Stridor, Aspiration, and Cough in Children

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Grand Rounds Presentation
December 31, 2003
Stridor: Introduction

- Harsh, high-pitched, musical sound produced by turbulent airflow through partially obstructed upper airway
- Poiseuille’s Law: Resistance inversely proportional to radius to $4^{th}$ power
- Bernoulli’s Law: Pressure decreases as velocity increases, causing tendency to collapse
Stridor: Introduction

- Supraglottic obstruction: Inspiratory stridor (high-pitched)
- Extrathoracic trachea obstruction – includes glottis & subglottis: Biphasic stridor (intermediate pitch)
- Intrathoracic trachea obstruction: Expiratory stridor (wheeze)
- Stertor = Low-pitched inspiratory sound from nose/nasopharynx (snoring)
Stridor: H&P

- Croup = most common cause of acute stridor
- Laryngomalacia = most common cause of congenital chronic stridor
- First step: Determine degree of distress
- Decreased intensity may indicate resolution or exhaustion
Stridor: H&P

- Positional stridor: Laryngomalacia, micrognathia, macroglossia, vascular compression
- Optimal position: Prone with neck extended
- Weak Cry: Disorder of TVC’s or poor pulmonary function
- Hoarseness: Laryngeal lesion (Normal voice does NOT rule out laryngeal lesion)
Stridor: H&P

- Passage of nasal catheter to determine patency: Oral airway will bypass choanal atresia
- Pierre-Robin sequence: Nasopharyngeal airway to temporize
- ALWAYS maintain high index of suspicion for foreign body (airway or esophagus)
Stridor: H&P

- Transnasal flexible endoscopy in stable patients while awake; can also evaluate swallow
Stridor: Imaging

- Lateral and A/P neck films: Inspiration distends hypopharynx, places epiglottis in vertical position, and stretches A-E folds diagonal

- Barium swallow: Aspiration, posterior laryngeal cleft, TEF, vascular ring, non-radioopaque esophageal foreign body (Difficult to distinguish cleft vs. aspiration)
Stridor: Imaging
Stridor: Imaging

- Double aortic arch: Most common extrinsic compressive disorder – bilateral curvilinear indentations at level of T-4
- Pulmonary artery sling: Compression of right mainstem & lower trachea – anterior indentation of upper thoracic esophagus on LATERAL projection
- Aberrant subclavian artery similar finding (less common)
Stridor: Imaging
Stridor: Imaging

- MRI: superior to angiography in diagnosis of vascular rings because images airway and vessels simultaneously
- Used as second line if Echo/plain films/barium swallow nondiagnostic because of sedation requirement
- T1 fast spin echo w/ cardiac gating: weighting of choice
- Pickhardt: completely normal A/P & Lateral CXR rule out vascular ring
Stridor: Imaging

- Airway fluoroscopy: dynamic study, evaluates multiple sites
- Average exposure 1-2 minutes, 10 mR
- Technique: evaluate diaphragm movement, focal air trapping, airway from NP to mainstem bronchi in A/P, oblique, and lateral projections
- Good for subglottic stenosis, tracheobronchomalacia, bronchial foreign body, oropharyngal collapse
Stridor: Imaging

- Bad for glottic/supraglottic lesions, TVC function, tracheal foreign body
- Rudman: Nasopharyngoscopy + airway fluoroscopy most cost-effective
Stridor: Endoscopy

- Gold Standard
- Use when diagnosis in doubt, subglottic stenosis, second distal airway lesion suspected, foreign body suspected
- Appropriate ETT: \(4 + \frac{\text{age}}{4}\), permits air leak at \(<30 \text{ cm H2O}\)
- Myer-Cotton: Comparison of actual ETT size vs. expected
- Flexible scope + ureteral stone forceps for Foreign bodies
Stridor: Endoscopy

- Most common complications: Arrhythmia, laryngospasm
Stridor: Post-Extubation

- Air leak test: Good predictor for laryngeal edema, recent tracheal surgery
- Children <7 yo more likely to fail extubation; air leak test NOT predictive for children <7 yo with initially normal airway
Stridor: Epiglottitis

- Rhode Island study (18 years)
  - 1974: Children 6/100,000/yr, Adults 0.8/100,000/yr
  - 1992: Children 0.3/100,000/yr, Adults 3/100,000/yr

