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WIRELESS TECHNOLOGY TO IMPROVE COMMUNICATION IN NOISE, PRESENTED IN PARTNERSHIP WITH SEMINARS IN HEARING

ACKNOWLEDGEMENTS

- Phonak
- Frye Electronics
- Students
  - Caryn McLellan
  - Jennifer Alford
  - Sarah Wallace
  - Lauren Schaper
  - Amanda Loveless
  - Jennifer Stockwell
  - Sarah Cain
- Catherine Palmer, Editor, Seminars in Hearing
BEGAN IN LAS VEGAS BUT THIS DOESN’T STAY IN VEGAS!

- Phonak ACCESS 3 conference
- Seminars in Hearing Issue
- Now Audiology Online Series!

SCHEDULE FOR THE WEEK
ALL AT 12:00 PM EST

- **Monday: Wireless Technology to Improve Communication in Noise**
  - Linda Thibodeau, University of Texas at Dallas
  - Cheryl DeConde Johnson, The ADEvantage
- **Tuesday: Cochlear Implants and Remote Microphone Technology**
  - Jace Wolfe, Hearts for Hearing
- **Wednesday: Use of Wireless Technology for Children with Auditory Processing Disorders, Attention-Deficit Hyperactivity Disorder, and Language Disorders**
  - Erin Schafer, University of North Texas
- **Thursday: FM for Preschoolers with Hearing Loss**
  - Imran Mulla, The Ear Foundation
- **Friday: Use of an FM System for Veterans with Blast Exposure, Perceived Hearing Problems & Normal Hearing Sensitivity**
  - Gabrielle Saunders, National Center for Rehabilitative Auditory Research
LEARNING OBJECTIVES

- After this course learners will be able to explain how wireless technology can benefit persons with a variety of processing challenges.
- After this course learners will be able to describe the differences between professional guidelines and standards for verification of hearing assistive technology.
- After this course learners will be able to describe ways to facilitate compliance with consistent use of technology.

OVERVIEW

- There are rapid advances in wireless technology, however, the best designed and fitted technology is only as effective as its utilization. The topics for the week will be introduced including use of wireless technology with adults and children with hearing aids, cochlear implants, learning challenges, and traumatic brain injury. Tools for verification including professional standards and guidelines as well as techniques for ensuring appropriate outcomes will be presented.
REMOTE MICROPHONE TECHNOLOGY PROVIDES SIGNIFICANT BENEFITS TO SPEECH RECOGNITION IN NOISE

- CHILDREN with
  - Reading delays (Purdy, Smart, Baily, & Sharma, 2009, Hornickel, Zecker, Bradlow & Kraus, 2012),
  - Hearing loss who wear hearing aids (Anderson & Goldstein, 2009),
  - Hearing loss who wear cochlear implants (Schafer & Thibodeau, 2006),
  - Auditory processing disorders (Johnston, 2009).
- ADULTS with
  - Hearing Loss who wear hearing aids (Chisolm, Noe, McArdle, & Abrams, 2007; Thibodeau, 20010) and
  - Hearing Loss who wear cochlear implants (Schafer, Wolfe, Lawless, & Stout, 2009; Wolfe et al, 2009)

DESPITE ADVANTAGES... THERE ARE SEVERAL CHALLENGES

First we'll deal with acoustic factors:

Neckloop Arrangements
(Thibodeau, McCaffrey, & Abrahamson, 1988)

DAI connections
(Thibodeau, 1990)

Low correlation with settings on FM body receivers and hearing loss
(Thibodeau & Saucedo, 1991)

FM Advantage re: Receiver Settings
(Bondurant & Thibodeau, 2012)
FITTING GUIDELINES

- These findings provided motivation to develop protocols that could be used by all professionals to evaluate Assistive Technology.
- Great Disparity between the time we spent evaluating hearing aids versus assistive devices.
  - Eg. Child could have 3-4 appts to fit a personal hearing aid and then go to a school program and at one time, remove that aid and put on one that was NEVER tested electroacoustically much less in the real ear!

ANSI STANDARDS FOR HADS LIKE ANSI STANDARDS FOR HEARING AIDS??

- In 2009 Submitted the FIRST draft of HADS standard (at least 20 years of work) and received major feedback/comments but not insurmountable.
WHERE TO BEGIN??

Major delays...
Definition... ALD? HAD? HAT?
Scope... Personal? Wide Area?
Alerting?
Those that improve SNR?
Infrared? FM? AM?

AAA GUIDELINES

  www.audiology.org
The Goals of fitting HAT are to:
1) provide audibility and intelligibility of speech that is commensurate with performance in ideal listening conditions,
2) maintain audibility of self and others, and
3) reduce the deleterious effects of distance, noise, and reverberation.

