Adolescent Hearing Loss: Improving Detection in the Medical Home
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April 29, 2014

Office Visit
- Any problems hearing?
- Did you pass your school hearing screen?

Adolescent Hearing Loss
- 19% of US adolescents have hearing loss (NHANES 2005-2006)
- 18.4% of 12-19 year-olds are obese and obesity is a national epidemic

Adolescent Hearing Loss
- 1 in 6 (16.4%) adolescents has high-frequency hearing loss most likely related to noise
- Low frequency hearing loss = 9%

Main hearing loss categories
- Cochlear (sensorineural) eg: Noise-induced hearing loss
- Conductive eg: Otis media
- Obstructive
- Central (retrocochlear) eg: Acoustic neuroma
- Auditory neuropathy
- Auditory processing disorder

Adolescent Hearing Loss

• Consequences of failure to detect congenital or acquired hearing loss in children
  – Speech-language acquisition
  – Poor academic performance
  – Social adjustment
  – Emotional difficulties

High-frequency Hearing Loss

• High-frequency losses initially not noticed
• Progress to affect speech/communication

Recommendations for Preventive Pediatric Healthcare

• Objective hearing assessment: newborn, 4-6 years, 8 years, 10 years
• Risk assessment followed by appropriate action if positive

PA Laws on Hearing Screening

• 28 PA Code, Chapter 23.5(d)** states "Each year, pupils in kindergarten, special ungraded classes and grades one, two, three, seven and 11 shall be given a hearing screening test."

IPod

CUPERTINO, California—October 23, 2001—Apple® today introduced iPod™, a breakthrough MP3 music player that packs up to 1,000 CD-quality songs into an ultra-portable, 6.5 ounce design that fits in your pocket.

Mosquito ring tones
- http://www.freemosquitoringtones.org/

Adolescent Hearing Screening
- Current protocols
- Improving screening
- Hearing loss prevention

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School-Based Hearing Screening
- School-based hearing screening implemented in 1920s
- Focus on speech-related frequencies

School-Based Hearing Screening
- No national standard
- Variations in protocols
  - Review current standards school-based screening across the United States

School-Based Hearing Screening
- Complete information 51/51(100%)
- Required 34/51(67%)
State Policies on School-Based Hearing Screening

Grade Levels for Required School-Based Hearing Screening

Screening School-Age Children for Hearing Loss
- Pure tone audiometry
- Cooperative child

Frequencies Tested per School Hearing Screen Protocols

School-Based Hearing Screening
- Recommendations to add high-frequency screen >30 years ago
- Majority of states fail to detect high-frequency hearing loss

Adolescent Hearing Loss
- Current protocols
- Improving screening
- Hearing loss prevention
Pennsylvania School Screen
- Mandated by the department of health
- Grades K-3, 7th, 11th grade
- Administered by school nurse

Pennsylvania School Screen
- Tested frequencies – 0.25, 0.5, 1, 2, 4 kHz
- 25 db HL

MAICO MA27 Audiometer

Objective
The study objective was to compare the sensitivity of PA’s school pure tone hearing screen (PA screen), against a pure tone threshold screening test including high-frequency test points (high-frequency screen) for detection of adolescent hearing loss.

Methods
- 11th graders at a single high school
- Utilized their usual process
  - High-frequency screen administered with PA screen
  - Used school audiometers
- Two certified audiologists reviewed results, discrepancies resolved by third

Methods
- Approved by Penn State College of Medicine’s Human Subjects Protection Office for a waiver of informed consent
**Hearing Screening Protocols**

<table>
<thead>
<tr>
<th>Hearing Screen</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA Screen</td>
<td>0.25, 0.5, 1, 2, 4 kHz at 25 dB HL</td>
</tr>
<tr>
<td>High-frequency Screen</td>
<td>0.25, 0.5, 1, 2, 3, 4, 6, 8 kHz; threshold test</td>
</tr>
<tr>
<td>AAP</td>
<td>0.5, 1, 2, 4 kHz at 20 dB HL</td>
</tr>
</tbody>
</table>

**Referral Criteria**

- PA Screen: Inability to hear >two 25 dB HL tones in one or both ears at any frequency
- High-frequency Screen: same + criteria for a noise-induced threshold shift

**Noise-Notch**

**Methods**

- All screening referrals plus a subset of passes invited to return for gold standard testing with audiology in a sound-treated booth
- To calculate sensitivity and specificity:
  - Estimated by standard 2x2 tables
  - 2 screens compared with McNemar’s test for paired responses

