Case Report

Critical asthma syndrome in trauma patients - A case report and literature review

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ABSTRACT

Critical asthma syndrome (CAS) is an umbrella term for many acute, life-threatening, and treatment resistant variants of asthma exacerbation, including refractory asthma, near fatal asthma, and status asthmaticus. The asthma mortality rate has steadily increased through the last decade and disproportionately affects women, African-Americans, patients of low socioeconomic status, and adults over the age of 55. Increased awareness of the diagnosis and therapies for CAS can help establish a therapeutic strategy for asthma beyond corticosteroids, bronchodilators, and other conventional treatments.

A 37 year-old African American woman presented to our Level 1 Trauma Center after a high-speed motor vehicle crash and was intubated on arrival for airway protection. The patient developed diffuse wheezing and persistent tachycardia, with elevated peak airway pressures and air trapping on mechanical ventilation. Her symptoms were refractory to inhaled steroids, systemic steroids, intravenous magnesium, continuous albuterol administration and ventilator optimization. Heliox, an admixture of 80:20 percent helium to oxygen, was initiated to assist with laminar flow. Throughout the next 24 h, the patient's air trapping improved, subsequently decreasing intrathoracic pressure, improving venous return and resolving her tachycardia. The patient's multiple orthopedic injuries were treated and she was eventually weaned off of Heliox, steroids, and continuous albuterol. She was extubated and endorsed a history of poorly controlled asthma requiring hospitalizations and multiple intubations.

Recognition of CAS can be challenging in the trauma patient with distracting injuries. This case illustrates the utility of a stepwise approach to a trauma patient suffering from CAS, and should encourage further research into novel therapies when conventional treatment fails. Given that the populations most affected by CAS are often also subject to a disproportionate burden of trauma, trauma surgeons should maintain both a vigilance for the syndrome as well as a working knowledge of the treatment modalities available.

Introduction

Critical asthma syndrome (CAS) is an umbrella term describing many acute, life-threatening and treatment resistant variants of asthma exacerbation [1,2]. These variants include acute severe asthma, refractory asthma, near fatal asthma and status asthmaticus.

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CAS is rarely encountered in traumatically injured patients and literature on its stepwise management is sparse. However, as the asthma prevalence and mortality rate steadily increases, its overlap with the trauma patient population has become more relevant [3]. Poorly controlled asthma disproportionately affects women, adults over the age of 55, Black patients, and patients of low socioeconomic status (3). Respectively, total traffic deaths and pedestrian traffic deaths have been found to have higher rates in Native American, Native Alaskan and Black persons, and persons living in areas of high economic hardship [4].

Case

A 37 year old African American female presented to a Level 1 Trauma Center after a highway head-on motor vehicle collision. Upon presentation, she was encephalopathic and unable to provide a history, subsequently requiring intubation for airway protection. CT imaging demonstrated multiple traumatic injuries including displaced, comminuted left acetabular fracture; left superior & inferior pubic rami fractures; left inferior sacral fracture, and multiple soft tissue injuries. The patient was resuscitated and remained intubated for planned orthopedic procedures. Soon after admission, the patient was noted to have diffuse bilateral wheezes and elevated peak inspiratory pressures that progressed to “quiet chest” (severe bronchospasm causing low flow and nearly absent breath sounds), dynamic hyperinflation, and persistent tachycardia. Having ruled out more common causes of respiratory distress in the trauma setting, including pneumothorax, pulmonary contusion, acute respiratory distress syndrome (ARDS), and ventilator dyssynchrony, the treatment team suspected CAS. Respiratory rate was lowered to 12, I:E ratio was modified to allow for prolonged expiration, and the ventilator circuit was disconnected multiple times to allow for release of air trapping. Additional administered interventions included inhaled steroids, systemic steroids, intravenous magnesium, and continuous albuterol administration. Due to ongoing dynamic hyperinflation and elevated peak pressures, Heliox was started to assist with laminar flow and albuterol delivery to smaller airways. The patient stabilized, and did not require paralytics for ventilator synchrony, as the patient was not breathing above the set rate of 12.