TRANSMITTERS
RECEIVERS
BATTERIES
<table>
<thead>
<tr>
<th>FM TRANSMITTER OPTIONS</th>
<th>AAA HAT GUIDELINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microphone</td>
<td></td>
</tr>
<tr>
<td>Channel</td>
<td></td>
</tr>
<tr>
<td>Controls</td>
<td></td>
</tr>
<tr>
<td>Programmable</td>
<td></td>
</tr>
<tr>
<td>Batteries</td>
<td></td>
</tr>
<tr>
<td>Indicator Lights</td>
<td></td>
</tr>
<tr>
<td>Accessory Jacks</td>
<td></td>
</tr>
<tr>
<td>Secondary Transmission</td>
<td></td>
</tr>
</tbody>
</table>

A Table is provided that includes the possible options for each category and the Pros and Cons. Example: FM Microphones can vary by:
- Location: Head, Cheek, Lapel, Conference
- Type: Omni, Directional-Fixed, Directional-User Select
VERIFICATION PRIORITIES
AAA HAT GUIDELINES

- The FM system should provide at least 10 dB relative advantage over hearing aid only
- If the system typically has both the FM and HA microphones active, then verification should be performed in the FM+HA position

FM TERMINOLOGY & SHORTHAND
AAA HAT GUIDELINES

- Standardization of verification type, device and level in an abbreviated format
- Type: E(electroacoustic), B(behavioral), R(real ear)
- Device: HA, FM, HA/FM, FM/HA, CI
- Inputs level: designated in dB HL or SPL
- When testing in noise, input level of main signal listed first, followed by level of noise
  EFM/HASPL
  BHA50/50HLD
**ELECTROACOUSTIC VERIFICATION**  
**AAA HAT GUIDELINES**

- Assumptions re: ear-level FM systems
  - Gain/Output characteristics of system are determined by hearing instrument settings
  - Hearing instrument has been set for appropriate output and audibility with a variety of speech inputs
  - Hearing instrument adjustments completed in coordination with dispensing audiologist

**PRINCIPLES OF ELECTROACOUSTIC VERIFICATION**

- Based on concept of Transparency: The condition in which equal inputs to the wireless and local microphones generate equal outputs from the hearing device
- Operational definition: Transparency in a personal wireless HAT system is attained when inputs of 65 dB_{SPL} to the FM and HA mics produce equal outputs from the HA
BASIC VERIFICATION STEPS
AAA HAT GUIDELINES

- Confirm HA response for user
  - Evaluate HA with 65 dB SPL input
- Attach FM receiver
- Set FM Receiver to Default (e.g. +10)
- FM Microphone on Mute
- Compare HA to HA+FM for impedance or programming differences
  - Evaluate HA/FM with 65 dB SPL input

BASIC VERIFICATION STEPS
AAA HAT GUIDELINES

- Evaluate FM (in FM+HA mode) with 65 dB SPL input
- Use 3 freq. average @ 750, 1000 and 2000 Hz
- Subtract EHAFM65 avg from EFMAH65. If difference is >±2, change FM setting as appropriate and re-evaluate
- Perform listening check with simultaneous inputs to FM and HA. Adjust relationship, as needed
LET'S GET BACK TO THE PART ABOUT AN ANSI STANDARD FOR HADS

So we have a Guideline that for selecting, fitting, and verifying remote microphone technology but still need procedures for Electroacoustic Evaluation in standard protocol to compare to manufacturer specifications or to compare one device to another!

SCOPE
ANSI SPECIFICATION OF HADS

- This document describes measurements of output characteristics when a remote microphone arrangement is used.
- There are potentially multiple components to HADS (e.g. FM transmitter delivering to an FM Receiver connected to a neckloop transmitting to a t-coil in a hearing aid), and several employ output transducers that cannot be measured with standard couplers,
The electroacoustic characteristics described within the standard include:

- family of response curves (50- to 90-dB SPL input in 10 dB increments)
- output sound pressure level for 90-dB SPL input
- high frequency average output sound pressure level for 90-dB SPL input
- high frequency average output sound pressure level for 50-dB SPL input
- frequency range

The electroacoustic characteristics described within the standard include:

- total harmonic distortion
- noise level with no input
- input-output characteristics
- dynamic automatic gain control (AGC) characteristics
- gain control linearity
- current drain
- immunity to electromagnetic interference
TEST ARRANGEMENT FOR NECKLOOP EVALUATION
ANSI SPECIFICATION OF HADS

SUMMARY

- AAA Guidelines address the selection, fitting, and verification of FM Systems
- ANSI Specifications for HADS address specific measurements that reflect the acoustic characteristics of the device to facilitate comparison across manufacturers and determine if a device is meeting specifications
- Technology is changing so fast, the Volunteers who work on these documents are constantly revising
- Professionals need to advocate for electroacoustic evaluation of all devices including those NOT sold in professional settings (ie personal sound amplifier)
MANAGEMENT AND CONSISTENT USE OF REMOTE MICROPHONE TECHNOLOGY IN THE CLASSROOM

- Typical Classroom Learning Environments: Dynamic... Interactive... Fast-Paced

WHAT ARE CHALLENGES IN MANAGING FM/HAT?

