Validation & Verification

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Plan....

Doug will address global issues.

Dave will address Real-Ear issues.
Which is Which?

Verification
(from the professional’s view?)

- Objective Analysis.
- ElectroAcoustic measures.
- REAL EAR measures.
- S-in-N test results?
- Speech Intelligibility Index.
Which is Which? Examples....

Validation
(from the patient’s view?)

Subjective Analysis.
Questionnaires.
Interviews. Profiles.
S-in-N test results?
V&V is Money

Universal verification and validation would make unnecessary 521,779 repeat office visits each year
Combining V&V results in 1.2 FEWER office visits.

76% of pts fit with “above average success” were fit in 1 or 2 office visits.

47% of pts with “below average success” were fit in 4 to 6 office visits.
“Highly successful patients required fewer visits to the office.”

Less is More.
FIGURE 2. Average patient visits to fit hearing aids based on use of verification (REM) and validation procedures (objective or subjective).
Status Quo: Data gathered Jan 2008 to Jan 2009, n=787.

- 36% Report V & V
- 34% Validation only
- 9% Verification only
- 22% Nada (how does that sound?)
- 64% USA practices not using V AND V
Hearing Journal, 1990...to estimate audibility of speech

Killion, Mead C.; Mueller, H. Gustav
The Hearing Journal. 63(1):10,12-14,16-17, January 2010.
Objective measures do NOT assure patient satisfaction.

Satisfaction includes; Relationship with HHP, ease of access to HHP, cosmetics, comfort, perceived expectations and value.

Dead Patients (yikes!)
Validation:

Questionnaires
Fill In The Blank
Interview, Profiles
Pre & Post Measures
SEVEN VERIFICATION PROTOCOLS

BEST verification =
Probe microphone measures.
Verification Protocol # 1

Probe Mic Measures:

Do gain and output measures meet target for different input levels in the real ear?
VERIFICATION PROTOCOL  #2

Functional Gain = The difference between aided and unaided in the soundfield.

FUNCTIONAL GAIN:

Does the HA meet prescribed targets for soft input levels?
VERIFICATION PROTOCOL #3

Audibility – Does the HA provide appropriate audibility for soft sounds?

Are soft sounds audible?
Count The Dots
Hearing Journal, 1990....to estimate audibility of speech

Killion, Mead C.; Mueller, H. Gustav
The Hearing Journal. 63(1):10,12-14,16-17, January 2010.
Estimating the Speech Intelligibility Index (SII)

The new Killion and Mueller SII Count-The-Dots audiogram for estimating the articulation index. The distribution of the 100 dots represents a speech level of 60 dB SPL (~45 dB HL).
Audibility Caveat:

Detection does not assure recognition. However, without detection there is no chance for identification or recognition....
VERIFICATION PROTOCOL  #4

Loudness Ratings:

45 dB SPL ~ Soft
65 dB SPL ~ Medium
85 dBSPL ~ loud but not uncomfortable
VERIFICATION PROTOCOL #5

Speech Intelligibility Measures:
Aided in SF at about 50 dB HL
(i.e., 65 dB SPL)

(Maybe HINT or Quick-SIN)
VERIFICATION PROTOCOL #6

Speech Intelligibility Judgments:

Pt judges intelligibility at 65 dB SPL: paired comparisons, ease of listening etc
VERIFICATION PROTOCOL #7

Speech Quality Judgments:

Pt judges quality at 65 dB SPL:
  paired comparisons
  ease of listening
  etc
Validation...Outcomes

To document the patient’s benefit and/or satisfaction.
Benefit vs Satisfaction:

Benefit: Aided minus unaided performance. Lab-based measures, relatively objective.

Satisfaction: More subjective, relates to expectations (did HA meet expectations?)
Subjective Outcomes measures assess the individual’s perception of their listening capabilities across multiple situations with and without amplification – thereby providing a measure of subjective benefit.

