Office Hours with Doc Otoblock

An open Q&A with Brad Ingrao, AuD

HLAA Webinar
February 20, 2019
What is a hearing aid?

• “A hearing aid is an ultra-miniature electro-acoustical device that is always too large.
• It must amplify sound a million times, but bring in no noise.
• It must operate, without failure, in a sea of perspiration, a cloud of talcum powder, or both.
• It is a product that one puts off buying for ten years after he needs it, but cannot do without it for thirty minutes when it has to be serviced.”
Crandell 1998

Hearing Aids and Functional Health Status
Audiology Today 10(4), 20-23.

- Affect of hearing loss (pre and post fitting) on health using the following scales:
  - Sickness Impact Profile (SIP)
    - Physical Scale
    - Psychosocial Scale
  - Short Form 36 Health Survey (SF-36)
Crandell 1998

- SIP Physical
- SIP Psychosocial
- SIP Total
Conclusions

• Hearing loss is very prevalent in the senior citizen cohort
• Untreated hearing loss negatively affects HRQoL
  • Chronic health concerns,
  • Increased managed care load
• Early evaluation and Treatment of HL has a net positive impact on HRQoL
• BUT.... How do patients feel about hearing aids?
MarkeTRAK

- Consumer survey of hearing aid use and non-use
- Develop by Sergei Kochkin at Knowles Electronics in 1990
- Continued at Better Hearing Institute
- Most recent survey (IX) completed in 2015
- Tracks trends in who does and does not buy hearing aids and why

http://www.hearingreview.com/2015/05/introduction-marketrak-ix-new-baseline-hearing-aid-market/
MarkeTRAK IX

• Owners/users
• N=765’
• HAs < 5 years old
MarkeTRAK IX – Who buys hearing aids?

Hearing Difficulty and HA Ownership by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Hearing Difficulty</th>
<th>HA Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 18</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>18-24</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>25-34</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>35-44</td>
<td>1%</td>
<td>7%</td>
</tr>
<tr>
<td>45-54</td>
<td>2%</td>
<td>11%</td>
</tr>
<tr>
<td>55-64</td>
<td>3%</td>
<td>17%</td>
</tr>
<tr>
<td>65-74</td>
<td>9%</td>
<td>22%</td>
</tr>
<tr>
<td>75-84</td>
<td>22%</td>
<td>34%</td>
</tr>
<tr>
<td>85+</td>
<td>62%</td>
<td>26%</td>
</tr>
</tbody>
</table>

http://www.hearingreview.com/2015/05/introduction-marketrak-ix-new-baseline-hearing-aid-market/
David Pascoe

• “Although it is true that mere detection of a sound does not ensure its recognition, it is even more true, that without detection the probabilities of correct identification are greatly diminished.”

• BUT…. What sounds are most important?

https://hearinghealthmatters.org/waynesworld/2015/hearing-quotes-and-sayings/
Where's the Speech? – Killion and Mueller 2010

Hearing Aid Fitting Process

Audio Eval → HA Consult → Wants HA?

- NO → Educate, Offer follow-up
- YES → HA Selection → HA Order

HA Check-in → HA Fitting → HA Follow-Up
Hearing Aid Candidacy

• “Hearing aids are not fitted based on the degree of hearing loss necessarily, but on the degree of hurt – and only when that hurt is great enough, whether socially, economically, emotionally, or psychologically, does this individual become a candidate for hearing aids.”

Dynamic Range

• Useable range of hearing
• Threshold through discomfort
Loudness Perception Correction (Compression)

Perceived Loudness

Very Soft (Threshold)

Soft

Medium (MCL)

Loud

Very Loud (UCL)

Sound Pressure Level (dB SPL)

0 20 40 60 80 100 120

Normal Speech Range

SNHL Speech Range

https://www.phon.ucl.ac.uk/courses/spsci/AUDL4007/HI%202014.pdf
Phonemic Regression

• Loss of frequency specificity
• OHC loss widens neural tuning
• IHC loss creates distortion
• Patient reports “I hear, but I don’t understand”
• More on this and tools to address it later...
Quick SIN (Speech in Noise)

