Assessment and management of acute asthma exacerbations in the outpatient setting

Objectives

1. Discuss basic elements of airflow and gas exchange in asthma to better understand evaluation and management.
2. Discuss what treatments are:
   - Clearly ineffective → Possibly ineffective
   - Possibly effective → Clearly effective

Asthma prevalence among children 0 to 17 years, 2003

Here he comes, Earl. Be gentle but firm. We are absolutely positively not driving him south again this winter.

**What is Asthma?**

- NIH: “a chronic inflammatory disorder of the airways...[with] recurrent episodes of wheezing, breathlessness, chest tightness, and cough, particularly at night and in the early morning”
- 122 childhood asthma studies: 60 distinct definitions of asthma (van Wondern et al. Eur Respir J. 2010;36:48-56)
- Not one disease: heterogeneous with multiple phenotypes

**Justice Potter Stewart on pornography: “I know it when I see it.”**

**What commonly triggers asthma?**

1. Viral infections
2. Weather changes
3. Cold air/dry air (exercise induced asthma)
4. Environmental toxins (sulfur dioxide, ozone)
5. Tobacco smoke??

**It’s not the smoke. It’s the Jackhammers!**
Asthma exacerbations in children

- 80% precipitated by respiratory viral infections
  - 2/3 of these human rhinovirus
  - Often followed by asymptomatic period with normal lung function
  - Fever common (and a good thing!)

Two relevant physiologic events

1. Dynamic hyperinflation/airway compression → auto-PEEP
2. Ventilation-perfusion mismatch

Normal air flow
**Dynamic Airway Compression**

- **Normal Inspiration**: Negative intrapleural pressure → airway dilation and airflow
- **Normal Expiration**: Release of negative intrapleural pressure → elastic recoil → passive alveolar emptying
- **Intrathoracic obstruction**: Applied (+) intrapleural pressure → dynamic airway obstruction

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- **V/Q mismatch**: Should SpO₂ improve with treatment?

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- **10-yr-old with episodic wheezing, dyspnea, and progressive exercise intolerance for 9 months not responsive to asthma tx's.**

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- **10-yr-old with episodic wheezing, dyspnea, and progressive exercise intolerance for 9 months not responsive to asthma tx's.**
**Treatment Goals (NAEPP)**
Hint: there are 3

1. Correction of significant hypoxia
2. Reversal of airflow obstruction
3. Reduction of likelihood of relapse (i.e., CCS)

**Assessing Acute Exacerbation Severity**

**Why use an asthma severity score?**

1. Need to assess severity and response-to-tx
   - Spirometry for %-predicted FEV₁ is difficult in children in respiratory distress
2. To communicate with EMS, ED, hospital
3. To guide escalation and de-escalation of tx

**The Acute Asthma Intensity Research Score (AAIRS)**

<table>
<thead>
<tr>
<th>Component</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retractions*</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supracostal SCM</td>
<td>No</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Intercostal</td>
<td>No</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Subcostal</td>
<td>No</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Air entry</td>
<td>Normal</td>
<td>Decreased at base</td>
<td>Widespread decrease</td>
<td>Absent or minimal</td>
</tr>
<tr>
<td>Wheezing</td>
<td>Absent</td>
<td>Expiratory</td>
<td>Inspiratory &amp; Expiratory</td>
<td>Audible without stethoscope or silent chest</td>
</tr>
<tr>
<td>SpO₂ (on room air)</td>
<td>&gt; 95%</td>
<td>92–94%</td>
<td>&lt; 92%</td>
<td></td>
</tr>
<tr>
<td>Expiratory phase**</td>
<td>Normal</td>
<td>Prolonged</td>
<td>Severely prolonged</td>
<td></td>
</tr>
<tr>
<td>Add component values</td>
<td>( )</td>
<td>+()</td>
<td>+()</td>
<td>+()</td>
</tr>
</tbody>
</table>

Possible score range 0 – 16: mild 1-6; moderate 7-11; severe 12-16.

*Any visible use of accessory muscle group (Yes/No)

**I:E ratio: Normal = 1:1; Prolonged = 1:2; Severely prolonged >= 1:3
Acute Asthma Intensity Research Score (AAIRS) predicting %-predicted FEV1 (top panel) and airway resistance by impulse oscillometry (% IOS, bottom panel).

AAIRS Teaching Video

https://vimeo.com/122443037

Management of Acute Exacerbations
Corticosteroids

- Oral CCS in 1st hour decrease hospital admits (OR 0.24, 95%CI 0.11-0.53) (Rowe et al. Cochrane Rev. 2001)
- But 17% do not respond to CCS
  - Pt with viral respiratory infection 1.6x more likely to not respond (Ducharme et al. Lancet Resp Med, 2016; Arnold, Lancet Resp Med, 2016)
Corticosteroids: Short-acting

Prednisolone
- 1 vs. 2 mg/kg x 3-5 days (Respir Med 92:541, 1998; Chest 122:624, 2002)
  - 1 mg/kg equally effective, fewer adverse effects (anxiety, hyperactivity, aggressive behavior)
  - Rx fill rate = 50-60% ( Butler. Ped Emerg Care. 20:730, 2004; Cooper. Arch Pediatr.

