Pediatric Rhinosinusitis

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Grand Rounds Presentation
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Introduction

- Sinusitis diagnosis rare 25 years ago
- Better understanding
  - pathophysiology, etiology, treatment outcomes
- Better diagnostic techniques
- 5-10% of viral URI’s complicated by bacterial rhinosinusitis
- Numerous controversies in diagnosis and treatment
Anatomy

Maxillary Sinus

- first to develop at day 65 of gestation
- seen on plain films at 4-5 months
- growth in phases at 3 years and 7 to 12 years
- slow expansion until 18 years
- average capacity is 14.75 mL
- drains into middle meatus
Anatomy

- Ethmoid Sinus
  - develop in third month of gestation
  - anterior from the lateral nasal wall
  - posterior from superior meatus
  - ethmoids seen on radiographs at one year
  - enlarges to reach adult size at age 12
  - 4-17 cells each side with volume 15 mL
  - drainage into middle and superior meatus
Anatomy

*Frontal Sinus*

- begins in fourth month of gestation from superior ethmoid cells
- seen on radiographs at age 5-6
- grows slowly to adult size by adolescence
- volume of 5-6 mL with variable development
- drains into frontal recess
Anatomy

◆ Sphenoid Sinus
  – originates in fourth gestational month from posterior part of nasal cavity
  – pneumatization begins at age 3
  – rapid growth to reach sella by age 7 and adult size at age 18
  – volume of 7.5 mL with drainage into superior meatus
Histology

- Pseudostratified columnar epithelium
- Cilia specifically arranged
- Similar mucosa to remainder of tracheobronchial tree
Pathophysiology and Etiology

- Normal function
  - patent ostia
  - normal cilia
  - normal mucous secretions

- Primary sinus abnormality is obstruction of the osteomeatal complex by edema or mechanical obstruction
Etiology

- Obstruction leads to retained secretions resulting in hypoxia of sinus mucosa--causes ciliary dysfunction and increased secretions--secondarily infected

- Edema and mechanical obstruction
  - local factors
  - regional factors
  - systemic factors
  - others
## Etiology

### Conditions That Predispose Children to Sinusitis

<table>
<thead>
<tr>
<th>Inflammatory conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viral upper respiratory infections</td>
</tr>
<tr>
<td>Irritants: tobacco smoke, fumes</td>
</tr>
<tr>
<td>Allergic/nonallergic rhinitis</td>
</tr>
<tr>
<td>Rhinitis medicamentosa</td>
</tr>
<tr>
<td>Gastroesophageal reflux</td>
</tr>
<tr>
<td>Local or anatomic</td>
</tr>
<tr>
<td>Osteomeatal complex abnormality: large ethmoid</td>
</tr>
<tr>
<td>bulla, abnormal uncinate process, concha bullosa, Haller cells</td>
</tr>
<tr>
<td>Nasal septal deviation (congenital or traumatic)</td>
</tr>
<tr>
<td>Partial choanal atresia</td>
</tr>
<tr>
<td>Adenoid hypertrophy</td>
</tr>
<tr>
<td>Nasal foreign body</td>
</tr>
<tr>
<td>Scars from previous surgery</td>
</tr>
<tr>
<td>Nasal polyps/tumor</td>
</tr>
<tr>
<td>Nasogastric or nasotracheal catheter</td>
</tr>
<tr>
<td>Systemic diseases</td>
</tr>
<tr>
<td>Cystic fibrosis</td>
</tr>
<tr>
<td>Cilia dyskinesia: primary ciliary dyskinesia, Kartagener's or Young's syndrome</td>
</tr>
<tr>
<td>Primary immune deficiency: IgA deficiency, X-linked agammaglobulinemia, common variable immune deficiency, IgG dysfunction or subclass deficiency, hyper-IgM syndrome, complement deficiency, ataxia-telangiectasia</td>
</tr>
<tr>
<td>Granulomatous disease: Wegener's granulomatosis</td>
</tr>
<tr>
<td>Secondary immune deficiency: acquired immune deficiency syndrome</td>
</tr>
</tbody>
</table>

