Update on Diagnostic Audiology: Reliance on Value-Added Tests

- Our old and worn out audiologic test battery
- Defining “best practices” and “standard of care”
- The concept of value added tests (VATs)
- A modern diagnostic audiology test battery
  - Aural immittance measures are still valuable
  - OAEs add value to audiologic assessment
  - Screening for auditory processing deficits
- Linkage between diagnostic procedures and intervention outcome

Audiology Test Battery: 60 years Ago

- Test battery at the beginning of our profession, in order of test administration
  - Air-conduction pure tone audiometry
  - Bone-conduction pure tone audiometry
  - Speech reception thresholds
  - Word recognition (PB word lists)
  - Uncomfortable loudness level (UCL), i.e., loudness discomfort level (LDL)

Source: Wiener F & Miller G. Hearing aids. In Combat Instruments II. Washington, D.C. NDRC Report 117, 216-232, 1946

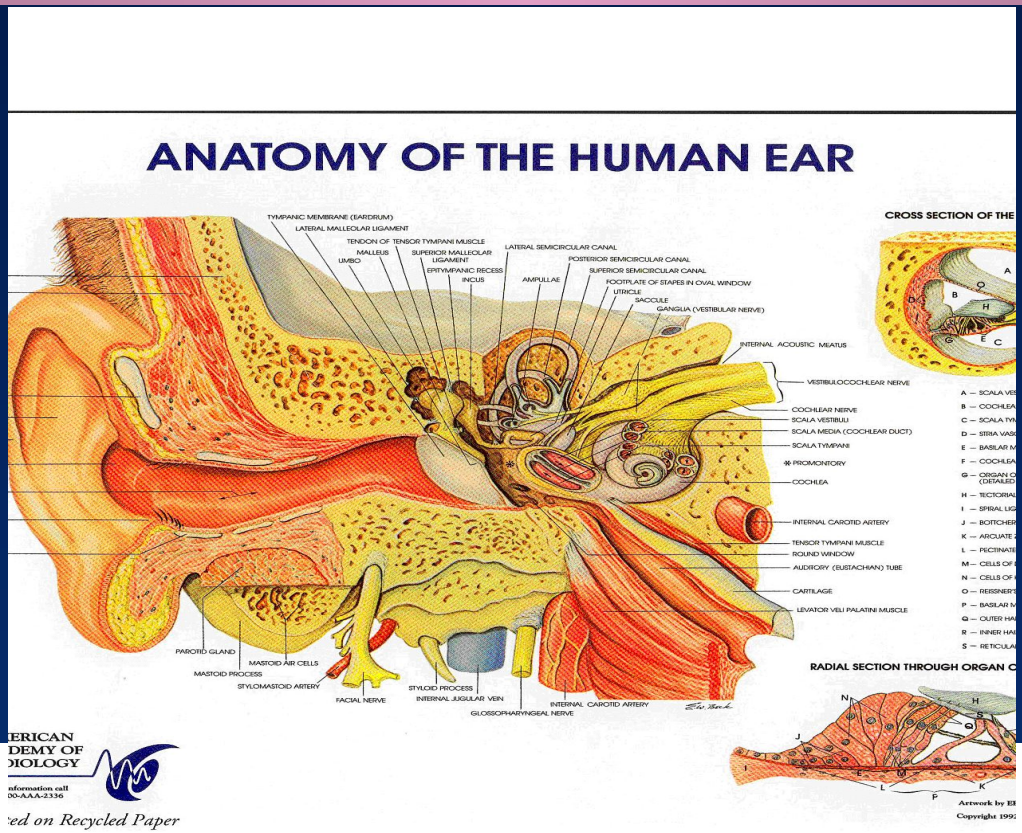
The Test Battery in Audiology Today: The Old and the New

Audiologic Test Battery Today

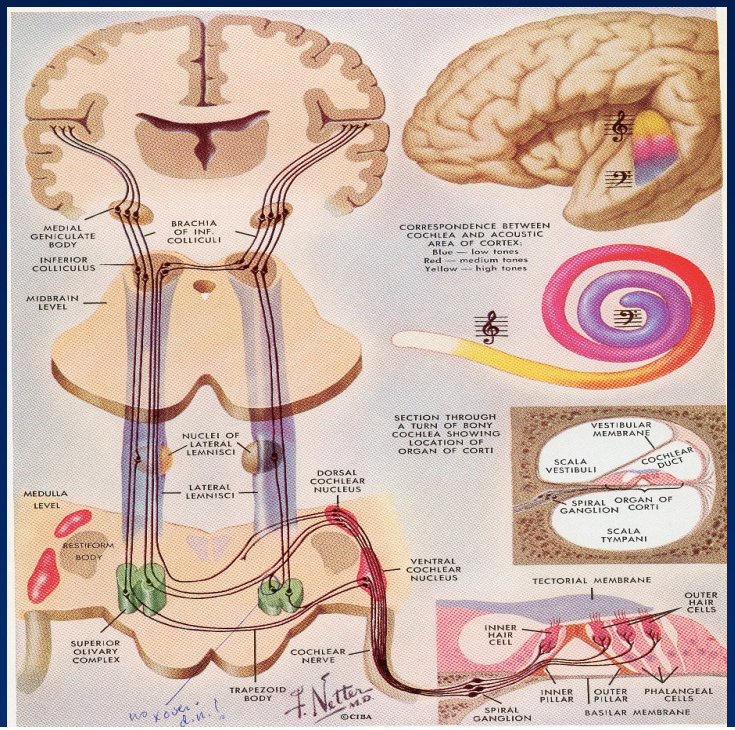
Procedure	% performing procedure
Pure tone audiometry: air conduction	100%
Pure tone audiometry: bone conduction	100%
Word recognition	95%
Speech reception threshold	91%
UCL (LDL) for speech	83%
Tympanometry	45%
UCL (LDL) for tones	45%
Acoustic reflexes	20%
Otoacoustic emissions (OAEs)	4%

Source: The Hearing Journal, December, 2002

Efficient and Sensitive Assessment of the Peripheral Auditory System



We Hear with Our Brain!
Screening for and Diagnosis of Auditory Processing Disorders



Toward a Modern Diagnostic Audiologic Test Battery

(In the order of testing for new patients. Test time < 1 hour.)

- Objective measures
  - Otoacoustic emissions (OAEs)
    - ✓ Diagnostic protocol for DPOAEs and/or TEOAEs
  - Aural immittance measures
    - ✓ Tympanometry
    - ✓ Acoustic reflexes (*crossed vs. uncrossed conditions)*
- Behavioral measures
  - Pure tone audiometry *(automated technique as appropriate)*
    - ✓ Inter-octave frequencies (e.g., 3000 and 6000 Hz)
    - ✓ High frequency (> 8000 Hz) audiometry as indicated
    - ✓ Bone conduction measurement only as indicated
  - Speech audiometry
    - ✓ SRT only as indicated
    - ✓ Word recognition using CD materials with 10 most difficult words first
    - ✓ Screening measure of speech perception in noise, as indicated by history or findings
    - ✓ Screening measure of dichotic listening, as indicated by history or findings

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Best Practices are Evidence-Based

"Those who fall in love with practice without science are like a sailor who steers a ship without a rudder or compass, and who can never be certain whither he is going."

Leonardo Da Vinci (1452-1519)

Categories for Strength of Evidence used in Developing Clinical Guidelines

- **Grade I:** Evidence is strong and usually obtained from randomized controlled trials or well-designed clinical studies.
- **Grade II:** Evidence is from clinical studies that were based on retrospective data analysis, clinical trials that were not randomized and/or carefully-controlled, or from panel consensus based on existing guidelines and practice patterns.
- **Grade III:** Evidence is secondary in that it is based on current or long-standing practice without substantial supporting basic or clinical data.

General Definitions of Standard of Care

- Consistent with local, regional or national clinical practice
- Follows guidelines or recommendations on clinical practice approved by national multi-disciplinary professional committees or panels, e.g., Joint Committee on Infant Hearing
- Follows guidelines or recommendations on clinical practice approved by national professional organizations, e.g., AAA or ASHA
- Is consistent with statements of
  - Scope of Practice
  - Code of Ethics
- Is in compliance with Federal guidelines for clinical practice and services, e.g., Joint Committee on Accreditation of Healthcare Organizations (JCAHO)

Legal Definitions of Standard of Care

- In tort law, the standard of care is the degree of prudence and caution required of an individual who is under a duty of care.
  (en.wikipedia.org/wiki/Standard of_care)

- In tort law, the degree of caution that a reasonable person should exercise in a given situation so as to avoid causing injury
  (en.wiktionary.org/wiki/standard_of_care)

- The degree or level of service, attention, care and protection that a person owes another person according to the law (see also Duty of care).
  (www.ibc.ca/en/need_more_info/glossary/S.asp)

- The level of care which all persons with a particular illness should receive; the level below which care would be considered substandard. standard therapy
  (aids.hallym.ac.kr/dict/s.html)

Legal Definitions of Standard of Care (2)

- Treatment regimen or medical management based on commonly accepted practices.
  (www.nortonhealthcare.com/body.cfm)

