Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

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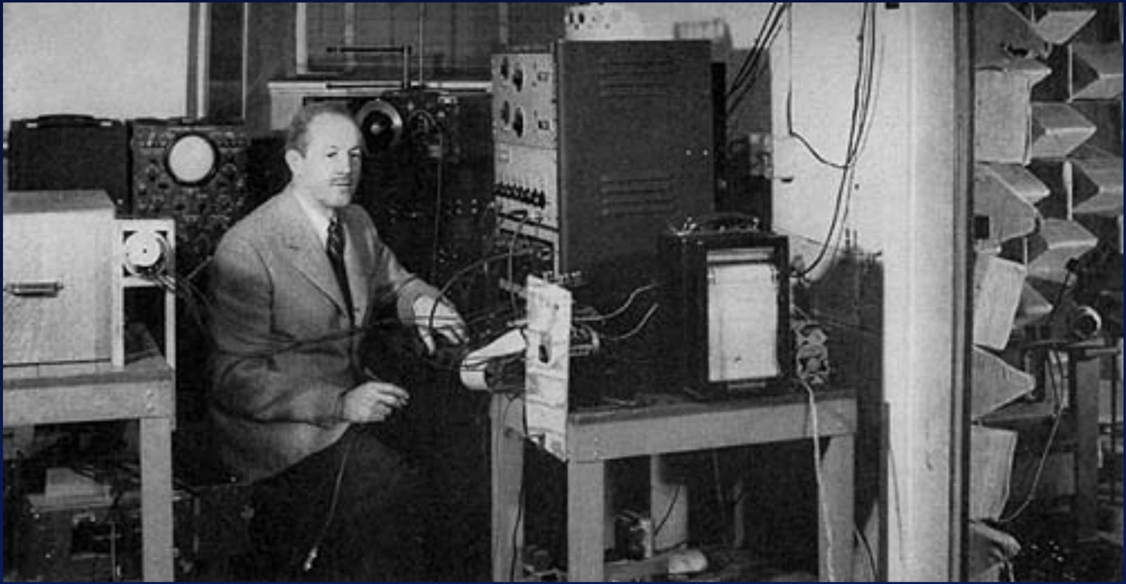
Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

- Historical Perspective
- Standard of Care in Audiology
- Definition of Best Practices
- Rationale for Best Practices
- Concept of Value Added Tests
- Clinical Practice Guidelines
- Guidelines for Efficient and Effective Diagnostic Test Batteries
- Summary, Questions and Answers

Scientific Foundation of Audiology
Psychoacoustics Laboratory (PAL)
Harvard University (1940s and 1950s)



SS Stevens

(1906-1973)

Scientific Foundations of Audiology
Our Audiology Grandparents

Georg von Bekesy
(1899 - 1972)

Nobel Prize for
Physiology or Medicine 1961

GSI E800
Bekesy Audiometer

Scientific Foundations of Audiology
Our Audiology Grandparents

Harvey Fletcher
(1884-1981)

PhD from University of Chicago under Nobel Prize Winner Robert Miliken

Illustrious Career at Bell Telephone Laboratories

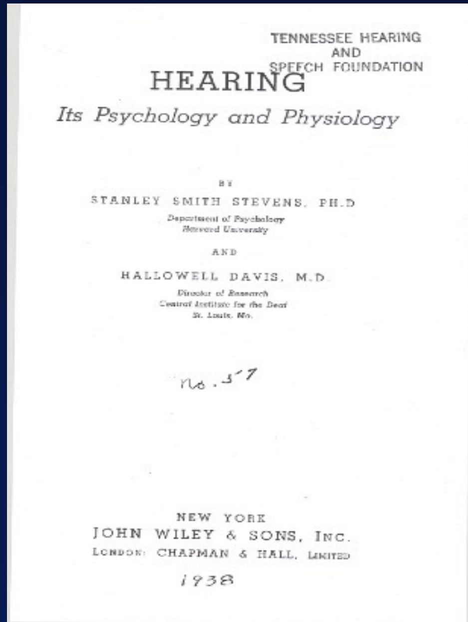
Seminal Publications, e.g.