### Etiological Factors in Pediatric Sinusitis

A. **Inflammatory:**
   1. Upper respiratory tract infections
   2. Allergy

B. **Mechanical:**
   1. Naso/septal deformity
   2. Osteomeatal complex obstruction
   3. Turbinate hypertrophy
   4. Polyps
   5. Tumors
   6. Large adenoids
   7. Foreign bodies
   8. Oste palate
   9. Choanal atresia or posterior nasal stenosis

C. **Systemic:**
   1. Cystic fibrosis
   2. Immotile cilia syndrome
   3. Kartagener’s syndrome
   4. Immunodeficiency
   5. Cyanotic congenital heart disease

D. **Miscellaneous:**
   1. Swimming, diving, flying
Definitions

◆ Rhinosinusitis
  – unable to differentiate clinically
  – isolated sinusitis rare

◆ Acute Rhinosinusitis
  – infection that resolves within 12 weeks
  – no URI during this 3 month period
  – divided into severe and nonsevere forms
Definitions

◆ **Recurrent Acute Rhinosinusitis**
  - repeated acute episodes completely resolving within 12 week time frame

◆ **Chronic Rhinosinusitis**
  - low grade symptoms and signs persistent for over 12 weeks
  - acute exacerbations can occur
Clinical Presentation

◆ History and PE vital to proper diagnosis

◆ Viral URI
  – unable to differentiate within 10 days
  – serous rhinorrhea--may be mucopurulent
  – nasal congestion and cough prominent
  – low grade fevers, malaise, headaches
  – nighttime cough may linger
Clinical Presentation

◆ Acute Nonsevere Rhinosinusitis
  – persistent cold symptoms over 10 days
  – rhinorrhea (any type), cough (dry or wet) worse at night, low grade fevers, fetid breath, painless periorbital swelling in AM, rarely facial pain
Clinical Presentation

- **Acute Severe Rhinosinusitis**
  - usually after 10 days but may be sooner
  - high fever, purulent and copious rhinorrhea, periorbital swelling, facial pain, headaches, dental pain

<table>
<thead>
<tr>
<th>Symptoms and Signs of Pediatric Rhinosinusitis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nonsevere Acute Rhinosinusitis</strong></td>
</tr>
<tr>
<td>Rhinorrhea (of any quality)</td>
</tr>
<tr>
<td>Nasal congestion</td>
</tr>
<tr>
<td>Cough</td>
</tr>
<tr>
<td>Headache, facial pain, and irritability (variable)</td>
</tr>
<tr>
<td>Low-grade or no fever</td>
</tr>
</tbody>
</table>
Diagnosis

- **History**

- **Physical Examination**
  - anterior rhinoscopy with otoscope
  - oropharynx
  - tenderness over sinuses
  - periorbital edema and discoloration
  - flexible and rigid endoscopy in older child
  - most specific-- mucopurulence, periorbital swelling, facial tenderness
Diagnosis

- Transillumination -- no value
- Ultrasonography -- little value
- Radiography
  - traditional views Water’s, Caldwell, Lateral, and Submentovertex
  - problems: ethmoids, disease findings, underdeveloped sinuses
Diagnosis
Diagnosis
Diagnosis

◆ Radiography
  – McAlister: compared radiographs with CT -- 45% normal X-ray but abnormal CT
  – 34% abnormal x-ray but normal CT
  – Not useful for uncomplicated rhinosinusitis
  – Uses in complicated acute rhinosinusitis
    » with AFL -- 75% positive isolates
Diagnosis
Diagnosis

- Computed tomography
  - gold standard
  - planning surgery or failed medical management
  - Indications
    » Clinical unresponsiveness to medical therapy
    » Immunosuppressed patient
    » Severe symptoms or signs
    » Life threatening complications
Diagnosis

- Sinus Aspirate
  - indications same for CT scanning
  - nasal, oral, nasopharyngeal cultures poor
  - needs cooperative patient -- usually GETA
  - middle meatal cultures?
Microbiology

- Similar to adults
- \textit{Streptococcus pneumoniae, Moraxella catarrhalis, nontypeable Hemophilus influenzae}
- Rare viruses, anaerobes, \textit{Staphylococcus}
- Normal flora in the sinus -- controversy

\begin{table}[h]
\centering
\begin{tabular}{|l|c|}
\hline
\textbf{Organism} & \textbf{Prevalence (\%)} \\
\hline
\textit{Streptococcus pneumoniae} & 25-30 \\
\textit{Moraxella (Branhamella) catarrhalis} & 15-20 \\
\textit{Hemophilus influenzae} & 15-20 \\
\textit{Streptococcus pyogenes} & 2-5 \\
Anaerobes & 2-5 \\
Sterile & 20-35 \\
\hline
\end{tabular}
\caption{Bacteriology of Acute Sinusitis}
\end{table}
Medical Management

