What To Do
When A Child Has
Life Threatening Asthma

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Objectives

To review the pharmacology, therapeutic alternatives and potential complications of the treatment of asthma.
Chance favors the prepared mind.
Asthma

- Since 1980’s, nearly a two-fold increase in pediatric asthma prevalence in the U.S.
- Between 6.5-9.0 million children with asthma
- Third leading cause of hospitalizations in children under age 15 years
Asthma

- 7 million office visits per year
- 754,000 ED visits per year
- 198,000 hospitalizations per year
- 14 million school days missed
- $3.2 billion spent in asthma treatments annually
Case:
C.D., 15 year old female. Several year history of asthma. Two admissions to ward past two years for asthma. No previous PICU admissions.

Breathing difficulties started this morning. No fever. Non-productive cough. Some vomiting this afternoon. Used Albuterol MDI “too many times to count” today.
Case: C.D., 15 year old female.

Much worse in evening. Told her father. Father started to take her to drug store to get another medicine (Primatene Mist), but on the way, patient requested to go to ER. Getting harder to breathe.
What is Primatene Mist?

Available over the counter.

Each inhalation delivers 0.22 mg of epinephrine.
Arrived in ER at 8:40 p.m.

- **Physical Exam:**
  - HR 150   RR 16   T 97.9   BP 108/62   Wt 60 kg
  - Pulse oximetry: 89% in room air.
  - Pink, alert but anxious, speaking in short intelligible sentences.
  - HEENT: WNL.     Neck: No crepitus.
  - Heart: RRR, tachycardia.
Significance of Crepitus?
Significance of Crepitus?

Pneumomediastinum/
Pneumothorax
ER Course

- Triage nurse recognized respiratory distress. Brought patient directly back to resuscitation room.
- Mask oxygen applied.
- 5 mg Albuterol Neb started.
- Placed on CR monitor with pulse oximetry.
- Physician summoned to room.
Albuterol

Relatively selective ($\beta > \alpha$) adrenergic bronchodilator.

Chemical Formula: $C_{13}H_{21}NO_3$
Albuterol

- Primary action is to increase intracellular cyclic-AMP
  - Relaxation of bronchial smooth muscle
  - Inhibition of release of immediate hypersensitivity mediators (such as histamine - especially from mast cells)
  - Leads to both vasodilatation as well as bronchodilatation.

- Typical Neb doses: Infants: .25 cc (1.25 mg)
  - Children: .5 cc (2.5 mg)
  - Adults: 1.0 cc (5 mg)

- Can be administered as continuous Neb, 5-20 mg/hr.
Xopenex (Levalbuterol)

- (R)-enantiomer of albuterol
- Less tachycardia
- Less jitteriness
ER Course

- Increasingly more anxious, breathing more labored.
- While preparing to place IV, gave subcutaneous epinephrine 1:1000, 0.3 cc.

**Epinephrine:**

![Epinephrine molecular structure]
Epinephrine:
- First introduced as a bronchodilator drug in 1910.
- Both α and β adrenergic agonist effects.
- Effective sub-cutaneously, IM, inhaled and IV.
- SQ/IM dose: 1:1000, 0.01cc/kg, max. 0.3cc (0.5cc).
- Brief duration (20-30 minutes).
**ER Course**

**Epinephrine:**

- Preparing your own “inhaled epi”:
  Add 3 cc of 1:1000 epi to 3 cc of NS.
  More effective than racemic epi in treating children with stridor.


- Standard racemic epi is 2.5%, mix 2.5 cc in 2-3 cc NS.
ER Course

- No recognizable improvement after SQ epi.
- Gave 120 mg IV Solumedrol (methylprednisolone).
- **Methylprednisolone:**
ER Course

- No recognizable improvement after SQ epi.
- Gave 120 mg IV Solumedrol (methylprednisolone).
- **Methylprednisolone:**

Steroids:
**Methylprednisolone:**
- Synthetic glucocorticoid analog with potent anti-inflammatory effects.
- During the first 4 - 24 hours, asthma progresses from the early bronchospastic phase to a latent inflammatory phase characterized by mucosal edema and mucous plugging.
- Dose: 1-2 mg/kg bolus, then 1-2 mg/kg/day, divided q 6 hours.
ER Course

- No noticeable improvement after Solumedrol.
- Then gave bolus of IV terbutaline 500 mcg and ordered a terbutaline drip.