Fletcher H (1929). Speech and Hearing. New York: D Van Nostrand

Fletcher H & Steinberg JC (1929). Articulation testing methods. Bell System Technical Journal, 8, 806-854

Scientific Foundations of Audiology
Our Audiology Grandparents

Hallowell Davis
(1896 - 1992)



TENNESSEE HEARING
AND
SPEECH FOUNDATION

HEARING
Its Psychology and Physiology

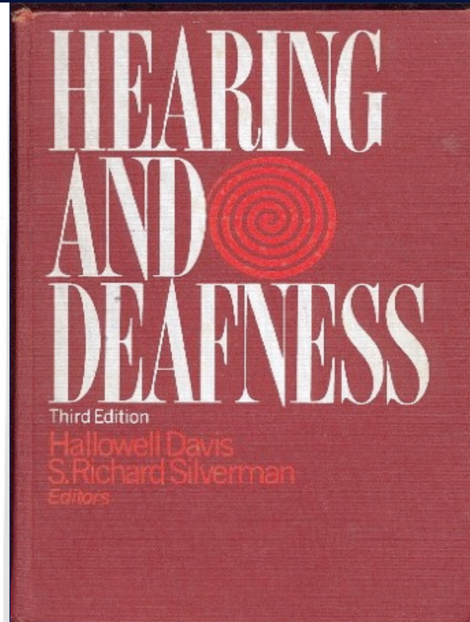
BY
STANLEY SMITH STEVENS, PH.D
Department of Psychology
Harvard University

AND

HALLOWELL DAVIS, M.D
Director of Research
Central Institute for the Deaf
St. Louis, Mo.

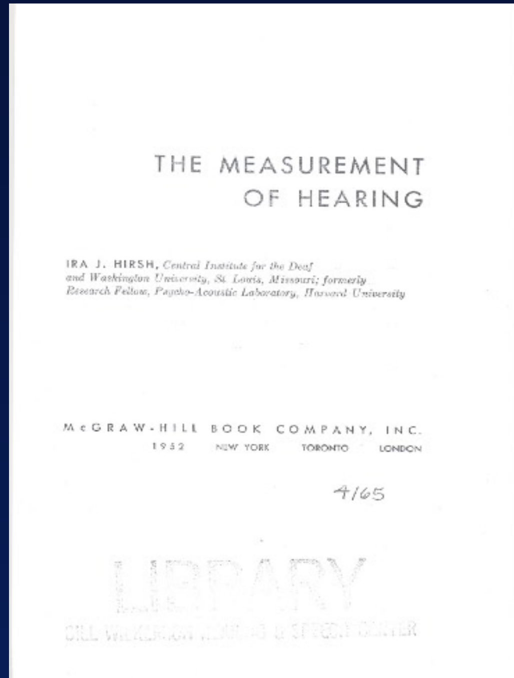
No. 57

NEW YORK
JOHN WILEY & SONS, INC.
LONDON: CHAPMAN & HALL, LIMITED
1938



Scientific Foundations of Audiology
Our Audiology Grandparents

Ira Hirsh
(1922 - 2010)



THE MEASUREMENT
OF HEARING

IRA J. HIRSH, *Central Institute for the Deaf and Washington University, St. Louis, Missouri; formerly Research Fellow, Psycho-Acoustic Laboratory, Harvard University*

