Pediatric Respiratory Urgencies and Emergencies

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Disclosure:
Reports no financial interests relevant to this presentation

Session Goals
• To discuss an overall step-by-step approach to evaluation and management of a child in respiratory distress
• To review clinical features along with a stepwise approach to addressing common pediatric respiratory urgencies
• To review clinical presentations and appropriate initial interventions for the most common life-threatening pediatric respiratory emergencies

“Not Just Little Adults . . .”
• #1 cause of pediatric cardiopulmonary arrest: Primary respiratory disturbances (not cardiac)
• Special factors impacting pediatric respiration
  — Smaller airways
  — Increased metabolic demands
  — Decreased respiratory reserves
  — Inadequate compensatory mechanisms

Pediatric Respiratory Emergencies

Good Outcome!

Causes of Respiratory Distress in the Pediatric Patient

• Infections
• Asthma
• Anaphylaxis
• Foreign body
• Chest wall deformity
• Mass lesion
• Tension pneumothorax
• Acute on chronic process (cystic fibrosis, sickle cell disease, etc.)
• Cardiovascular disease
• Toxicologic

• Metabolic/endocrine
• Neurologic
  — Depressed respiratory drive
  — Loss of airway protective reflexes (aspiration)
• Gastrointestinal
  — Abdominal distention
  — GERD/aspiration
• Trauma
• Hematologic
  — Anemia

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Step-by-Step Approach

- Initial rapid assessment (A-ABC) and stabilization
  - Is child in respiratory distress?
  - What interventions must occur NOW to prevent respiratory failure?
- Focused history
- Physical examination
- Diagnostics
- Pinpoint underlying disorder
- Initiate acute management
- Continued supportive care and monitoring
- Frequent reassessment (always returning to A-ABC)

Appearance

• Airway
• Breathing
• Circulation

Appearance: “From the Door” Assessment

• “Sick or not sick?”
• Level of alertness/activity
• Color
• Tone/position
• Respiratory mechanics
• Is child’s response to environment developmentally appropriate?

Appearance “Red Flags”

• Level of activity
  - Lethargy
  - Irritable, inconsolable
  - Response to environment not developmentally appropriate
• Position/tone
  - Decreased tone; “floppy baby”
  - Refusal to move out of specific position
• Color
  - Pallor
  - Mottling
  - Cyanosis
• Respiratory mechanics
  - Marked increased work of breathing
  - Decreasing respiratory effort, fatigue
• Voice/cry
  - Hoarse/muffled voice or cry
  - Abnormal airway noise
  - Verbal child unable to speak in sentences or phrases

Airway

• Child’s cry or vocalization
  - Clear vocalization = open airway
  - Hoarse or muffled = possible partial obstruction
• Secretions (including nasal passages)
• Consciousness level consistent with ability to protect airway?
• Child’s position of comfort
• Inspiratory sounds

Airway “Red Flags”

• Choking or gagging
• Hoarse or muffled voice
• Stridor
• Drooling
• Lethargy causing inability to maintain airway
• Refusal to move out of certain position of comfort
  - Sniffing Position
  - Tripod Position

Child assuming the tripod position as a reaction to impaired breathing. (Illustration by Jason M. McAlexander, MFA. Copyright © 2007 by Wild Iris Medical Education.)
**Breathing**

- Respiratory rate
- Depth of respirations
- Air exchange
- Work of breathing
- Presence of abnormal lung sounds
- Chest wall movement

**Respiratory Rate “Rules of Thumb”**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Breaths/Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonate</td>
<td>35-50</td>
</tr>
<tr>
<td>Older Infant/Toddler</td>
<td>30-40</td>
</tr>
<tr>
<td>Elementary School Age</td>
<td>20-30</td>
</tr>
<tr>
<td>Older Child/Adolescent</td>
<td>12-20</td>
</tr>
</tbody>
</table>

- Conditions increasing respiratory rate
  - Fever
  - Anxiety
  - Pain
- Addressing above factors will also help tachypnea
- Respiratory rate best evaluated before hands-on assessment!

**Breathing “Red Flags”**

- Respiratory Rate
  - >60 in child < 2 years
  - >40 in child 2 years & up
- Work of breathing
  - Apnea or inadequate respiratory effort
  - Retractions
  - Nasal flaring
  - Grunting
  - Head bobbing
- Breath sounds
  - Unequal
  - Decreased air exchange

**Circulation**

- Skin color and temperature
- Heart rate/rhythm
- Pulses (central and peripheral)
- Blood pressure
- Capillary refill time
- End-organ function
  - Cerebral perfusion (mental status)
  - Skin perfusion
  - Renal perfusion (urine output)

**Circulation “Red Flags”**

- Pallor
- Cyanosis
- Skin cool, mottled
- Extreme tachycardia
- Bradycardia (may indicate imminent arrest!)
- Hypotension
- Weak pulses
- Capillary refill time >2 seconds
- Irritability/decreased mental status
- Decreased urine output

**Initial Management for Pediatric Respiratory Distress: Airway**

- Alert child: Support airway
  - Allow child to maintain position of comfort
  - Avoid agitation
- Unresponsive/ethargic child: Open the airway
  - Head tilt/chin lift
  - Jaw thrust if potential for C-spine injury
- Clear airway
  - Suction nose and mouth
  - Remove any foreign body seen

Bottom image: The Royal Children’s Hospital with permission http://www.rch.org.au/emplibrary/paed_trauma/Aairwayjawthrust.jpg
Core Content In Urgent Care Medicine

Initial Management for Pediatric Respiratory Distress: Airway

- When indicated, use airway adjuncts if adequate to maintain airway
  - Nasopharyngeal airway
  - Oral airway

- Unable to maintain airway using simple measures:
  - CALL FOR ASSISTANCE
  - Prepare for advanced airway placement:
    - Endotracheal intubation
    - Laryngeal mask airway
    - Surgical airway

