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World Health Organization "Make Listening Safe" Initiative

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Learning Objectives

After this course learners will be able to:

- Describe the number of people in the world at risk for recreational noise-induced hearing loss.
- Describe 3 different levels of noise exposure associated with zero risk, slight risk, or modest risk for noise-induced hearing loss.
- Summarize how headphone manufacturers can conduct real-time dosimetry as feedback to users regarding their risk, relative to the 3 different levels of risk.

Headphones and Hearing Loss

http://www.nbcnews.com/nightly-news/video/study-headphones-designed-for-children-may-not-be-safe-for-their-ears-851963971906

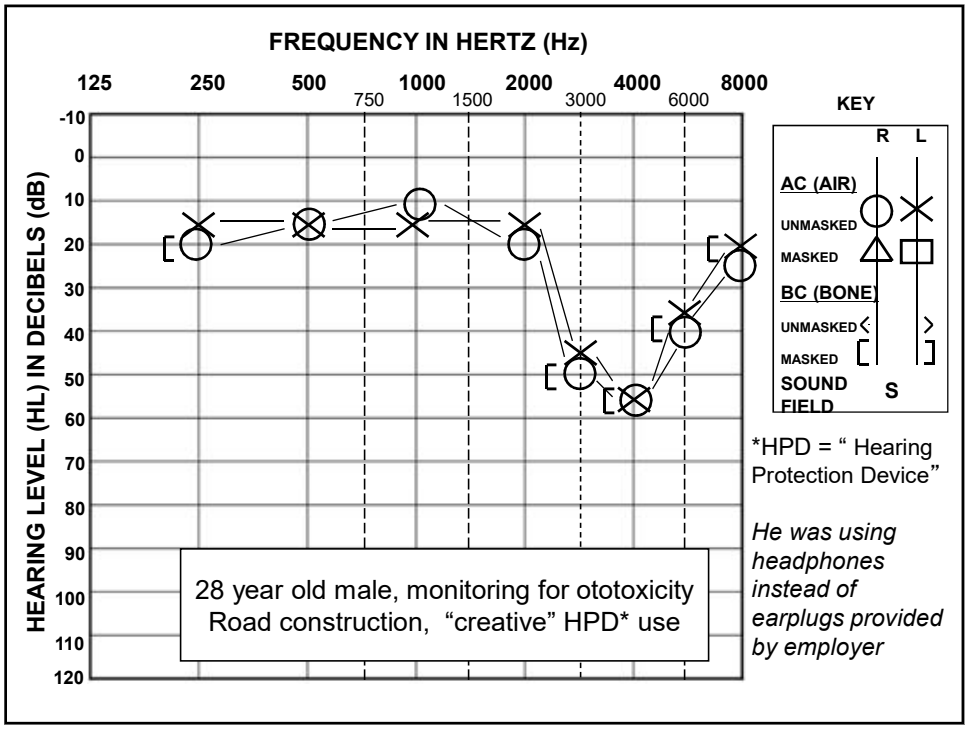
http://thewirecutter.com/reviews/best-kids-headphones/

Global Concern for Noise-Induced Hearing Loss

"WHO estimates that 1.1 billion young people worldwide could be at risk of hearing loss due to unsafe listening practices. Nearly half of all teenagers and young adults (12 - 35 years old) in middle- and high-income countries are exposed to unsafe levels of sound from the use of personal audio devices and some 40% of them are exposed to potentially damaging sound levels at clubs, discotheques and bars."