- It's the level of care, which an average practitioner would practice. Or in other words how a similar qualified practitioner would manage their patient's care under similar circumstances. Medical Malpractice claims must establish the standard of care and show that the standard has been breached.
  (www.gmlaw.com/medical-malpractice-resources-terms.cfm)

- In medicine, treatment that experts agree is appropriate, accepted, and widely used. Health care providers are obligated to provide patients with the standard of care. Also called best practice and standard therapy.
  (National Cancer Institute)

- This is the degree of cautionary action which must be performed at all times when treating and/or performing surgery on a patient. If a breach of contract occurs, the care provider can be held liable for negligence.
  (www.cosmeticsurgerymalpractice.com/resources.cfm/malpractice-glossary.html)

Best Practices in Audiology Today: Specific Sources for Practice Guidelines (Standard of Care)

- Guidelines for different clinical practices, e.g.,
  - Diagnostic audiometry in adults
  - Pediatric diagnostic audiology
  - Hearing aids and amplification
  - Auditory processing disorders (APD) assessment and management
  - Tinnitus assessment and management
- Selected sources of guidelines
  - V.A. guidelines by Joint Commission (*Audiology Today)*
  - Tinnitus guidelines *(www.audiology.org)*
  - Audiologic assessment of children birth to 5 years. *ASHA 2004.*
  - Joint Committee on Infant Hearing (JCIH) 2007 Statement
  - Guidelines for auditory processing disorders. *AAA (2010)*
  - Guidelines for otoacoustic emissions (OAEs). *AAA (in progress)*

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The Concept of Value Added Tests (VATs): Fundamental Criteria for Inclusion in a Test Battery

- Value added tests (VATs)
  - The procedure adds value to the description of auditory status for the patient … information that's
    - ✓ Not available from other procedures,
    - ✓ Obtained quicker than with another procedure
    - ✓ Useful in managing the patient
    - ✓ Contributes to better outcome for the patient
- OAEs are an example of a VAT
- Some traditional test procedures do *not* invariably add value, e.g.,
  - SRT
  - Bone conduction pure tone audiometry
  - Word recognition in quiet at 40 dB SL

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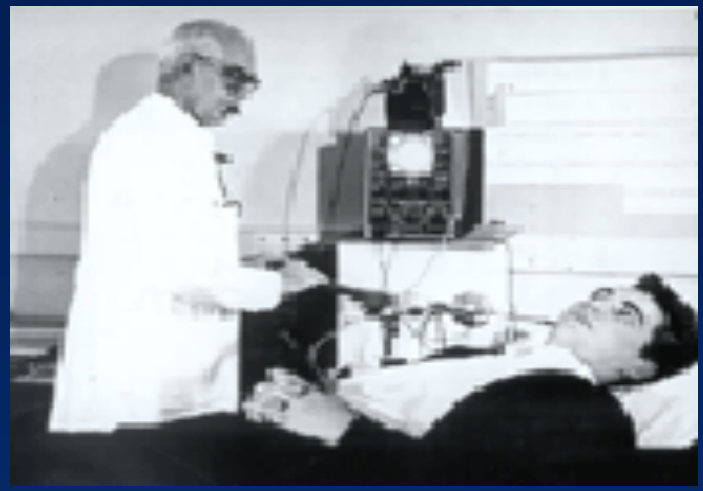
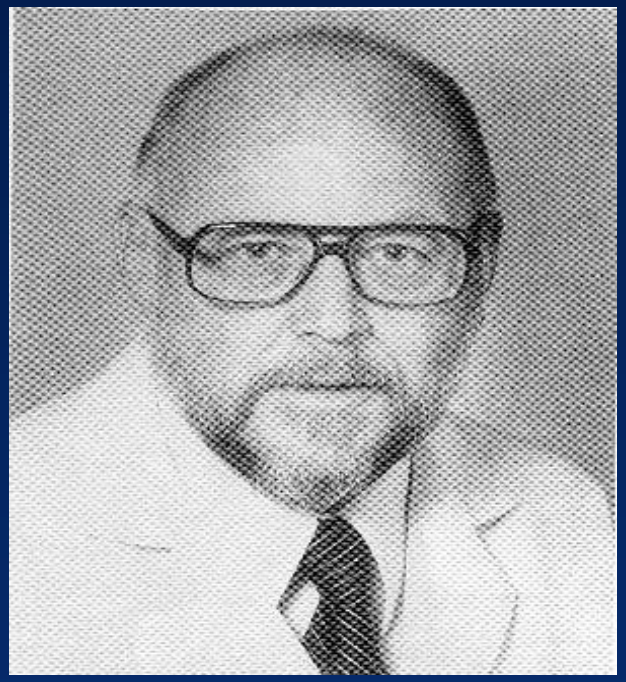
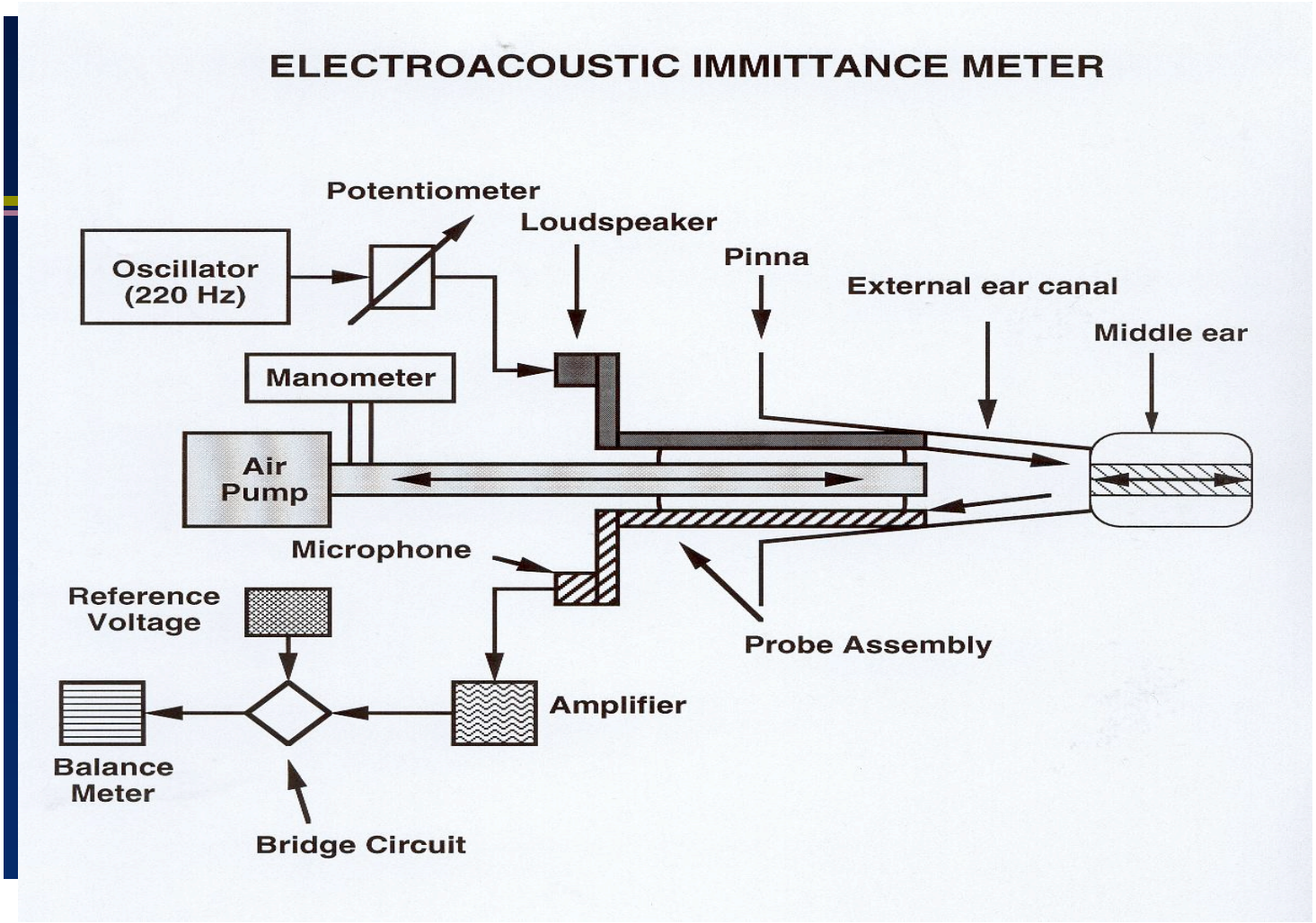
Aural Immittance (Impedance) in the 1940s: Otto Metz (1905-1995)