Initial Management for Pediatric Respiratory Distress: Breathing

- Oxygen
  - High concentration for severe distress or failure
  - Nonrebreathing system if available

- Continuously monitor pulse oximetry

- Assisted ventilation (bag-mask ventilation) if needed

- If respiratory failure imminent:
  - Seek expert assistance immediately
  - Prepare intubation equipment and medications

- Respiratory medications as needed
  - Albuterol
  - Nebulized epinephrine

Initial Management for Pediatric Respiratory Distress: Circulation

- Cardiac monitoring

- Establish vascular access as indicated
  - Intraosseous access good option in pediatrics if unable to establish intravascular access
  - Fluid therapy
  - Medications for circulatory support as indicated

Case 1: “Bad Cough”

18-month-old, previously healthy boy is brought in by his parents after he woke from sleep with a persistent harsh cough and “noisy breathing.” For the past 2 days he has also had rhinorrhea and a low-grade fever. Just upon entering the exam room, you can hear that he has a harsh, “barky” cough. Once he sees you enter, he begins crying and you note intermittent inspiratory stridor.

Croup Hallmarks

- Inspiratory stridor
- Barky cough
- Hoarseness

Croup Epidemiology

- Who?
  - Children aged 6-36 months

- When?
  - Most cases occur in the fall or early winter months
### Croup Pathophysiology
- Cause usually viral (Parainfluenza type 1 is most common cause)
- Viruses causing croup infect the mucosa of the nose and throat, then spread down the respiratory tract to the larynx and trachea
- Classic symptoms result from inflammation in the larynx and subglottic airway
- Anatomic hallmark: tracheal narrowing in the subglottic region
- Further “dynamic obstruction” occurs when child is agitated

### Croup Clinical Features
- Usually begins with nonspecific URI symptoms
- Gradual progression over 12-48 hrs to include fever, hoarseness, barking cough, and inspiratory stridor
- Stridor can range from mild (with agitation only) to severe (present at rest)
- Associated tachypnea and retractions occur in more severe cases
- Symptoms exacerbated by crying and agitation
- Persists over 3 to 7 days with gradual resolution

### Croup Initial Rapid Assessment
- Goal: To quickly identify children with significant upper airway obstruction and potential for respiratory failure
- Key components of rapid assessment:
  - General appearance (“Sick” or “not sick”?)
  - Vital signs and pulse oximetry
  - Airway stability (stridor at rest?)
  - Work of breathing
  - Mental status

### Croup “Red Flags”
- Extreme irritability or listlessness
- Lethargy
- Stridor at rest
- Marked retractions
- Decreased or absent breath sounds
- Cyanosis or pallor
- Toxic appearance
- Refusal to move from particular position

### Goals of Croup Physical Examination
- To assess the severity of upper airway obstruction
- To exclude other infectious and non-infectious causes of acute upper airway obstruction
- To minimize agitation in order to avoid worsening of respiratory distress
  - Allow child to maintain position of comfort
  - Allow child to remain held by caregiver
  - Much information gained from observation alone

### Croup: Key Elements of History
- Symptom onset, duration, and progression
- Fever?
- Hoarseness and barking cough?
- Difficulty swallowing?
- Drooling/excessive secretions?
- Preceding choking or gagging episodes?
- Past medical history:
  - Known history of upper airway abnormality?
  - History of intubation?
  - Prior episodes of stridor?
Croup: High-Yield Exam Components

- Overall appearance?
  - Stridor at rest?
  - Position of comfort?
- Quality of voice/cry
- Work of breathing
  - Tachypnea?
  - Retractions?
  - Grunting or flaring?
- Lung examination
  - Air entry
  - Abnormal sounds
    - Stridor?
    - Wheeze?
- Examination of oropharynx
- Hydration status

Croup Differential Diagnosis*

- Bacterial tracheitis
- Acute epiglottitis
- Peritonsillar and retropharyngeal abscesses
- Foreign body aspiration or ingestion
- Allergic reaction/acute angioedema
- Upper airway injury
- Congenital upper airway anomalies
* Not all inclusive

Bacterial Tracheitis

- Thick, purulent exudate within trachea may obstruct upper airway
- ++Fever; patients appear toxic
- Symptoms generally develop over 1-3 days
- May occur as secondary bacterial infection after episode of croup (rare)

Source: Dr. Jerri Anne Rose

Acute Epiglottitis

- Rare in the era of Hib vaccine
- Onset sudden
- Barking cough absent
- ++Fever; patients toxic-appearing, anxious
- Swallowing difficulty, drooling often seen
- UPPER AIRWAY EMERGENCY!

Upper Airway or Esophageal Foreign Body

- Foreign body aspiration leading cause of accidental death in toddlers
- History of choking or gagging often present
- Abrupt onset of symptoms
- Drooling, dysphagia often seen
- Suspect if no preceding URI symptoms, no fever

Peritonsillar or Retropharyngeal Abscesses

- Drooling, swallowing difficulty often seen
- Barking cough absent
- Peritonsillar abscesses: Muffled “hot potato” voice
- ++Fever; patients may appear toxic
- Neck extension, decreased neck motion

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**Core Content In Urgent Care Medicine**

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**Allergic Reaction/Angioedema**
- Rapid onset
- No preceding URI symptoms or fever
- Look for lip/tongue swelling, urticaria, throat discomfort without hoarseness
- May be history of allergy and/or exposure precipitating symptoms

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**Upper Airway Injury**
- Airway may sustain injury from smoke or chemical burns
- No preceding fever or URI symptoms
- History of exposure (to smoke, chemical products) is key to diagnosis

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**Upper Airway Anomalies**
- Symptoms typically more chronic
- Fever, URI symptoms typically absent
- Viral croup superimposed on abnormal airway may present much more severely!
- Examples
  - Laryngeal webs
  - Laryngomalacia
  - Vocal cord paralysis
  - Subglottic stenosis
  - Laryngeal papillomas

