MICHIGAN MEDICINE
UNIVERSITY OF MICHIGAN

Asthma: When Albuterol Fails

Dr. Tim Visclosky, MD
Special Thanks to Dr. Elaine Pomeranz, MD

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DISCLOSURES

- There are no conflicts of interest to disclose

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OBJECTIVES

- Discuss potential reasons albuterol may fail
- Review appropriate adjunctive therapies
- Outline step-wise escalation of asthma management
- Review evidence for various forms of respiratory support

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STEP 1 - IDENTIFY WHAT YOU'RE TREATING

Asthma	Bronchiolitis
>2 years of age	<2 years of age
+ Family History	+ Fever
+ Personal history of atopy	Preceded by URI sxs
+ Wheezing, prolonged expiratory, poor aeration	+ Tachypnea, rales, wheezing, work of breathing

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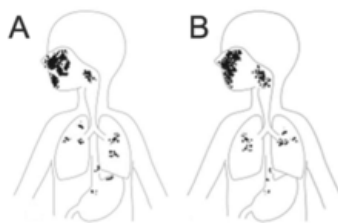
DIFFICULTIES WITH PEDIATRIC ALBUTEROL

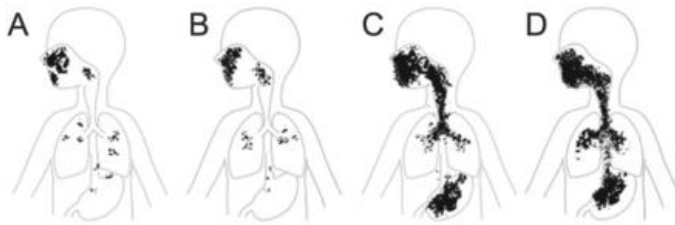
- Low tidal volumes
- Smaller airways result in higher resistance
- Shorter I:E ratio increases drug loss with exhalation
- Behavioral

DRUG DEPOSITION IN YOUNG CHILD



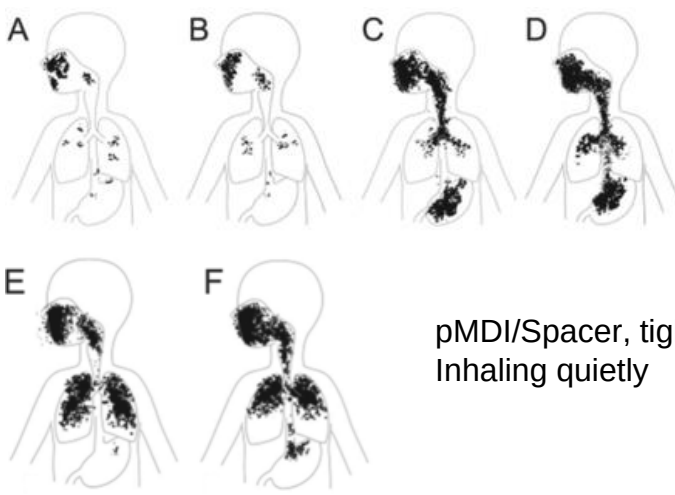
pMDI/Spacer and Nebulizer
with loose fitting face mask

DRUG DEPOSITION IN YOUNG CHILD



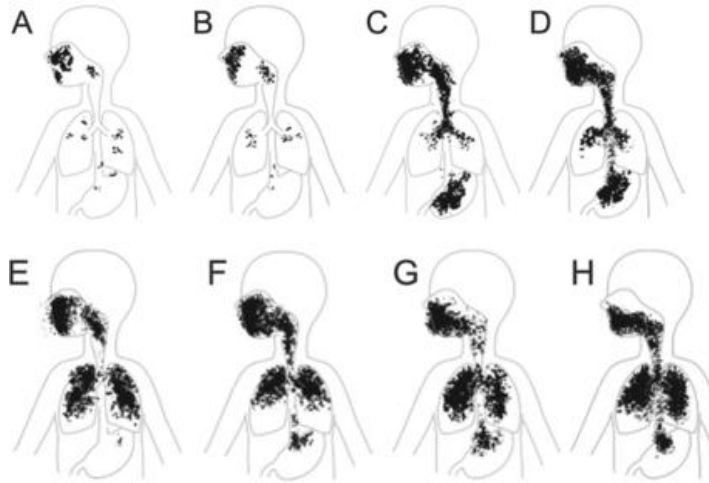
Tightly fitted masks -
Screaming

DRUG DEPOSITION IN YOUNG CHILD



pMDI/Spacer, tightly fitted -
Inhaling quietly

DRUG DEPOSITION IN YOUNG CHILD



Nebulizer, tightly fitted - Inhaling quietly

STEP 2 - TROUBLESHOOTING ALBUTEROL

- Be flexible
- Enlist the family
- pMDI/spacer vs nebulizer decreases stay in ED
- Blow-by is negligible - not recommended