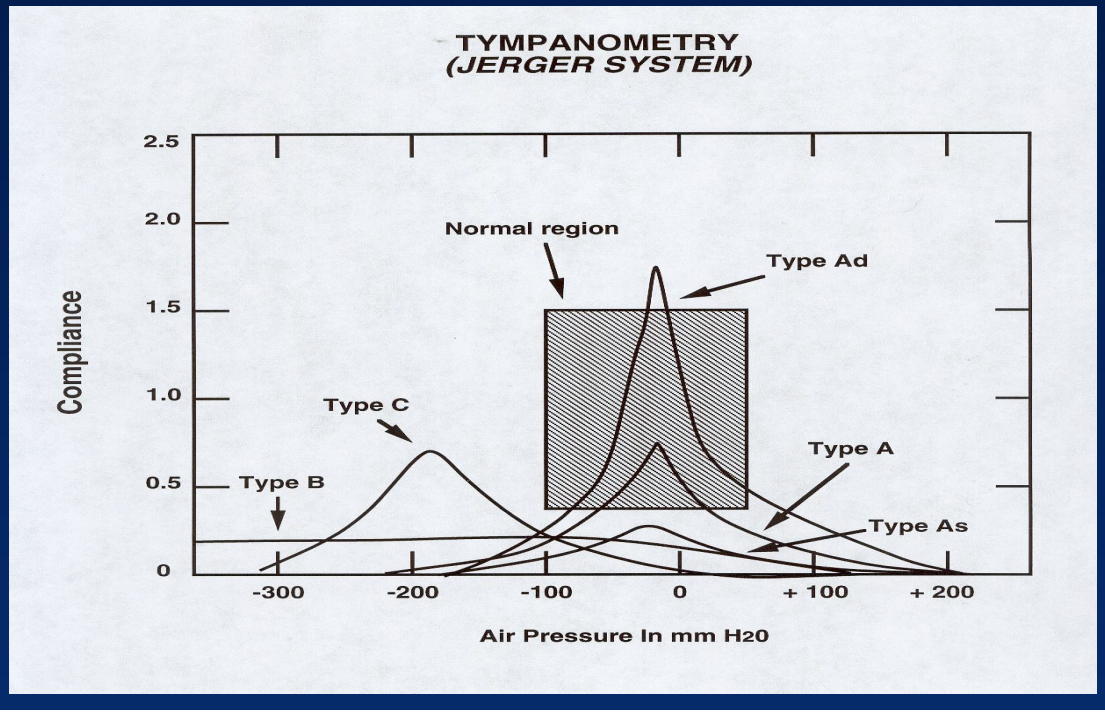


James Jerger
"Father of Diagnostic Audiology"
Observed Impedance Measurements in 1960 in Denmark




ELECTROACOUSTIC IMMITTANCE METER
Potentiometer
Loudspeaker
Oscillator
(220 Hz)
Pinna
External ear canal
Middle ear
Manometer
Air
Pump
Microphone
Reference
Voltage
Probe Assembly
Amplifier
Balance
Meter
Bridge Circuit

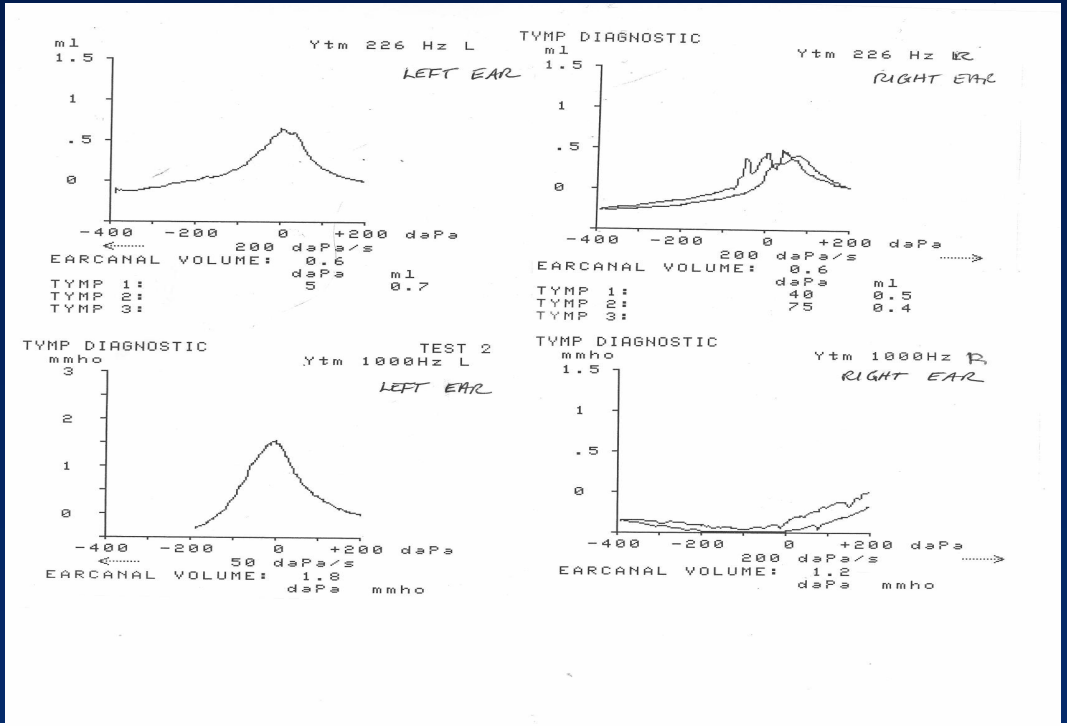
A Simple System for Categorizing Tympanograms



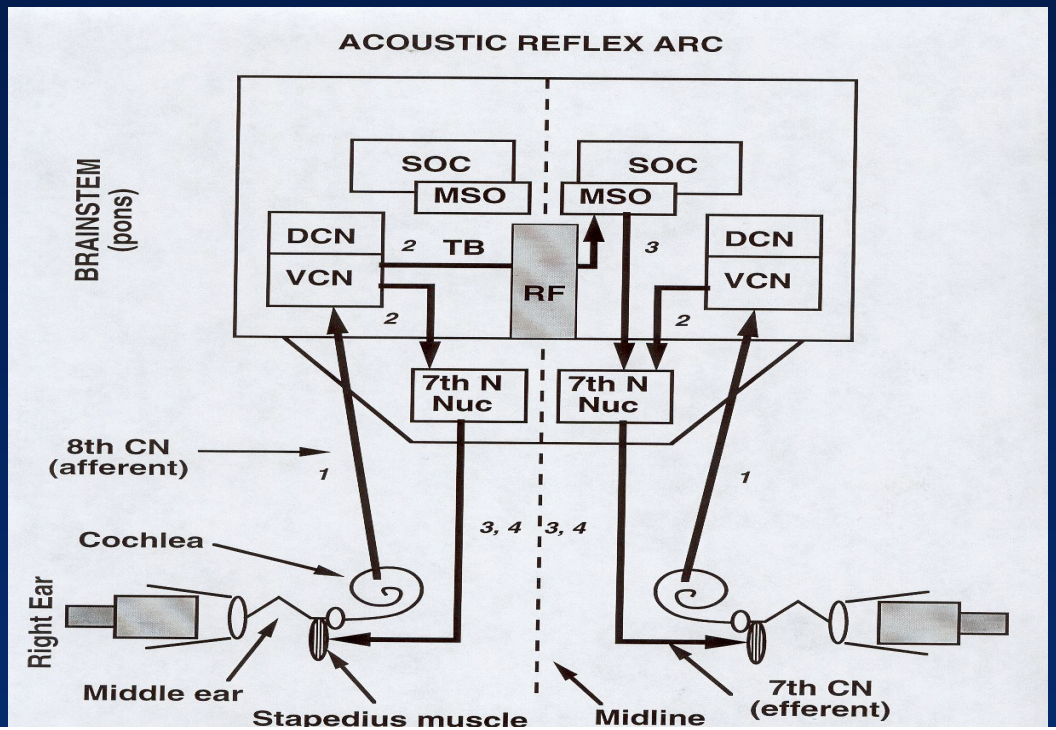
Diagnosis of Hearing Loss: Protocol for Confirmation of Hearing Loss in Infants and Toddlers (0 to 6 months)
Year 2007 JCIH Position Statement

- Child and family history
- Otoacoustic emissions
- ABR during initial evaluation to confirm type, degree & configuration of hearing loss
- Acoustic immittance measures (including acoustic reflexes) *using high frequency (1000 Hz) probe tone*
- Supplemental procedures (insufficient evidence to use of procedures as "sole measure of auditory status in newborn and infant populations")
  - Auditory steady state response (ASSR)
  - Acoustic middle ear reflexes for infants < 4 months
  - Broad band reflectance
- Behavioral response audiometry *(if feasible)*
  - ✓ Visual reinforcement audiometry *or*
  - ✓ Conditioned play audiometry
  - ✓ Speech detection and recognition
- Parental report of auditory & visual behaviors
- Screening of infant's communication milestones

Low (226 Hz) versus High (1000 Hz) Probe Tone for Infant Tympanometry



Acoustic Stapedial Reflex
(Anatomy adapted from Borg)



Plotting the Results of Acoustic Reflex Measurements

Acoustic reflex patterns ("faces")

- Conductive/efferent pattern
- Sensory pattern
- Neural pattern
- Brainstem pattern

