Lower Respiratory Problems in Children and Adolescents

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Initial Care of the Child with Status Asthmaticus

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Clinical Scenario

• A mother brings her 10 year old son to see you. He has a diagnosis of asthma.

• He developed URTI symptoms four days ago and has seemed to be wheezing off and on since then.

• He has a steroid inhaler that he is supposed to use daily, but mother allows him to manage his medicines and she is not sure that he is using it.

• He has an albuterol inhaler, however, he came to mother today complaining that he has been wheezing and has run out of albuterol.

• When asked how many times he has used the inhaler, he cannot estimate the number of uses. He is quite short of breath today, prompting his visit.

Clinical Scenario

• On exam, the child is obviously distressed.

• He speaks in one word answers and seems breathless doing so.

• He has sternal, suprasternal and intercostal retractions.

• His respiratory rate is 35-40 per minute. The expiratory phase is markedly prolonged.

• He has a few wheezes bilaterally.

• His pulse oximeter saturation is 85% on room air.

• His pulsus paradoxus is 20 mm.
**Definition - Asthma**

- Diffuse reversible obstructive lung disease characterized by inflammation and hyperreactivity of the small airways

- Evidence for role of inflammation first derived from autopsies of patients with fatal asthma

- Studies of bronchial biopsies of asthma patients have demonstrated significant inflammation, *even in mild disease*

**Prevalence**

- Asthma is the most common chronic disease of childhood

- Prevalence of 8.5% in general population
  - 13 % among African Americans and Native Americans

- 5.2 % of children have had an asthma attack in last year

Pediatrics 2008; e217-e222.
Pathophysiology of Asthma

• Eosinophils contribute inflammatory proteins including peroxidase, eosinophil neurotoxin and other proteins that may directly damage airway epithelium, increase bronchial reactivity and recruit further mast cell and lymphocyte infiltration

• Eosinophils also release leukotrienes which increase vascular permeability and promote airway smooth muscle spasm

• In allergic asthma, trigger generates early phase of histamine and leukotrienes from mast cells – lead to smooth muscle constriction

• Late phase (4 – 6 hours) obstruction of airways following initial response of mast cells, tissue macrophages and recruited lymphocytes

Pathophysiology

• Airflow obstruction
  – Bronchospasm
  – Mucosal edema
  – Increased mucous leading to plugging

• Ventilation-perfusion mismatching
  – Hypoxemia
  – Hypercapnea
**Historical Factors**

- Known triggers
- Novel triggers (e.g. current viral illness)
- Exposure to second hand smoke
- Current medications - compliance
- Duration of episode
- Days of school missed

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**Historical Factors**

- Pre-existing lung disease (CF or BPD)
- Prematurity
- Family history
- Foreign body possibility (esp if <3 years)
- Previous episodes - number and natural history
- Need for intubation in past
  - **LOOK OUT!** - real trouble possible
Clinical Presentation

- Wheezing
- Tachypnea
- Respiratory distress
- Fearfulness
- Co-morbid symptoms caused by trigger
- Air trapping
- Hyperinflation

Clinical Features

- Shorter duration of symptoms implies greater responsiveness to therapy

- Longer duration of symptoms implies less responsiveness to therapy

- Triage scoring of these groups of patients tends to be similar

Physical Exam

• Assess mental status
• Gauge level of accessory muscle use
• Presence of breathless speech
• Pulsus paradoxus
• Hydration
• Degree of wheezing
• Lack of air movement on inspiration

Physical Findings

• PEFR 70 - 90 %
  – Usually minimal retractions, alert, able to talk

• PEFR 50 – 70 %
  – Retractions common, “breathless speech”

• PEFR < 50 %
  – Usually severe distress, struggling to breathe, agitated
**Pulsus Paradoxus**

- Normal phenomenon
  - Systolic BP drops slightly with inspiration

- Exaggerated with asthma
  - Greater exaggeration with more severe attacks

- Normal is 10 mm Hg or less

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**Who Needs a Chest X-ray? Consider if …….**

- New asthmatic or diagnosis questionable
- Patient is sick enough for admission
  - Admitted patients rarely have + CXR findings of consequence
- Intercurrent worsening in admitted patient

- Changes seen on chest x-ray
  - Hyperexpansion
  - Atelectasis
  - Pneumomediastinum / pneumothorax
  - Foreign body (exceedingly rare)
  - Heart size (usually small)
Blood Gases

• Rarely necessary
  — Clinical exam is more important

• In a moderately sick asthmatic, which is the more reassuring blood gas?
  — 7.40 / 38 / 60

  — 7.48 / 31 / 60

• Lactic acidosis is very worrisome.