**Terbutaline:**

![Terbutaline molecule image]
Terbutaline:
- Relatively selective β adrenergic bronchodilator.
- Similar to albuterol.
- IV dosing reaches smaller more distal airways more effectively than inhaled form.
- Dose: 10 mcg/kg bolus over 5 minutes (adult dose 500 mcg), then begin drip at 0.5 mcg/kg/min. Titrate as needed. Can be given SQ.
- Major side effects: tachycardia, tremors, hypokalemia, dysrhythmias, ST segment changes.
Is It Starting To Feel Like This?
ER Course

- Still no improvement after terbutaline bolus.
- While waiting for terbutaline drip, gave second Albuterol Neb, this time with Atrovent added.

**Anticholinergics:**

- Stimulation of the cholinergic receptors by various mechanical and chemical stimuli can cause reflex bronchoconstriction.

- Anticholinergic (parasympatholytic) agents act by blocking receptors and inhibiting cyclic-GMP metabolites with resultant bronchodilatation.
ER Course

- **Atrovent**: (Ipratropium bromide).
  - Synthetic quaternary ammonium derivative of atropine.
  - Peak effect 30 min, duration 4-6 hours.
  - Dose: 500 mcg vial (1 unit dose) via Neb q 6-8 hours.
  - Selective local site specific effect on airway smooth muscle.
ER Course

**Atrovent**: (Ipratropium bromide).

- Combination with a Beta adrenergic drug is more effective than either drug given alone ("Combivent" available as MDI).
- Beta adrenergic drugs exert their effects primarily on small airways.
- Aerosolized anticholinergics show predominant effect on larger airways.
ER Course

- After combination Albuterol and Atrovent Neb, began to tire even more.
- Received IV Ketamine, 50 mg (light dose).
**ER Course**

**Ketamine:**
- Produces sedation, amnesia and analgesia.
- Maintains protective airway reflexes and respiratory drive.
- Bronchodilatory effect.
- Good choice as induction agent prior to intubation of an asthmatic.

Dose:
- Bolus 1mg/kg IV
- Infusion: 1-2 mg/kg/hr.

Side effects: emergence reactions, increased ICP, increased BP, myocardium sensitized to sympathomimetics.
Are Things Getting Worse, Or Is It Just Me?
ER Course

- Tired even more, became unarousable with near respiratory arrest.
- Hand BVM ventilated, paralyzed with Rocuronium and intubated with 7.0 cuffed ETT.
- Still extremely tight, given additional Ketamine, 150 mg IV.
ER Course

Intubation:

- 1% - 3% of acute severe asthma exacerbations require intubation
- Pre-oxygenate optimally due to decreased oxygen reserve
- Perform RSI in initial position of comfort
- Pre-treat with lidocaine (?) - 1.5 mg/kg - attenuate reflex bronchospasm in response to airway manipulation
ER Course

Extremely difficult to bag. Required manual compression of chest to achieve expiration.

CXR markedly hyper-expanded. Proper ETT position. No pneumothorax, pneumomediastinum, infiltrate or atelectasis.
ER Course

- Began **Magnesium Sulfate** drip:
  - Rapid onset of action.
  - Bronchodilatory effect.
  - Dose: 20-50 mg/kg loading dose over 10-15 min (Adult dose 2 gm). Then infuse 10-60 mg/kg/hr. Aim for serum level of 4-8 mg/dl.
  - Potential adverse effects: Hypotension, hypocalcemia, respiratory paralysis, circulatory collapse
OH SHIT!
ER Course

- HR dropping to 72. BP dropping to 84/52.
- Epi: 1:10,000. 2cc given IV.
- HR down to 50.
- Atropine: 1 amp (0.4mg).
- NaHCO$_3$: 1 amp (50 mEq) X2. Then THAM 500 cc X2.
- Another 2 cc of Epi 1:10,000. Another amp of atropine.
- PVC’s in runs. Lidocaine 50 mg X2, then lidocaine drip.
- Boluses of NS. (Ultimately received 3 liters NS in ER).
ER Course

Reasons for boluses of IV fluids:
- Increased respiratory rate and work of breathing → increased insensible losses.
- Decreased oral intake.
- Albuterol and terbutaline are also vasodilators.
- Magnesium is a vasodilator.
- Global sympathetic exhaustion.
- Intubation can lead to decreased venous return and decreased cardiac output.
ER Course

9:50 p.m. Called anesthesiologist. Brought anesthesia machine. Arrived 10:20 p.m.