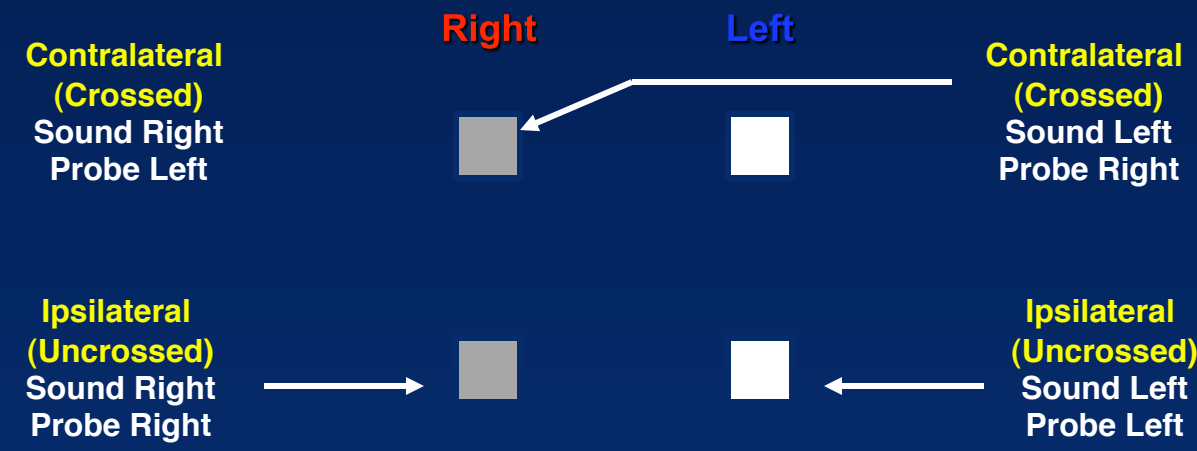
	Right	Left
Crossed (contralateral) Sound in ear		
Uncrossed (ipsilateral) Probe and sound in ear		

Plotting the Results of Acoustic Reflex Measurements

Abnormal Acoustic Reflex

Vertical pattern

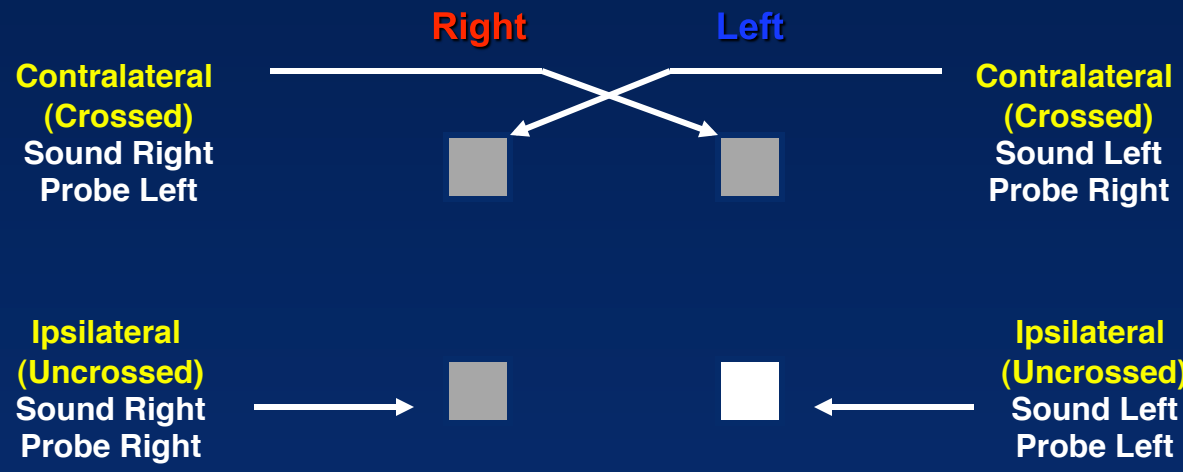
Mild conductive hearing loss pattern or efferent (7th CN) pattern (normal tymp and no air bone gap) on right ear



Plotting the Results of Acoustic Reflex Measurements

Abnormal Acoustic Reflex

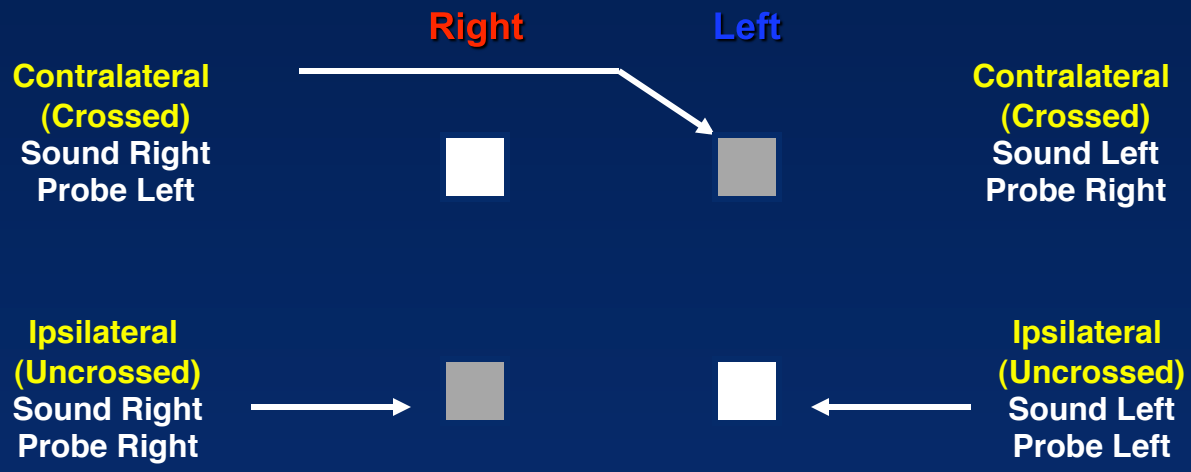
Inverted "L" pattern
Moderate or severe conductive hearing loss on right ear



Plotting the Results of Acoustic Reflex Measurements

Abnormal Acoustic Reflex

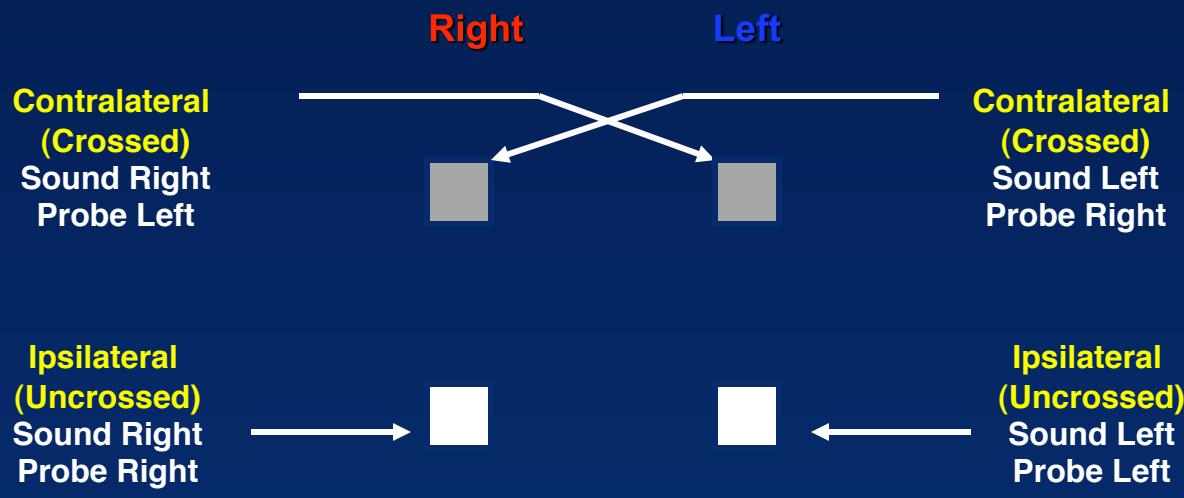
Diagonal pattern
Severe sensory hearing loss or 8th nerve auditory dysfunction on right ear



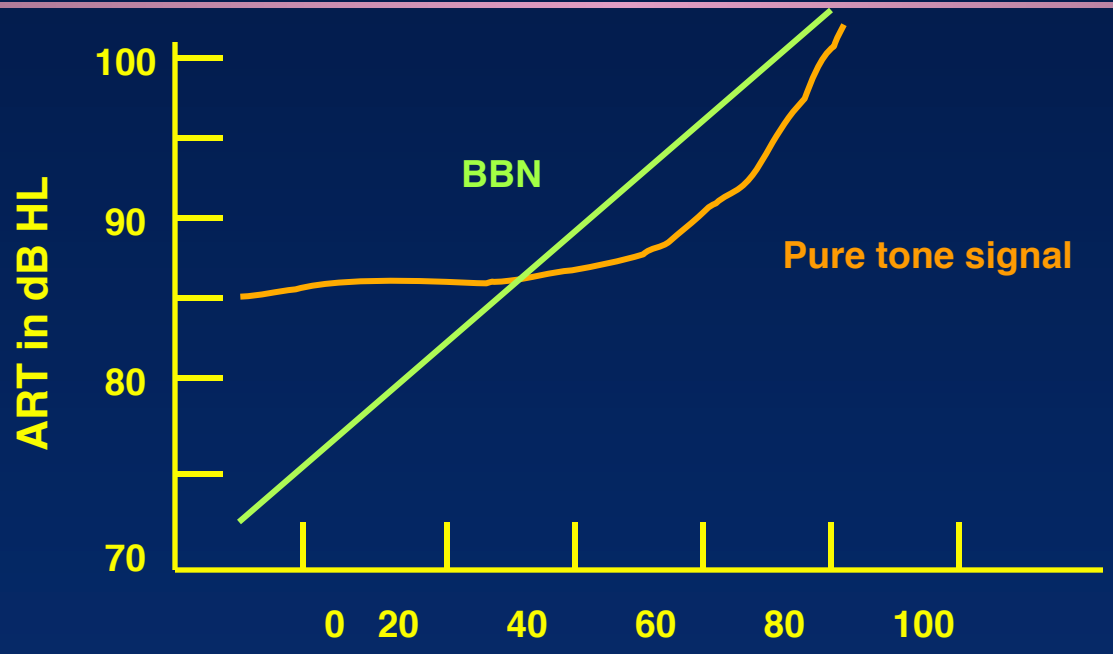
Plotting the Results of Acoustic Reflex Measurements

Abnormal Acoustic Reflex

Horizontal pattern
Brainstem auditory dysfunction



Estimation of Hearing Sensitivity with Acoustic Reflex Thresholds for Pure Tones versus Broad Band Noise (BBN): Simplified SPAR (Sensitivity Prediction by the Acoustic Reflex)



Want more information about the many valuable clinical applications of aural immittance measurements?