- Killion et al 2004
- Target sentences with multi-talker noise
  - Pre-mixed signal-to-noise ratios (SNR)
- Stimuli:
  - Standard lists (flat response)
  - High Frequency Emphasis
  - High Frequency Emphasis Low Pass
Quick SIN (Speech in Noise)

• Scoring:
  • 1 point for each key word correct
  • $25.5 - \text{total correct} = \text{SNR Loss}$
  • SNR loss drives recommendation

<table>
<thead>
<tr>
<th>SNR Loss</th>
<th>Degree of Loss</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3 dB</td>
<td>Normal/Near normal</td>
<td>May hear better than normals hear in noise.</td>
</tr>
<tr>
<td>3-7 dB</td>
<td>Mild SNR loss</td>
<td>May hear almost as well as normals hear in noise.</td>
</tr>
<tr>
<td>7-15 dB</td>
<td>Moderate SNR loss</td>
<td>Directional microphones help. Consider array microphone.</td>
</tr>
<tr>
<td>&gt; 15 dB</td>
<td>Severe SNR loss</td>
<td>Maximum SNR improvement is needed. Consider FM system</td>
</tr>
</tbody>
</table>
Quick SIN - Hands-On Exercise

• Pair up
• Score Quick SIN on your partner
• Instructor will play recordings

<table>
<thead>
<tr>
<th>Group</th>
<th>HFE-LP</th>
<th>HFE</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>🎧</td>
<td>🎧</td>
<td>🎧</td>
</tr>
<tr>
<td>2</td>
<td>🎧</td>
<td>🎧</td>
<td>🎧</td>
</tr>
</tbody>
</table>
Self-Report Questionnaires

• Patient’s “real-world” report of their hearing loss

• Closed Set
  • APHAB

• Open Set
  • COSI

• There are several other questionnaires that will be covered in AMP 2 and Adult AR
Abbreviated Profile of Hearing Aid Benefit (APHAB)

- Cox and Alexander, 1995
- Use cases:
  - Aided/Unaided
  - Hearing Aid 1/Hearing Aid 2
    - Can compare interventions as well
- Norms
  - Young
  - Elderly
  - Linear
  - WDRC
APHAB Noah Questionnaire Module - Results

**Patient Scores (UNAIDED) - Elderly**

Compared to unaided elderly listeners with few or no hearing problems:

<table>
<thead>
<tr>
<th>Subscale</th>
<th>% Reporting Fewer Problems</th>
<th>% Reporting More Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>85.5</td>
<td>14.5</td>
</tr>
<tr>
<td>RV</td>
<td>94.1</td>
<td>5.9</td>
</tr>
<tr>
<td>BN</td>
<td>&gt; 95</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>AV</td>
<td>83.7</td>
<td>16.3</td>
</tr>
</tbody>
</table>

**Patient Scores (AIDED) - Elderly**

Compared to unaided elderly listeners with few or no hearing problems:

**Subscale Scores**

<table>
<thead>
<tr>
<th>Subscale</th>
<th>% Reporting Fewer Problems</th>
<th>% Reporting More Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>&lt; 5</td>
<td>&gt; 95</td>
</tr>
<tr>
<td>RV</td>
<td>&lt; 5</td>
<td>&gt; 95</td>
</tr>
<tr>
<td>BN</td>
<td>&lt; 5</td>
<td>&gt; 95</td>
</tr>
<tr>
<td>AV</td>
<td>&lt; 5</td>
<td>&gt; 95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># of Items</th>
<th>GBL</th>
<th>EC</th>
<th>RV</th>
<th>BN</th>
<th>AV</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>48.5</td>
<td>24.8</td>
<td>47.8</td>
<td>72.8</td>
<td>45.8</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
APPHAB in Clinical Practice (Ingrao- Data collected at Long Beach VA 2018)

Average APHAB Outcomes (n=29)
COSI – Noah Questionnaire Module

**Specific Needs:**
- I want to hear the TV better (turn the volume down).
- I want to understand my family better at dinner.
- I can't understand at restaurants.
- I want music to sound clear again.