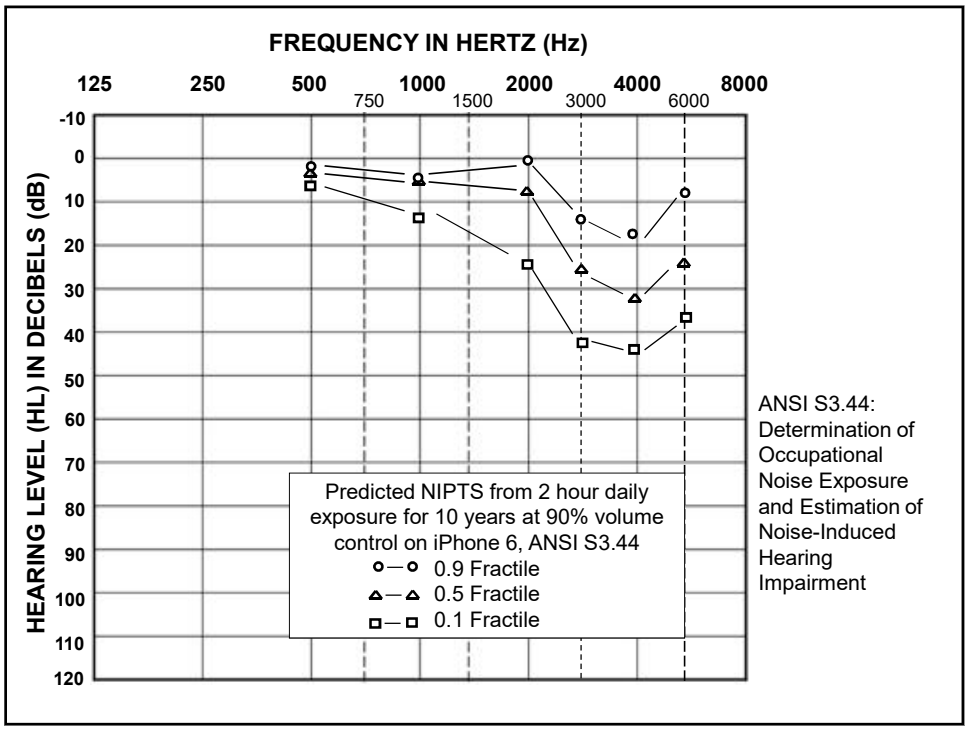
- World Health Organization (WHO) "Hearing loss due to recreational exposures to loud sounds: a review" 2015 (http://www.who.int)

- Majority of Flemish high school students use PLD daily, 35% set the volume control to 80% or higher (Gilles et al, 2013)
- 75% of Flemish high school students have temporary tinnitus, 18% constant tinnitus; 5% use Hearing Protection Devices (Gilles et al, 2013)



*HPD = " Hearing Protection Device"

He was using headphones instead of earplugs provided by employer



ANSI S3.44: Determination of Occupational Noise Exposure and Estimation of Noise-Induced Hearing Impairment

Make Listening Safe™ Initiative

World Health Organization and
International Telecommunications Union

What "Technical" Solutions Exist?

1. Has it been established that PLD poses a global risk for NIHL?
2. How to mitigate (lessen) this risk, if we were to accept #1?
3. Responsibilities of:
   - Consumers
   - Manufacturers
   - Policy-makers
   - Public Health and Medical community
4. How commercially viable and technically feasible are these technical solutions?

WHO-ITU Risk Assessment and Definitions Subgroup

- Experts in academia, industry, public health:
  Ian Wiggins, Jeremie Voix, Warwick Williams, Peter Thorne, Richard Neitzel, Christian Giguère, Christian Huggonet, Chuck Kardous, Michael Santucci, and Brian Fligor
- Guidance and participation from Shelly Chadha for WHO

Purpose of Subgroup on Standards for PAS

- Provide guidance to PAS manufacturers, end users, and public health professionals how to provide and use tools to make PAS use safer
- Guidance in the form of written reports, reviews, and critiques from the scientific literature
  - Gap analysis
  - Current scientific consensus
  - Acknowledgement of limitations of current knowledge

Gap Analysis, and Framing of the Questions

http://www.who.int/pbd/deafness/Monograph_on_determination_of_risk_of_HL_due_to_exposure_to_recreational_sounds.pdf?ua=1

Lead and completed by Rick Neitzel (2017)

Dosimetry for Standards for PAS

WHO Gap Analysis, question framed:

"What is the most appropriate exposure limit according to present understanding and knowledge? In other words, are the typical current occupational exposure limits of 85 dBA for 8 hours with a 3 dB time-intensity exchange rate the most suitable limits?" (Neitzel and Fligor, 2017)

"If I can't listen all the way up, how loud can I listen?"

Key Considerations for Standards for PAS

- The use of PAS poses some risk for non-occupational noise-induced hearing loss (NIHL): this is despite efforts for level-limiting earphones, Android device warnings, and EU standards for maximum PAS output
- There is **benefit** to using PAS, and there is a dose-effect relationship between level and benefit
  - Rubinelli et al (Listening Habits review): excitement, relaxation, concentration, define personal space ("urban sherpa"), combat boredom
- Ambient noise in listening environment further influences chosen/preferred listening level

Key Considerations for Standards for PAS

- Seminal studies of dose-effect relationship in occupational NIHL provide baseline guidance ("Damage Risk Criteria")
  - Limitations of generalizing occupational noise exposure to non-occupational noise exposure
  - Durations of exposure (40-year working lifetime vs. lifespan)
  - Threshold for "acceptable" risk
- No clear dose-effect relationship between noise exposure and onset of bothersome tinnitus (or other auditory injury; e.g., hyperacusis, diplacusis)