Page Ten. The Hearing Journal.
63 (4), April 2010

PAGE 10

The late 1960s and early 1970s were an exciting time for diagnostic audiology. A new instrument developed in Europe—the Madsen electroacoustic Zodiac (Model ZO 70)—had found its way to the U.S., and tons of data were pouring in—most notably from Dr. James Jerger. Soon there were equipment from other manufacturers, and we had all kinds of new terminology to discuss. Were we testing impedance, admittance, or immittance? Did the "S" of A_S stand for stiffness or shallow? And what about the D of A_D—deep or diametrization? Fun times.

Today, 40 years later, the immittance battery has become routine—so routine that the usefulness of the procedure may be ignored, or at least often overlooked. To take us "back to the future," we've brought in a guest author whose audiology career was emerging also if the same time as the ZO 70—and he's still running!

When **James W. (Jay) Hall III** was completing his master's degree studies in speech pathology at Northwestern University, and specifically while taking a rhinolaryngology introduction to Audiology course, he realized that audiology was his destiny. Despite that realization, he took a position as a speech pathologist at Methodist Hospital in Houston. However, soon he was spending only his mornings on speech pathology and helping out in the audiology clinic in the afternoons. During one period, his whole job was conducting impedance measurements. In the evenings, Jay took coursework at Baylor College of Medicine, and before long he completed a PhD in audiology under the direction of none other than Dr. Jerger. And it wasn't those times were the heyday of clinical research on impedance (immittance) measurements.

Dr. Hall currently is clinical professor in the Department of Communicative Disorders at the University of Florida, where he teaches doctoral courses, participates in funded research, and maintains a clinical practice. When I left him on campus, you can often find Jay in his study on the third floor of his 1927 vintage Victorian house in St. Augustine. As many of you know, Dr. Hall also is often on the road, giving lectures and workshops. He travels sometimes take him to the University of Pretoria in South Africa, where he holds the modest academic title of "Extraordinary Professor."

One of Jay's popular lectures these days is an evidence-based update on the clinical applications of aural immittance measurements. In this month's Page Ten, he'll explain why these are as important today as when they emerged 40 years ago.

GUS MUELLER
Page Ten Editor

Aural immittance measures are more useful now than ever

By James W. Hall III

James W. Hall III

1 I'm not too sure I can come up with 20 questions on this topic. These measures have been around for so many years, there's not really much new to talk about, is there?

Not so fast, my friend. There's plenty of new information on immittance measures, from valuable new clinical applications of tympanometry to uses of the acoustic reflexes to new CPT codes!

2 Okay, you've piqued my curiosity a little. So, for starters, what's with the name "aural immittance"? We called it impedance back when I was in school.

Impedance, admittance, bridges, and meters. There have been a lot of terms tossed around since this test became clinically popular back in the early 1970s. The preferred term today is "aural immittance measures." Some people use *acoustic* immittance measures, but either term is fine.

Aural impedance or admittance (combined in the hybrid term "immittance") permits estimation of external ear canal volume, documentation of the integrity of the tympanic membrane, and description of mechanical properties of the normal or abnormal middle ear. Acoustic reflexes are, of course, measured when aural immittance is measured during the presentation of high-intensity sounds to either ear. Therefore, if you say you're doing "immittance testing," that suggests you are also conducting acoustic reflex measures.

Immittance measurements are valuable clinically because they are quick, technically simple, have relatively high sensitivity and specificity, and can be recorded in persons of all ages without regard to developmental or cognitive status.

3 Got it. So let's start with the basics. What's new with tympanometry?

For starters, you're probably aware that aural immittance characteristics in infants are substantially different from those in older children and adults. Beginning in the 1970s, published reports described multi-peaked tympanograms in infants with apparently normal middle ear function and normal-appearing tympanograms with a low-frequency probe tone in neonates with middle ear pathology. Nowadays, a probe-tone frequency of 1000 Hz is recommended (e.g., Joint Committee on Infant Hearing, 2007) for tympanometry in neonates and older infants (at least up to age 4 months). Ear canal volume measurements in infants, however, should be conducted with a low-frequency (e.g., 226 Hz) probe tone. By the way, with most immittance devices, probe-tone intensity is specified in dB SPL.

4 Do you mean it's possible to record a normal tympanogram on an infant who really has middle ear pathology?

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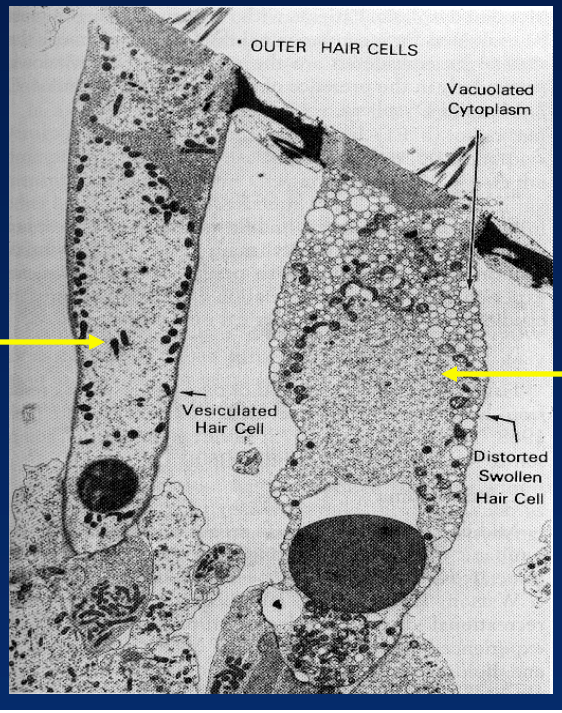
OAEs in Early Detection of Outer Hair Cell Dysfunction

Normal OHC (OAEs)



Abnormal OHC (OAEs)

CLINICAL APPLICATION OF OTOACOUSTIC EMISSIONS (OAE): General advantages

- Highly sensitive to cochlear (outer hair cell function)
- Site specific (to outer hair cells)
- Do not require behavioral cooperation or response
- Ear specific
- Highly frequency specific
- Do not require sound-treated environment
- Can be quick (< 30 seconds)
- Portable (handheld devices)
- Relatively inexpensive

CLINICAL APPLICATION OF OTOACOUSTIC EMISSIONS (OAE): Possible disadvantages

- Susceptible to effects of noise
- Affected greatly by middle ear status
- Provide cochlear information only about outer hair cells
- May be abnormal or not detected with normal audiogram
- Are not detectable with hearing loss > 40 dB HL
- Cannot be used to estimate degree of hearing loss
- Not a measure of neural or CNS auditory function
- Not a test of hearing

Selected Clinical Applications of OAEs in Pediatric Populations

- Pediatric Applications
  - Newborn hearing screening
  - Diagnosis of auditory dysfunction in infants and young children (including identification of auditory neuropathy spectrum disorder)
  - Monitoring ototoxicity*
  - Pre-school/school screenings*
  - Identification of pseudohypacusis*

** Evidence-based but under-utilized clinical application*

Clinical Applications of OAEs in Adult Populations

- Adult Applications
  - Diagnosis of cochlear versus retrocochlear auditory dysfunction
  - Identification of pseudohypacusis (malingering)
  - Monitoring ototoxicity
  - Hearing screening*
    - ✓industrial settings
    - ✓Military personnel
  - Diagnosis of auditory dysfunction in noise/music exposure *
  - Diagnosis and management of tinnitus & hyperacusis *