**Priority:**
- I want to hear the TV better (turn the volume down).
  - Priority: 3
- I want to understand my family better at dinner.
  - Priority: 1
- I can't understand at restaurants.
  - Priority: 2
- I want music to sound clear again.
  - Priority: 4

**Degree of change:**
- Because of the new hearing instrument, I now hear...

<table>
<thead>
<tr>
<th>Final Ability</th>
<th>10% (Hardly ever)</th>
<th>25% (Occasionally)</th>
<th>50% (Half the time)</th>
<th>75% (Most of the time)</th>
<th>95% (Almost Always)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can hear satisfactorily...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
Patient reports improved hearing in quiet, but still struggles somewhat in background noise.
IOI-HA

• Developed at HARL as a quick method to evaluate needs and outcome
• Intended to be used in conjunction with other questionnaires such as the APHAB
• Integrated into Noah (v 4.8 and higher)
• Integrated into VA’s ROES system
INTERNATIONAL OUTCOME INVENTORY - HEARING AIDS (IOI-HA)

Date of HA fitting: December 19, 2018

1. Think about how much you used your present hearing aid(s) over the past two weeks. On an average day, how many hours did you use the hearing aid(s)?
   - none
   - less than 1 hour a day
   - 1 to 4 hours a day
   - 4 to 8 hours a day
   - more than 8 hours a day

2. Think about the situation where you most wanted to hear better, before you got your present hearing aid(s). Over the past two weeks, how much has the hearing aid helped in that situation?
   - helped not at all
   - helped slightly
   - helped moderately
   - helped quite a lot
   - helped very much

3. Think again about the situation where you most wanted to hear better. When you use your present hearing aid(s), how much difficulty do you STILL have in that situation?
   - very much difficulty
   - quite a lot of difficulty
   - moderate difficulty
   - slight difficulty
   - no difficulty

4. Considering everything, do you think your present hearing aid(s) is worth the trouble?
   - not at all worth it
   - slightly worth it
   - moderately worth it
   - quite a lot worth it
   - very much worth it

5. Over the past two weeks, with your present hearing aid(s), how much have your hearing difficulties affected the things you can do?
   - affected very much
   - affected quite a lot
   - affected moderately
   - affected slightly
   - affected not at all

6. Over the past two weeks, with your present hearing aid(s), how much do you think other people were bothered by your hearing difficulties?

Score: [ ] [ ]

Date of outcome measure: [ ] [ ]
Scores of the middle 50% of individuals in the normative group are represented by the shaded region. Scores plotted above the shaded region represent a superior outcome. Scores plotted below represent a poorer outcome.


Journal of the American Academy of Audiology. 14(8), 403-13
Satisfaction with Amplification in Daily Life (SADL)

• Evaluates the satisfaction that people feel with their current hearing aids.

• Quantifies the following scores:
  • Global
  • Positive Effect,
  • Service and Cost
  • Negative Features
  • Personal Image.

• Use cases:
  • Satisfaction with a new or current hearing aids
  • Differences between previous and new hearing aids.

Hearing Aid Basic Electronics

• Transducers: Energy Converters
  • Microphone: Acoustic to Electric
  • T-Coil: Magnetic to Electric
  • Receiver: Electric to Acoustic

• Amplifiers increase the signal’s intensity
  • Filters modify the amount of signal in specific ranges
  • Current hearing aids use compression to correct for recruitment

• Potentiometers modify the signal intensity after it leaves the amplifier (i.e. Volume Control).
Measuring Amplification

• Input
  • Sound pressure level entering the hearing aid

• Output
  • Sound pressure level exiting the hearing aid

• Gain
  • Output – Input

• We will look at tools and procedures for measuring these later
Hearing Aid Schematic

Battery (1.4v)

Front Mic

Rear Mic

Telecoil

Wireless Antenna

Power Switch (Battery Door)

Pre-Amp

Input Limiter

Analog to Digital Converter (A/D)

