Respiratory Distress in Children: When Do I Need to be Worried?

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Pediatric Critical Care Medicine
Disclosures

- None
Goals and Objectives

- Review of signs and symptoms of respiratory distress
- Identification of signs of impending respiratory failure
- Anatomy and physiology of pediatric airway
- Overview of different pediatric respiratory illnesses
- Overview other conditions resembling airway disease
You are called to the bedside for a 2-year-old male with “fast breathing” and “decreased activity.”

What’s going through your head while you are walking to the ED?
Pediatric Assessment Triangle

- **Appearance**: Tone, interactiveness, consolability, look/gaze, speech/cry
- **Work of Breathing**: Airway sounds, positioning, accessory muscle use
- **Circulation**: To the skin
Signs of Respiratory Distress

- Tachypnea
- Tachycardia
- Grunting
- Stridor
- Head bobbing
- Flaring
- Inability to lie down
- Agitation

- Retractions
- Accessory Muscle use
- Wheezing
- Sweating
- Apnea
- Cyanosis
Vital Signs

- **RESPIRATORY RATE:**
  - Too fast
  - Too slow or irregular
  - Not breathing at all

- **HEART RATE:**
  - Tachycardia = early warning sign
  - Bradycardia usually means decompensation
Oxygen Saturation

• Factors that can lead to false readings:
  o Probe removed by patient, improper placement, or motion artifact
  o Poor peripheral perfusion
  o Severe anemia (hemoglobin <5 g/dL)
  o Hypothermia
  o Venous congestion
  o Nail polish
Impending Respiratory Failure

- Reduced air entry
- Severe work
- Cyanosis despite $O_2$
- Irregular breathing/apnea
- Altered consciousness/restlessness
- Diaphoresis
Anatomy

Children are very different than adults !!!
Pediatric Airway Anatomy & Physiology

- Larynx
  - Cephalad
    - Infant: C 1
    - 6 months: C 3
    - Adult: C 5-6
  - Anterior
    - While intubating, may have to be below and look up
Pediatric Airway Anatomy & Physiology

• Nose is nearly half of total airway resistance at any age
  o Infants nose is short, soft, and flat.
  o Infant: blockage of nose = respiratory distress
• Large tongue, easy posterior displacement
Anatomy and Physiology

- Compliant rib cage, diaphragm dependent
- Physiological collapse of small airways at the end of expiration
- Relative high $O_2$ consumption for breathing effort
Anatomy and Physiology

- Narrowest point in airway is subglottic
- Internal dimensions of trachea are one-third of adult airway
- Small amounts of edema cause significant reduction in airway diameter
Physiology: Effect of Edema

Poiseuille’s law

\[ R = \frac{8 \pi l}{\pi r^4} \]

If radius is halved, resistance increases 16 fold
Airway Positioning for Children <2yrs

Towel placed under the shoulders.
Airway Positioning for Children >2yrs

- Sniffing position
- Towel placed under the head
How Do I Know What I am Dealing With?

At the New Year's winter party RSV and flu always got a little out of control.
# Localization of respiratory distress by physical findings

**Upper airway obstruction**
- Sniffing position: neck is flexed with head extended to open airway
- Nasal flaring: also seen with lower airway disease
- Prolonged inspiration
- Retractions: supraventricular, suprasternal
- Abnormal voice: hoarseness, hot potato voice
- Stridor
- Barking cough
- Transmitted upper airway sounds (stertor)

**Lower airway disease**
- Retractions: intercostal, subcostal
- Nasal flaring: also seen with upper airway obstruction
- Prolonged expiration: lower airway obstruction
- Wheezing: intrathoracic airway obstruction
- Grunting: may indicate severe respiratory distress or severe pain from an intraabdominal process
- Rales (crackles)
- Pleural rub
- Bronchophony
- Pulsus paradoxus: caused by severe lower airway obstruction or cardiac tamponade

**Cardiac disease**
- Gallop
- Cardiac murmur
- Rales (crackles)
- Jugular venous distention
- Hepatomegaly
- Peripheral or periorbital edema
- Pulsus paradoxus: caused by cardiac tamponade or severe lower airway obstruction

**Central nervous system**
- Abnormal respiratory pattern (Cheyne-Stokes, or ataxic)

**Metabolic**
- Kussmaul respirations
Types of Respiratory Illnesses

- Bronchiolitis
- Pneumonia
- Asthma
- Croup
- Epiglottitis
- Bacterial Tracheitis
- Pertussis
- Other stuff
Bronchiolitis

