MANAGING COMMON DISEASES IN OTOLOGY: EAR INFECTIONS, MENIERE’S DISEASE, AND SENSORINEURAL HEARING LOSS
Mission

• Curing deafness worldwide, one patient, one disease at a time.
HOUGH EAR INSTITUTE

Worldwide...

One patient...

One disease...
OVERVIEW

Ear Infections
- AOM
  - Pathophysiology
  - Indications for PETs
- COM
  - Cholesteatoma
- Complications of OM

Meniere’s Disease
- Pathophysiology
- Diagnosis
- Treatment

SNHL
- Pathophysiology
- Life impact
- Treatment and rehabilitation
- Hope for the future
AOM - PATHOPHYSIOLOGY

- ETD
- Allergic rhinitis
- Adenotonsillar hypertrophy
- GER
- Bacterial pathogens
- Middle ear effusion

Viral URTI → Ascending bacterial (±viral) infection via ET → AOM

↓ Mucociliary defense
↑ Bacterial colonization
↑ Bacterial adhesion
Altered immune response

Adenoids: bacterial reservoir?

Nose blowing
Sniffing

↑ Reflux of nasopharynx
Microbes into ME

↑ Negative ME pressure

↓ Secretions and edema
ET dysfunction

Mucus accumulation: medium for bacterial growth
ACUTE OTITIS MEDIA

Microorganisms Associated With AOM

- Streptococcus pneumoniae: 25-50%
- Hemophilus influenzae: 15-30%
- Moraxella catarrhalis: 3%
- Streptococcus pyogenes (gr. A): 2%
- Staphylococcus aureus: 1%
- Viruses: 45-70%
- No microorganisms: 16-25%

Treatment

- Primary
  - Amoxicillin high dose, or high-dose amox/clav (Augmentin ES, XR)
- Alternative
  - Cefpodoxime (Vantin), cefdinir (Omnicef), Ceftriaxone (Rocephin) IM – one injection daily (or every day) x3, Levo-or-moxifloxican (Adults)
**CHRONIC SUPPURATIVE OTITIS MEDIA**

**Microbiology**
- Mixed Infections with both aerobic and anaerobic pathogens
  - Pseudomonas aeruginosa, Staph. aureus, and epidermidis, proteus species, klebiella, and E. coli are isolated, as are prevotella and porphyromonas anaerobes

**Treatment**
- Draining ears, especially if cholesteatoma (keratoma) is present
- Medicinal
  - Primary Ototopical Therapy
    - Ofloxican (Floxin otic) or ciprofloxican (Cipro HC otic, Ciloxan ophthalmic, Ciprodex)
  - Alternative Ototopical Therapy
    - Providone-iodine (Betadine), Boric acid/iodine powder et al. antiseptics
  - Primary Oral/Parenteral Therapy
    - Ciprofloxican (Cipro) or levofloxican (Levaquin) in adults with or without clindamycin, IV piperacillin/tazobactam (Zosyn)
  - Alternative Oral/Parenteral Therapy
    - IV ceftazidime (Fortaz) or cefepime (Maxipime), with or without clindamycin, IV meropenem with or without clindamycin or metronidazole
AOM-INDICATIONS FOR PETS

- 6 or more infections in a year with ME effusion
- Persistent ME effusion for 3 months or more
- Cleft palate
Diagnosis:
Recurrent ear infections usually with otorrhea
Pathology may be hidden in pars flaccida region
Hearing loss

COM-CHOLESTEATOMA

Treatment:
- Surgical treatment
- Ossicular reconstruction
- Recurrences
Warning signs of a complication of otitis media
- Persistent fever despite antibiotics
- Unremitting pain
- Marked increase in ear drainage

Temporal Bone
- Coalescent mastoiditis with or without subperiosteal abscess
- Facial nerve paralysis
- Labyrinthitis

Central Nervous System
- Extradural abscess
- Sigmoid sinus thrombophlebitis
- Subdural abscess
- Meningitis
- Brain abscess
Temporal Bone
- Coalescent mastoiditis with or without subperiosteal abscess
  - Diagnosis: bone destruction on CT, retroauricular tender mass
  - Treatment: parenteral antibiotics and possible mastoidectomy and PE tube
- Facial nerve paralysis
  - Diagnosis: facial nerve paralysis in the face of acute or chronic ear infection
  - Treatment
    - AOM: PE tube, IV antibiotics, based on culture, close monitoring
    - COM: mastoidectomy and IV antibiotics based on culture

Labyrinthitis
- Diagnosis
  - Acute severe vertigo and hearing loss with pain in the face of AOM
  - Chronic mild vertigo or imbalance in the face of chronic ear infection
- Treatment
  - Acute severe vertigo with a bacterial acute ear infection is a risk for meningitis and should be treated with PE tube and parenteral antibiotics and diagnostic lumbar puncture
  - COM: parenteral antibiotics and appropriate mastoid surgery
Central Nervous System

- **Extradural abscess**
  - Diagnosis: headache, low grade fever, MRI with contrast
  - Treatment: mastoidectomy with drainage and parenteral antibiotics based on culture