Blood Gases

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• In a moderately sick asthmatic, which is the more reassuring blood gas?
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  — Asthmatics usually have little difficulty getting rid of CO₂ and have high minute ventilation — normal or rising CO₂ implies patient is tiring

  — 7.48 / 31 / 60

• Lactic acidosis is very worrisome
  — Significant lactic acidosis (> 3 mmol/L) is very worrisome
Oxygen

- Oxygen saturation commonly ≤ 90% on admission
  - Due to ventilation perfusion mismatching
  - Secondary to atelectasis and hypoxic pulmonary vasoconstriction

- Provide supplemental O₂ to keep saturation >90%

- Don’t fixate on oxygen saturations
  - Mid to high 80’s are fine

Therapy: Drugs

- Oxygen
- β₂- adrenergic agonists
- Steroids
- Anti-cholinergics
- Maybe
  - Magnesium sulfate, methylxanthines, heliox
Therapy: Short Acting $\beta_2$ Adrenergics (SABAs)

- All of the short acting agents have an onset of <5 minutes
- More frequent use tends to decrease duration of action
  - Necessitating increasingly frequent dosing
- Scheduled dosing not been shown to improve outcomes
  - Dosing should be as needed or anticipatory

Nebulized $\beta_2$ - Agonists: Albuterol

- Effective for bronchoconstriction NOT edema
  - 5 mg is unit dose
- May be given “back to back” or continuously
- Three back to back treatments in ED for patients who do not clear
- Continuous albuterol
  - 0.5 -1 mg/kg/hr to max of 15 mg/h
  - Should be reserved for patients with hypoxemia despite high FiO$_2$, extreme discomfort, in imminent danger of intubation
Therapy: Steroids

- Decrease inflammation (takes hours)
- Up-regulates adrenergic receptors
- Give early
- Oral unless sick to stomach or at risk of respiratory failure.
- Load with 2 mg/kg po/IV or max of 60-80 mg
- First day 4 mg/kg then 4 days at 2 mg/kg/d

Therapy: Anti-cholinergics: Ipratropium

- Stimulation of M3 receptor leads to bronchoconstriction
- Ipratropium antagonizes M3 mediated bronchoconstriction
- Does not cross BBB
- If 3 back to back albuterols fail to clear patient in ED
  - Follow immediately with 500 mcg of nebulized Ipratropium
  - Regimen in conjunction with early administration of steroids shown to decrease hospitalization rate in moderate to severe asthmatics
- Continue 250 mcg every 6 hours in sick hospitalized asthmatics
**Therapy**

- Oxygen for all until attack controlled
- Short acting $\beta_2$ agonist inhalation
  - Albuterol 0.15 mg/kg/dose
    - < 30 kg  2.5 mg maximum
    - > 30 kg  5 mg maximum
- Standard approach in ED and PICU
  - Give via nebulizer
  - Allows administration of oxygen and other inhaled drugs
- Metered dose inhalers are equally effective

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**Continuous Inhalation of SABAs**

- Dosing is 0.5 mg/kg/hr – max 25-30 mg/hr
- Very well tolerated
- No difference in HR, BP, potassium in controlled trials of intermittent vs. continuous administration

**Steroids**

- The sooner, the better
  - Goal < 60 minutes administration time

- Must assure administration
  - Steroids are the most effective agent to break the attack

- If patient vomits oral dose
  - Give dose IM or IV

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**When SABAs and Steroids Aren’t Working – What Next?**

- Consider magnesium sulfate infusion
  - Especially if symptomatology is short

- Dose 50 – 75 mg/kg/dose IV q 4 – 6 hours
  - Very safe dose

- Increasing serum magnesium to > 4 mg/dL may be necessary to achieve bronchodilation
Helium-Oxygen mixtures

- Typically a 70% He/30% O₂ mixture
- Conflicting reports of efficacy
- Use for severe attack not improving within one hour of intensive conventional therapy
- Sometimes provides dramatic response
Clinical Scenario

• A mother brings her 3 month old former 32 week premie girl to see you. She is concerned that her child has a fever and is breathing fast. The child is breathing so fast she barely eats.