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**Croup Diagnostics**
- Diagnosis is CLINICAL
- Diagnostic testing not required in children with characteristic presentation
- AP/lateral neck X-rays may be useful if presentation atypical and diagnosis is in question

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**Assessment of Croup Severity**

<table>
<thead>
<tr>
<th>Barking Cough</th>
<th>Stridor at Rest</th>
<th>Retractions</th>
<th>Air Entry</th>
<th>Agitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Occasional</td>
<td>None</td>
<td>None or minimal</td>
<td>Good</td>
</tr>
<tr>
<td>Moderate</td>
<td>Frequent</td>
<td>+</td>
<td>Good</td>
<td>None or minimal</td>
</tr>
<tr>
<td>Severe</td>
<td>Frequent</td>
<td>++</td>
<td>Decreased</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Impending Respiratory Failure:
- Resp. effort may decrease
- +++
- +++ or decreased effort
- Poor
- Significant or Lethargy

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**Croup: Principles of Acute Management**
- Most patients (>95%) can be managed successfully as outpatients
- Goals of acute therapy:
  - To decrease airway inflammation and edema
  - To provide respiratory support
  - To maintain hydration
Croup: Mainstays of Acute Therapy

- Corticosteroids (dexamethasone)
  - Reduce upper airway inflammation and edema
  - Compiled clinical trial data shows significant benefits:
    - Decreased clinical croup scores
    - Decreased risk of intubation
    - Reduced symptom duration, even with mild illness
- Nebulized epinephrine
  - Reduces tracheal secretions and mucosal edema
  - Clinical benefit supported by randomized controlled trials

Use of Corticosteroids in Croup

- Single dose of dexamethasone recommended for children with mild, moderate, and severe croup
- Standard recommended dose: 0.6 mg/kg
  - May be given orally, intramuscularly, or intravenously
  - Improvement rates similar when PO and IM forms compared; use least invasive route possible
  - Repeat doses of corticosteroids have no proven benefit and are not routinely recommended

Nebulized Epinephrine

- Recommended for moderate to severe croup
  - Stridor at rest
  - Moderate to severe retractions
- Either racemic or L-epinephrine may be used
  - Racemic 0.05 mL/kg (max 0.5 mL)
  - L-epinephrine (1:1,000 solution) 0.5 mL/kg (max 5 mL)
- "Rebound phenomenon": tendency to return to initial clinical picture after epinephrine wears off
  - Should observe patients at least 3 hours before discharge (see references)
  - Patients requiring additional doses should be hospitalized

Croup and "Mist" Therapy

- Traditional croup treatment included use of humidified oxygen in the hospital setting
- Meta-analysis of studies examining use of humidified oxygen for children with moderate croup in hospital settings shows NO significant improvement in clinical outcomes
- No longer used as mainstay of treatment in ED/hospital setting due to lack of supporting evidence
- Steamy bathroom/cool night air still commonly advised as options for supportive home care

Severity-Based Management of Croup

<table>
<thead>
<tr>
<th>Severity</th>
<th>Management</th>
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<tbody>
<tr>
<td>Mild Croup</td>
<td>Supportive Care</td>
</tr>
<tr>
<td></td>
<td>Single oral dose of dexamethasone (unless symptoms very mild)</td>
</tr>
<tr>
<td>Moderate to Severe Croup</td>
<td>Administer oxygen if tolerated</td>
</tr>
<tr>
<td></td>
<td>Nebulized racemic epinephrine or L-epinephrine</td>
</tr>
<tr>
<td></td>
<td>Single oral or IM dose of dexamethasone</td>
</tr>
<tr>
<td></td>
<td>Observe 2 hours after nebulized epinephrine for &quot;rebound&quot;</td>
</tr>
<tr>
<td></td>
<td>Hospital admission if no significant improvement or &quot;rebound&quot;</td>
</tr>
<tr>
<td>Extreme→Impending Respiratory Failure</td>
<td>Administer high concentration of oxygen</td>
</tr>
<tr>
<td></td>
<td>Bag-mask ventilation if necessary</td>
</tr>
<tr>
<td></td>
<td>Dexamethasone IV</td>
</tr>
<tr>
<td></td>
<td>Prepare for endotracheal intubation if indicated Call for Anesthesia/ENT assistance if available</td>
</tr>
<tr>
<td></td>
<td>Anticipate potential need for surgical airway</td>
</tr>
</tbody>
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Croup: Indications for Hospitalization

- Moderate to severe croup, not improved after nebulized epinephrine and steroids
- Need for supplemental oxygen
- Tachypnea
- Increased work of breathing
- Rapidly progressing symptoms
- Decreased level of consciousness
- Toxic-appearing child; concern for serious bacterial infection
- Dehydration/inability to tolerate oral intake
- Very young age (<6 months)
- Inability of family to return for care or to understand indications for return

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Croup: Checklist for Safe Discharge

- No stridor at rest
- Good air exchange
- Work of breathing not increased (or minimally increased)
- Respiratory rate within normal range
- Normal pulse oximetry
- Normal perfusion
- Normal level of consciousness
- Well hydrated with demonstrated ability to tolerate fluids
- Caregivers able to recognize indications for return for medical care and to do so if necessary

Croup Discharge Plan/Instructions

- Home treatment
  - Encourage fluid intake
  - Antipyretics for fever
  - Steamy bathroom/cool night air/cool mist vaporizers: No definite evidence, but seem to help empirically
- Follow up with primary care provider within 24 hours
- Parents should be educated regarding “warning signs”
- Immediate return for medical care if:
  - Trouble breathing
  - Pallor/cyanosis
  - Decreased level of consciousness
  - Stridor at rest
  - Continuous coughing, not improving after home treatment
  - Drooling/trouble swallowing
  - Increasing fever (>102 F)
  - Parental concerns that symptoms are progressing

Key Points: Acute Croup Management

- Oral dexamethasone and nebulized epinephrine are mainstays of treatment
- Children should be observed a minimum of 3 hours following nebulized epinephrine for “rebound” prior to discharge home
- Consider alternative differentials for infectious upper airway obstruction including epiglottitis, tracheitis, and deep neck abscesses in children appearing toxic or with rapidly progressive symptoms

Case 2: “Not Breathing Right”

A frantic mother presents to the Urgent Care triage area with her 3-month-old infant with the chief complaint, “She’s not breathing right!” The triage nurse calls for you to come and quickly assess the patient, and you find a pale, tired-appearing infant who is tachypneic with marked subcostal and intercostal retractions and nasal flaring. On auscultation, the baby’s breath sounds are course with diffusely scattered wheezes and crackles.