• Inflammation of the bronchioles, the smallest air passages of the lungs.
• Usually affects children less than two years of age with the majority being between three and six months.
Bronchiolitis
• 1.65 million bronchiolitis hospitalizations 17 years
  o <1 year old 81% hospitalizations
• Median LOS 3 days
• In the US most RSV infections occur during a period of about 22 weeks from November to May.
• The peak activity in most of the country is usually in January or February.
History

- Most respiratory infections in children are caused by viruses (RSV, influenza, adenovirus, rhinovirus etc.)
- Introduction in families through school aged child (common cold in the adult)
- Spread through large droplet secretions
- Inoculation through upper respiratory tract
- Incubation 2-6 days
Signs & Symptoms

- URI symptoms
- Mild-to-moderate fever
- Cough, wheezing, and/or mild respiratory distress
- Apnea
Populations with Increased Risk for Severe Disease

- Prematurity
- Chronic lung disease
- Congenital heart disease
- Immunodeficiencies
- Young infants:
  - Apnea is a common presentation in infants, especially *those born prematurely, and those younger than two months of age*
What Happens in Bronchiolitis?

- Peribronchial mononuclear infiltrate
- Necrosis of epithelium of small airways
- Plugging of airway lumen
- Atelectasis and over-inflation
Altered Physiology

- Changes in lung mechanics
  - Small and large airway obstruction
  - Expiratory flow limitation
  - Atelectasis and over-inflation
- Errors in gas exchange
  - Increased dead space ventilation
    - Increased PaCO$_2$, respiratory acidosis
  - VQ mismatch
    - Hypoxemia
What is Wheezing?

A high-pitched sound produced when air is forced through narrowed airways.
Not all wheezing = bronchospasm.
Albuterol

- Beta-adrenergic agonist
- Selectively acts on the beta (2)-adrenergic receptors of intracellular adenyl cyclase
  - Converts adenosine triphosphate (ATP) to cyclic-3', 5'-adenosine monophosphate (cyclic AMP)
- Increased cyclic AMP results in bronchial smooth muscle relaxation
Implications for practice

• Bronchodilators produce small short-term improvements in clinical scores among infants with bronchiolitis treated as outpatients.

• However, given their high cost, adverse effects and lack of effect on $O_2$ saturation, bronchodilators cannot be recommended for routine management of first-time wheezers who present with the clinical findings of bronchiolitis, in either inpatient or outpatient settings.
Racemic Epinephrine

- A sympathomimetic catecholamine
- Acts on both alpha & beta-adrenergic receptors
- Causes vasoconstriction through its effect on alpha-adrenergic receptors
- Relaxation of the bronchial smooth muscle on beta-adrenergic receptors
Therefore...

- Wheezing in bronchiolitis is usually due to mucus and inflamed airways (not bronchospasm); bronchodilators just don’t make much sense physiologically…
- …and the evidence proves this!
- **IF** you want to try a bronchodilator, try racemic epinephrine.
- If racemic doesn’t change anything, albuterol won’t either!
High Flow Nasal Cannula

• Infants with bronchiolitis, 57 pre and 58 post introduction of HFNC
• 23% rate of intubation prior to HFNC
• 9% rate of intubation after HFNC
  o (68% decrease in intubations)
• LOS decreased 6 days → 4 days
  o McKiernan C. J Peds 2010;156:634
• 50-90 Bronchiolitis admits/yr
• 37% rate of intubation prior to HFNC
• 7% rate of intubation after HFNC
  o Schibler A et al Intensive Care Med 2011; 37(5)847-52
Bronchiolitis Pearls

• Bronchodilators probably don’t help
• If you feel a need to try a bronchodilator, try racemic epinephrine
• Steroids don’t help either
• High Flow NC is an acceptable alternative to intubation
Asthma

- A chronic, long-term disease that inflames and narrows the airways.
- The most common medical emergency in the pediatric population.
- Overall incidence appears to be increasing.
- Mortality is increasing.
## Risk Factors for Near-Fatal Asthma