STEP 2 - TROUBLESHOOTING ALBUTEROL

Medication Dosing **Recommended starting doses, may choose different dosing based on clinical judgement*

Albuterol Weight based starting dosing	Nebulizer	MDI	Continuous (*titrate to effect)
5-10 kg	2.5 mg (0.5 mL)	2-4 puffs	7.5 mg/hr
10-20 kg	2.5 mg (0.5 mL)	4 puffs	10 mg/hr
>20 kg	5 mg (1 mL)	8 puffs	15 mg/hr

STEP 3 - MAXIMIZE ADJUNCTIVES

- Systemic Corticosteroids
  - Prednisone based regimens - PO for mild/moderate, IV for severe
  - Dexamethasone based regimens - IV, IM, or PO
- Anticholinergics (e.g. ipratropium)
  - Parasympathetic blockage, increase beta-agonist
  - For moderate-severe exacerbations, or poor response to short-acting beta agonists (SABAs)

STEROIDS: DEX Vs. PRED

- Dexamethasone associated with:
  - Shorter length of stay
  - Lower hospital costs
  - Improved compliance
  - Improved tolerance

- Similar rates of symptom relapse, readmission
- No difference in ICU transfer rates

STEROIDS: DEX Vs. PRED

Dosing For Asthma Medications	
Methylprednisolone	
0-60 kg	1 mg/kg Q6H
>60 kg	60 mg Q6H
Prednisone/Prednisolone/	
0-30 kg	2 mg/kg/day
>30 kg	60 mg/day
Dexamethasone	0.6 mg/kg (max 16 mg) once daily, 1-2 days total

STEP 4 - IV MAGNESIUM

- Blocks calcium → smooth muscle relaxant
- May result in hypotension
- For severe exacerbations failing initial therapies
- Given as bolus
  - Currently investigating infusion vs inhaled

Dosing For Asthma Medications	
Magnesium Sulfate	
0-40 kg	50 mg/kg (with 20 mL/kg NS bolus)
40-50 kg	2 g (with 20 mL/kg NS bolus)
>50 kg	2 g (with 1L NS bolus)

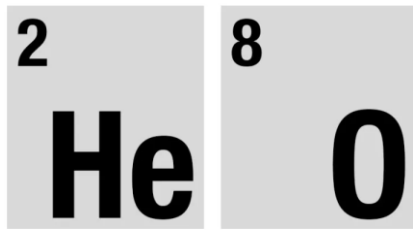
STEP 5 - SYSTEMIC BETA AGONIST

- Epinephrine vs Terbutaline
- Effective even with poor ventilation
- Prefer the more readily available option (often epi)
- Terbutaline more common in ICU

Systemic (injected) beta$_2$-agonists	
Epinephrine 1:1,000 (1 mg/ml)	0.01 mg/kg up to 0.3–0.5 mg every 20 min for 3 doses sq.
Terbutaline (1 mg/ml)	0.01 mg/kg every 20 min for 3 doses then every 2–6 h as needed sq.

STEP 6 - HELIOX

- Converts turbulent to laminar flow
- Improves delivery of SABAs to distal airways
- Limits FiO2
- Recent studies suggest no improvement in clinical outcomes



STEP 7 - KETAMINE

- Bronchodilatory and sedative effects
- Can avoid intubation vs use as RSI med
- Similar efficacy to theophylline with improved safety
- Can aggravate bronchorrhea
- Initial bolus of 0.5-1 mg/kg over 2-4 minutes, followed by infusion of 0.5-2 mg/kg/hr

HIGH FLOW NASAL CANNULA

- Limited evidence
- Often better tolerated than CPAP/BIPAP
- Potentially delays non-invasive ventilation
- Does not appear to decrease intubations