- Smoking increases risk >2X

- Stridor in 80% of children, 27% of adults

- Epiglottitis due to thermal injury from illicit drug use (4 cases)

- Children w/ mild to moderate sx: Immediate introduction of artificial airway has significantly decreased number of deaths
Aspiration: Introduction

- Penetration of secretions/other material below TVCs
- Aspiration during sleep in all normal, healthy individuals
- Children: Swallow dysfunction impairs respiratory function
- Complications: Tracheitis, bronchitis, bronchospasm, pneumonia, pulmonary abscess, ? SIDS
<table>
<thead>
<tr>
<th>Underlying Illness</th>
<th>No. (%)</th>
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<tbody>
<tr>
<td>Aspiration syndrome</td>
<td>114 (47.9)</td>
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<tr>
<td>Immune disorder</td>
<td>34 (14.3)</td>
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<tr>
<td>Congenital heart disease</td>
<td>22 (9.2)</td>
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<tr>
<td>Bronchial asthma</td>
<td>19 (8.0)</td>
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<tr>
<td>Anomalies of the respiratory system</td>
<td>18 (7.6)</td>
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<tr>
<td>Gastroesophageal reflux</td>
<td>13 (5.4)</td>
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<tr>
<td>Unknown</td>
<td>18 (7.6)</td>
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</table>
Aspiration: Introduction

- Swallow at 16 weeks gestation
- Suckle at 34 weeks gestation
- Chewing at 6 months of age
- 3 categories of aspirate: orally ingested, oral/airway secretions, regurgitated gastric contents
Aspiration: History

- GER = abnormality most commonly associated with chronic aspiration
- GER si/sx: Postprandial cough, regurgitation, emesis, bronchospasm, laryngospasm, central apnea, bradycardia
- Risk factors: Depressed consciousness, prematurity/swallow dysfunction, CP, epilepsy, muscular dystrophy, intestinal motility disorder, scoliosis
Aspiration: History

- 4 months: Milestone for lengthening of swallow apparatus – increased risk of swallow problems/aspiration
Aspiration: Workup

- NP reflux suggests swallow dysfunction
- Lateral neck and plain chest films: 14% of films normal
- MBS & Barium swallow: Ba swallow 50-85% sensitive, 70-75% specific for GER
- Scintiscan: Study of choice for gastric emptying
Aspiration: Treatment

- Correct anatomic abnormalities (cleft, TEF)
- GER natural hx: Resolution by 18-24 months
  - Conservative Tx: Positioning, Thicken feeds, Small frequent feeds. Optimal position prone and flat with body tilted 30 degrees. Sitting may worsen GER
- Medical tx: Metoclopramide increases LES tone and gastric emptying; H2 blockers/PPIs; Sucralfate if duodenal ulcers
Aspiration: Treatment

- Surgery for GER: Fundoplication if failure after 6 weeks on medication

- Surgery for chronic aspiration
  - G/J tubes most common
  - Trach – Temporary or complimentary
  - In setting of congenital TVC paralysis, should delay laryngeal surgery
  - Laryngeal diversion/separation: Lindeman, modified Lindeman
  - Cincinnati: Bilateral submax glands/parotid ducts, obviates need for trach
Aspiration: Foreign Body

- Esophageal foreign bodies – respiratory sx in 10%
- Vegetable matter most common airway FB: NUTS, carrot pieces, beans, sunflower/watermelon seeds
- Conforming objects/balloons most common airway FB causing death; at least 2 deaths from latex gloves in MD’s office; spherical objects second most common
Aspiration: Foreign Body

- Natural history: 3 stages
  - Choking/coughing/gagging
  - Asymptomatic interval (up to ½ cases diagnosed beyond 1 week)
  - Complications: cough, hemoptysis, pneumonia, lung abscess, fever, malaise

- Workup: I/E CXR, lateral decubitus
- Exam, films usually normal 1st 24 hours
Aspiration: Foreign Body
Cough: Introduction

- Most common symptom of respiratory dz
- Rare and less vigorous in neonates
- Highest cough receptor concentrations: larynx, lower ½ trachea, carina, mid-sized bronchi. Carina the most sensitive
- Glottic closure NOT essential for cough, but results in lower & earlier peak flow
Cough: Differential Dx & Tx