Digital Signal Processor (DSP)
Multi-Channel WDRC
Multiple Input Level Knee Points

MPO MPO MPO

G80 G80 G80

G60 G60 G60

G40 G40 G40

<1kHz 1k – 2.5Hz > 2.5Hz

Speaker

Volume Control

Digital to Analog Converter (D/A)
BTE Hearing Aids

• All components inside housing
• Typically fit on children and severe + losses
• Coupling to ear via tube and earmold (more on them later)
• Durable
• Connectivity
  • Telecoil
  • Wireless
  • Direct Audio Input
RIC Hearing Aids

• Majority of components inside housing
• Speaker (Receiver) in the ear connected by a wire
  • This component can be replaced in the office
• Mild to severe losses
• Coupling to ear via dome or earmold (more on them later)
• Connectivity
  • Telecoil
  • Wireless
  • Direct Audio Input
Receiver In the Canal (RIC)

- Microphones
- Multi-Function Switch
- RIC Wire
- RIC (Speaker)
- Dome
- Battery Door

Source: Oticon
Slim Tube/RITA Hearing Aids

- All components inside housing (essentially a BTE)
- Mild to severe losses
- Thin tube (~2mm) sized to patient’s ear coupled to ear via dome or earmold (more on them later)
- Connectivity
  - Telecoil
  - Wireless
  - Direct Audio Input
Behind The Ear Styles

Power BTE

Mini BTE/Thin Tube/RITA

RIC/RITE

Source: Phonak
In The Ear (ITE)

- Microphones
- Battery Door
- Program Switch
- Volume Control
- Vent

Source: Phonak
In The Ear (Custom) Styles

- Full Shell
- Half Shell
- ITC
- CIC
- IIC

Source: Oticon
In The Ear (Custom) Styles

- Full Shell
- Half Shell
- ITC
- CIC/IIC

Source: Phonak
Zinc Air Hearing Aid Batteries

- **675** – Power BTE, Cochlear Implants
- **13** – RIC, RITA and Full Shell ITE (Orange)
- **312** – Mini RIC, RITA, Half Shell ITE (Brown)
- **10A** – ITC, CIC, IIC (Yellow)
- **5A** – IIC (Red)
Rechargeable Hearing Aid Batteries

Nickle Metal Hydride (NiMH)
Life Span: ~ 1year
Can use Zinc Air?: Usually
Current Models: Signia (Siemens) Primax

Source: Signia.com
Rechargeable Hearing Aid Batteries

Lithium-ion (LiON)
Life Span: ~ 3 years
Can use Zinc Air? Usually not

Current Hearing Aid Models:
Phonak: B-R, Marvel (in release cycle now)
Signia: Cellion and Charge n Go
Starkey: Muse iQR
ReSound Linx Quattro

Current Cochlear Implant Models:
Advanced Bionics: Naida Q70ci and Naida Q90ci
Cochlear: Nucleus 7
MedEl: Sonnet, Rondo2
Rechargeable Hearing Aid Batteries

**Silver-zinc** (AgZn)
- Life Span: ~ 1 year
- Can use Zinc Air? Usually
- Brand: Z-Power
  - ReSound Linx 3D-61 (312 battery)
  - Oticon OPN
  - Starkey Muse Micro 312 R
  - Widex Unique
  - Unitron Moxi All and Stride R
Hearing Aid Features

• Noise Reduction
• Directional Microphones
• Signal Classification (Scene analysis)
• Wireless Connectivity
• Special amplifier features
Digital Noise Reduction

• Steady-State Noise
  • Machine noise
  • Wind Noise
• High intensity impulse sounds
• Reverberation
• Modulated noise between speech peaks
Reverberation Reduction

- Attempts to identify specific acoustic signatures
- Anecdotal reports of listening preference, but little data on improved word recognition
- EEG studies show some reduction in listening effort with reverberation reduction
  - Froehlich et al 2017
  - Littmann et al 2017
Directional Microphones