Corticosteroids: Long-acting

- Dexamethasone 0.6 mg/kg x 1 or 2 doses (Cross KP. Can J. Pediatr. 103:158, 2011; Pediatrics 133:493, 2014)
  - 6 studies (2 doses in 2 studies)
  - Relapse/hospitalization risk same @ 5, 10-14, 30 d.
  - 2 doses for more severe episodes?
- Vanderbilt experience, relapse rates (Kremer & Arnold, 2016)
  - Orapred: 2% (n = 7,130)
  - Decadron: 1.3% (n = 1639)

Corticosteroids: Inhaled

- Should I quintuple inhaled CCS at the first time of an exacerbation?
  - NO! This does not reduce rate of exacerbations or improve other outcomes (Jackson et al. NEJM;378:10.2018)
Albuterol

- Mainstay of acute Tx
- $\beta_2$-receptor polymorphisms
  - Explain some of the variability in pt response
  - Levosalbutamol (R-isomer) may decrease side effects but offers no therapeutic advantage
- Viral infections decrease $\beta_2$-response

Albuterol

- Delivery
  - MDI-spacer vs. wet neb (Cates CJ et al. Cochrane Rev. 2013)
    - MDI as effective
    - Decreased EDLOS (33 vs. 103 min) and cost (from et al. Pediatrics, 2011)
    - Decreased tachycardia and tremor
    - 4 – 8 puffs q20m x3 then q 1hr PRN (NAEP guidelines)

MDI with holding chamber is more effective than nebulizer

MDI technique is critical!!

- Video of ED Respiratory Therapist assisting autistic child with AAIR Score of 13 in MDI

Ipratropium

Do I have to learn how to spell this?

- Ach → M1, M2, M3 receptors
  - M1, M3 → bronchoconstriction
  - M2 → feedback inhibition of Ach release → ↓ bronchoconstriction
- Ipratropium → nonselective blockade
**Ipratropium**
Do I need to always order it?

- Best pediatric study and meta-analysis of RCTs
  (Qureshi et al, NEJM. 339:1030-1035; Stoolley et al, Ann Emerg Med:34)
  - Modest improvement in FEV₁ and hospitalization rates overall
  - Benefit: risk favors using this medication
  - 1.5mg by neb for 1st hour or Combivent (+albuterol) 4 puff q 20min x 3

**Parenteral β₂-agonists: Terbutaline**

- Minimal incremental benefit for patient receiving inhaled β₂-agonists
- SQ: 0.005 – 0.01mg/kg Q 15 min x 3
- IV: 0.01mg/kg (max 0.4mg) then 0.1-10mcg/kg/min
Parenteral $\beta$-agonists: Epinephrine

- Epi is R-isomer (racemic = R + S)
- $\alpha$-agonist may shrink edematous mucosa
- SQ / IM: 0.01mg/kg (max 0.3mg) Q 15 min x 3
- Nebulized: 0.5ml/kg of 1:1000 diluted to 3ml
  - <= 4 years: max 2.5ml
  - > 4 years: max 5ml

Should I give IV fluid boluses?

- Fluid overload (> 7% over baseline weight) leads to:
  - ↑ Extravascular lung water
  - Worse clinical outcomes
    - ↑ hypoxia
    - ↑ Duration of treatment
    - ↑ Hospital length-of-stay
  - Practice the art and science of pediatrics
  - Assess fluid balance and provide fluids accordingly

Should I get a CXR??

- Clinically significant CXR findings can be predicted by localized rales, wheezes, or BS that do not resolve with tx
  - ↑ hypoxia
  - ↑ Duration of treatment
  - ↑ Hospital length-of-stay
  - Practice the art and science of pediatrics
  - Assess fluid balance and provide fluids accordingly
  - CXR rarely alters management
  - Consider CXR if:
    - Localized findings do not resolve with tx
    - Fever not explained by apparent viral illness
    - Chest pain (r/o pneumothorax)
    - Poor response to tx (r/o CHF, FB)
    - Infant with 1st episode unexplained wheezing or stridor
Noninvasive Ventilation

- Option for child who is fatiguing or approaching respiratory failure
- May increase at-taping, increase airway pressures, and/or lead to circulatory compromise (Ruud, Am Rev Respir Dis. 146:54, 1992)
- Tight-fitting mask and aspiration risk

So what’s the answer?

Possibly or Clearly effective in the office and urgent care setting:
- Prevention! (e.g., ICS)
- Steroids (PO, IV, IM)
- Albuterol
- Parenteral Beta-agonists
  - Epinephrine
  - Terbutaline
- Ipratropium
- BiPAP

Ineffective, offering no additional value, or detrimental:
- CXR
- Xopenex
- Tobacco smoke
- Excess IV fluids

Where can I learn more?

- www.nhlbi.nih.gov/guidelines/asthma
- www.ginasthma.com/GuidelinesResources.asp?l1=2&l2=0