- **Sigmoid sinus thrombophlebitis**
  - Diagnosis: headache, malaise, spiking fevers, MRI and MRV
  - Treatment: mastoid surgery and appropriate parenteral antibiotics

- **Subdural abscess**
  - Diagnosis: fever, decreased LOC, headache, seizure, hemiparesis MRI with contrast
  - Treatment: neurosurgical transcranial drainage of the abscess and appropriate parenteral antibiotics

- **Meningitis**
  - Diagnosis: headache, fever, stiff neck, MRI with contrast, spinal tap
  - Treatment: parenteral antibiotics, PE tube, possible mastoid surgery when stable

- **Brain abscess**
  - Diagnosis: Fever, decreased LOC, headache, vomiting, stiff neck, papilledema, MRI with contrast, key is early diagnosis
  - Treatment: parenteral antibiotics and neurosurgical drainage of abscess
COMPLICATIONS OF OTITIS MEDIA
MENIERE’S DISEASE—PATHOPHYSIOLOGY

- The hydropic ear
- Electrolyte imbalance
- Vestibular dark cells
- Allergy
Diagnosis of exclusion

Typical presentation
- Severe vertigo
- Increase in tinnitus
- Drop in hearing
- Increased aural fullness

Differential Diagnosis
- CVA
- Labyrinthitis
- Migraine associated vertigo
- BPPV

Audiometric findings
- Low frequency SNHL
- EcoG
- Normal CT/MRI
MENIERE’S DISEASE-TREATMENT

Education
Low sodium diet (caffeine too)
Vitamin D
Diuretic
- Lasix 20-40 mg q d with potassium supplementation
Transtympanic steroid therapy
Transtympanic gentamicin ablation
Surgery
- ELS
- Labyrinthectomy
- VNS
SENSORINEURAL HEARING LOSS - PATHOPHYSIOLOGY

- Noise-induced hearing loss
- Presbycusis
- Idiopathic sudden sensorineural hearing loss
- Toxic hearing loss
- Congenital hearing loss

![Hair bundle before noise](image1)

![Hair bundle after noise](image2)
SENSORINEURAL HEARING LOSS-LIFE IMPACT

- Social and relational impact
- Educational Impact
- Career impact
- Financial impact
- Mental health impact
- Physical health impact
PRESBYCUSIS

- 35% of people over age 65
- 50% of people over age 75
- Association with brain shrinkage and dementia
- Association with falls
- Association with depression
ISSNHL

- ENT emergency
- Typically presents with “I woke up this morning and I couldn’t hear out of my right ear”
- Often diagnosis missed or delayed
- Delay or missed diagnosis can be avoided with a simple tuning fork test
- 10% of patients with a vestibular schwannoma will present with sudden hearing loss MRI required
- Pathophysiology: viral, vascular, membrane breaks
- Treatment
  - High dose oral steroids (prednisone 60 mg q AM for 10-14 days)
  - Transtympanic decadron in hyaluronic acid injected weekly X 3
SENSORINEURAL HEARING LOSS - TREATMENT AND REHABILITATION

- Hearing amplification
- Cochlear Implantation
- Other implantable devices
- FM systems
HEARING AMPLIFICATION

- Improving all the time
- High satisfaction rate with proper fitting and education
- Babies can be fit with hearing aids
- Insurance pays for child HAs in OK
Dr. Jack Hough, founder of Hough Ear Institute, was an early pioneer of the cochlear implant.
COCHLEAR IMPLANTATION
HYBRID COCHLEAR IMPLANT

- Low frequency acoustic hearing
- High frequency electrical stimulation
- Superior results
- Expanded indications
IMPLANTABLE DEVICES FOR SINGLE SIDED DEAFNESS AND CONDUCTIVE HEARING LOSS
44 y.o. male presents with recurrent draining ear, progressive hearing loss and dizziness.

Granulation tissue in attic region.

Culture of ear drainage: S. aureus, pseudomonas aeruginosa, beta-hemolytic strep.

Audiogram
RADIOGRAPHIC FINDINGS
TREATMENT

- Ear cleaning and topical antibiotics (ofloxacin drops, topical antibiotic powder)
- Canal wall down mastoidectomy
- Gamma knife vs. transmastiod/translabyrinthine resection of vestibular schwannoma
- Hearing rehabilitation
  - Implantable device for single sided deafness
  - Or Bi-cross hearing aid
SENSORINEURAL HEARING LOSS - HOPE FOR THE FUTURE

- Pharmacological treatment of acute acoustic trauma
- Regenerative strategies
Pill to treat acute noise trauma

Regeneration treatment

Battery

OHCx3

Tuner/amp

Transducer

IHC

Electrical signal
SENSORINEURAL HEARING LOSS - LIFE IMPACT
# NAC ALONE: CLINICAL DATA