Key Considerations for Standards for PAS

Framework of solutions:

- Dosimetry, rather than level-limiting, is thoroughly supported in the scientific literature as the appropriate metric for dose-monitoring/NIHL risk
  - Level limits against acute acoustic trauma
- Current PAS technology has the capacity to provide dosimetry metrics, with some definable error
- Best-practices in health communication can draw from multiple fields to craft the information provided to end users
  - Product packaging, IFU, User Interface, Parental Controls

Three Levels of "Acceptable Risk"

TABLE 3. Exposure limits, and predicted NIPTS at the most noise-susceptible frequencies (3, 4, 6 kHz) in the 10% and 5% most susceptible population

	10 years of exposure		40 years of exposure	
Exposure limit (8 hour L_{EQ})	10^{th} Percentile, predicted threshold shift at 3, 4, 6 kHz (dBHL) (ANSI S3.44)	5^{th} Percentile, predicted threshold shift at 3, 4, 6 kHz (dBHL) (ANSI S3.44)	10^{th} Percentile, predicted threshold shift at 3, 4, 6 kHz (dBHL) (ANSI S3.44)	5^{th} Percentile, predicted threshold shift at 3, 4, 6 kHz (dBHL) (ANSI S3.44)
75	0	0	0	0
76.4	0	0	0	0.1
80	0.8	0.9	1.0	1.2
83	2.4	2.7	3.3	3.7
85	4.1	4.6	5.5	6.2

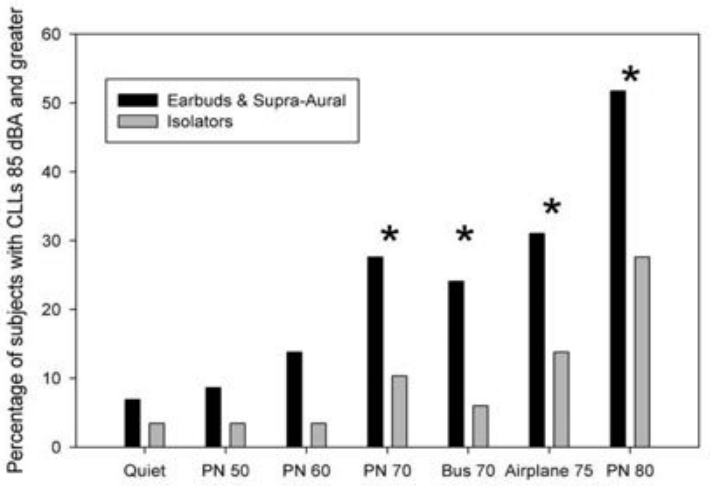
- 83 dBA 8-hr L_{EQ} (78 dBA 24-hr L_{EQ}; 92 dBA 1-hr)= Willing to tolerate modest risk
- 80 dBA 8-hr L_{EQ} (75 dBA 24-hr L_{EQ} ; 89 dBA 1-hr L_{EQ}) = Optimal trade-off between risk and benefit
- 75 dBA 8-hr L_{EQ} (70 dBA 24-hr L_{EQ}; 84 dBA 1-hr L_{EQ})= lowest risk profile (no risk?)

Three Levels of "Acceptable Risk"

- 83 dBA 8-hr L_{EQ} (78 dBA 24-hr L_{EQ}; 92 dBA 1-hr)= Willing to tolerate modest risk
- 80 dBA 8-hr L_{EQ} (75 dBA 24-hr L_{EQ} ; 89 dBA 1-hr L_{EQ}) = Optimal trade-off between risk and benefit
- 75 dBA 8-hr L_{EQ} (70 dBA 24-hr L_{EQ}; 84 dBA 1-hr L_{EQ})= lowest risk profile (no risk?)