- Historically -- aspiration and irrigation
- Antibiotics -- viral URI common and increasing numbers of drug resistant bacteria
  - 40-60% sinusitis episodes resolve (AOM)
  - 35% of S. pneumoniae penicillin-resistant
  - 16% of S. pneumoniae penicillin-intermediate
  - rapid cure, prevent complications, prevent chronic sinusitis, sterilize sinus
### Medical management of pediatric sinusitis

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin</td>
<td>40 mg/kg/day in equally divided doses</td>
</tr>
<tr>
<td>Amoxicillin-potassium clavulanate (Augmentin)</td>
<td>40/10 mg/kg/day in 3 divided doses</td>
</tr>
<tr>
<td>Erythromycin-sulfisoxazole (Pediazoze)</td>
<td>50/150 mg/kg/day in 4 divided doses</td>
</tr>
<tr>
<td>Sulfamethoxazole-trimethoprim (Sulfa or Bactrim)</td>
<td>40/8 mg/kg/day in divided doses</td>
</tr>
<tr>
<td>Cefuroxime axetil (Ceftin)</td>
<td>30 mg/kg/day in 2 divided doses</td>
</tr>
<tr>
<td>Cefprozil (Cefzil)</td>
<td>30 mg/kg/day in 2 divided doses</td>
</tr>
<tr>
<td>Cefixime (Suprax)</td>
<td>8 mg/kg/day in 1 dose or 2 divided doses</td>
</tr>
<tr>
<td>Cefpodoxime proxetil (Vantin)</td>
<td>10 mg/kg/day in 2 divided doses</td>
</tr>
<tr>
<td>Loracarbef (Lorabid)</td>
<td>30 mg/kg/day in 2 divided doses</td>
</tr>
<tr>
<td>Clindamycin (Cleocin)</td>
<td>30 mg/kg/day in 4 divided doses</td>
</tr>
<tr>
<td>Clarithromycin (Biaxin)</td>
<td>15 mg/kg/day in 2 divided doses</td>
</tr>
<tr>
<td>Azithromycin (Zithromax)</td>
<td>10 mg/kg/day in 1 loaded dose</td>
</tr>
</tbody>
</table>
Medical Management

Acute Nonsevere Rhinosinusitis (no ABX)

- Amoxicillin (45-90 mg/kg/day), amoxicillin/clavulanate, cefpodoxime, or cefuroxime
- 10 to 14 day course
- PCN-allergic may receive azithromycin, clarithromycin, erythromycin, or TMP/SMX but limited effectiveness (25% failure rate)
Medical Management

- Acute nonsevere rhinosinusitis (with ABX)
  - Acute severe rhinosinusitis (no ABX)
    - Amoxicillin/clavulanate, high dose amoxicillin (80-90 mg/kg/day), cefpodoxime, or cefuroxime
- Acute severe rhinosinusitis (with ABX)
  - Amoxicillin/clavulanate or combination therapy (amoxicillin or clindamycin plus cefpodoxime or cefixime)
Medical Management

- Complications or severe illness
  - IV cefotaxime or ceftriaxone plus clindamycin

- Chronic Rhinosinusitis
  - beta lactam stable agent (amoxicillin/clavulanate or combination therapy) for 3-6 weeks
## Medical Management