- Knowledge of current HAT options to select, adjust, implement, monitor, and maintain devices
- Assessment of the acoustic and learning environment
- Garnering student, family, and professional support
- Balance of acoustic benefit and psychosocial factors
- Connectivity with classroom instructional and assessment technologies
- Consistent implementation
- Student responsibility and self-advocacy
- Monitoring and maintenance
21st Century Learning

Learning and Innovation Skills
- Creativity & innovation
- Critical thinking & problem solving
- Communication & collaboration

Disruptive Education
(Christiansen, 2008)

- Hybrid & flipped classrooms
- Computerized assessments

- Web instructional content: YouTube, videos etc.
- Tracking visual & auditory inputs
- Lighting, noise
- Universal design?
- Accommodations & connectivity with personal hearing instruments and HAT
Provides for “effective communication” that is defined as communication that is as effective as it is for non-disabled peers
“affording an equal opportunity to obtain the same result, to gain the same benefit, or to reach the same level of achievement as that provided to others” [ADA Title II 28 C.F.R. 35.130 (b)(1)(iii)]

Students in public schools have eligibility under both IDEA and ADA. In some cases ADA may provide a higher standard than IDEA.

How do we evaluate “effective communication”?

For further information see references:
DOJ/OSEP (November 12, 2014).
WHAT DO OUR STUDENTS SAY ABOUT USING FM?

<table>
<thead>
<tr>
<th>BOBBY</th>
<th>KATHY</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School Jr</td>
<td>High School sophomore</td>
</tr>
<tr>
<td>Moderate-severe bilateral SNHL</td>
<td>Moderate-severe bilateral SNHL</td>
</tr>
<tr>
<td>Previous FM user</td>
<td>Current FM user</td>
</tr>
<tr>
<td>No longer uses FM because:</td>
<td>HA with integrated FM</td>
</tr>
<tr>
<td>▪ I don’t like having to wear it, I don’t like others seeing it, I don’t like that it makes me look different, I get teased if I use it, I don’t like how it sounds, I don’t like having to carry the equipment, it doesn’t help me hear better</td>
<td>Everyday – all classes</td>
</tr>
<tr>
<td>▪ Sabotaged use by taking it home and leaving it there</td>
<td>If not in use, because teachers won’t use it</td>
</tr>
<tr>
<td>▪ School solution: classroom sound field system (CADS)</td>
<td>Comments:</td>
</tr>
<tr>
<td></td>
<td>▪ “Helps me a lot”</td>
</tr>
<tr>
<td></td>
<td>▪ “FM systems are great to use”</td>
</tr>
</tbody>
</table>

WHAT IS THE PROBLEM?

- Student?
- School/Teacher/Staff?
- Technology?
- Support?
- Knowledge?
- Orientation and Training?
FINDINGS
Jennifer Franks, Eastern Michigan University, MA

- No correlation between use and type of hearing loss (unilateral vs bilateral)
- At least half of participants (53% average, students 56%) believe that the primary reason for non-use is social

<table>
<thead>
<tr>
<th>Area</th>
<th>All</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical</td>
<td>15.4%</td>
<td>22%</td>
</tr>
<tr>
<td>Support</td>
<td>17.3%</td>
<td>11%</td>
</tr>
<tr>
<td>Benefit</td>
<td>12.7%</td>
<td>44%</td>
</tr>
<tr>
<td>Convenience</td>
<td>10%</td>
<td>22%</td>
</tr>
<tr>
<td>Comfort</td>
<td>9.8%</td>
<td>22%</td>
</tr>
</tbody>
</table>

- Students, more than any other group, did not see the value of the FM system
- All non-social areas can be addressed through audiological management

Table 1
Opinion: Main Reasons FM System is Not Used Consistently

<table>
<thead>
<tr>
<th></th>
<th>Gen Ed Tiers</th>
<th>Spe Ed Tiers</th>
<th>TCU</th>
<th>Other</th>
<th>Parent</th>
<th>Audiologist</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>40</td>
<td>60</td>
<td>50</td>
<td>60</td>
<td>44</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Mechanical</td>
<td>18</td>
<td>13</td>
<td>14</td>
<td>8</td>
<td>20</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Comfort</td>
<td>9</td>
<td>7</td>
<td>14</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Support</td>
<td>9</td>
<td>0</td>
<td>14</td>
<td>25</td>
<td>40</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>20</td>
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<td>Convenience</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>22</td>
<td>22</td>
</tr>
</tbody>
</table>