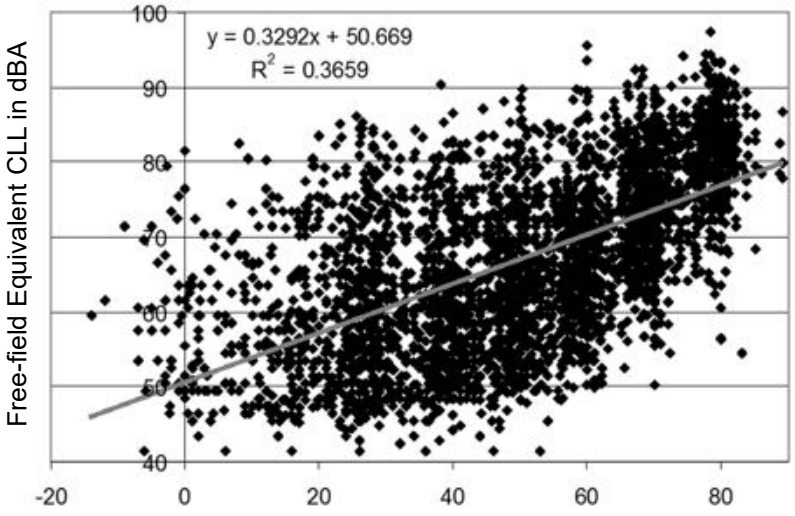
" Examples of individuals who may wish to eliminate any risk for music-induced hearing loss and adopt the most protective 75 dBA 8-hr L_{EX} are:
(1)Young children or those not expected to have the autonomy to make informed personal health decisions;
(2)Persons with pre-existing hearing loss (NIHL or from another cause) or pre-existing tinnitus;
(3)Persons who have a family history of NIHL, or in whom there is reason to believe increased susceptibility to NIHL or noise-induced tinnitus (e.g., persons treated with ototoxic medications; persons exposed to chemicals that might potentiate the deleterious effects of noise)."

Headphone type and Chosen Listening Level



Portnuff, Fligor & Arehart (2011)

Influence of Ambient Noise on Listening Level



Estimated Ambient Noise Level in the Ear Canal in dBA

Fligor and Ives: NIHL Prevention in Children, Oct 2006, Cincinnati, OH, USA

Acceptable HLPP strategy with PLD?
Passive sound isolation: custom vs. non-custom

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Acceptable HLPP strategy with PLD?
Active Noise Reduction and/or Passive Isolation

Influence of ambient noise on chosen listening level

Earphones providing no sound isolation vs. earphones that provide active noise reduction to block ambient noise

No Sound Isolation	Sound isolating/ambient noise excluding earphones
CLL 72dBA	CLL 72dBA, café
CLL 72dBA, café (74 dBA)	CLL 72dBA, airplane
CLL 72dBA, airplane (82 dBA)	CLL 72dBA, lawnmower
CLL 72dBA, lawnmower (90 dBA)	
CLL 87 dBA, café (+13dB SNR)	
CLL 92 dBA, airplane (+10dB SNR)	One can extrapolate the risk for hearing loss
CLL 97 dBA, lawnmower (+7dB SNR)	

Next Steps, Standards for PAS

- Agree upon framework for standards
  - Dosimetry (with upper threshold for level-limit)
  - Health communication driven interface with end user
  - Ability to integrate data to learn from and improve standards, screening protocols, user behaviour
  - Messaging from public health respects user autonomy while holding to accurate information
  - Manufacturers given freedom to innovate within the standards' framework
- Update the standards, as a living document, as new knowledge becomes available

Solutions, and Challenges

Sound is the ***intent***, not an unwanted byproduct

- Level-limiting (engineering control)
  - Effectiveness? Commercial viability?
- Dosimetry, level indicators (engineering/administrative controls)
  - Product liability challenges? Induce ***riskier*** behaviors?
- Ambient sound exclusion (engineering control, HPD)
  - Cost, comfort, loss of situational awareness
- Annual hearing test, or as needed (audiometric monitoring)
  - No mandate, insidious onset, access to specialist, after-the-fact
- Peer-to-Peer Outreach, Public Service Announcements, Music streaming services (education and motivation)
  - Health communication best-practices, "Finger-wagging" is worse than useless

Summary: "Technical" Solutions

- In quiet, the majority of people don't listen too loud for too long to cause NIHL
- But, we often listen to our music in noisy situations (exercising, commuting, traveling, working, etc.)
- Ambient noise significantly influences listening behavior
- Ambient sound blocking allows listening at lower levels

Summary: "Technical" Solutions

- In-line dosimetry or in-line level monitoring could provide input to education and motivation, as well as engineering and administrative controls
- Public Service Announcements and Peer-to-Peer efforts following Health Communication fundamentals could influence listening behavior
- Concerted efforts by all stakeholders could reduce the likelihood of unnecessary NIHL and other associated noise-induced injuries

Summary: "Technical" Solutions

- Apps for crowdsourcing ambient sound levels "iHearU"
  - Kelly Tremblay and colleagues http://journals.lww.com/thehearingjournal/Fulltext/2017/07000/Hearing_in_a_Noisy_World___Problems_and_Solutions.3.aspx
- App for remote access to periodic hearing testing is a possibility
  - De Wet Swanepoel and colleagues "hearX" https://hearxgroup.com/about/

Teach them early, they will listen…
Thank you!

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