Bronchiolitis

- Acute, virally-mediated inflammatory disease of lower respiratory tract
- Most common lower respiratory tract infection in infants
- Most cases (~80%) caused by Respiratory Syncytial Virus (RSV)
- Mortality >5% in “high risk” groups

Bronchiolitis: Epidemiology

- Who?
  - Young children
  - Almost exclusively affects children <2 years
- When?
  - Winter and early spring
  - Highest incidence of infection between December and March
Bronchiolitis Pathophysiology

Viral infection
↓
Inflammation of bronchiolar epithelium
↓
Epithelial necrosis
Epithelial cell sloughing
Bronchiolar obstruction
Increased mucus production
Bronchospasm

Bronchiolitis Clinical Features

• Viral upper respiratory prodrome: rhinorrhea, cough, low-grade fever, decreased appetite
• Symptoms progress over 1-2 days to reflect lower respiratory involvement:
  – Tachypnea
  – Wheezing/Crackles/Rhonchi
  – Increased respiratory effort
• Apnea can be presenting sign in young infants

Potential Bronchiolitis Complications

• Hypoxemia
• Respiratory failure
• Apnea
  – Seen in 21% of infants <12 months in one study
  – May occur prior to onset of any URI symptoms
• Secondary pneumonia
• Acute otitis media
• Dehydration
  – Increased fluid needs from fever, tachypnea
  – Decreased oral intake
  – Vomiting

Bronchiolitis Initial Rapid Assessment

• Goal: To quickly identify children at risk for respiratory failure so that immediate intervention can occur
• Key components of rapid assessment:
  – General appearance (“Sick” or “not sick”?)
  – Color
  – Level of activity
  – Vital signs and pulse oximetry
  – Work of breathing

Bronchiolitis “Red Flags”

• Toxic appearance
• Lethargy
• Poor color/cyanosis
• Apnea
• Hypoxemia
• Dehydration
• Persistent respiratory distress
  – Tachypnea
  – Retractions
  – Nasal flaring
  – Grunting
• Poor feeding

Bronchiolitis: Key Elements of History

• Symptom onset, duration, and progression
• Prior wheezing episodes?
• Difficulty feeding?
• History of apneic episodes, cyanosis?
• Risk factors for severe disease:
  – Age < 12 weeks
  – History of prematurity
  – Underlying cardiopulmonary disease
  – Immunodeficiency
Goals of Physical Examination in Bronchiolitis

- To differentiate infants with bronchiolitis from those with other disorders
- To assess illness severity

High-Yield Exam Components

- Overall appearance
  - Color
  - Level of consciousness
  - Observed ability to feed
- Work of breathing
  - Tachypnea
  - Retractions
  - Grunting or flaring
  - Apneic episodes
- Auscultatory findings
  - Air entry
  - Wheezing/crackles
- Hydration status

Bronchiolitis: Differential Diagnoses

- Asthma
- Cardiovascular disease/heart failure
  - Congenital heart disease
  - Acquired cardiac disease (myocarditis)
- Cystic fibrosis
- Vascular ring/congenital anomalies
- Lower airway foreign body

Cardiovascular Disease/Heart Failure

- CHF may arise from both congenital and acquired heart diseases
- May also present with tachypnea, wheezing, rales, and rhonchi
- Distinguishing features:
  - Hepatomegaly, weak and thready pulses, and cool moist skin may be present
- Patient’s condition may worsen with fluid administration

Lower Airway Foreign Body

- Relatively common in children 1 to 4 years
- History may be significant for choking/coughing episode
- Suspect with acute onset of first-time wheeze (especially if unilateral or focal)
- CXR may reveal unilateral air trapping
- Definitive diagnosis made by bronchoscopy

Bronchiolitis Diagnostics

- Diagnosis and severity assessment should be made on CLINICAL basis
- Routine laboratory and imaging studies not recommended
- Rapid RSV antigen testing available, but clinical utility limited

Source: CDC/ Dawn Arlotta
Source: www.mypacs.net, Source Roy Nelson, MD, with permission.
**Principles of Acute Management**

- Disease is self-limited; care mainly supportive
- Components of bronchiolitis supportive care:
  - Saline drops/bulb suctioning for nasal congestion
  - Antipyretics for fever (acetaminophen)
  - Intravenous fluids if hydration status inadequate and infant unable to feed safely
  - Supplemental oxygen for hypoxemia (AAP recommends for SpO2 persistently < 90%)

**AAP Evidence-Based Management Recommendations for Bronchiolitis**

- **Inhaled bronchodilators**
  - Routine use not recommended
  - Carefully monitored trial of inhaled alpha- or beta-adrenergic medication (albuterol or nebulized epinephrine) “an option” per AAP and recommended by other experts
  - Continue only if positive clinical response
    - Albuterol may be continued at home if response positive
    - Nebulized epinephrine not traditionally used as home medication
- **Corticosteroids**
  - Routine use not recommended
  - May have benefit for patients with chronic lung disease or reactive airway disease (controversial)

**Bronchiolitis: Indications for Hospitalization**

- Persistent respiratory distress/respiratory failure
- Apnea
- Hypoxemia
- Dehydration/inability to feed
- Toxic-appearing, lethargic
- Adjusted age < 6 weeks
- Inability of caretaker to care for infant at home or to return when indicated
- Strongly consider admission if risk factors for severe disease present (prematurity, underlying disease, immunodeficiency)