** Evidence-based but under-utilized clinical application*

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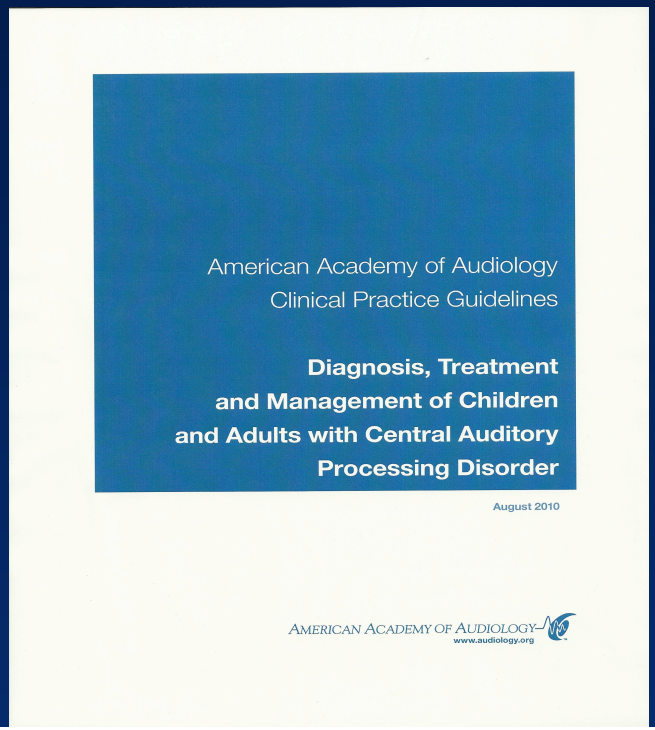
AAA Clinical Guidelines on Auditory Processing Disorders *(www.audiology.org)*




AMERICAN

Consequences of Late Identification of APD

- Reading failure
- Academic failure
- Psychosocial problems
  - Behavioral Assessment System for Children, Volume II (BASC-II)
    - ✓ A profile of adaptive and maladaptive behaviors and emotions of children and adolescents.
  - Children with APD are at risk for or have clinically significant evidence of
    - ✓ Externalizing problems (e.g., aggression, conduct problems)
    - ✓ Internalizing problems (e.g., anxiety, depression)
    - ✓ Behavioral symptoms index (e.g., withdrawal)
    - ✓ Adaptive skills (e.g., social skills, functional communication)
- May require long-term remediation
  - Increased cost and decreased benefit versus early identification and intervention

AAA Clinical Guidelines on Auditory Processing Disorders *(www.audiology.org)*

- Executive summary & Introduction
- Patient History and Selection Criteria
  - Age considerations
  - Cognitive abilities
  - Language status and proficiency
  - Speech intelligibility
  - Peripheral hearing loss

AAA Clinical Guidelines on Auditory Processing Disorders *(www.audiology.org)*

- Diagnosis (Bellis & Hall)
  - Introduction (discussion of evidence grades)
  - Minimum age for testing
  - Speech versus non-speech test stimuli
  - Efficiency and test performance
  - Behavioral tests
  - Auditory electrophysiological tests
  - Interpretation of (C) APD test results
- Intervention

AAA Clinical Guidelines on Auditory Processing Disorders *(www.audiology.org)*

- Intervention
  - Intervention components
    - ✓ Bottom up approaches
    - ✓ Top down approaches
  - Multidisciplinary team
  - Determining goals and documenting improvement
  - Intervention principles
  - Auditory training
  - Individualizing intervention
  - Sources of materials for intervention
  - Alternative sound-based programs
- Professional Issues, Training, and Education

Assessment of APD: Peripheral Test Battery (< 20 minutes)

- Otoacoustic emissions (OAEs)
  - Diagnostic protocol, e.g.,
    - ✓ 500 to 8000 Hz
    - ✓ ≥ 5 frequencies per octave
  - OAEs are abnormal in 35% of children undergoing APD assessment
- Aural immittance measures
  - Tympanometry
  - Acoustic reflexes
    - ✓ *crossed vs. uncrossed conditions … initial measure of CNS function*
- Pure tone audiometry
  - Inter-octave frequencies (e.g., 3000 and 6000 Hz)
  - High frequency (> 8000 Hz) audiometry (as indicated)
- Speech audiometry
  - Word recognition (use CD materials with 10 most difficult words first)

APD ASSESSMENT:
Behavioral Test Battery for Auditory Processes (1)
(ASHA, 2005; AAA, 2010)

- **Auditory Discrimination Tests:** Assess the ability to differentiate similar acoustic stimuli that differ in frequency, intensity, and/or temporal parameters, e.g.,
  - Difference limens for frequency, intensity, and duration
  - Psychophysical tuning curves
  - Phoneme discrimination).
- **Auditory Temporal Processing and Patterning Tests:** Assess the ability to analyze acoustic events over time, e.g.,
  - Sequencing and patterns
  - Gap detection (Gaps in Noise, GIN, test)
  - Forward and backward masking)
- **Dichotic Speech Tests:** Assess the ability to separate (i.e., binaural separation) or integrate (i.e., binaural integration) disparate auditory stimuli presented to each ear simultaneously, e.g.,
  - Dichotic CVs
  - Dichotic digits
  - Dichotic words
  - Dichotic sentence identification

APD ASSESSMENT:
Behavioral Test Battery for Auditory Processes (2)
(ASHA, 2005; AAA, 2009)

- **Monaural Low-Redundancy Speech Tests:** Assess recognition of degraded speech stimuli presented to one ear at a time (e.g., filtered, time-altered, intensity- altered, e.g.,
  - Performance-intensity PI-PB functions
  - Speech-in-noise or speech-in-competition
    - ✓ Synthetic sentence identification with ipsilateral competing message (SSI-ICM)
    - ✓ Listening in Spatialized Noise-Sentences (LiSN-S) procedure
  - Hearing In Noise Test (HINT)
  - Speech In Noise (SIN or QuickSIN) test
- **Binaural Interaction Tests:** Assess binaural (i.e., diotic) processes dependent on intensity or time differences of acoustic stimuli, e.g.,
  - Masking level difference
  - Localization & lateralization (e.g., LiSN-S)

Auditory Processing Disorders in Adults: Risk Factors and Clinical Indications

- Medical history
- Audiological history
  - Communication complaints greater than expected by audiogram
  - Deterioration in communication abilities with stable audiogram
  - Unusually poor benefit from amplification
- Audiological findings
  - Abnormality for crossed versus uncrossed acoustic reflexes
  - Speech audiometry
    - ✓ Very poor speech perception
    - ✓ Rollover on PI PB functions
    - ✓ Problems with speech in noise
  - Slow response time and processing speed
  - Poor benefit from amplification

Auditory Processing Disorders in Adults: Some of the Etiologies

- Aging of the central auditory nervous system
  - Longstanding evidence
  - Recent findings
- Combined peripheral and central auditory disorders
  - Central auditory dysfunction with progressive peripheral hearing loss
  - Peripheral hearing loss with progressive central auditory dysfunction
- Psychiatric/Neurological disorders, e.g.,
  - Neoplasms
  - Cardiovascular disease
  - Dementias (Alzheimer's dementia)
  - Schizophrenia?
  - Parkinson's Disease
- Traumatic head injury
  - Motor vehicle accidents
  - Gunshot wounds
  - Military blasts and explosions

Screening for Auditory Processing Deficits

- Patient history
- Close attention to risk factors
- Ipsilateral versus contralateral acoustic reflexes
- Dichotic digits
- Speech in noise test

Update on Diagnostic Audiology: Reliance on Value-Added Tests

- Our old and worn out audiologic test battery
- Defining “best practices” and “standard of care”
- The concept of value added tests (VATs)
- A modern diagnostic audiology test battery
  - Aural immittance measures are still valuable
  - OAEs add value to audiologic assessment
  - Screening for auditory processing deficits
- Linkage between selected diagnostic procedures and intervention outcome
  - Aural immittance measures
  - ASSRs
  - OAEs
  - Measures of auditory processing

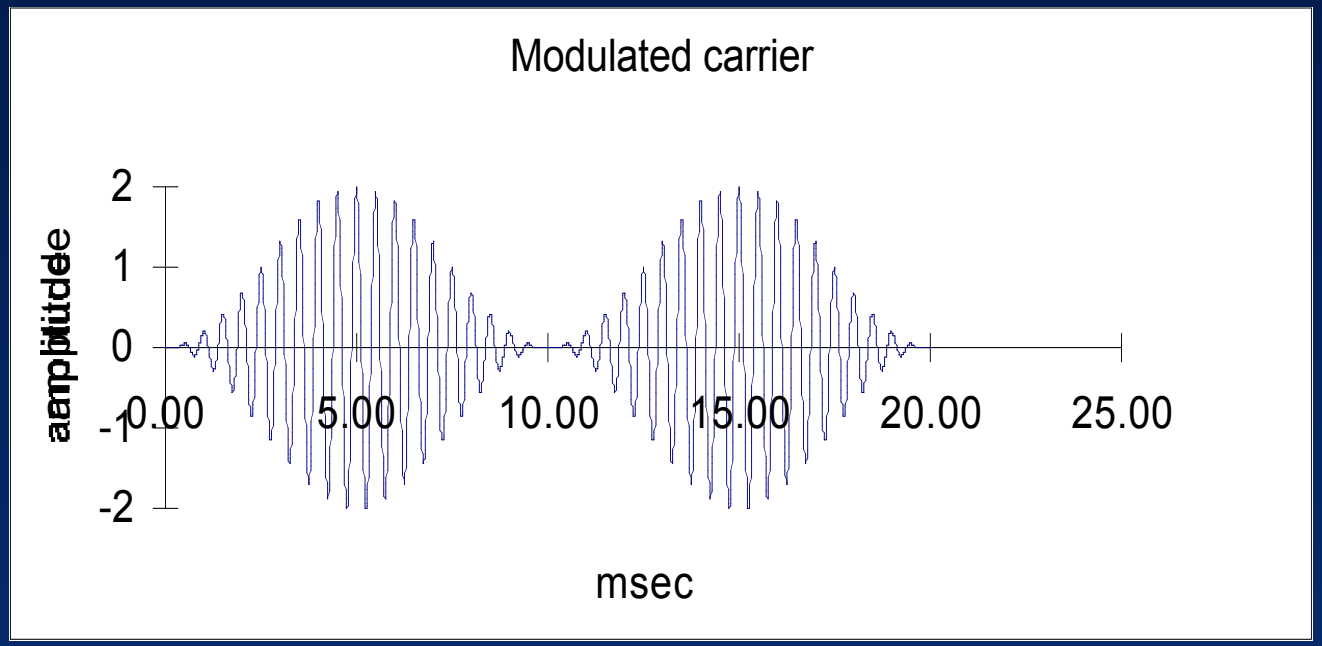
Linkage between Diagnostic Procedures and Intervention Outcome
Aural Immittance Measurement