NON-INVASIVE VENTILATION

- Limited evidence
- Increasingly being used to avoid intubation
- Reasonable to use in short trials

MECHANICAL VENTILATION

- Do not delay once deemed necessary
  - Apnea or Coma
  - PCO2 ≥42 mmHg
  - Inability to speak or AMS
  - Worsening fatigue/intercostal retractions
- Anticipate rapid desaturation and laryngospasm with RSI
- Increased risk for cardiovascular collapse and barotrauma

FINAL STEP - EDUCATION

- Review the Discharge Plan
- Review triggers and Asthma Action Plan
- Discuss signs, symptoms, home management
- Encourage appropriate follow-up
- Consider referrals and home peak flow meters

NOT RECOMMENDED

- Methylxanthines
- Antibiotics except as needed for comorbid conditions
- Aggressive hydration
- Chest PT
- Mucolytics
- Sedation (except as part of RSI)

KEY POINTS

- Know what you're treating
- Be flexible and work with families
- Consider reasons albuterol may fail
- Reasonable to attempt alternatives to intubation, but only for short trial

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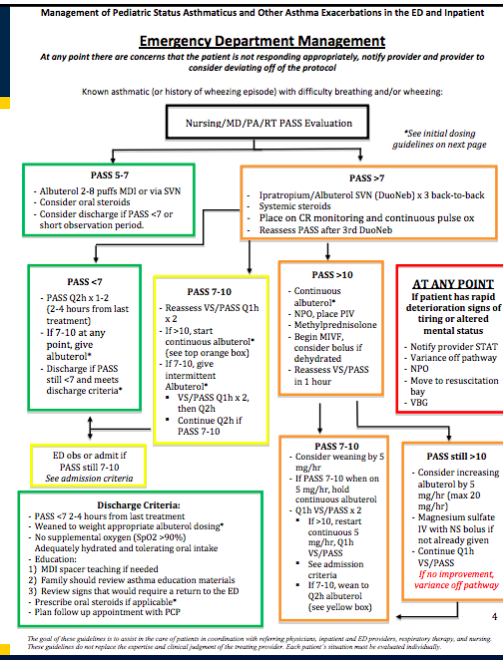
METHYLXANTHINES (E.G. THEOPHYLLINE)

- Phosphodiesterase inhibitor resulting in bronchodilation
- Narrow therapeutic window and numerous drug interactions
- Not recommended by National Asthma Education and Prevention Program
- Recent evidence shows similar clinical improvement at subtherapeutic levels

Aerosol Device and Interface	Age
Small-volume nebulizer with mask or hood	Infant
Small-volume nebulizer with mask	≤ 3 y
Small-volume nebulizer with mouthpiece	≥ 3 y
pMDI with valved holding chamber/spacer and mask	< 4 y
pMDI with valved holding chamber/spacer	≥ 4 y
DPI	≥ 4 y
MDI	≥ 5 y
Breath-actuated MDI (eg, Autohaler)	≥ 5 y
Breath-actuated nebulizer	≥ 5 y

From Reference 17.
pMDI = pressurized metered-dose inhaler
DPI = dry powder inhaler



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Modified Pediatric Asthma Severity Score (PASS):

Assessment Category	1 point	2 points	3 points
Age Specific Respiratory Rate 2-3 years 4 to 5 years 6 to 12 years > 12 years	Spontaneous without vent support ≤ 34 ≤ 30 ≤ 26 ≤ 23	Spontaneous without vent support 35-39 31-35 27-30 24-27	Spontaneous without vent support >40 >36 >31 >28 Or Vent support required
Oxygenation (SpO2 or SO2)	> 95% on room air	92%-95% on room air Or FiO2 <= 40% (nasal cannula)	<92% on room air Or FiO2 >40% (simple facemask, non-rebreather, NIPPV or PPV)
Auscultation	Normal breath sounds to end-expiratory wheeze only	Expiratory wheezing throughout expiratory phase in one or more areas	Inspiratory and expiratory wheezing to diminished breath sounds or silent breath sounds or poor aeration
Retractions	Zero to one site	Observable in two sites	Observable in 3 or more sites
Dyspnea / Work of breathing	Speaks in sentences Or Unlabored and at rest	Speaks in partial sentences, short cry	Speaks in single words / short phrases / grunting Or Requires intubation

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