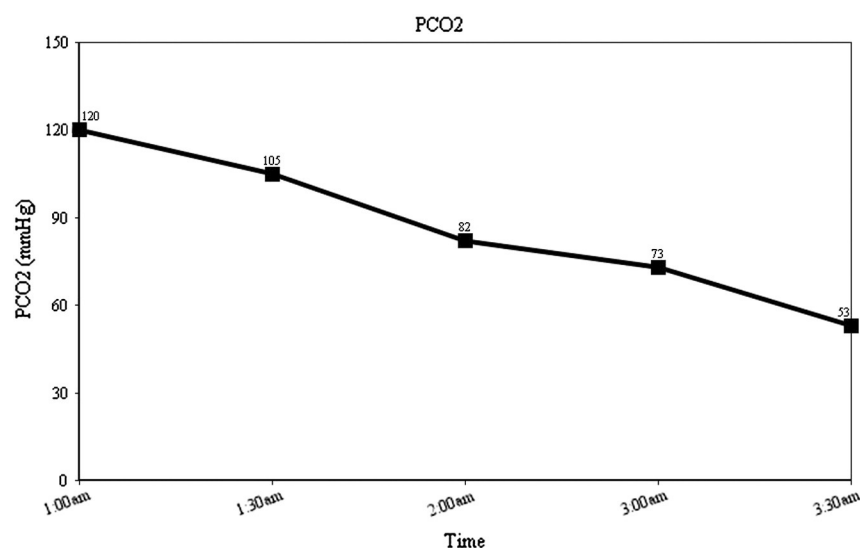


Fig. 4. Partial pressures of carbon dioxide during sevoflurane administration.

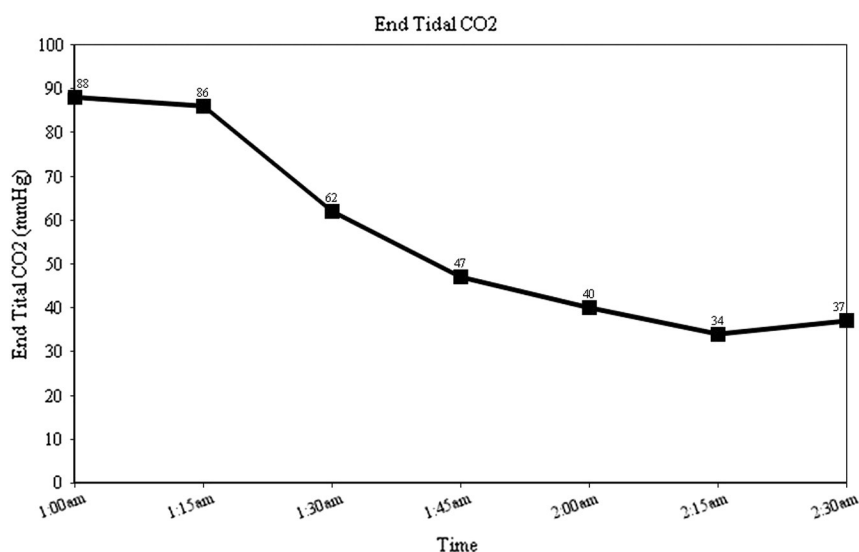


Fig. 5. End-tidal carbon dioxide measurements during sevoflurane administration.

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