<table>
<thead>
<tr>
<th>FIGURE 5–2a. RISK FACTORS FOR DEATH FROM ASTHMA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asthma history</strong></td>
</tr>
<tr>
<td>Previous severe exacerbation (e.g., intubation or ICU admission for asthma)</td>
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<tr>
<td>Two or more hospitalizations for asthma in the past year</td>
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<tr>
<td>Three or more ED visits for asthma in the past year</td>
</tr>
<tr>
<td>Hospitalization or ED visit for asthma in the past month</td>
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<tr>
<td>Using &gt;2 canisters of SABA per month</td>
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<tr>
<td>Difficulty perceiving asthma symptoms or severity of exacerbations</td>
</tr>
<tr>
<td>Other risk factors: lack of a written asthma action plan, sensitivity to <em>Alternaria</em></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th><strong>Social history</strong></th>
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<tbody>
<tr>
<td>Low socioeconomic status or inner-city residence</td>
</tr>
<tr>
<td>Illicit drug use</td>
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<tr>
<td>Major psychosocial problems</td>
</tr>
</tbody>
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<table>
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<tr>
<th><strong>Comorbidities</strong></th>
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<tbody>
<tr>
<td>Cardiovascular disease</td>
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<tr>
<td>Other chronic lung disease</td>
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<tr>
<td>Chronic psychiatric disease</td>
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</tbody>
</table>

Key: ED, emergency department; ICU, intensive care unit; SABA, short-acting beta₂-agonist

Physical Examination

- Expiratory wheeze
- Biphasic wheeze
- The *Silent Chest*:
  - Airflow so obstructed as to be insufficient to create a wheeze
  - Development of wheezing indicates improvement
Assessment

• Findings consistent with *impending respiratory failure*:
  
  o Altered level of consciousness
  o Inability to speak
  o Absent breath sounds
  o Central cyanosis
  o Diaphoresis
  o Inability to lie down
Oxygen

• Deliver high flow oxygen, as severe asthma causes V/Q mismatch (shunt).
ß-Agonists

- Less than 10% of nebulized drug reach the lung under ideal conditions.

- Drug delivery depends on
  - Breathing pattern:
  - Tidal volume
  - Nebulizer type and gas flow
Other Treatment Modalities

- **Steroids**: anti-inflammatory effect (takes a few hours to work)
- **Magnesium Sulfate**: relaxes smooth muscle
- **Aminophylline or Terbutaline infusion**
- **NIPPV**: Prevents airway collapse during exhalation, can maintain small airway patency, inspiratory pressure improves dyspnea & gas exchange by augmenting spontaneous breaths
Intubation

• Absolute indications
  o Cardiac and respiratory arrest
  o Severe hypoxia
  o Rapid deterioration in mental status

• Relative indication
  o Progressive exhaustion despite maximal treatment
Intubation

- More than 50% of complications in asthmatic patients receiving ventilation occur during or immediately after intubation
- Complications are largely due to gas trapping
  - Barotrauma (pneumothorax, subcutaneous emphysema)
  - Hypotension, oxygen desaturation, cardiac arrest
Croup

- S&S: “barking cough” and hoarseness
- The most common cause is a viral infection (parainfluenza or influenza) that leads to swelling of the larynx and trachea.
- Occurs mostly in infants and children between six months and three years of age.
Croup

• Most cases don’t require intervention
• More severe cases:
  o Dexamethasone
  o Racemic Epi
Epiglottitis

- Inflammation of the epiglottis and adjacent supraglottic structures.
- *Haemophilus influenzae* type b (Hib) is the most common infectious cause in children.
Epiglottitis

- Abrupt onset and rapid progression (within hours) of dysphagia
- “The Three D’s”: dysphagia, drooling, and distress are hallmarks of epiglottitis in children
Epiglottitis: Treatment

- Keep patient calm
- Hands-off approach
- Requires emergent medical attention, possible intubation, antibiotics.
Bacterial Tracheitis

- An invasive exudative bacterial infection of the soft tissues of the trachea

**S&S:**
- Fever (common but not universal)
- Stridor (inspiratory or expiratory)
- Cough (not painful; membranous exudates may be expectorated)
- Drooling is uncommon, but may be present
- Preference to lie flat
Pertussis

- Caused by Bordetella pertussis. Immunization prevents infection.
- Prolonged respiratory illness with paroxysmal coughing, often followed by forced inspiratory effort, causing a “whoop.”
- Complications:
  - Apnea
  - Vomiting
  - Seizures
  - Death
Not all wheezing = bronchospasm.
What Can Narrow an Airway…and Thus Can Cause Wheezing?