## Clinical design – performed during a standard training exercise

<table>
<thead>
<tr>
<th>ASHA definition</th>
<th>Placebo</th>
<th>NAC</th>
<th><em>p</em>-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger-hand ear</td>
<td>27.56</td>
<td>21.56</td>
<td>0.0620</td>
</tr>
<tr>
<td>Non trigger-hand ear</td>
<td>17.67</td>
<td>21.56</td>
<td>0.8962</td>
</tr>
<tr>
<td>Left ear for left trigger-hand recruits</td>
<td>19.23</td>
<td>23.08</td>
<td>0.7507</td>
</tr>
<tr>
<td>Right ear for left trigger-hand recruits</td>
<td>11.54</td>
<td>23.08</td>
<td>0.9300</td>
</tr>
<tr>
<td>Left ear for right trigger-hand recruits</td>
<td>18.29</td>
<td>21.40</td>
<td>0.8376</td>
</tr>
<tr>
<td>Right ear for right trigger-hand recruits</td>
<td>28.40</td>
<td>21.40</td>
<td>0.0439</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adapted Navy definition</th>
<th>Placebo</th>
<th>NAC</th>
<th><em>p</em>-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger-hand ear</td>
<td>34.98</td>
<td>27.14</td>
<td>0.0288</td>
</tr>
<tr>
<td>Left ear</td>
<td>33.56</td>
<td>29.60</td>
<td>0.1781</td>
</tr>
<tr>
<td>Right ear</td>
<td>34.60</td>
<td>27.08</td>
<td>0.0323</td>
</tr>
<tr>
<td>Both ears</td>
<td>14.88</td>
<td>10.11</td>
<td>0.0560</td>
</tr>
<tr>
<td>Non-trigger hand ear</td>
<td>32.16</td>
<td>30.86</td>
<td>0.4064</td>
</tr>
<tr>
<td>Left ear for left trigger-hand recruits</td>
<td>26.92</td>
<td>26.92</td>
<td>0.6223</td>
</tr>
<tr>
<td>Right ear for left trigger-hand recruits</td>
<td>19.23</td>
<td>34.62</td>
<td>0.9418</td>
</tr>
<tr>
<td>Left ear for right trigger-hand recruits</td>
<td>34.46</td>
<td>30.45</td>
<td>0.2660</td>
</tr>
<tr>
<td>Right ear for right trigger-hand recruits</td>
<td>35.80</td>
<td>27.16</td>
<td>0.0237</td>
</tr>
</tbody>
</table>
HPN-07 WITH NAC: COMBINATION THERAPY INCREASES EFFICACY

- Chinchilla (Noise: 105 dB SPL for 6 h)
- 300 mg/kg HPN-07
- 325 mg/kg NAC
- Oral dosing
- 4 hours post-noise, then 2 doses per day for 2 days (5 doses total)
- NAC alone effect = HPN-07 alone effect
- NAC plus HPN-07 or related nitrone 4-OHPBN have synergistic effect

Threshold Shift (2-8 kHz)

Synergistic efficacy
Hearing loss reduced from 35 dB to 10 dB
Rat (Noise: 1hr, 10-20 kHz OBN, 115 dB SPL)
Similar to what would be experienced on an aircraft carrier flight deck

Significant reduction in both temporary and permanent hearing loss

Lu et al., 2014
*ABR = Auditory Brainstem Response
HPN-07/NAC PROTECTS HAIR CELLS

Rat (Noise: 1hr, 10-20 kHz OBN, 115 dB SPL)
Similar to what would be experienced on an aircraft carrier

Noise-induced hair cell loss was reduced in treated animals by 85%

Lu et al., 2014
*OHC = Outer Hair Cell
HPN-07/NAC REDUCES HEARING LOSS AND PRESERVES HAIR CELLS IN BLAST MODEL

Rat (Blast exposure: 3 X 14 psi)

21 Days after blast exposure

**Treatment preserves hearing**

**Treatment preserves hair cells**

Ewert et al., 2012

*ABR = Auditory Brainstem Response

*OHC = Outer Hair Cell
HPN-07 plus NAC Phase I
- Combination antioxidant
- Can be given prophylactically or after noise insult

Ebselen Phase I
- Antioxidant pre-treatment

D-methionine Phase II
- Antioxidant related to NAC
HEARING RESTORATION
Acoustic trauma or Ototoxic insult

Supporting Cell

Anti-HC differentiation factors

Hair Cell

Supporting Cell

Supporting Cell

Anti-HC differentiation factors

Auditory Signaling
Viral vector gene delivery of Atoh 1 gene

- Phase I
- No inner hair cell regeneration in rodent
- Spotty outer hair cell regeneration in rodent
- Potential safety issues with viral vector gene therapy
SUMMARY AND CONCLUSIONS

❖ Ear infections still common
  ❖ Complications rare
  ❖ PETs can be helpful

❖ Meniere’s syndrome
  ❖ A diagnosis of exclusion can be managed well medically
  ❖ Fewer invasive surgeries needed but can be very beneficial

❖ SNHL has multiple effects on patient and family
  ❖ Early diagnosis essential in childhood
  ❖ Hearing aids and implantable devices providing excellent help
  ❖ Pharmacological and regenerative strategies provide hope for the future
QUESTIONS
Dr. Richard Kopke
Hough Ear Institute
Website: houghear.org
Office: 405.639.2877
Clinic: 405.639.2811
Email: rkopke@houghear.org