• Attempt to reduce something signals by steering microphone sensitivity toward desired signal (usually speech)
• Sensitivity graphed on Polar Plots
• May be fixed or adaptive
• Modern hearing aids offer several polar plot options
Examples of Fixed Polar Plots

- **Cardioid**
- **Hypercardioid**
- **Bi-directional**
Examples of Adaptive Polar Plots
Signal Classification (Scene analysis)

• Attempts to identify the key acoustic content arriving at the hearing aid microphones

• Typical “scenes” include:
  • Quiet
  • Speech
  • Noise
  • Speech in Noise
  • Music

• https://www.youtube.com/watch?v=6tDNtANdTrE
Earmolds

• Provide coupling from hearing aid to ear canal
• Used with BTEs, RICs and RITAs
• Can also be used for non-amplification use cases
  • In the ear monitors
  • Hearing protection
  • Custom molds for audio players
  • Communication systems
  • Medical monitoring
Anatomy of a Hearing Aid Earmold

Tube

Bore

Canal

Vent
Earmold Styles

• Basic styles are somewhat standard
• Manufacturers may use different names
  • Order forms generally have drawings
• Style selection depends on several factors
  • Anatomy of ear
  • Hearing loss severity
  • Patient dexterity
  • Patient age
  • Audiologist preference
Shell

• Most problem free style
• Appropriate for all losses
• Most labs will guarantee against feedback
• Excellent retention and concealment
• Available in all materials
Half Shell

- Easier insertion due to removed helix
- Appropriate for up to severe losses
- Excellent retention and concealment
- Available in all materials
Skeleton or Silhouette

- Designed to fit the contour of the concha
- Appropriate for up to moderate losses
- Excellent retention and concealment
- Available in all materials
Semi Skeleton

- Designed to fit the contour of the concha
- Appropriate for up to moderate losses
- Excellent retention and concealment
- Available in all materials
Canal Lock

• Designed for maximum concealment
• Appropriate for up to moderate losses
• Good retention with porous materials
• Longer canal is advised to reduce feedback
Canal Only

- Designed for maximum concealment
- Appropriate for up to moderate losses
- Good retention with porous materials
- Longer canal is advised to reduce feedback
Material Selection

• Recent studies indicate that the earmold material per se will not reduce feedback (C. Perzanski)
• Traditionally, softer materials have been used for children
• Individual preferences, for both patients and audiologists will often drive typical material selection.
# Earmold Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Texture</th>
<th>Applications and Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucite</td>
<td>Hard</td>
<td>Poor Dexterity, Collapsing Canals, CROS Transmitters</td>
</tr>
<tr>
<td>Flexible Plastic</td>
<td>Softens in Canal</td>
<td>Balance of ease of insertion and comfort</td>
</tr>
<tr>
<td>Vinyl</td>
<td>Soft</td>
<td>All Losses. TMJ Mold ejection</td>
</tr>
<tr>
<td>Silicone</td>
<td>Soft</td>
<td>All Losses, Requires special tools and techniques to grind &amp; buff</td>
</tr>
</tbody>
</table>
Comfort and Fit

• Earmolds should be snug not tight
• Accuracy of shape is critical
• A properly fitting hard mold is more comfortable than a poorly fitting soft mold
Acoustic Modifications

HORN

REVERSE HORN
Libby Horn

• Pre-formed tubing
• Specific dimensions must be maintained for desired effect
• Available in 3mm and 4mm sizes
Continuous Flow Adapter

- Developed by Norm Schlagel at Pacific Coast Labs
- More predictable bore configurations
- Prevents gradual tubing shrinkage caused by glued in tube

Bore #1
No emphasis

Bore #2
+12 dB @4kHz

Bore #3
+10 dB
All frequencies
Domes

• Designed to address several issues with custom earmolds
  • Instant fit
    • Earmolds generally have a 7 to 14 day turn-around
  • Preferred by many users, particularly new users with mild loss
    • Less occlusion
    • More comfortable
• General sizes and types
  • 6mm to 12mm diameter
  • Open, closed, Tulip, Power