<table>
<thead>
<tr>
<th>Agent</th>
<th>Susceptible breakpoint (µg/mL)</th>
<th>S pneumoniae (all)</th>
<th>Penicillin-susceptible S pneumoniae (n = 973)</th>
<th>Penicillin-intermediate S pneumoniae (n = 264)</th>
<th>Penicillin-resistant S pneumoniae (n = 503)</th>
<th>H Influenzae (n = 1919)</th>
<th>M catarrhalis (n = 204)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-dose Amoxicillin³</td>
<td>4/−</td>
<td>94.2/−</td>
<td>100/100</td>
<td>100/100</td>
<td>79.7</td>
<td>61.1</td>
<td>13.7</td>
</tr>
<tr>
<td>Amoxicillin/clavulanate</td>
<td>2/2¹</td>
<td>90.2/90.2</td>
<td>100/100</td>
<td>100/100</td>
<td>65.6/65.6</td>
<td>97.0</td>
<td>100</td>
</tr>
<tr>
<td>High-dose amoxicillin/clavulanate²</td>
<td>4/1−</td>
<td>94.3/−</td>
<td>100/100</td>
<td>100/100</td>
<td>80.1</td>
<td>99.6</td>
<td>100</td>
</tr>
<tr>
<td>Cefactor</td>
<td>0.5/1</td>
<td>27.4/46.0</td>
<td>47.3/77.5</td>
<td>7.4/18.7</td>
<td>0.2/0.4</td>
<td>2.3</td>
<td>5.4</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>1/0.5</td>
<td>57.3/52.1</td>
<td>95.3/90.0</td>
<td>28.5/14.4</td>
<td>0.4/0.2</td>
<td>99.9</td>
<td>100</td>
</tr>
<tr>
<td>Cefpodoxime</td>
<td>0.5/0.5</td>
<td>63.0/63.0</td>
<td>100/100</td>
<td>48.2/48.2</td>
<td>0/0</td>
<td>99.9</td>
<td>64.1</td>
</tr>
<tr>
<td>Cefprozil</td>
<td>1/2</td>
<td>64.2/67.4</td>
<td>99.2/99.6</td>
<td>57.7/75.4</td>
<td>0.4/0.8</td>
<td>18.2</td>
<td>6.4</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>1/1</td>
<td>64.8/64.8</td>
<td>99.8/99.8</td>
<td>59.9/59.9</td>
<td>0/0</td>
<td>79.6</td>
<td>37.3</td>
</tr>
<tr>
<td>Loracarbef</td>
<td>0.5/2</td>
<td>9.2/59.5</td>
<td>15.8/98.2</td>
<td>3.5/31.7</td>
<td>0/0</td>
<td>9.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>0.12/0.5</td>
<td>67.0/67.7</td>
<td>93.9/94.5</td>
<td>51.1/52.8</td>
<td>23.9/24.5</td>
<td>0.2</td>
<td>100</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>0.25/0.25</td>
<td>67.8/67.8</td>
<td>94.6/94.6</td>
<td>53.2/53.2</td>
<td>24.5/24.5</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>0.25/0.25</td>
<td>67.5/67.5</td>
<td>94.3/94.3</td>
<td>51.8/51.8</td>
<td>24.5/24.5</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>−0.25/−</td>
<td>−89.2/−</td>
<td>−98.5</td>
<td>−84.9</td>
<td>−73.8</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Doxycycline</td>
<td>0.25/−</td>
<td>76.1/−</td>
<td>96.4</td>
<td>74.6/−</td>
<td>45.3/−</td>
<td>20.2</td>
<td>96.6</td>
</tr>
<tr>
<td>Levofoxacin</td>
<td>2/2</td>
<td>99.8/99.8</td>
<td>99.6/99.6</td>
<td>100/100</td>
<td>100/100</td>
<td>100</td>
<td>99.8</td>
</tr>
<tr>
<td>TMP/SMX</td>
<td>−0.5/1</td>
<td>−156.9</td>
<td>−86.0</td>
<td>−42.6</td>
<td>−8.8</td>
<td>75.5</td>
<td>9.8</td>
</tr>
</tbody>
</table>
Medical Management

- Antihistamines -- dry mucosal secretions
- Isotonic saline nose drops, sprays, irrigations, and steam inhalations -- anecdotal
- Topical decongestants -- inhibits cilial motion
- Nasal steroids
- Mucolytics
Medical management

- Recalcitrant rhinosinusitis
  - allergy
  - immunodeficiency
  - cystic fibrosis
  - ciliary dismotility disorders
  - gastroesophageal reflux disease
Surgical Management

- **Adenoidectomy**
  - nasal obstruction and symptoms
  - small size of trials

- **Septoplasty**
  - rare to have significant septal deviation

- **Antral aspiration and lavage**
  - indications same as sinus aspiration
  - only treats maxillary sinus
  - need GETA
Surgical Management

