Diagnosis and Management of Music-Induced Hearing Disorders

Brian Fligor, ScD
Instructor, Otology and Laryngology, Harvard Medical School
Director of Diagnostic Audiology, Boston Children’s Hospital
brian.fligor@childrens.harvard.edu

Acknowledgements

• Mead Killion, PhD, ScD(hon), Gail Gudmundsen, AuD, Patty Niquette, AuD, Etymotic Research, Inc.
• Michael Santucci, AuD, Sensaphonics
• Elliot Berger, 3M
• Benj Kanters, Columbia College
• Kris Chesky, PhD, University of North Texas
• Cory Portnuff, AuD, PhD, University of Colorado, ENT of Denver
• Frank Wartinger, AuD, All Children’s Health System/Johns Hopkins Medicine
• Sandra Levey, PhD, and Tania Levey, PhD, City Univ New York

FREQUENCY IN HERTZ (Hz)

HEARING LEVEL (HL) IN DECIBELS (dB)

KEY

15 year old male following right cerumenectomy
daily PSS use "all the way up"
Risk for Music Induced Hearing Loss

- Limit listening level to 60% of max
- Limit listening time to 1 hour
- Because in-ear earphones were 7-9 dB higher than over-the-ear at the same gain setting, shorter time or lower level is necessary

David Letterman: Recommendations?

Oregon Museum of Science and Industry (OMSI): Listen Up!

<table>
<thead>
<tr>
<th>Activity</th>
<th>Young Female</th>
<th>Young Male</th>
<th>Adult Female</th>
<th>Adult Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used stereo headphones</td>
<td>33%</td>
<td>34%</td>
<td>56%</td>
<td>59%</td>
</tr>
<tr>
<td>Used a gas-powered lawn mower or leaf blower</td>
<td>34%</td>
<td>56%</td>
<td>33%</td>
<td>73%</td>
</tr>
<tr>
<td>Rode on a jet ski, snowmobile, or motorcycle</td>
<td>32%</td>
<td>37%</td>
<td>19%</td>
<td>41%</td>
</tr>
<tr>
<td>Fired a gun</td>
<td>24%</td>
<td>46%</td>
<td>10%</td>
<td>45%</td>
</tr>
<tr>
<td>Rode on a motorcycle or a dirt bike</td>
<td>35%</td>
<td>46%</td>
<td>71%</td>
<td>73%</td>
</tr>
<tr>
<td>Played in band</td>
<td>22%</td>
<td>32%</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Went to a motorcycle or car race</td>
<td>22%</td>
<td>26%</td>
<td>13%</td>
<td>26%</td>
</tr>
<tr>
<td>Went to a concert</td>
<td>30%</td>
<td>42%</td>
<td>54%</td>
<td>52%</td>
</tr>
<tr>
<td>Went to a tractor pull or monster truck show</td>
<td>15%</td>
<td>24%</td>
<td>10%</td>
<td>16%</td>
</tr>
</tbody>
</table>
Dangerous Decibels, OMSI: Listen Up!

Youth group: 10% had > 30 dB HL at 4k Hz
- 9% of the boys (6,400)
- 10% of the girls (9,700)

Adult group: 12% had > 30 dB HL at 4k Hz
- 16% of the men (8,700)
- 9% of the women (12,000)

http://www.dangerousdecibels.org/research/omsi-research-data/
14-year-old male (seen 1/09)
Did not pass school hearing screen
1 month prior, iPhone user

DPOAEs, 14-year-old iPod users (1 ½ years), notched audiogram

- Reduced or absent DPOAEs at frequencies 4000 Hz and above re: 95% normals (Gorga, et al., 1997)

The “80-90 Rule” for using MP3 players

Teenagers and Earphones

- Portnuff et al (2011):
  - Average listening time: 2 hours
  - Estimated CLL: 74.09 dBA (52.3 - 91.8 dBA, SD 10.8 dBA)

OSHA NIOSH/ACGIH EU

<table>
<thead>
<tr>
<th>Noise Dose Range</th>
<th>Average Noise Dose</th>
<th>Subjects exceeding:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-74.1%</td>
<td>0.9%</td>
<td>50% Noise Dose</td>
</tr>
<tr>
<td>0-241.0%</td>
<td>20.9%</td>
<td>1 (1.4%)</td>
</tr>
<tr>
<td>0-765%</td>
<td>66.4%</td>
<td>100% Noise Dose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 (0%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (6.9%)</td>
</tr>
</tbody>
</table>

Urban College Students (CUNY): PLD use

- Levey, Levey & Fligor (2011)

| Box-and-whisker plots showing equivalent continuous 8-hr and 40-hr levels (Leq) for median, interquartile range, and maximum and minimum
| Mean LA8hn = 87.2 dBA |
| Range 80 – 115 dBA |
| Mean LA8w = 87.4 dBA |
| Range 78 – 116.4 dBA |
Sound Exposures: Bamboozle Road Show, June 2010