Domes

Open

Closed

Power

Tulip

RIC Earmolds

• “Micro Mold”
  • Minimal size
  • Standard RICs snap in (LP, MP, HP)
  • Designed for comfort and cosmetics
  • RICs can still be changed in the office

• Encased Mold
  • Used for either severe losses (HP, UP receivers) or very curvy ears
  • RIC is disassembled and placed inside a CIC-type shell
  • Speaker and mold must go to manufacturer for repair or replacement
Wireless Connectivity

- NFMI
- 2.4 kHz
  - BTLE
- 900 MHz
- Combined systems
  - SWORD, Signia
- Telecoil
NFMI

• Near Field Magnetic Inductance
  • Low power
  • Small size
  • Limited range (~30 cm)

• Use Cases
  • Hearing Aid Programming
  • Bluetooth and Accessory Gateways
  • “Ear-to-Ear” hearing aid communication

• Current Examples
  • Oticon Epoch to AltaPro
  • Phonak Spice to Beyond
  • Widex Clear →
  • Siemens/Signia Orion 2 to Primax
2.4 GHz

• Direct connection to instrument
  • Low power
  • Small size
  • Long range (~60 feet)

• Use Cases
  • Hearing Aid Programming
  • Bluetooth and Accessory Gateways
  • “Ear-to-Ear” hearing aid communication

• Current Examples
  • GN ReSound Alera ➔
  • Oticon OPN
  • Phonak Marvel
  • Signia Nx
  • Widex Evoke
Bluetooth LE (Made for iOS)

• Direct connection to instrument
  • Low power
  • Small size
  • Medium range (~30 feet)

• Use Cases
  • Hearing Aid Programming
  • Direct streaming from iOS devices (iPhone, iPad, Apple Watch)
  • “Ear-to-Ear” hearing aid communication

• Current Examples
  • GN ReSound Linx 2
  • Oticon OPN
  • Phonak Marvel
  • Signia Nx
  • Starkey Halo, Livio AI
  • Widex Evoke
900 MHz

• Direct connection to instrument
  • Low power
  • Small size
  • Medium range (~30 feet)

• Use Cases
  • Hearing Aid Programming
  • Direct streaming to media streamers
  • Bluetooth connection via gateway
  • “Ear-to-Ear” hearing aid communication

• Current Examples
  • Starkey Z series to Muse IQ
Combined Systems

• Direct connection to instrument
  • Low power
  • Small size
  • Medium range (~30 feet)

• Use Cases
  • Hearing Aid Programming
  • Direct streaming to media streamers and some phones
  • Bluetooth connection via gateway
  • “Ear-to-Ear” hearing aid communication

• Current Examples
  • Signia PX, NX
  • Phonak B-Direct
Telecoil

• Converts magnetic signals into electronic signals
• Available in BTE and some ITE hearing aids as well as most Cochlear Implant processors
Why Do I Need a Telecoil?

• “Universal” Assistive Device Receiver
  • Telephone, Neck Loop, Silhouette Inductors, Loop Pad, Room Loop

• Growing movement to loop more public venues
  • Theatres, houses of worship, public transit, grocery stores
Why do we need all this tech?

Primary “Hearing Hazards”

• Distance

• Reverberation

• Background Noise

These factors reduce speech understanding for ALL people, regardless of how well they hear. Those with hearing loss are affected to a MUCH greater degree.
Inverse square law applies

- $2x$ the distance = $\frac{1}{4}$ the intensity
- Conversely, halving the distance, increases intensity 4x
- This works to both improve and worsen hearing...
Reverberation Time

Word Recognition

Reverberation Time in Seconds

NRML Quiet
HOH Quiet
NRML 0dB SNR
HOH 0 dB SNR

Data Source: AVR Sonovation
Recordings: Brad Ingrao, AuD
Data Adapted from Dirks, Morgan, and Dubno 1982

Recordings: Etymotic Research

Hearing in Noise

Word Recognition

Normal Hearing

Hard of Hearing

Speech to Noise Ratio in dB

NRML Hearing

Hard of Hearing
Combating Hearing Hazards

**Capture**

Collect signal with the best Signal to Noise ratio
Microphone technique is key (GIGO)