The patient’s condition improved over the next 24 h, at which point the Heliox was discontinued and continuous albuterol weaned to 10 mg/h. Continuous albuterol was used for operative intervention on her left pelvis, and the patient received volatile anesthetic intraoperatively. Unfortunately, the patient developed status asthmaticus and required Intensive Care Unit (ICU) admission and reintubation of continuous nebulized albuterol at 30 mg/h. Once stabilized, the patient was taken to the operating room (OR) a second time for complete surgical repair of the left acetabular fracture with ongoing albuterol. With time, bronchodilators were deescalated to intermittent administration and the patient was successfully extubated. Once extubated, the patient endorsed a history of poorly controlled asthma with intermittent rescue inhaler use, multiple hospitalizations in the past year, and multiple intubations for acute exacerbations.

Discussion

While our patient received initial treatment as suggested by current guidelines (bronchodilators, systemic corticosteroids, magnesium and appropriate ventilator settings), several adjunctive therapies helped stabilize her condition. Importantly, the diagnosis was made quickly, which can be challenging in trauma patients when other sources of physiologic perturbation such as pain, aspiration, blood in the airways, and frank wheezing present. Amsmatic patients that initially present with classic wheezing, cough and dyspnea will develop harbingar symptoms that indicate risk of progression to CAS. Diaphragmatic contractions will become more forceful, as additional thoracic muscles are recruited to aid with increased work of breathing. Wheezing may progress to “quiet chest” as airway obstruction prevents effective airflow into the lungs. Jugular veins may become distended as dynamic hyperinflation compresses cardiac preload, resulting in peripheral congestion. These changes will be reflected on the ventilator as elevated peak inspiratory pressures and “auto-pee”, as insufficient time for exhalation traps residual air before the next breath starts. The ventilator will also show an expiratory flow waveform that does not return to baseline. Ventilator settings may be optimized by decreasing the respiratory rate to approximately 10–14 breaths/min, maintaining low tidal volumes at 6–8 ml/kg, decreasing the inspiratory to expiratory (I:E) ratio, and minimizing PEEP to allow for sufficient exhalation and avoidance of additional hyperinflation [5].

The patient was treated with continuous albuterol, which is more often seen in pediatrics, as opposed to intermittent administration used mainly in adults. Shrestha et al. have described the most improvement in FEV1 and the least amount of side effects with continuous administration of a standard (2.5 mg/h) dose of albuterol compared to patients receiving intermittent or higher (7.5 mg/h) doses of albuterol, suggesting that continuous administration outweighs the benefit of increased dosage [6]. Continuous administration is also associated with improved FEV1, PEFR and decreased hospital admission with well tolerated side effects including non-significant tachycardia, hypertension, hypokalemia, and tremor [6]. While our patient received a very high dose of albuterol, tachycardia did not worsen and improved with stabilization of the underlying physiology. However, much debate remains regarding a preference between continuous versus intermittent B2 agonists [5–8]. While acute settings may prompt physicians to administer variable doses and frequencies of albuterol, the overall goal in the management of severe acute asthma is the fastest delivery of medication to the most distal regions of the bronchial tree. Heliox, a 70:30 or 80:20 ratio of helium and oxygen, is less dense than atmospheric air or pure oxygen due to helium’s small atomic weight. Its low density allows for less turbulence in obstructed airways and improved deposition of oxygen and bronchodilators in the deepest alveoli. As helium is insoluble in human tissue, there are minimal side effects [2], but patients may notice an increase in voice pitch as air flows more quickly through their vocal cords. While Heliox does not directly stimulate bronchodilation, its improvement in laminar airflow leads to improved pH, PaCO2, FEV1, peak expiratory flow rate, and peak airway pressure during mechanical ventilation.
ventilation [9]. Literature on Heliox’s benefits is sparse, possibly owing to its high cost, logistical complexity, and limited availability. Future studies on appropriate Heliox administration rates, effects on asthmatic subtypes, and differences in non-intubated versus intubated patients await exploration.

**Conclusion**

CAS is a life-threatening condition in and of itself. The overlap with trauma patients means that trauma surgeons should be facile with the stepwise approach to treating CAS. Proactive, instead of reactive, approaches work better to control the disease process. Continuous albuterol may be helpful in severe adult cases, even though it is used mainly in pediatrics. Other adjuncts including Heliox should be considered as well.

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