Began Halothane anesthesia.
**ER Course**

- **Halothane anesthesia.**
  - Started at 5%, then reduced to 1.5% after improved compliance.
  - Potent bronchodilator effect in 15-20 minutes.
  - Vasodilator effect with hypotension. Can increase ventilation/perfusion mismatch.
  - Hemodynamic depression with reduced cardiac output.
  - Myocardial sensitization to catecholamines.
  - Tachycardia.
ER Course

- Still requiring manual chest decompression as well as manual bagging via anesthesia machine.
- Unable to detect BP.
- Placed femoral venous and arterial catheters. Started epi drip.
- HR to 120. BP 97/51.
- Peak Inspiratory Pressures 50-70. TV 600 cc.
- ABG: pH 6.8, pCO₂ 110, pO₂ 65.
- Still on terbutaline drip, magnesium infusion, lidocaine drip, epi drip.
- Finally stable enough to transfer to PICU at 11:30 p.m.
Effect of acidosis on oxygen dissociation from hemoglobin

![Diagram showing the effect of acidosis on oxygen dissociation from hemoglobin. The graph illustrates the relationship between oxygen saturation (% saturation) and partial pressure of oxygen (P_{O_2} in mmHg). Arrows indicate changes in pH, DPG, and temperature affecting the dissociation curve.]
ER Course

In PICU, 00:30 a.m.

Able to discontinue Halothane and switch to 70/30 Heliox mixture via Servo 900 ventilator.

Rate 12, TV 800 cc, Peak Inspiratory Pressure down to 44.

If intubated: General Considerations.

- Longer I:E of 1:3 or 1:4.
- Rate 10-12.
- Initial tidal volume of 10-12 cc/kg (Adult 6-8cc/kg) to avoid barotrauma
ER Course

- Mechanical Ventilation:
  - No absolute guidelines for initiating mechanical ventilation.
  - Consider:
    - Decrease in respiratory effort due to exhaustion.
    - Deterioration in mental status.
    - Absence of breath sounds and wheezing.
    - Cyanosis in 40% oxygen.
    - Hypoxemia with $pO_2 < 60$ in $>6L/min O_2$.
    - Hypercapnia with $pCO_2 > 50$. 
ER Course

Mechanical Ventilation:

- May be necessary and life saving, but incidence of major complications during mechanical ventilation of patients with acute severe asthma is >2X that occurring in non-asthmatic patients.
ER Course

Mechanical Ventilation:
- Mucous plugs with uneven distribution of positive pressure ventilation.
- Can result in:
  - Pneumothorax
  - Pneumomediastinum
  - Atelectasis
  - Subcutaneous emphysema
  - Pneumonia
  - Tension Hyperinflation
  - Hypoventilation
Maintenance of normal oxygenation and ventilation may require high mechanical respiratory rates, pressures, oxygen concentrations and occasionally high PEEP. This can lead to barotrauma and complications.

**Controlled Hypoventilation:**
- Low rates: 6-10 breaths/min.
- Low tidal volumes: 8-12 cc/kg.
- Limit peak airway pressure to 50 cm of H₂O.
- Maintain normal pO₂.
- Allow hypercapnia and respiratory acidosis.
Other Considerations:

- Bronchial lavage.
- PEEP.
- ECMO.
- Helium delivered bronchodilators
- Leukotriene inhibitors
- Aminophylline (Methyl Xanthines)
ER Course

• Rescue Meds

• Controller Meds
  - Prevent asthma symptoms from occurring
  - Do not demonstrate immediate effects
  - Should be taken daily
  - Should not be used to relieve acute asthma symptoms
  - Common controller meds:
    - Inhaled steroids (Pulmocort, Flovent)
    - Leukotriene inhibitors (Singulair)
Final Disposition:
- Remained intubated for 4 days.
- Initially managed with controlled hypoventilation.
- Extremely weak for > 1 week.
- Physical and occupational therapy while in hospital.
- Neurologically normal at discharge.
- Home on weaning course of prednisone.

One Year Later:
- Visited ER on anniversary of treatment.
- Normal happy teenager.
ER Course

Expect the unexpected
THANK YOU!!