**Bronchiolitis: Checklist for Safe Discharge**

- Respiratory rate < 70 breaths/minute
- No increased work of breathing
- No need for supplemental oxygen
- Adequate hydration
- Infant able to feed, stay adequately hydrated
- Caregiver factors
  - Ability to care for infant at home
  - Suctioning
  - Home bronchodilator therapy if indicated
  - Ability to recognize signs of worsening
  - Ability to return for medical care

**Bronchiolitis: Discharge Plan/Instructions**

- **Home treatment**
  - Nasal saline/bulb suction to clear airway
  - Offer fluids frequently
  - Antipyretics for fever
  - If positive clinical response to inhaled bronchodilator observed→ albuterol every 4-6 hours as needed
- **Follow-up with primary care provider within 24-48 hours**

- **Return for medical attention immediately if:**
  - Increasing respiratory rate
  - Increased work of breathing
  - Increased fevers
  - Apnea
  - Inability to maintain adequate hydration
  - Worsening general appearance
Bronchiolitis:
Key Points for Caregiver Education
• Expected clinical course for bronchiolitis
  – Median duration of illness for children < 2 yrs = 12 days
  – ~20% of children will remain ill after 3 weeks
  – Almost 10% will have symptoms after 4 weeks
• Proper techniques for bulb suctioning of nose
• Signs of worsening clinical status

Key Points:
Acute Bronchiolitis Management
• Care is mainly supportive
• Trial of inhaled beta-agonists (albuterol) may be useful, but medication should be continued only if positive clinical response is observed
• Routine use of corticosteroids is not supported by the majority of current evidence
• Antibiotics only indicated for clinically evident concurrent bacterial infections
• Symptoms may last up to 3-4 weeks in some children

Case 3: “Asthma Acting Up Again”
An 8-year-old boy with prior history of asthma now presents because, in the words of his father, “His asthma is acting up again.” The boy was at his baseline state of health until 2 days ago after he went on a family camping trip in the cool fall weather. He now presents with frequent cough and wheezing that has not been relieved by use of his albuterol metered-dose inhaler at home.

Asthma
• Most common chronic childhood illness in the U.S.
  – Affects 6 million children
  – Pediatric prevalence = 8.5%
• Exaggerated response to environmental stimuli
• Caused by combination of host factors and environmental exposures

Pathophysiology of Asthma
• Complex chronic inflammatory condition of the airways
• Hallmark: episodic and reversible airflow obstruction
• Airway hypersensitivity triggered by inflammation leads to
  – Muscular bronchoconstriction
  – Airway edema
  – Increased mucous production
  – Airway remodeling over time

Clinical Features of Asthma
• Recurrent episodes of
  – Cough
  – Wheezing
  – Shortness of breath
  – Chest tightness
• Common triggers
  – Viral respiratory infections
  – Exercise
  – Environmental allergens
  – Weather changes
  – Environmental tobacco smoke
Potential Asthma Complications

- Atelectasis
  - Secondary to mucous plugging
- Air leak
  - Pneumothorax
  - Pneumomediastinum
- Cardiac arrhythmias
  - Relatively less common
  - Associated with use of adrenergic agents

Asthma: Initial Rapid Assessment

- Vital signs with pulse oximetry
- Mental status
- Work of breathing
- Breath sounds
- Skin color/perfusion
- Hydration status

Asthma: “Red Flags”

- Agitation
- Decreased mental status
- Hypoxemia
- Cyanosis
- Marked accessory muscle use
- Inability to speak in full sentences
- Poor air exchange; faint or inaudible wheeze due to severe obstruction

Asthma: Key Elements of History

- Onset/duration of current exacerbation
- Precipitating factors
  - Infections
  - Exercise
  - Environmental changes
  - Smoke exposure
  - Allergens
- Current medications
  - Number/timing of recent bronchodilator treatments
  - Current or recent use of systemic steroids
  - Compliance
- History of asthma
  - Hospital admissions
  - ICU admissions
  - History of intubation
  - First-time wheeze?
  - Other atopic diseases: food allergies, eczema, allergic rhinitis
  - Family history of asthma
  - Coughing/choking episodes

Asthma: Goals of Physical Exam

- To rapidly determine the severity of the acute exacerbation
- To help differentiate wheezing secondary to asthma from that caused by other obstructive processes

High-Yield Examination Components

- Overall appearance
  - Color
  - Level of consciousness
- Respiratory mechanics
  - Tachypnea
  - Retractions
  - Nasal flaring
  - Grunting
  - Abdominal breathing
  - Prolonged expiratory phase
- Auscultatory findings
  - Degree of air exchange
  - Wheeze
  - Symmetry of breath sounds
- Hydration status
Asthma: Differential Diagnosis

- Foreign body aspiration (lower airway)
- Bronchiolitis
- GERD
- Cystic fibrosis
- Chronic lung disease of prematurity (BPD)
- Congestive heart failure
- Extrinsic airway compression
- Pneumonia

Asthma Diagnostics

- Diagnosis of acute exacerbation and assessment of severity based mainly on CLINICAL findings
  - Additional testing not necessary for effective management
  - Routine laboratory and imaging studies not recommended based on available evidence
- Commonly considered ancillary studies: peak expiratory flow rate, chest radiographs, arterial blood gas

Peak Expiratory Flow Rate (PEFR)

- Most commonly used pulmonary function test in acute care
- Simple, inexpensive measure of airway obstruction in children with mild to moderate distress
  - Pros: Easily performed, uses inexpensive handheld device, measures response to therapy
  - Cons: Cannot be performed reliably by young children, effort-dependent, predominantly measures large airway disease
- Estimated normal values depend on child’s age and height
- Results expressed as percentage of predicted value, or of patient’s usual best
  - PEFR of at least 80% predicted: Mild disease
  - PEFR 50-80% of predicted: Moderate disease
  - PEFR <50% of predicted: Severe disease