• The baby has a wheezy wet cough. She seems to produce a fair amount of mucus. She has frequent episodes in which she coughs and seems to have trouble catching her breath.

• On exam, the baby has a temperature of 38.5 C. She is breathing 80 times a minute, with intercostal and sternal retractions. Her eyes appear a bit sunken. Her mouth is dry. She has a lot of nasal mucus. She has crackles on auscultation in all lung fields. Her pulse oximetry is 90%. She has no heart murmurs. Her abdomen is benign.

Overview

• Bronchiolitis is the most common cause of hospitalization in infancy

  – Illness as "a seasonal viral illness characterized by fever, nasal discharge and dry wheezy cough.
  – On examination there are fine inspiratory crackles and/or high pitched expiratory wheeze."^1

^1American Academy of Pediatrics, Subcommittee on Diagnosis and Management of Bronchiolitis. Pediatrics. 2006; 118(4) 1774-1793
Overview

• Ninety percent of children are infected with RSV in the first two years of life: it is ubiquitous and unavoidable\(^1\)

• Only a fraction of all children infected develop clinical bronchiolitis (30-40\%)\(^1\)

• Infection with RSV does not confer long term immunity; reinfections are common\(^1\)

• Population study showed that RSV alone accounted for 17 hospitalizations, 55 Emergency Department visit and 132 office visits per 1000 children less than 6 months\(^2\)

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1\(^{\text{American Academy of Pediatrics, Subcommittee on Diagnosis and Management of Bronchiolitis.}}\)

2\(^{\text{Hall CB, Weinberg GA, Iwane MK et al: The burden of respiratory syncytial virus infection in young children.}}\)

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Bronchiolitis: Causes

• Depending on region, respiratory syncytial virus (RSV) causes 50 to 80\% of bronchiolitis

• Other causes include influenza virus, parainfluenza virus (esp. Type 3) and human metapneumovirus (HMPV)

• Molecular diagnostic techniques have shown 10 – 30 \% of children with bronchiolitis are infected with more than one virus (typically RSV and HMPV)

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Zorc JJ and Hall CB: Bronchiolitis: Recent evidence on diagnosis and management.\(^3\)

*Pediatrics* 2010; 125:342-349
AAP Guidelines

• Recommendation 1a
  – “Clinicians should diagnose bronchiolitis and assess disease severity on the basis of history and physical examination.
  – Clinicians should not routinely order laboratory and radiologic studies for diagnosis…”

• Lack of tachypnea implies that there is little or no lower respiratory infection

• Very important to assess the level of respiratory distress and its impact on child’s ability to feed, the need for oxygen and the ability of the family to deal with the illness
AAP Guidelines

• Recommendation 1b
  – “Clinicians should assess risk factors for severe disease such as age less than 12 weeks, a history of prematurity, underlying cardiopulmonary disease, or immunodeficiency when making decisions about evaluation and management of children with bronchiolitis…”

• Premature birth (less than 37 weeks gestation), congenital heart disease requiring diuretics and digoxin for control of congestive heart failure, cyanotic congenital heart disease, chronic lung disease (bronchopulmonary dysplasia, cystic fibrosis, etc.) and immune compromised state

• All substantially increase the likelihood of severe disease (need for hospitalization, intensive care, mechanical respiratory support)

AAP Guidelines

• Recommendation 2a
  – “Bronchodilators should not be used routinely in the management of bronchiolitis…”

• Recommendation 2b
  – A carefully monitored trial of α-adrenergic or β-adrenergic medication is an option. Inhaled bronchodilators should be continued only if there is a documented positive clinical response…using an objective means of evaluation…”