- Cough in neonate suggests congenital anomaly, GER, CF, chlamydia pneumonia
- Chronic cough = daily cough for >2-3 weeks; affects 7-10% of children; usually resolves spontaneously
- Holinger: Common causes of chronic cough
  - <18 months: Aberrant innominate, cough variant asthma, GER
  - 18 mo-6 yrs: Sinusitis (50%), cough variant asthma
  - 6-16 yrs: Cough variant asthma, psychogenic cough (1/3), sinusitis
Cough: Differential Dx & Tx

Cystic Fibrosis: Must be considered in any child w/ chronic cough
- Poor growth despite good appetite, rectal prolapse, NASAL POLYPS
- Dx: Sweat chloride test

Environment: More common in urban areas; Prenatal smoking a risk factor through 1st 3 yrs, but NOT postnatal smoking
Cough: Differential Dx & Tx

- Psychogenic cough: Most common in adolescents; frequent, repetitive, honking; disruptive during office visit; only cough absent during sleep.

- Chlamydia pneumonia: Staccato cough, usually 1st 6 months of life; prolonged afebrile illness w/ congestion, tachypnea, rales, hyperinflated lungs w/ diffuse infiltrates, peripheral eosinophilia, +/- preceding conjunctivitis.
Cough: Differential Dx & Tx

- **Pertussis**: Paroxysmal cough followed by rapid inspiration (“whoop”)
  - In infants & children > 5 yo, whoop uncommon
  - Infants may have facial plethora, vomiting, apnea, no cough
  - Epidemic cycles Q2-4 yrs
  - Most frequently reported vaccine preventable dz in children
  - Complications (pneumonia/neurologic sequellae) in 4-15%

- Dx by NP swab
- Tx: Must report to county; Erythromycin or TMP/SMX
Cough: Differential Dx & Tx

- GER: Postprandial and bedtime cough
  - Frequent cause in neonate & infant
  - Causes chronic cough in 10% of cases of children w/ normal CXR

- Bronchitis: Usually tracheobronchitis, usually viral (can be Pertussis), worse in fall/winter
  - Chronic, nonproductive cough after resp infection
  - Chronic bronchitis unusual in children, suggests underlying dz, e.g., CF, immotile cilia, etc.
  - Usual age 5-7 yo
Cough: Differential Dx & Tx

Asthma/RAD: Usually presents w/ wheeze, but may be cough variant asthma
  - Cough exacerbated by running or laughing; also common during sleep
  - Dx by response to bronchodilator tx OR PFTs w/ methacholine challenge
  - Asthma usually occurs by age 6, thus, bronchodilator if child < 6, PFTs if child > 6
  - Chang: Cough & asthma same trigger, different pathways; 1-2 wk trial of bronchodilator only
Cough: Differential Dx & Tx

- Bronchiectasis: Dilation of bronchi due to inflammation, affects bronchial wall, accumulation of secretions
  - Chronic productive cough; repeat episodes of pneumonia in SAME lobe (LLL); hemoptysis in 50%
  - Associated w/ CF, GER, and Kartagener Syndrome

- Hemoptysis: Unusual in children; DDx = bronchiectasis, CF, AIRWAY FB, pulmonary hemosiderosis, Tb
Cough: Differential Dx & Tx

- Workup: All children w/ chronic cough should obtain P/A & lateral CXR
  - Holinger: Children < 18 mos, endoscopy most useful, then Ba swallow, empiric bronchodilator
  - Children 18 mos-6 yrs, sinus films most useful, then endoscopy, empiric bronchodilator
  - Children 6-16 yrs, PFT’s w/ methacholine challenge most useful, then sinus films
# Cough: Differential Dx & Tx

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<thead>
<tr>
<th>Category</th>
<th>Specific Disorder</th>
<th>Number</th>
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<tbody>
<tr>
<td>Large airway, upper</td>
<td>Allergic rhinitis</td>
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<tr>
<td></td>
<td>Chronic sinusitis</td>
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<tr>
<td>Large airway, lower</td>
<td>Chronic bronchitis</td>
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<td>Gastroesophageal reflux</td>
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<td></td>
<td>Tracheomalacia</td>
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<td>Vascular ring</td>
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<td>Small airway</td>
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<td>Parenchymal</td>
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<table>
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<tr>
<th>Diagnostic studies</th>
<th>Total Number</th>
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<td>Therapeutic trial</td>
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<td>Lung function test</td>
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<td>Barium esophagram</td>
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<td>History</td>
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<td>Physical examination</td>
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<td>Chest radiograph</td>
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