Utility of Chest Radiographs for Acute Asthma

- Findings rarely alter acute management and do not correlate well with illness severity
- Not recommended on routine basis
- Indications for obtaining chest radiographs:
  - Failure to respond to therapy
  - Asymmetric breath sounds/focal findings on lung exam persisting after bronchodilator therapy
  - Suspected pneumothorax and/or pneumomediastinum
  - High fever/suspected concurrent pneumonia
  - Diagnosis in question (first-time wheeze)

Typical Chest Radiograph Findings in Acute Asthma:
- Hyperinflation
- Atelectasis
- Peribronchial thickening

Principles of Acute Asthma Management

- Primary goals of acute management
  - Correction of hypoxemia
  - Rapid reversal of airflow obstruction
- Mainstays of acute asthma therapy
  - Supplemental oxygen
  - Inhaled Short-acting Beta-2 agonists (albuterol)
  - Systemic corticosteroids
**Oxygen Administration in Acute Asthma**

- **Mechanism of action**
  - Increases partial pressure of arterial oxygen
  - Decreases work of breathing
  - Has bronchodilatory effect
- **Consider in all moderate to severe exacerbations, regardless of pulse oximetry**
- **Supplemental oxygen definitely indicated to maintain pulse oximetry above 90%**

**Short-Acting Inhaled Beta-2 Agonists**

- **Mechanisms of action**
  - Directly relax bronchial smooth muscle
  - Modulate mediator release from mast cells and basophils
- **Albuterol** most widely recognized and commonly used member of this class
- **Frequent (Q 15-20 minute) doses appear effective in reversing airway obstruction**

**Short-Acting Inhaled Beta-2 Agonists**

- **Standard initial albuterol dosing:**
  - 2.5 mg for children under 5 years (<30 kg)
  - 5 mg for children 5 years and up (>30 kg)
- **Up to 3-4 treatments given over 1 hour considered safe and effective initial therapy**
  - Fewer treatments may be needed if presentation mild
  - Onset of action for albuterol typically 5 minutes or less
- **Continuous nebulized albuterol**: an option if presentation more severe
  - Dosing: 0.5 mg/kg/hour (max: 25-30 mg/hour)
  - Several clinical trials have supported safety, tolerability

**Metered-Dose Inhalers (MDIs) versus Nebulized Albuterol**

- **Clinically equivalent when MDI used with spacer and mask**
- **Practical considerations**
  - Less time-intensive
  - Less expensive
  - Portable
- **Recommended number of MDI puffs per treatment**
  - Young children: 2-4
  - Older children: 4-6
  - Adolescent/adult: 4-8

**Systemic Corticosteroids in Acute Asthma**

- **Mechanism of action**
  - Decrease airway inflammation and edema
  - Believed to enhance effect of beta-2 agonists through receptor up-regulation
- **Evidence supports benefits of early use**
  - Decreased need for emergency treatment and hospitalization
  - Reduced morbidity
- **Should be administered as soon as possible to patients with moderate to severe acute exacerbation**
  - Clinical effect typically observed within 2 hours
  - Peak effect occurs after 6-12 hours

**Dosing of Systemic Corticosteroids in Pediatric Acute Asthma**

- **Oral and intravenous forms equally effective, even among severely ill patients**
  - Opt for least invasive route possible
  - IV route if persistent vomiting or severe distress preventing oral intake
- **Oral options**
  - Prednisone or prednisolone 1-2 mg/kg (max: 60-80 mg)
  - Dexamethasone 0.6 mg/kg (max: 16 mg)
- **Intravenous option**
  - Methylprednisolone 1-2 mg/kg (max: 60-80 mg)
Ipratropium Bromide

- Mechanism of action:
  - Provides additional bronchodilation through action on cholinergic receptors
  - May enhance the effect of beta-2 agonists
- May be used in combination with albuterol in more severe exacerbations
  - Pediatric studies have shown benefit in children with severe exacerbations
  - Benefit in more moderate disease less clear
- Low cost, minimal adverse effects

Pediatric Acute Asthma: Indications for Hospitalization

- Persistent respiratory distress despite bronchodilator therapy
- Need for supplemental oxygen (pulse ox 91% or less)
- PEFR <50% predicted
- Inability to tolerate oral medications or fluids
- Mental status changes, lethargy
- Pneumothorax or pneumomediastinum
- Caregiver factors:
  - Unable to provide care at home or recognizes worsening
  - No ability to return for care
- Consider hospitalization for:
  - Previous emergency treatment in last 24 hours
  - History of previous serious exacerbations, ICU admits, intubation

Asthma: Checklist for Safe Discharge

- Adequate clinical response to therapy
- No clinical worsening following last bronchodilator treatment (Observe 30-60 minutes prior to discharge)
- No respiratory distress
- Good air exchange with no or minimal wheeze
- No need for supplemental oxygen
- Able to tolerate oral intake, stay adequately hydrated
- Normal mental status
- Caregiver factors:
  - Able to administer medications and provide care at home
  - Able to recognize signs of clinical worsening
  - Asthma education completed in acute setting

Asthma Discharge Plan/ Instructions

- Prescribe adequate medications for home
  - Albuterol nebs or MDI with spacer: Q 4-6 hours until exacerbation resolves
  - Short course of oral steroids for moderate to severe exacerbation
    - Prednisone or prednisolone—typically 5-day course
    - Dexamethasone—2-day course shown to have similar efficacy
  - Child should continue any routine “maintenance” medications
- Family education
  - Dosing and frequency of medications
  - Proper use of nebulizer or MDI/spacer
  - Avoid asthma triggers
  - Follow-up with primary provider within 24 hours for moderate to severe exacerbation
  - Signs of clinical worsening

Key Points: Acute Asthma Management

- Mainstays of therapy:
  - Frequent (every 20 minutes) inhaled albuterol
  - Oral steroids as early as possible
- Consider adding ipratropium bromide to albuterol if symptoms severe or in case of incomplete response
- Monitor response to therapy with frequent clinical assessments