Subjective Outcomes seem to have become the “gold standard.”
To document the patient’s benefit and/or satisfaction.
Taylor and Mueller (2011)

Domains/Areas to be addressed:

- Daily Use
- Sound Quality
- Speech Understanding
- Loudness Normalization
- Listening Effort
- Quality of Life
- Social Interaction
- Reduced Burden of Significant Other
Speech Tests for Validation

W-22 & NU-6, not real world.

But if using them....compare unaided soft speech (40 dB HL) to aided soft speech, one ear at a time.
Speech Tests for Validation/Verification?

Speech Perception in Noise (SPIN)
QuickSIN
Hearing in Noise Test (HINT)
Estimating the Speech Intelligibility Index (SII)

The new Killion and Mueller SII Count-The-Dots audiogram for estimating the articulation index. The distribution of the 100 dots represents a speech level of 60 dB SPL (~45 dB HL).

Killion, Mead C.; Mueller, H. Gustav
The Hearing Journal. 63(1):10,12-14,16-17, January 2010.
Seven Self-Reports of Outcome

1. Client Oriented Scale of Improvement (COSI)
2. Glasgow Hearing Aid Benefit Profile (GHABP)
3. Abbreviated Profile of Hearing Aid Benefit (APHAB)
4. Hearing Handicap Inventory for Adults (HHIA)
5. Hearing Handicap Inventory for the Elderly (HHIE)
6. Satisfaction With Amplification in Daily Life (SADL)
7. International Outcome Inventory Hearing Aids (IOI-HA)
Client Oriented Scale of Improvement (COSI)

NAL, 1997, Open-Ended

Pt’s task is to create five listening situations which he/she would like to improve via amplification.

Easy, intuitive....
Glasgow Hearing Aid Benefit Profile (GHABP)

Six dimensions of amplification outcome:
- disability,
- handicap,
- hearing aid use,
- benefit,
- satisfaction,
- residual disability.

GHABP can discriminate between HA fittings.
“...derived, optimized and verified...”

(Gatehouse, S., JAAA Vol 10, pgs 80-103, 1999)
Abbreviated Profile of Hearing Aid Benefit (APHAB)

4 subscales; ease of communication, reverberation, listening in noise & aversiveness to sound.

Aided vs unaided percent of problems. Computer or paper-based.

(MOST COMMON OUTCOMES BASED MEASURE)
Hearing Handicap Inventory for the Elderly (HHIE) and HHI-Adults (HHIA) over/under age 65 years. Designed to quantify handicap and to assess benefit post fitting. 25-item and 10-item (screening versions).

Easy, quick, useful!
Satisfaction With Amplification in Daily Life (SADL)

15 items rated on 5 pt scale.

4 sub-scales;

1- positive effects
2- service and costs
3- negative features
4- personal image

(Rx: JAAA Vol 16, 2005, Uriarte, Denzin, Dunstan....)
International Outcome Inventory for Hearing Aids (IOI-HA)
www.memphis.edu/ausp/harl/ioi-ha.htm

Seven items, sufficiently general. Practically oriented, provides “mini-profile.”
Based on "Measuring Outcomes in Audiological Rehabilitation Using Hearing Aids" Eriksholm, Denmark.

IOI-HA does not replace existing outcome measures. Serves potentially...as a stand alone tool for quality assessment.
International Outcome Inventory for Hearing Aids

For scoring purposes, responses from left to right on the page are assigned a value from 1 to 5. The values are then added. Higher scores indicate a more favorable outcome.
International Outcome Inventory for Hearing Aids (IOI-HA)

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 those situations?
   - 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
IOI-HA Questions 5 through 8

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?

- bothered very much
- bothered quite a lot
- bothered moderately
- bothered slightly
- bothered not at all

7. Considering everything, how much has your present hearing aid(s) changed your enjoyment of life?

- worse
- no change
- slightly better
- quite a lot better
- Very much better

8. How much hearing difficulty do you have when you are not wearing a hearing aid?

- severe
- moderately-severe
- moderate
- mild
- none
IOI-HA has been shown to be a valid instrument for distinguishing satisfied from non-satisfied patients.
N = 131 male veterans.