<table>
<thead>
<tr>
<th>Leq* (dBA)</th>
<th>105</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (hrs)</td>
<td>4</td>
</tr>
<tr>
<td>Noise dose**</td>
<td>5000%</td>
</tr>
</tbody>
</table>

Table 1. Total audience exposure

<table>
<thead>
<tr>
<th>Leq* (dBA)</th>
<th>99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (hrs)</td>
<td>7</td>
</tr>
<tr>
<td>Noise dose**</td>
<td>2198%</td>
</tr>
</tbody>
</table>

Table 2. Total crew exposure (4 hours show + sound check and setup)
* Leq is the typical 5-minute equivalent continuous sound level in A-weighted decibels
** DRC for determining “Noise dose” = 85 dBA for 8-hr Leq, 3dB exchange rate

Audiology Today May/June 2011: pp 30-40

Musicians’ Hearing Program

Elements of a Hearing Loss Prevention Program (HLPP)
- Noise Survey (assessment)
- Engineering Controls
- Audiometric Monitoring
- Education and Motivation
- Hearing Protection Devices

Music-Induced Hearing Disorders

Typical Music-Induced Hearing Disorders
- Noise-Induced Permanent Threshold Shift (NIPTS)
- Tinnitus
- Hyperacusis
- Diplacusis
- Noise-Induced Temporary Threshold Shift (NITTS)
MHP’s Elements of HLPP

- Audiometric Monitoring
  - Comprehensive audiometry (air, bone, speech)
  - Impedance, +/- MEMR
  - DPOAEs, 1500-10k Hz, 4 freq’s per octave
    At least annually
- Additions to evaluation for tinnitus complaint:
  - Tinnitus Reaction Questionnaire (Wilson et al, 1991):
    > 17 = “clinically significant”
    At intake and end point of therapy
  - Minimum masking level, +/- loudness and pitch matching
  - Informational Counseling

MHP’s Patient Goals

Considering the patient’s chief complaint, what is the extent of the disorder now?

What can we reasonably do to mitigate future risk without disrupting participation in musical activities?

Can current suffering be mitigated with devices and single session of counseling, or require multiple sessions focused on tinnitus/hyperacusis?

<table>
<thead>
<tr>
<th>FREQUENCY IN HERTZ (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>125        250        500        1000        2000        4000        8000</td>
</tr>
<tr>
<td>0  10  20  30  40  50  60  70  80  90  100  110</td>
</tr>
</tbody>
</table>

39 year old male
Singer/guitarist, 20 years
Tinnitus sufferer, consistent use of custom HPD
Normal tympanograms AU
WRS = 100% AU
DPOAEs, 39 year old singer/guitarist (20 years experience), essentially normal audiogram
Tinnitus sufferer

- Absent DPOAEs at F2 = 6000 – 10,031 Hz Bilaterally
- Reduced DPOAEs at other discrete frequencies re: 95% normals (Gorga, et al., 1997)

HPD: “Flat Frequency Attenuators”
HPD: “Flat Frequency Attenuators”

“They told me these were flat, but I don’t think they are.”
**“Real Ear” Probe Microphone sound level measures**

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**Principle Complaint Against HPD**

“Muffling” / “Distortion”
- Change of timbre of music (change of harmonics relative to the fundamental frequency)
- Loss of natural ear canal resonance

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**Do these look (or sound) flat?**
Refitted with ER-15

HPD: “Flat Frequency Attenuators”

“I can tell this is how they were supposed to sound!”

Verification of Flat Attenuation
Verification of Flat Attenuation


M. Killion, 6/22/12: used with permission

Hypothetical Protected Sound Exposures: Bamboozle Road Show 2010

<table>
<thead>
<tr>
<th>Leq (dBA)</th>
<th>Time (hrs)</th>
<th>Noise dose*</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
<td>4</td>
<td>5000%</td>
</tr>
<tr>
<td>w/ ER9 (-9dB)</td>
<td>629%</td>
<td></td>
</tr>
<tr>
<td>w/ ER15 (-15dB)</td>
<td>158%</td>
<td></td>
</tr>
<tr>
<td>w/ ER25 (-25dB)</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>w/ foam (-20dB)</td>
<td>50%</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Total audience exposure with hypothetical reduction in exposure from use of different HPD

<table>
<thead>
<tr>
<th>Leq (dBA)</th>
<th>Time (hrs)</th>
<th>Noise dose*</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
<td>7</td>
<td>2198%</td>
</tr>
<tr>
<td>w/ ER9 (-9dB)</td>
<td>277%</td>
<td></td>
</tr>
<tr>
<td>w/ ER15 (-15dB)</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>w/ ER25 (-25dB)</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>w/ foam (-20dB)</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Total crew exposure with hypothetical reduction in exposure from use of different HPD

Audiology Today MayJune 2011: pp 30-40
Conclusions

- This is not always "recreational" but it is most often "unregulated"
- Exposures are significant for risk for MIHD
- We have excellent tools for assessing MIHD, and early risk for MIHD
- Devices help us fulfill the promise of HLPP and management when MIHD hasn’t been prevented… but devices are not THE fix:
  We are.