Mechanical Ventilation of the Severe Asthmatic: Avoiding The Pitfalls

Key Article

- *Laher AE, et al. Mechanically ventilating the severe asthmatic. J Intensive Care Med. 2017; 1-11.*

Background

- More than 2 million patients seek care in US EDs for acute asthma exacerbations
- Up to 4% may require ICU admission – 33% of these patients may require intubation and mechanical ventilation (MV)
- MV in the asthmatic is fraught with peril – patients can develop serious complications
    - Hypotension
    - Dysrhythmias
    - Barotrauma
    - Laryngospasm
    - Aspiration
    - Seizures

Risk Factors for Fatal Asthma Requiring MV

- Younger age
- Poor outpatient compliance with therapy and follow up
- More than 3 ED visits in preceding year
- Recent hospitalization
- Prior MV

General Indications for Intubating and Initiating MV

- Cyanosis
- PaO2 < 60 mm Hg despite oxygen
- Rising PaCO2
- Bradycardia
- Persistent acidosis
- Worsening mental status
- Signs of exhaustion
- Paradoxical thoracoabdominal motion
- Respiratory arrest

Intubation / RSI / Sedation

- Pearls
    - In general, avoid nasotracheal route due to association of asthma with nasal polyposis

    - Use the largest ETT possible to decrease resistance of circuit and facilitate suctioning of the airway
- Hypotension – Greater risk in the asthmatic undergoing RSI
    - Dynamic hyperinflation – can lead to acute rise in PVR, increases right-sided pressures, decreases venous return, decreases RV preload, decreases LV preload, and cardiac output
    - Ventricular interdependence
    - Excessive dehydration due to loss from tachypnea
    - Administer IVFs
    - Ready a vasopressor infusion
- Meds
    - Ketamine and propofol have bronchodilator properties – careful with propofol as it also has vasodilatory properties and can worsen hypotension
    - Etomidate can also be used
    - Succinylcholine and non-depolarizing agents both shown to be safe in asthma
    - Sedation
        - Dexmedetomidine, propofol, and remifentanyl associated with shorter ICU LOS, shorter MV duration, and improved long-term outcomes compared with benzos.

Mode of Mechanical Ventilation

- Pressures
    - Peak inspiratory pressure (PIP)
        - Increased PIP along with an elevated PIP to Pplat ratio indicates airflow resistance
        - PIP > 80 cm H2O not uncommon in asthma
    - Plateau pressure (Pplat)
        - Usually normal in asthmatics – as pathophysiology does not usually involve the alveoli
        - As long as Pplat is maintained < 30 cm H2O, high levels of PIP are not associated with barotrauma/alveoli injury
        - An increase in Pplat suggests expanding pneumothorax or worsening bronchospasm with gas trapping
- Volume control vs. Pressure control
    - No overall outcome differences between volume-controlled or pressure-controlled modes
    - Volume controlled mode generally preferred given the ability to monitor PIP and Pplat
    - Pearl: be sure to reset the upper pressure limit to a value above the patient's intrinsic PIP to prevent potentially fatal alveolar hypoventilation

Dynamic Hyperinflation

- AKA gas trapping, intrinsic PEEP, auto-PEEP, dynamic hyperinflation, expiratory flow obstruction
- Can be determined by analyzing the ventilator waveform graphs
    - Pressure/time waveform

        - Observe for an increase in pressure above the set PEEP after initiating an end-expiratory hold maneuver with patient paralyzed
        - Difference between this and the set PEEP is the intrinsic PEEP
        - Can also observe for an increase in both Pplat and PIP with not change to the PIP to Pplat gradient
    - Flow/time waveform
        - Failure of the expiratory flow to return back to its baseline prior to initiation of the next inspiration
    - Volume/time waveform
        - Failure of the expiratory (descending) arm of the waveform to return to its baseline OR
        - Difference between the inspiratory and expiratory volumes is also indicative of intrinsic PEEP

Settings

- Key Principle: setting the ventilator to allow for a longer expiratory time to minimize the buildup of intrinsic PEEP
- Mode: volume cycled
- RR: 6 to 10 bpm
- Tidal volume: 4 to 6 ml/kg PBW
- FiO2: adjust to maintain SpO2 > 94%
- Pplat: monitor to keep < 30 cm H2O
- PIP limit: adjust to level above the peak airway pressure
- I:E ratio: 1:4 or 1:5
- PEEP:
    - 0 cm H2O if paralyzed and sedated
    - Can use low levels if patient non-paralyzed with some spontaneous effort; shown to reduce the work of breathing as well as improve respiratory effort, mechanics, V/Q mismatch, and gas exchange
- Peak inspiratory flow: 80 to 100 L/min

Troubleshooting High Pressure Alarm

- Look at pressure-time waveform to see if high pressures are due to increase in resistance or increase in compliance
    - Worsening compliance (increase in PIP and Pplat with no change in PIP/Pplat gradient)
        - Consider dynamic hyperinflation, PTX, Pneumonia, ARDS, atelectasis (mucus plug)
        - Obtain CXR and/or US
        - When indicated:
            - Disconnect ventilator and decompress chest
            - Increase bronchodilator therapy
            - Antibiotics if not given already

        - Consider chest tube
        - Consider bronchoscopy
    - Worsening resistance (increase in PIP with increase in PIP/Pplat gradient)
        - Disconnect from ventilator and manually ventilate using BVM
        - Easy to ventilate?
            - Consider ventilator malfunction
            - Consider ventilator circuit malfunction
            - Replace ventilator, replace circuit, or replace filter
        - Difficult to ventilate?
            - Consider ETT obstruction
            - Consider airway obstruction (worsening bronchospasm)
            - Suction ETT or replace
            - Increase bronchodilator therapy

Permissive Hypercapnia

- Retention of CO2 results from worsening airflow obstruction and increase in gas trapping
- Alveolar ventilation unable to overcome CO2 production – hypercarbia
- You can't simply increase the RR – will decrease expiratory time, worsen dynamic hyperinflation, and worsen hypercarbia
- We tolerate higher levels of CO2 and lower pH in order to more effectively ventilate these patients
- Typically maintain pH > 7.2, though this is debatable
- Avoid simply giving bicarbonate – will increase CO2 and worsen intracellular acidosis

ECMO

- Indications not well defined
- Scare literature currently regarding its use in status asthmaticus
- Limited literature to date demonstrates good survival to hospital DC when used for patients with refractory hypoxemia or severe hypercarbia

Don't Forget to Continue Asthma Therapy

- Continuous inhaled bronchodilator therapy via in-line unit on the ventilator
- Be sure to continue corticosteroids and possibly magnesium, depending on the severity of illness
- Success of heliox limited to case reports – not widely used