Internal consistency of IOI-HA was good.

Test-retest reliability is high.

There is a 95% chance that a change in one response unit reflects a true change.
Verify and Validate
VERIFICATION = REAL EAR
(and related measures)

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Real-ear Measurements (REM)

An Introduction
1. Verification with Real-ear Measurements.
   - What is a Real-ear Measurement?
   - Why is it used?
   - When is it used?

2. Terminology and Procedures

3. Considerations in Real-ear Measurements.
What is Verification?

“An action to determine or prove if something that was believed is actually correct.”

(Politikens Nudansk Ordbog, 2001)
What do you think is the most popular method of verifying hearing aids?

The “HOW-DOES-THAT-SOUND Method”
What is REM?
An example

REIG (65 dB Warble Tone)

Target

Measurement
When is REM used?

• Every time you do a hearing aid fitting?
• Rarely since REM is not really helpful in clinical practice?
• Only if you have time?
• Only for trouble shooting?
• ...?
Why use REM?

• **Objectively** evaluates the function of the hearing aids *while the patient is wearing them*.

• Takes into account characteristics of the individual ear.
More SPL  →  Give LESS gain

Less SPL  →  Give MORE gain

The bigger ear the more gain!
Simulated REM screens

- **Averaged** or anticipated results.
- **Not** intended to replace REM.
Simulated REM screens

(Hawkins and Cook, 2003)
How is REM used?

You need to have the following:

• REM equipment (hardware and software)
• Loud speaker
• In-situ headset
• Probe tube
• Reference microphone
More portable solutions are also available
How is REM done?
Fitting flow

First Fit

Fine tune

REM

Validation
An example

Hearing thresholds (in SPL)

Target

Measurements
TERMINOLOGY AND PROCEDURES

Based on Pumford & Sinclair (2001)
The Basic Measures

- REUR/REUG
- REAR/REAG
- REIG
- (Visible) Speech Mapping
Does it end with R or G

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An example

The only difference is the reference point.
REIG
Real-ear Insertion Gain

REAR – REUR = REIG

INPUT: 65 dB Warble Tone
CONSIDERATIONS IN REM
First Thing to do!

Otoscropy!
Tube Calibration

The probe affects the sound as it travels through it.
The calibration compensates for this effect!

1. Place the microphone tube of the IntraSet headset as shown on the picture.
2. Place the headset in front of the IntraSet loudspeaker as shown on the picture and press OK. This will replace the existing calibration curve with a new one.

To leave this menu without changing calibration press Cancel instead of OK.
Loudspeaker Location

- 0.5 – 1 meter distance
- 0° or 45° azimuth
Probe Placement

3-6 mm
Probe Placement

Avoid standing waves!
Acoustic Parameters

- Room acoustics (reverberation) and diffraction effects
No Movements!

- Probe movements
- Head movements
- Hearing instrument movements
Fitting Prescriptions
Generic Prescriptions

NAL-NL1
NAL-NL2
Third Gain
Half Gain
Berger
NAL RP
NAL R
POGO 1
POGO 2
DSL mi/o
Stimuli?

Warble Tone

Pure Tone

Male Speech

Random Noise

Pink Noise

Female Speech

Male Speech

ISTS

Speech Dialog

Pure Tone

oticon
Automatic Features

Switch OFF if you want to match target!
Open Ear Fittings
REM benefits

- Match the target
- Smoothing the response
- Verifying fine-tuning
- Confirming complaints
- Evaluate occlusion
- Fitting difficult patients
- Counseling

- Hit it out of the ballpark!
Summary

- Go beyond the audiogram and first fit
- New fittings are science-based
- REM provides objective data
- Supplement with patients feedback
- Develop a simple routine
- Practice makes perfect
- Improve patient education
- Higher satisfaction = fewer returns.
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Questions?