Participants
Candidacy Considerations

Step 2. Considerations [in and out of school]
- Acoustic environment
- Social/emotional
  - Functional
  - Support
- Motivation: Student & teachers or child & family
- Attention & Fatigue
- Self-image

Self-advocacy
Social acceptance
Classroom culture
Family support
IMPLEMENTATION AND VALIDATION

Step 5. Implementation and Validation

- Orientation, training & usage plan
  - IDEA AT requirements
  - Usage plan individualized with each student

- Validation

- Monitoring

ASSISTIVE TECHNOLOGY SERVICE MEANS ANY SERVICE THAT DIRECTLY ASSISTS A CHILD WITH A DISABILITY IN THE SELECTION, ACQUISITION, OR USE OF AN ASSISTIVE TECHNOLOGY DEVICE.

(a) The evaluation of the needs of a child with a disability, including a functional evaluation of the child in the child’s customary environment;

(b) Purchasing, leasing, or otherwise providing for the acquisition of assistive technology devices by children with disabilities;

(c) Selecting, designing, fitting, customizing, adapting, applying, maintaining, repairing, or replacing assistive technology devices;

(d) Coordinating and using other therapies, interventions, or services with assistive technology devices, such as those associated with existing education and rehabilitation plans and programs;

(e) Training or technical assistance for a child with a disability or, if appropriate, that child’s family; and

(f) Training or technical assistance for professionals (including individuals providing education or rehabilitation services), employers, or other individuals who provide services to, employ, or are otherwise substantially involved in the major life functions of children with disabilities.
ORIENTATION & TRAINING TOPICS

**Children/Youth**
- Implications of HL
- Device features & function
- Expectations: Benefits/limitations
- Usage – school and extra-curricular activities
- Care & Maintenance
- Basic troubleshooting
- Self-monitoring of function
- Self-advocacy

**Parents/Caregivers/Teachers**
- Implications of HL
- Basic function of device
- Device features & function
- Expectations: Benefits/limitations
- Listening check & basic troubleshooting
- Report of a suspected malfunction
- Advocacy
- Classroom/community setting orientation to HAT

---

**USAGE PLAN**

- Fulltime
- Part-time

Specific environments or classes:

___________________________________________
___________________________________________

Specific activities:
- __assemblies  __therapy  __computer instruction
- __classroom discussion  __lectures  __media
- __PE & other organized physical activities
- __Team sports
- __Extra-curricular activities (e.g., clubs, theater)
- __other_________________________________________

- Out of School_________________________________________
VALIDATION PROCEDURES

Are we achieving the intended results?

- Validation is a demonstration of the benefits (and limitations) of the recommended HAT device.

- Outcomes:
  - Full audibility and intelligibility of speech commensurate with best listening ability in quiet
  - Full audibility of self and others
  - Reduced effects of distance, noise, and reverberation

- Tools
  - Self-assessments
  - Checklists
  - Functional listening evaluations

MONITORING PROCEDURES

- IDEA requires that schools must monitor all amplification devices to assure that they are functioning properly
- Any student who uses HAT should have a monitoring plan
- Repairs need to be completed in a timely manner
- Loaners/back-up must be provided
MONITORING PROCEDURES

Individual monitoring plan documents proper functioning of amplification devices:
- Who
- Where
- When
- How
- What if...

Audiological monitoring should document whether the child’s performance with the amplification instruments:
- Meets auditory/listening goals
- Achieves communication access with
  - Teachers and school staff
  - Classmates & peers
  - Self

IMPLEMENTATION CONSIDERATIONS

**Student**
- Knowledge: understanding what it is and what it does
- Responsibility: Determine students’ role to self-advocate
- Negotiate:
  - discuss pros & cons for each situation;
  - consider students’ preferences & interests
  - use grades, acoustical environments, and class learning situations to determine when needed;
- Agreements: student and teacher for accommodations, signals for clarification, use of FM

**Team Support**
- Audiologist:
  - Appropriate fitting (benefit, mechanical, orientation & training)
  - Facilitate compliance from teachers & school staff (support, monitoring)
- Teacher: Be positive and consistent about use
- Parents: acceptance and positive support
- Reminders
  - Encourage but never force a student to use FM
  - Counseling, peer activities to address personal issues
SUMMARY: RECOMMENDATIONS FOR HAT ARE ONLY AS GOOD AS HOW WELL THEY ARE IMPLEMENTED!

Management is necessary...
- To engage the student in adoption of the technology
- To achieve goal of providing consistent auditory access to all classroom discourse, communication, and connectivity to computers and other media)
- To validate benefit and use...
  - HAT usage plan is appropriate
  - HAT is used as prescribed
  - HAT is used consistently
  - HAT is working properly

Other Tips:
- Adopt a team approach: student, parent, teachers, audiologist, TODHH, SLP etc
- Use the law
- Remember ADA Title II “Effective Communication”
REFERENCES