Case 4: “High Fever and Vomiting”

A 4-year-old previously healthy girl is brought for medical care by her parents, who states she was doing well until she developed a high fever last night. Since this morning, the patient has developed a cough and has had 4 episodes of nonbilious, nonbloody emesis. Initial assessment reveals an ill-appearing child with fever of 103° F, respiratory rate of 60 breaths/minute, and SpO₂ of 91%.
Community-Acquired Pneumonia (CAP)

- Acute infection of pulmonary parenchyma, acquired outside a hospital setting
- Develops more often in childhood than at any other age

CAP Pathophysiology

- Bacterial and/or viral pathogens reach lung by inhalation of infectious organisms, aspiration, or hematogenous spread
- Acute inflammatory reaction occurs within lung in response to pathogens

CAP Epidemiology

- Who?
  - Patients of all ages; most common in young children
  - Incidence varies inversely with age
- When?
  - Year-round, but seasonal variations occur
  - Certain viral agents have peak “seasons”
  - Tends to increase in colder months due to increased crowding, respiratory droplet spread

Common Etiologies of Pediatric CAP

**Bacterial**

- *Strep Pneumoniae*
  - Most commonly identified bacterial agent in children
  - Incidence reduced due to heptavalent conjugated pneumococcal vaccine (Prevnar®)
- *Group A Streptococcus, Staphylococcus aureus, H. influenzae*
- *Mycoplasma and Chlamydia pneumoniae* (“Atypicals”)
  - More common in school aged children

**Viral**

- Most often identified in children <5 years
- RSV is most common agent in children <3 years
- Adenovirus, parainfluenza, influenza, human metapneumovirus also frequently responsible

**Mixed etiologies**

- Reported etiologies
  - 30-50% of patients

CAP Etiologies by Age Group

<table>
<thead>
<tr>
<th>Age</th>
<th>Viral Etiologies</th>
<th>Bacterial Etiologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth-2 weeks</td>
<td>CMV, HSV, Rubella</td>
<td>Group B Streptococcus, Escherichia coli, Listeria monocytogenes</td>
</tr>
<tr>
<td>2 weeks-2 months</td>
<td>RSV, Adenovirus, Influenza, EBV, Parainfluenza</td>
<td></td>
</tr>
<tr>
<td>2 months-3 years</td>
<td>RSV, Parainfluenza, Adenovirus, Influenza, EBV</td>
<td></td>
</tr>
<tr>
<td>3-19 years</td>
<td>Influenza, Adenovirus, Parainfluenza, EBV</td>
<td></td>
</tr>
</tbody>
</table>

CAP Clinical Features

- Fever
- Cough
- Difficulty feeding/poor appetite
- Pleuritic chest pain
- Referred abdominal pain
- Vomiting
- Neck stiffness (referred from upper lobe disease)

- Signs and symptoms are nonspecific
- Presentation may be subtle, especially in young infants
### Potential CAP Complications

- Pleural effusion and empyema
- Necrotizing pneumonia
- Lung abscess
- Pneumatocele
- Hyponatremia

### CAP Initial Rapid Assessment

- **Goals:** To assess child’s degree of respiratory distress and determine need for immediate management interventions
- **Key components of rapid assessment**
  - General appearance
  - Vital signs, including pulse oximetry
  - Assessment of degree of respiratory distress
  - Lung examination

### CAP “Red Flags”

- Hypoxemia
- Severe respiratory distress
  - Severe retractions
  - Grunting
- Signs of respiratory fatigue
- Toxic-appearing
- Cyanosis or pallor
- Lethargy
- Severe dehydration

### CAP: Key Elements of History

- Duration of symptoms
- Presence of fever
- Presence of cough, chest pain, difficulty breathing
- Associated symptoms (URI symptoms, headache, vomiting, malaise)
- Previous antibiotic therapy
- Prior episodes of pneumonia

### CAP: Goals of Physical Exam

- Differentiation of pneumonia from other respiratory illnesses
- Assessment of illness severity

### CAP: High-Yield Exam Components

- **Respiratory mechanics**
  - Tachypnea
  - Retractions
  - Nasal flaring
  - Grunting
- **Lung examination**
  - Crackles
  - Decreased breath sounds
  - Dullness to percussion
  - Wheezing (more common in atypical and viral pneumonia)
CAP Differential Diagnoses
- Congestive heart failure
- Aspiration pneumonia
- Chronic pulmonary diseases (cystic fibrosis)
- Asthma
- Bronchiolitis
- Primary and metastatic tumors
- Congenital abnormalities

CAP Diagnostics: Chest X-ray
- Not required when diagnosis clinically evident
  - Chest X-rays not consistently shown to alter management or improve clinical outcomes
  - Cannot definitively differentiate viral from bacterial/other causes
- Obtain in children with clinical evidence of CAP when
  - Clinical findings ambiguous
  - Complication is suspected
  - Course is prolonged, unresponsive to antibiotics

CAP Diagnostics: Acute Laboratory Assessment
- Complete Blood Count with Differential
  - Recommended only when additional information needed to help guide decision regarding antibiotic therapy
  - Likelihood of bacterial cause generally increases as WBC counts increase >15,000/mm³
- Blood cultures
  - Should not be routinely obtained beyond the neonatal period
  - May be helpful for inpatients with more severe, resistant, or unusual forms of pneumonia
- Serum electrolytes
  - May help assess degree of dehydration in children with poor fluid intake
  - May detect hyponatremia, a potential complication of pneumonia
- Sputum Gram stain & culture
  - Consider in children with more severe disease (requiring admission)
  - Adequate specimen difficult to obtain in younger children (<5 years)

Assessment of CAP Severity
- Should be based on child’s overall clinical appearance and behavior
- Evidence of increased work of breathing suggests more severe form of disease