- Diagnostic information
  - Differentiation of middle ear versus sensory auditory dysfunction
  - Objective confirmation of sensory hearing loss (acoustic reflexes)
  - Objective evidence of retrocochlear auditory dysfunction (acoustic reflexes)
  - Objective evidence of central auditory nervous system dysfunction (acoustic reflexes)
- Impact on Intervention Outcome
  - Prompt medical management of middle ear disorder
  - Cost effective and lower risk decisions regarding further diagnostic test procedures (e.g., ABR under anesthesia)
  - Timely referral for otologic consultation and MRI referral
  - Timely referral for APD assessment or neurological consultation

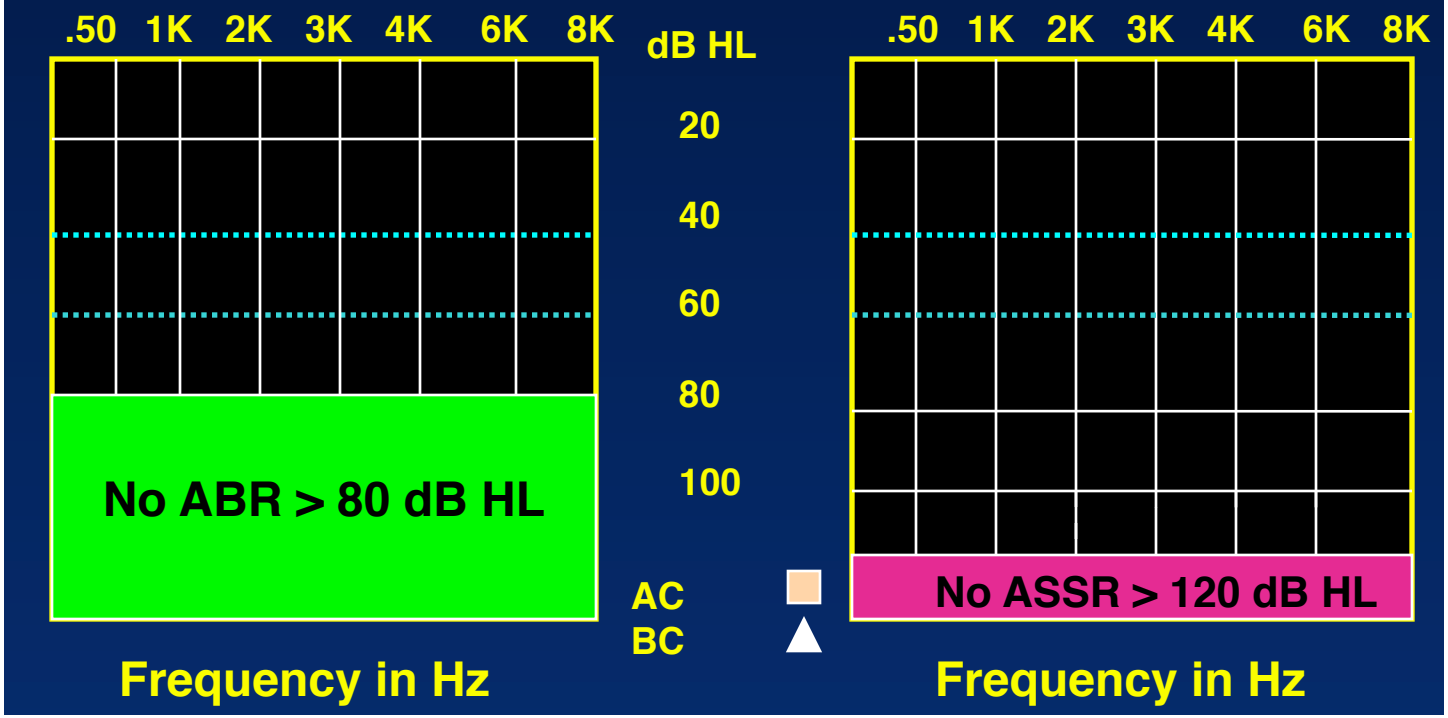
Year 2007 JCIH Position Statement: Protocol for Evaluation for Hearing Loss In Infants and Toddlers from Birth to 6 months

- Child and family history
- Evaluation of risk factors for congenital hearing loss
- Parental report of infant's responses to sound
- "Clinical observation of infant's auditory behavior. *Behavioral observation alone is not adequate for determining whether hearing loss is present in this age group, and is not adequate for the fitting of amplification devices."*
- Audiological assessment
  - Auditory brainstem response (ABR)
    - ✓ Click-evoked ABR with rarefaction and condensation single-polarity stimulation if there are risk factors for auditory neuropathy
    - ✓ Frequency-specific ABR with air-conduction tone bursts
    - ✓ Bone-conduction stimulation (as indicated)
  - Otoacoustic emissions (distortion product or transient OAEs)
  - Tympanometry with 1000 Hz probe tone
  - Supplemental procedures, e.g.,
    - ✓ Electrocochleography (ECochG)
    - ✓ Auditory steady state response (ASSR)
    - ✓ Acoustic reflex measurement (for 1000 Hz probe tone)

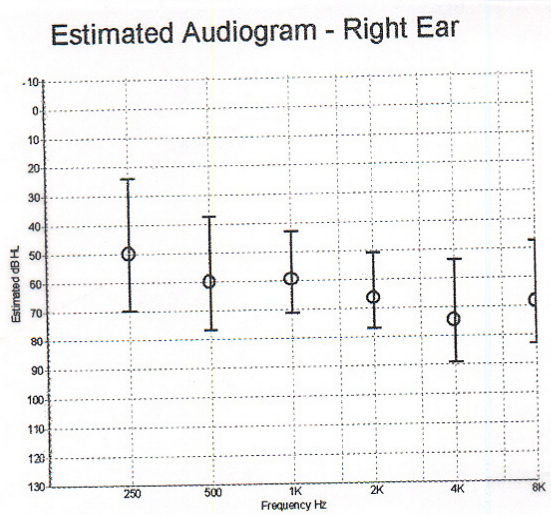
Auditory Steady State Response (ASSR): 2000 Hz tone modulated at rate of 100 Hz