**Carry**

Deliver signal over distance **without losing quality**

**Couple**

Connect to HA or CI **without losing quality**
Carry Options

- Magnetic Induction
- Infrared
- FM
- Bluetooth
- Non-Bluetooth Wireless
Non-Bluetooth RF

Some hearing aids and cochlear implants use a radio frequency to:

• Control the devices (volume, programs, etc.)
• Connect to Remote Mics
• Connect to Media Streamers and Bluetooth phones
Coupling Options

• Direct Audio Input (DAI)
• Telecoil (T-Coil)
• NFMI and other “Ear to Ear Wireless”
Alerting Devices

• Make us aware of significant event in our life:
  • Waking up
  • Informational notifications
  • The Arrival of visitors
  • Hazardous conditions
Can You Hear Me Now?

Traditional telephones are difficult for several reasons:

• Limited bandwidth (300 – 3000 Hz)
• Insufficient volume
• Monaural hearing
• No visual information
Under-utilized tools

• Real World Validation (APHAB)
• Expanded Word Recognition Testing
• Frequency Lowering
• Dedicated Noise Reduction Programs
• Impulse noise reduction
APHAB

• Abbreviated Profile of Hearing Aid Benefit (Cox and Alexander 1995)

• Identifies frequency of listening difficulty in 4 areas:
  • Ease of Communication (Quiet settings)
  • Reverberation
  • Background Noise
  • Aversiveness (Sensitivity to sudden loud sound)
• Included in Noah hearing aid fitting framework used by nearly all hearing care professionals
• Takes less than 5 minutes to complete
• Can compare function to others in similar normative groups and between interventions
# APHAB Question Samples

### Patient Information
- **Name:** Eduardo Ignacio
- **Date of Birth:** February 20, 2018
- **Audiologist:** Brad Ingino, AuD

### Analysis Setup
- **Type of Test:**
  - Unsaid / Aided
  - Hearing Aid 1 / 2
- **Conditions to Test:**
  - Unsaid
  - Aided

### Example and Instructions:

<table>
<thead>
<tr>
<th>Item</th>
<th>Without Hearing Aid</th>
<th>With Hearing Aid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When I am in a crowded grocery store, talking with the cashier, I can follow the conversation.</td>
<td>A B C D E F G</td>
<td>A B C D E F G</td>
</tr>
<tr>
<td>2. I miss a lot of information when I'm listening to a lecture.</td>
<td>A B C D E F G</td>
<td>A B C D E F G</td>
</tr>
<tr>
<td>3. Unexpected sounds, like a smoke detector or alarm bell are uncomfortable.</td>
<td>A B C D E F G</td>
<td>A B C D E F G</td>
</tr>
<tr>
<td>4. I have difficulty hearing a conversation when I'm with one of my family at home.</td>
<td>A B C D E F G</td>
<td>A B C D E F G</td>
</tr>
<tr>
<td>5. I have trouble understanding the dialog in a movie or at the theater.</td>
<td>A B C D E F G</td>
<td>A B C D E F G</td>
</tr>
</tbody>
</table>
Expanded Word Recognition Tests

• Binaural Unaided Testing
• Aided Testing at 60 dB SPL
Frequency Lowering

- Addresses “dead hair cell” regions
- Can provide 15 to 20% improved word understanding with 4-6 weeks practice
- Available from all major manufacturers

<table>
<thead>
<tr>
<th>Ear</th>
<th>Test</th>
<th>dB</th>
<th>%</th>
<th>%</th>
<th>SNR</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>WRS</td>
<td>48</td>
<td>56%</td>
<td>56%</td>
<td>SF</td>
<td>NU No. 6 No FreqLower</td>
</tr>
<tr>
<td>L</td>
<td>WRS</td>
<td>48</td>
<td>72%</td>
<td>72%</td>
<td>SF</td>
<td>NU No. 6 FreqLow</td>
</tr>
</tbody>
</table>
Noise Reduction Programs