CAP: Recommendations for Outpatient Antibiotic Treatment
- Children 60 days to 5 years: high-dose amoxicillin (80-90 mg/kg/day for 7-10 days)
  - Will cover *S. pneumoniae*
  - May consider macrolide or cephalosporin for penicillin-allergic patients
  - Ceftriaxone—option for children unable to tolerate fluids initially (single dose ceftriaxone + complete oral course)
- Children 5 years and older: macrolide (erythromycin or azithromycin)
  - Will cover *M. pneumoniae* and *C. pneumoniae*
  - May also cover *S. pneumoniae*

CAP Treatment Recommendations
- Children with respiratory distress requiring hospitalization
  - Supplemental oxygen as needed
  - Antipyretics
  - Intravenous antibiotics
  - Consider bronchodilator therapy as option
- Children with more severe illness
  - Combination of macrolide and beta-lactam agent recommended to provide better coverage for resistant organisms and mixed infections
  - Mixed etiologies reported in 30-50% of children with community-acquired pneumonia
**CAP Indications for Hospitalization**

- Hypoxemia
- Moderate or severe respiratory distress
- Toxic appearance
- Pleural effusion
- Age < 3 months
- Impaired immune function

- "Failure" of oral antibiotic therapy
- Severe dehydration
- Inability to tolerate oral intake
- Caregiver factors
  - Unable to care for child at home
  - Unable to recognize or act upon signs of clinical worsening

**CAP: Checklist for Safe Discharge**

- No signs of respiratory distress
- No need for supplemental oxygen
- Nontoxic appearing
- Age > 3 months
- No underlying immunodeficiency or serious chronic disease
- Normal mental status

- Normal hydration status
- Able to tolerate adequate oral intake
- No pneumonia complications such as pleural effusion
- Caregiver factors
  - Able to care for child at home
  - Able to administer outpatient antibiotic regimen to child
  - Able to recognize signs of clinical worsening

**CAP Discharge Plan/Instructions**

- Home supportive care
  - Antipyretics for fever, discomfort
  - Frequent fluid intake
  - Anti-tussives not recommended
- Follow-up with primary provider within 24-48 hours

- Return for medical attention immediately if:
  - Increasing shortness of breath or trouble breathing
  - Breathing faster
  - Unwilling to feed or unable to tolerate fluids
  - Child looks blue or passes out
  - Child appears more ill or anxious

**Key Points: Acute CAP Management**

- Most cases caused by viral etiology
- *Streptococcus pneumoniae*—most common bacterial cause in children
- Signs and symptoms of CAP are nonspecific and can be especially subtle in young infants
- Tachypnea is a sensitive and specific sign for CAP in children

**Most Common Life-Threatening Respiratory Emergencies in Pediatrics**

- Upper airway foreign body
- Tension pneumothorax
- Epiglottitis
- Cardiac tamponade

**Upper Airway Foreign Body**

- Leading cause of accidental death in toddlers
- History of abrupt-onset choking or gagging suggestive
- No air exchange despite effort, cyanosis with complete obstruction
- Keep index of suspicion HIGH in toddler-aged child
**Complete Upper Airway Obstruction: Acute Interventions**

- **Open airway**
  - Remove any visual object
  - Blind finger sweep NOT recommended!
- **Child responsive**
  - <1 yr: back blows/chest thrust
  - >1 yr: abdominal thrusts
- **Child unresponsive**: Begin CPR
- May attempt removal of object under direct visualization
- Seek immediate assistance from airway management specialist (Anesthesia, ENT)

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**Tension Pneumothorax**

- Progressive accumulation of air within pleural cavity
  - Collapse of ipsilateral lung → Compression of contralateral lung → Decreased venous return to heart
- **Clinical signs**
  - Severe respiratory distress
  - Decreased breath sounds on affected side
  - Tachycardia, peripheral vasoconstriction
  - Appearance of hypotensive shock:
    - cool, clammy, cyanotic
    - Mediastinal shift (late sign)

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**Needle Decompression**

- Midclavicular line, 2nd intercostal space of ipsilateral side
- Large-bore angiocath advanced perpendicular to chest wall, over rib
- Immediate release of air should result
- Most be followed by tube thoracotomy

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**Epiglottitis**

- Life-threatening bacterial infection of epiglottis and surrounding structures
- Now rare in the age of Hib vaccine
- Very abrupt onset of fever, stridor, sore throat, drooling; patients toxic-appearing
- Swollen inflamed epiglottis may be seen on exam of pharynx

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**Epiglottitis Acute Management Interventions**

- Minimize agitation; allow child to maintain position of comfort
- Insure adequate ventilation
- Prepare for placement of artificial airway
  - Call early for advanced help (i.e., anesthesia)
  - Secure IV access if child will tolerate without severe agitation
  - Prepare for endotracheal intubation by most experienced provider possible
  - Anticipate potential need for surgical airway

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**Cardiac Tamponade**

- Accumulation of blood in pericardial sac
- Generally results from severe trauma, myocardial injury
- **Clinical signs**
  - Distant heart sounds
  - Hypotension
  - Poor perfusion
  - Narrow pulse pressure
  - Electromechanical dissociation

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http://www.mypacs.net
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Source: Alex Maclennan, MD with permission.
Pericardial Tamponade Acute Management Interventions

- Begin with ABCs
  - Stabilize airway and breathing
  - Vascular access
  - Fluid resuscitation
  - Continuous cardiac monitoring
- Initial intervention:
  Pericardiocentesis
  - Puncture skin 1-2 cm inferior to left xiphochondral junction, at 45° angle to skin
  - Carefully advance large over-needle catheter cephalad toward tip of left scapula

In Summary . . .

- Infants and children are at increased risk for complications due to specific respiratory urgencies and emergencies
- Initial rapid assessment with immediate support of Airway, Breathing, and Circulation as indicated can be life saving
- Always call early for advanced assistance when child displays “Red Flags” indicating potential for respiratory failure