- Caldwell-Luc -- damages dentition
- Inferior antrostomy
  - goes against proven cilial outflow
  - possible for cilial dismotility/CF
- FESS
  - controversial -- difficult, too radical (AOM), reversible changes on CT
Surgical Management

◆ FESS

– excellent results: 71% normal at one year, meta analysis 89% success with 0.6% complications
– usually maxillary antrostomy/anterior ethmoidectomy
Surgical Management

◆ FESS (absolute)
  – complete nasal obstruction in CF
  – antrochoanal polyp
  – intracranial or orbital complications
  – mucocoeles or mucopyocoeles
  – traumatic injury in optic canal
  – resistant dacryocystorhinitis
  – fungal sinusitis
  – some meningoencephaloceles/neoplasms
Surgical Management

✦ FESS (possible)
  – persistent chronic rhinosinusitis that fails optimum medical treatment and after exclusion of systemic disease
  – asthmatic exacerbations associated with rhinosinusitis
Complications

◆ Routes of spread
  – arterial
  – venous
  – lymphatic
  – direct
Complications

◆ Stage I

- periorbital inflammatory edema
- obstruction of venous channels
- no vision loss
- no EOM limitation
Complications

◆ Stage II
  – orbital cellulitis with edema, chemosis, proptosis, pain
  – no abscess
  – ophthalmplegia may occur due to edema or spasm
  – no visual loss
Complications

◆ Stage III
  - subperiosteal abscess
  - globe displaced laterally or downward
  - orbital cellulitis present with decreased EOM
  - vision decreased
Complications

◆ Stage IV
  – orbital abscess
  – severe proptosis and chemosis
  – usually no globe displacement
  – opthalmoplegia present
  – visual loss (13%) due to ischemia or neuritis
Complications

- Stage V
  - cavernous sinus thrombosis
  - progressive symptoms
  - proptosis and fixation
  - CN II, IV, VI
  - meningitis
  - high mortality
Complications

- History an physical examination
- Ophthalmology consultation
- IV antibiotics (ceftriaxone plus metronidazole and oxacillin)
- CT scan
- Surgery -- abscess, worsening vision, progression, persistent after 24 hours
  - external, FESS, frontal sinus trephine
Complications

◆ Intracranial -- meningitis, subdural or epidural abscess, cerebral abscess, CST
  – neurosurgery, ophthalmology, ID
Allergy and Rhinosinusitis

- Allergy estimated at 15-30% of population
- Major contributing factor in rhinosinusitis
- Similar pathogenesis as viral etiology with obstruction -- mucostasis -- hypoxia -- colonization
Allergy Diagnosis

- History is critical
  - itching mucous membranes, clear rhinorrhea, eczema, food intolerance, nasal congestion, stuffiness, fluctuating rhinorrhea, sneezing, cough, behavioral changes, headaches, facial pressure
  - prior history of infantile colic, formula changes, otitis media, ADHD
Allergy Diagnosis

Physical Examination
- allergic shiners and allergic salute
- nasal obstruction with cracked lips
- rash over cheeks or urticaria
- eczema
- posterior pharyngeal lymphoid tissue
- ETD
Allergy Diagnosis

- Clinical diagnosis
- Two to four week food diary
- Open feeding challenge
- RAST testing -- poor for food allergy
- Nasal smear analysis
- Skin testing
Allergy Treatment

◆ Avoidance
  – clean, allergy proof house, filter, no pets, air conditioning

◆ Pharmacotherapy
  – antihistamines, nasal steroids, mast cell stabilizers

◆ Immunotherapy
Asthma and Rhinosinusitis

- URI’s including rhinosinusitis may be trigger for asthmatic outbreaks
  - cause-effect not proven
- Rachelefsky found strong correlation with resolution of sinus disease on ability to stop bronchodilator therapy
- Friedman showed improvements in PFT’s with resolution of rhinosinusitis in small group
- Oliveria demonstrated bronchial hyperreactiveness was improved with treating rhinosinusitis
Asthma and Rhinosinusitis

- Numerous studies document improvement in controlling asthma symptoms and reducing asthma medications in patients treated surgically.
- Research not proven to assess if rhinosinusitis is etiologic factor for asthma or simply an exacerbating condition.
Case Presentation