Hearing Loss and Usher Syndrome

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Usher Family Conference
Portland, Oregon
July 13, 2013
Overview

• **Childhood hearing loss**
  – How we measure hearing
  – Review of audiograms
  – Medical evaluation
  – Management of children with HL

• **Usher Syndrome and hearing loss**
Milestones in diagnosis of childhood hearing loss

• 1960’s Auditory brainstem response testing
• 1980s Automated auditory testing
  – ABR and EOAE
• 1999 Walsh Bill
• 2000’s Early Hearing loss Diagnosis Detection and Intervention (EHDDI)
  – Screening by 1 month
  – Diagnosis by 3 months
  – Intervention by 6 months
# How we measure hearing

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<tr>
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<th>Requirements</th>
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<th>Disadvantages</th>
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<td>- Requires sedation over 6 months of age&lt;br&gt;- Physiologic response</td>
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<td><strong>Behavioral</strong></td>
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<td>VRA-visual reinforced</td>
<td>&gt;6 months old</td>
<td>Gold standard for assessment of hearing</td>
<td>Patient must be developmentally ready to understand the test</td>
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<td>CPA-conditioned play</td>
<td>Cooperative</td>
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<td>CA-conventional</td>
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Ears and Hearing 101

AUDIOGRAM OF FAMILIAR SOUNDS

FREQUENCY IN CYCLES PER SECOND (HZ)

HEARING LEVEL IN DECIBELS (dB)

AMERICAN ACADEMY OF AUDIOLOGY

http://www.audiology.org
Ears and Hearing 101

AUDIGRAM OF FAMILIAR SOUNDS

FREQUENCY IN CYCLES PER SECOND (HZ)

HEARING LEVEL IN DECIBELS (DB)

NORMAL
MILD
MODERATE
SEVERE
PROFOUND
Ears and Hearing 101

AUDIOMETRIC OF FAMILIAR SOUNDS

FREQUENCY IN CYCLES PER SECOND (HZ)

125 250 500 1000 2000 4000 8000

HEARING LEVEL IN DECIBELS (dB)

0 10 20 30 40 50 60 70 80 90 100 120

NORMAL

MILD

MODERATE

SEVERE

PROFOUND
Example Audiograms
Medical evaluation of childhood hearing loss

• History
• Physical examination
• Characterization of hearing loss
• Imaging studies
  – CT and/or MRI scans
• Tests for specific causes of hearing loss
  – CMV testing
  – Genetic tests
• Tests to look for associated problems
  – Balance testing
  – Ophthalmologic evaluation
  – Electrocardiogram
  – Renal ultrasound
  – Thyroid function studies
  – Others
Childhood Hearing Loss

Prelingual Deaf Children 1/1000

- Idiopathic 25%
- Non-genetic 25%
- Genetic 50%

Non-syndromic 70%

- Autosomal recessive 75% - 85%
  - DFNB1 50%
  - Other DFNB 50%
- Autosomal dominant 15% - 24%
- X-linked 1% - 2%

Syndromic 30%

From www.genetests.org
CT scans

- Normal
- Mondini
- Enlarged vestibular aqueduct
Management of children with hearing loss

Early intervention/exposure to language

Amplification
- Hearing aids and cochlear implants
- FM systems

Accommodations in the school setting
Diagnosis of Usher Syndrome

• Family history
• Congenital bilateral profound hearing loss and bilateral vestibular arreflexia
• ERG
• Clinical presentation
• Genetic testing (looking for one of 11 loci on 9 different genes)
  – Otochip
  – Otoscope
Childhood Hearing Loss: Cochlear implantation

• Indications/guidelines
  – No significant speech benefit from appropriately fit hearing aids
  – 12 months of age
  – Absence of medical contraindications

• Emerging trends in CI
  – Bilateral CI
  – Earlier age
  – Lesser degrees of HL
Hearing loss and US1
Aided hearing and US1

AUDIограмма знакомых звуков

Уровень слышимости (дБ)

FREQUENCY IN CYCLES PER SECOND (HZ)

125 250 500 1000 2000 4000 8000

0 10 20 30 40 50 60 70 80 90 100

NORMAL
MILD
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SEVERE
PROFOUND
Cl and US 1

AUDIODEGRAM OF FAMILIAR SOUNDS

FREQUENCY IN CYCLES PER SECOND (HZ)

125 250 500 1000 2000 4000 8000

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NORMAL
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HEARING LEVEL IN DECIBELS (dB)

0 10 20 30 40 50 60 70 80 90 100 110 120

CI and US 1
Usher Syndrome and hearing loss

• CHILDHOOD HEARING LOSS IN USA
  – 1-3/1000 newborns have severe to profound HL
  – 2-5/1000 newborns have milder degrees of HL
  – over 90% of children with hearing loss have parents with normal hearing.

• USHER SYNDROME ACCOUNTS FOR:
  – about 1:23,000 in USA
  – 3-6% of children with hearing loss in USA
  – 50% of people with deaf-blindness in USA
  – the most common recessively inherited form of syndromic hearing loss.
## Hearing loss and Usher Syndrome

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<tr>
<th>US Type</th>
<th>Hearing</th>
<th>Vision</th>
<th>Balance</th>
<th>Genes</th>
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<tr>
<td>Type II</td>
<td>Congenital Bilateral High frequency</td>
<td>RP Adolescent to adult onset</td>
<td>Normal</td>
<td>USH2A, GPR98, DFNB31</td>
</tr>
<tr>
<td>Type III</td>
<td>Postlingual Bilateral Progressive</td>
<td>RP Late onset</td>
<td>Variable Progressive</td>
<td>CLRN1</td>
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How the ear functions
How the ear functions – microscopically

courtesy of Bechara Kachar, NIDCD, NIH (USA)
How the ear functions – molecularly
Usher Syndrome Type 1

- **USH 1B** MYO7A
- **USH1C** USH1C
- **USH1D** CDH23
- **USH1E** unknown
- **USH1F** PCDH15
- **USH1G** USH1G
- **USH1H** unknown
- **USH1J** CIB2
- **USH1K** unknown
Usher Syndrome and hearing loss

• Genetic therapies for US hearing loss are not yet available.

• Understanding the molecular mechanisms of hearing loss will pave the way for biologic interventions.
Childhood hearing loss: Seattle Children’s Hospital

- Hearing Loss Clinic
  - Audiologists
  - Counselor
  - Developmental pediatrician
  - Education specialist
  - Genetic counselor
  - Nursing
  - Otolaryngologist