**Results**

- 282/290 11th graders participated
- 53% female, 80% self-identified as white, 28% reported URI symptoms. None wore hearing aids
- Demographic factors not significantly associated with hearing screening results
No difference in the rescreen group and those who did not return for testing

<table>
<thead>
<tr>
<th>Demographic</th>
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</tr>
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<tbody>
<tr>
<td>Sex (M/F)</td>
<td>Female (F)</td>
<td>Male (M)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>10 (25)</td>
<td>10 (25)</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td>White (W)</td>
<td>Black (B)</td>
<td></td>
</tr>
<tr>
<td>Age in years</td>
<td>7 (25)</td>
<td>7 (25)</td>
<td></td>
</tr>
<tr>
<td>Age in years</td>
<td>8 (90)</td>
<td>8 (90)</td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity/Specificity of PA School Pure Tone Screen (PA Screen)

<table>
<thead>
<tr>
<th>Pure Tone Sound-treated Booth (gold standard)</th>
<th>Fail</th>
<th>Pass</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA Screen</td>
<td>Fail</td>
<td>Pass</td>
<td>Total</td>
</tr>
<tr>
<td>Fail</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pass</td>
<td>7</td>
<td>38</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>39</td>
<td>47</td>
</tr>
</tbody>
</table>

Sensitivity = 13% (95% CI 0-53%)
Specificity = 97% (95% CI 87-100%)
Sensitivity/Specificity of High-frequency Screen (HF Screen)

<table>
<thead>
<tr>
<th>Pure Tone Sound-treated Booth (gold standard)</th>
<th>Fail</th>
<th>Pass</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF Screen Fail</td>
<td>9</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>HF Screen Pass</td>
<td>0</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>HF Screen Total</td>
<td>9</td>
<td>39</td>
<td>48</td>
</tr>
</tbody>
</table>

Sensitivity = 100% (95% CI 70-100%)
Specificity = 49% (95% CI 34-64%)

9 Participants Diagnosed with Hearing Loss via gold standard
Limitations

• Not all test failures returned
  – Lack of education
  – Parent/participant feeling that this is a low priority
  – Concerns related to diagnosis

• Larger number of false positives

Conclusions

• Currently recommended PA school hearing screen demonstrates low sensitivity (11%) for adolescent hearing loss
  • It is ineffective as a screening tool

Conclusions

• PA Screen is similar to many other state hearing screening protocols and the AAP recommended hearing screen

• Options are to stop screening with an ineffective tool or develop a more sensitive screening protocol

Adolescent Hearing Screening

• Current protocols

• Improving screening

• Hearing loss prevention

Hearing exposures

Digital audio player
  • volume level

Cell phone

Instrument

Concerts

Lawn mower/lawn tractor

Shop equipment

Hunting/gunfire

Motocycle/motorbike/ATV use

• Both volume level and time of exposure

• There is a genetic component
Surveying Parents on Hearing Loss

- Cross-sectional, internet-based survey; nationally representative online sample of 1626 parents
- Adolescents aged 13-17 years

Talking with Teens About Hearing Loss

- 725 qualified for our survey
- 69% had not talked with their teens about NIHL
- Of these 78% did not believe their child was at risk for NIHL

Talking with Teens About Hearing Loss

- When parents talked to their teen re: hearing loss the conversation was prompted by
  - 70% teen playing music too loudly
  - 34% parents’ personal experience
  - 16% parent read/saw info re: hearing loss
  - 4% MD/health professional raised

Talking with Teens About Hearing Loss

- About 1/3 of parents knew about volume-limiting headphones
- Over half of parents would buy such a product for their teens, but only 1/3 of parents think their teen would be willing to use them

Talking with Teens About Hearing Loss

- 57% recognize that both volume of noise and time exposed are associated with hearing loss
- Among common loud noise exposures, only use of headphones or ear buds to listen to music at maximum volume was considered a high-risk activity by a majority (58%) of parents

Talking with Teens About Hearing Loss

- Parents are unable to recognize common causes of adolescent hearing loss
- A minority feel their own teen is at risk
Take Home Points

- Current protocols
  - Not standardized
  - Not adolescent-specific
- Improving screening
  - Add high frequency tones +/- threshold testing
  - Additional false positives, follow-up
  - Temporary threshold shift
- Hearing loss prevention
  - Hazardous noise exposures
  - Parent/teen awareness

What we can do today

- Obvious exposures of concern
  - Mowing lawn with iPod
  - Hunting
  - Concerts
- New studies
  - Infant sound machines

Future Directions

- Change policy on hearing screens
  - Office screens are similar to school screens
- K23 grant to develop prevention programs