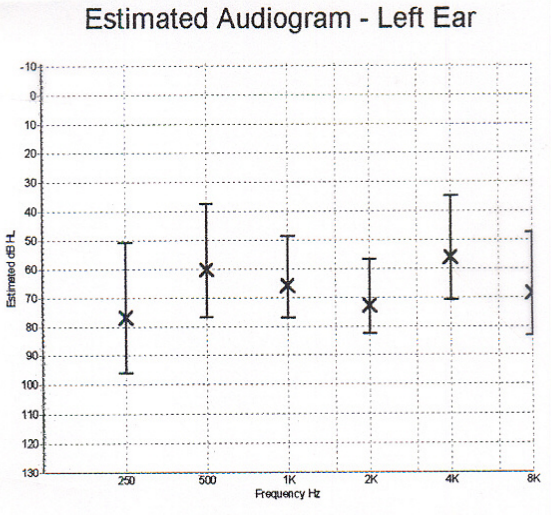


Limitation of Tone Burst ABR in Severe-to-Profound Hearing Loss

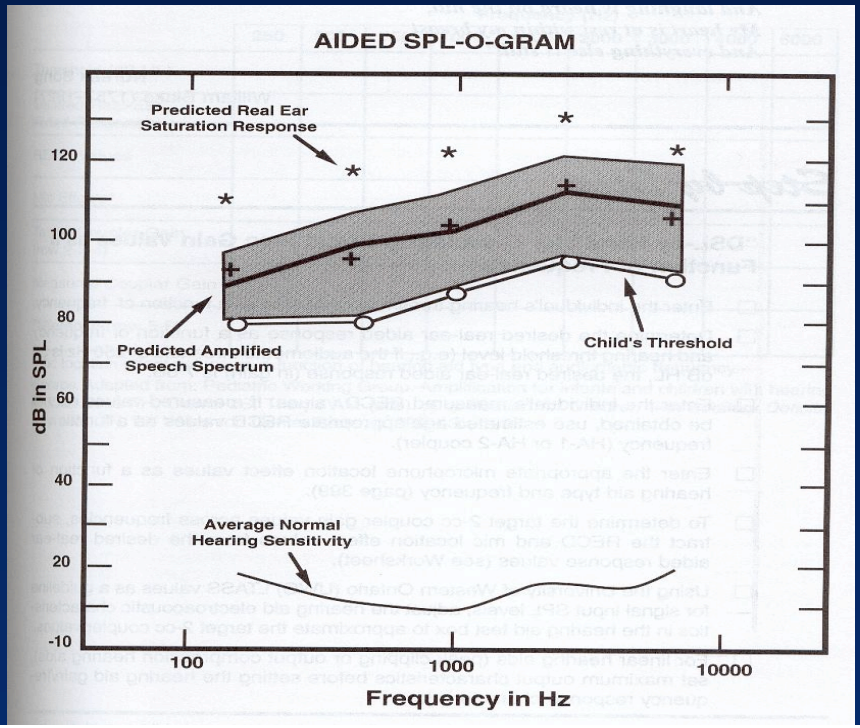


ASSR Measurement:
Frequency-Specific Thresholds from 250 to 8000 Hz

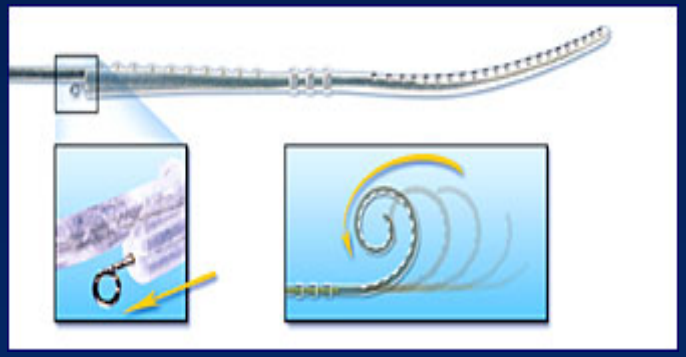




Estimation of Frequency-Specific Auditory Thresholds with Auditory Electrophysiology: DSL Hearing Aid Fitting



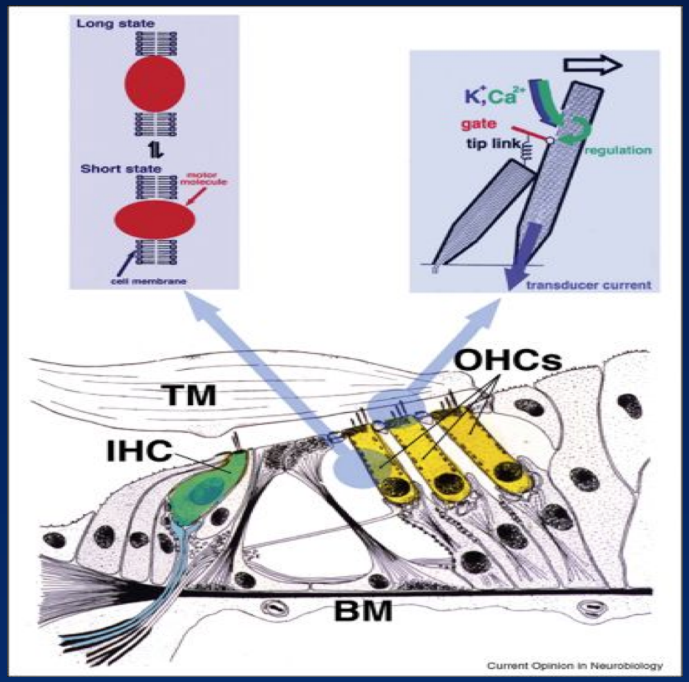
Management of Infant Hearing Loss: Cochlear Implants



Linkage between Diagnostic Procedures and Intervention Outcome
Auditory Steady State Response (ASSR)

- Diagnostic information
  - Objective estimation of severe-to-profound hearing loss in infants and young children
- Impact on Intervention Outcome
  - Timely and confident decisions regarding management with cochlear implants versus amplification significantly improve communication outcome

Cochlear Origins of OAEs



Linkage between Diagnostic Procedures and Intervention Outcome: *Otoacoustic Emissions (OAEs)*

- Diagnostic information
  - Early detection of cochlear (outer hair cell) dysfunction
  - Objective confirmation of sensory auditory dysfunction in infants
  - Frequency specific details on cochlear dysfunction
- Impact on Intervention Outcome
  - Preventative measures for persons at risk for noise/music hearing loss
  - Preventative measures or modification of drug therapy for persons at risk for ototoxicity related hearing loss
  - Effective and appropriate management of pseudohypacusis
  - Effective and appropriate management of tinnitus
  - Early intervention for permanent sensory hearing loss in infants
  - Early intervention for auditory neuropathy spectrum disorder (ANSD)
  - Decision to include FM technology in management of APD

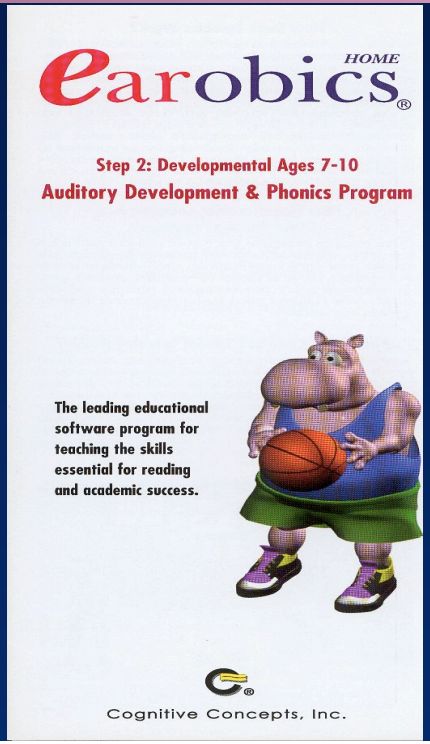
AAA Clinical Guidelines (2010) on Auditory Processing Disorders: Terminology for Habilitation/Rehabilitation

- **Intervention**: "…encompassing term referring to one or more actions taken in order to produce an effect and to alter the course of a disease, disorder, or pathological condition."
- **Treatment:** "…any specific procedure used to prevent, remediate (I.e., cure), or ameliorate a disease, disorder, or pathological condition."
- **Management**: "…refers to compensatory approaches (e.g., strategies, technologies) used to reduce the impact of deficits that are resistant to remediation."

Linkage between Diagnostic Procedures and Intervention Outcome
Measures of Auditory Processing

- Diagnostic information
  - Identification of central auditory nervous system dysfunction
  - Differentiation among types of auditory processing deficits
- Impact on Intervention Outcome
  - Timely referrals for
    - ✓ Comprehensive APD assessment
    - ✓ Speech-language consultation
    - ✓ Neurological consultation
    - ✓ Neuro-psychological consultation
  - Implementation of treatment, including:
    - ✓ Auditory training, e.g., Earbobics or LACE (Listening and Communication Enhancement)
    - ✓ FM technology
    - ✓ Amplification

APD MANAGEMENT: Computer-based Auditory Therapy (www.cogcon.com)



Earobics comes in two versions:

Earobics Foundations for pre-kindergarten, kindergarten, and first grade students

- **Earobics Connections for second and third grade students, and other struggling readers**

Instructions available in 10 languages

Dichotic Intensity Increment Difference (DIID) Tasks

- Binaural separation
- Ear directed targets (monaural)
- Ear directed targets (binaural)
- Ear directed manipulations
- Ear directed judgments
- Intensity, clarity
- Materials should be a mixture of dichotic materials
  - Digits
  - Spondee words
  - Single syllable words
  - Sentences

Dichotic Intensity Increment Difference (DIID) Tasks

Deborah W. Moncrieff*
Diane Wertz

*** Department of Communication Science and Disorders, University of Pittsburgh, USA**

***International Journal of Audiology 2008*; 47:84Auditory rehabilitation for interaural asymmetry: Preliminary evidence of improved dichotic listening performance following intensive training**

Phonak EduLink FM System Use Improves Academic Performance and Psychosocial Status in Children with APD

Johnston, John, Kreisman, Hall & Crandell. (2009). Multiple benefits of personal FM system use by children with auditory processing disorder (APD). *International Journal of Audiology, 48*, 371 - 383

EduLink Receivers

Campus S

Transmitter

Mini-Boom Microphone

Toward a Modern Diagnostic Audiologic Test Battery

(In the order of testing for new patients. Test time < 1 hour.)

- Objective measures
  - Otoacoustic emissions (OAEs)
    - ✓ Diagnostic protocol for DPOAEs and/or TEOAEs
  - Aural immittance measures
    - ✓ Tympanometry
    - ✓ Acoustic reflexes (*crossed vs. uncrossed conditions)*
- Behavioral measures
  - Pure tone audiometry *(automated technique as appropriate)*
    - ✓ Inter-octave frequencies (e.g., 3000 and 6000 Hz)
    - ✓ High frequency (> 8000 Hz) audiometry as indicated
    - ✓ Bone conduction measurement only as indicated
  - Speech audiometry
    - ✓ SRT only as indicated
    - ✓ Word recognition using CD materials with 10 most difficult words first
    - ✓ Screening measure of speech perception in noise, as indicated by history or findings
    - ✓ Screening measure of dichotic listening, as indicated by history or findings

Update on Diagnostic Audiology: Reliance on Value-Added Tests

Questions?