• Tracheomalacia
• External airway compression (mass, vascular compression, etc.)
• GERD leading to inflammation
• Increased pulmonary vessel pressure can squeeze the bronchioles (“cardiac asthma”)
• Foreign body
• Mucus!
Tracheomalacia
Vascular Ring

Double Aortic Arch

Anterior View

Posterior View

Esophagus
Trachea
Left subclavian A.
Left common carotid A.
Vascular ring

Pulmonary arteries

Pulsatile Compression
GERD, Aspiration
Myocarditis with CHF
Foreign Body
<table>
<thead>
<tr>
<th>Respiratory tract</th>
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<tbody>
<tr>
<td><strong>Infection</strong></td>
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<tr>
<td>Uvulitis</td>
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<tr>
<td>Epiglottitis</td>
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<tr>
<td>Retropharyngeal abscess</td>
</tr>
<tr>
<td>Parotid gland abscess</td>
</tr>
<tr>
<td>Croup</td>
</tr>
<tr>
<td>Tracheitis</td>
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<tr>
<td>Bronchiolitis</td>
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<tr>
<td>Pneumonia</td>
</tr>
<tr>
<td>Asthma</td>
</tr>
<tr>
<td><strong>Anaphylaxis</strong></td>
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<tr>
<td>Foreign body (upper airway, lower airway, esophagus)</td>
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<tr>
<td>Airway anomalies (eg, laryngomalacia, laryngospasm, tracheoesophageal fistula, tracheal stenosis, tracheal ring or sling)</td>
</tr>
<tr>
<td>Biologic or chemical weapons (eg, anthrax, tularemia, phosgene, nitrogen mustard, nerve agents, ricin)</td>
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<tr>
<td>Chest wall trauma or abnormalities (eg, flail chest, open pneumothorax, thoracic dystrophy)</td>
</tr>
<tr>
<td>Thoracic cavity trauma or conditions (eg, pneumothorax, hemothorax, pleural effusion, empyema, mediastinal mass)</td>
</tr>
<tr>
<td>Pulmonary trauma or conditions (contusion, embolism, hemorrhage)</td>
</tr>
<tr>
<td>Smoke inhalation</td>
</tr>
<tr>
<td>Chemical agent exposures (eg, phosgene, chlorine, cyanide)</td>
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<tr>
<td>Submersion injury (near-drowning)</td>
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<tr>
<td><strong>Cardiovascular</strong></td>
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<tr>
<td>Congenital heart disease</td>
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<tr>
<td>Acute decompensated heart failure</td>
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<tr>
<td>Myocarditis</td>
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<tr>
<td>Pericarditis</td>
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<tr>
<td>Arrhythmia</td>
</tr>
<tr>
<td>Shock</td>
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<tr>
<td>Cardiac tamponade</td>
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<tr>
<td>Myocardial infarction</td>
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<tr>
<td><strong>Nervous system</strong></td>
</tr>
<tr>
<td>Depressed ventilation (eg, ingestion, CNS trauma, seizures, or CNS infection)</td>
</tr>
<tr>
<td>Hypotonia (conditions causing poor airway or respiratory muscle tone and ineffective respiratory effort)</td>
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<tr>
<td>Pulmonary aspiration due to loss of airway protective reflexes</td>
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<tr>
<td><strong>Gastrointestinal</strong></td>
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<tr>
<td>Hypoventilation due to abdominal pain or distention (eg, intraabdominal trauma, small bowel obstruction, bowel perforation)</td>
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<tr>
<td>Gastroesophageal reflux with pulmonary aspiration</td>
</tr>
<tr>
<td><strong>Metabolic and endocrine diseases</strong></td>
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<tr>
<td>Metabolic acidosis (eg, diabetic ketoacidosis, severe dehydration, sepsis, toxic ingestions, inborn errors of metabolism)</td>
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<tr>
<td>Hyperthyroidism</td>
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<tr>
<td>Hypothyroidism</td>
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<tr>
<td>Hyperammonemia</td>
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<tr>
<td>Hypocalcemia (laryngospasm)</td>
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<tr>
<td><strong>Hematologic</strong></td>
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<tr>
<td>Decreased O2 carrying capacity (eg, acute severe anemia from hemolysis, methemoglobinemia, carbon monoxide poisoning)</td>
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<tr>
<td>Acute chest syndrome (patients with sickle cell disease)</td>
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</tbody>
</table>

Conditions listed in red are immediately life threatening.

CNS: central nervous system; O2: oxygen.
Take Home Points

• Respiratory distress common presentation of children with respiratory infections.

• Remember: respiratory distress can be leading symptom for non-respiratory conditions.

• Identify child with severe respiratory distress and risk for respiratory failure.

• Vital signs important but need to be interpreted in the clinical context.
Thank You!

We got you something.
I love it! I'm going to share it with EVERYONE!