• Automatic scene analysis programs are great but...
  • Several factors produce greater difficulty than can be addressed by these programs:
    • Severity of loss
    • Slower processing due to age
    • Attention issues

• Dedicated, fixed directional programs can often provide more control and predictability in noise
Impulse Noise Control

• Many people have hyper sensitivity to high intensity, short duration (loud impact) sounds.
• Often reported as “hearing aids are too loud”
  • Incorrect lowering of overall amplification
  • Sacrificing dynamic range and audibility
• Most current instruments have a specific control for this type of sound
Improved IP Ratings

- **IP = Ingress Protection**

- Many current hearing aids and cochlear implant processors have IP67 or 68 ratings

- **IP 67**
  - Completely sealed against dust entering the device
  - Can be submerged in water for up to 30 minutes at a depth of 1 meter

- **IP 68**
  - Completely sealed against dust entering the device
  - Can be submerged in water for more than 30 minutes at a depth greater than 1 meter. Specifics are detailed by manufacturers.

**NOTE:** this is NOT an indicator of long term durability or quality
Rechargeable Hearing Aid Batteries

**Nickle Metal Hydride (NiMH)**

Life Span: ~ 1 year

Can use Zinc Air?: Usually

Current Models: Signia (Siemens) Primax
Rechargeable Hearing Aid Batteries

**Lithium-ion (LiON)**
Life Span: ~ 3 years
Can use Zinc Air? Usually not

**Current Hearing Aid Models:**
- Phonak: B-R, Marvel (in release cycle now)
- Signia: Cellion and Charge n Go
- Starkey: Muse iQR

**Current Cochlear Implant Models:**
- Advanced Bionics: Naida Q70ci and Naida Q90ci
- Cochlear: Nucleus 7
- MedEl: Sonnet, Rondo2
Rechargeable Hearing Aid Batteries

**Silver-zinc** (AgZn)
Life Span: ~ 1 year
Can use Zinc Air? Usually
Brand: Z-Power
- ReSound Linx 3D-61 (312 battery)
- Oticon OPN
- Starkey Muse Micro 312 R
- Widex Unique
- Unitron Moxi All and Stride R
Direct wireless connectivity

- **Made for iOS**
  - Hearing Aids
    - GN ReSound Linx2, 3D Quattro
    - Oticon OPN
    - Signia NX
    - Starkey Halo, Halo 2
    - Widex Beyond, Evoke
  - CI
    - Nucleus 7
  - OI
    - Baha 5

- **Made for All**
  - Phonak B—Direct, Marvel (in release)
• Improved Remote Microphones

• 3rd party partnerships
  • Signia, Oticon

• Multi-Function Mics
  • MultiMic 2
  • Roger Pen

• Adaptive table mic
  • Roger Select
Cochlear Implant MRI compatibility

• MRI Strength measured in Teslas
• Typical MRIs today are 1.5T or 3.0 T
• Magnet intact
  • Head Wrap
  • No wrap
• Magnet Removal
MRI compatibility – Intact Magnet

- Head Splint Kit
  - Supports Magnet
  - Splint plus compression bandage

- Rotating Magnet
  - Magnet moves in opposition of MRI magnetic field
MRI compatibility – Magnet Removal

- Magnet is removed prior to MRI
- Non-magnetic spacer inserted
- Implant remains in place
- After MRI, a new, sterile magnet is installed
- Incision id closed
- Patient may use processor immediately after magnet replacement
- Detailed coverage of this topic coming in a future issue of Hearing Life magazine.
One-piece Cochlear Implant Processors

- Cochlear CP950
- Med-El Rondo and Rondo 2
PSAPs and Over the Counter Hearing Aids

• Personal Sound Amplification Products
  • NOT hearing aids
  • Indicated for enhancing recreational sounds, not correcting hearing loss
  • Range in price from 10s to 100s of dollars

• Over The Counter Hearing Aids
  • New FDA class of hearing aids (2017)
  • Indications
    • Over 18 years old
    • Mild to Moderate hearing loss
    • Distribution regulations still being developed