• Bronchodilators have not consistently shown to help children with bronchiolitis.
  – Rarely help for long and do not decrease length of stay

• Tendency for racemic epinephrine to be more helpful than albuterol
AAP Guidelines

• Recommendation 3
  – “Corticosteroids should not be used routinely…”

  • Corticosteroids do not typically improve clinical condition or decrease length of stay
  
  • Corticosteroids do not improve oxygen saturations
  
  • Inhaled corticosteroids do not appear to have any positive effect

AAP Guidelines

• Recommendation 4
  – “Ribavarin should not be used routinely…”

  • Ribavarin is very difficult and dangerous to administer (requires very specialized equipment and tends to obstruct endotracheal tubes of intubated children) and is very expensive
  
  • Ribavarin should be reserved for special circumstances
  
  • Ribavarin is also a potential teratogen that may be inhaled by health care workers
AAP Guidelines

• Recommendation 5
  – “Antimicrobial medications should be used only ion children with bronchiolitis who have specific indications of the coexistence of a bacterial infection.
  – When present, bacterial infection should be treated in the same manner as in the absence of bronchiolitis…”

• Children with RSV positive bronchiolitis have low rates of serious bacterial infection
  – Some studies do not show any increase in rate compared to RSV negative children

• Most common coexistent bacterial infections are urinary tract infection and otitis media

• Children with RSV bronchiolitis frequently have atelectasis on CXR that is interpreted as possible pneumonia

AAP Guidelines

• Recommendation 6a
  – “Clinicians should assess hydration and ability to take fluids orally…”

• Recommendation 6b
  – “Chest physiotherapy should not be used routinely in the management of bronchiolitis…”

• Children breathing faster than 60 times a minute are rarely able to feed well.
  – Use of a small nasogastric tube frequently allows the maintenance of enteral feeding and avoids the use of sedation for the irritable, non-fed infant

• Chest physiotherapy in bronchiolitis only makes the infant irritable and sleepless
  – This agitates parents and makes caregivers miserable
AAP Guidelines

• Recommendation 7a
  – “Supplemental oxygen is indicated if the oxyhemoglobin saturation (SpO₂) persistently falls below 90% in previously healthy infants.
  – If the SpO₂ does persistently fall below 90%, adequate supplemental oxygen should be used to maintain SpO₂ at or above 90%.”

• Recommendation 7b
  – “As the child’s course improves, continuous measurement of SpO₂ is not routinely needed…”

• Recommendation 7c
  – “Infants with a known history of hemodynamically significant heart or lung disease and premature infants require close as the oxygen is being weaned (strong recommendation)…”

  • Hemodynamically significant heart disease is defined as heart disease requiring medication for control of congestive heart failure or cyanotic congenital heart disease

  • Significant lung disease defined as bronchopulmonary lung disease, cystic fibrosis and other lung disease requiring regular medication for control of symptoms
    – Bronchodilator, diuretic or corticosteroid therapy
AAP Guidelines

• Recommendation 8a
  – “Clinicians may administer palivizumab to selected children with CLD or a history of prematurity (less than 35 weeks gestation) or with congenital heart disease (recommendation: evidence level A; RCT; preponderance of benefit over harm).”

• Recommendation 8b
  – “When given, prophylaxis with palivizumab should be given in 5 monthly doses, usually beginning in November or December, at a dose of 15 mg/kg per dose administered intramuscularly…”

AAP Guidelines

• RSV season typically runs from November to March in North America.
  – Median duration of season is 15 weeks
  – Range of 13 to 20 weeks.

• Consideration should be given to providing RSV prophylaxis for those children less than 24 months of age who have required medical therapy for chronic lung disease in the 6 months prior to the start of RSV season

• Palivizumab prophylaxis reduces the risk of hospitalization
  – Does not reduce the severity of RSV disease if it is acquired

• Risk factors for RSV
Risk Factors For Hospitalization With RSV

- Child care attendance
- School aged siblings
- Exposure to environmental pollutants
- Congenital or acquired abnormalities of the airway
- Severe neurologic disease

No single factor predominates
Risk is additive with each factor present