McGRAW-HILL BOOK COMPANY, INC.
1952 NEW YORK TORONTO LONDON

4/65

Scientific Foundations of Audiology

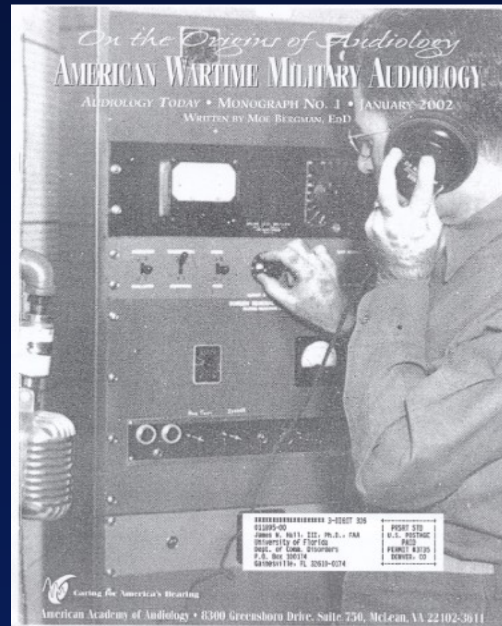
Our Audiology Grandparents

The Hearing Journal, 64 (8), 2011

Robert Galambos, PhD, MD
(1914 - 2010)

Origins of Audiology in the USA

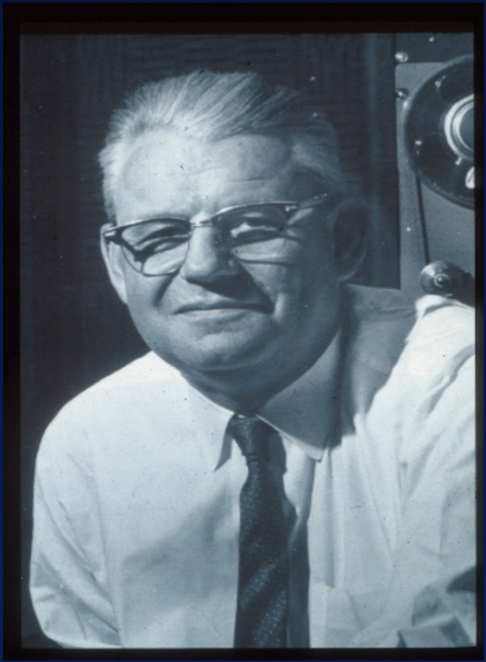
Demand for Hearing Services During and After WW II



Raymond Carhart: Father of Audiology
Developed Audiology Test Battery 70+Years Ago
(Audiology Father of James Jerger)

- 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)

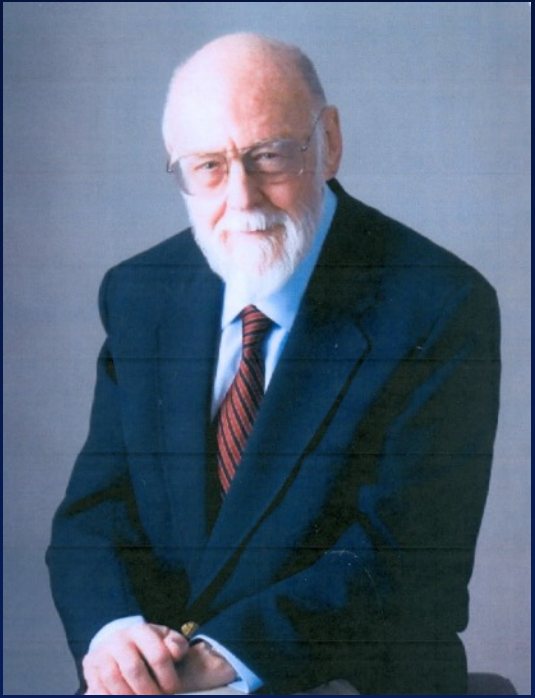
Source: Wiener F & Miller G. Hearing aids. In Combat Instruments II. Washington, D.C. NDRC Report 117, 216-232, 1946



Raymond Carhart

Scientific Foundation of Audiology
James Jerger, PhD … My Audiology Father

Father of Diagnostic Audiology; Founder of American Academy of Audiology



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Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

Standard of Care

- The degree of caution that a reasonable person should exercise in a given situation so as to avoid causing injury … try to help but do not harm
- Consistent with local, regional or national clinical practice
- Follows guidelines on clinical practice approved by
  - Multi-disciplinary professional committees or panels, e.g., Joint Committee on Infant Hearing
  - National professional organizations
- Is consistent with statements of
  - Scope of Practice
  - Code of Ethics
- In compliance with Federal guidelines for clinical practice

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Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Best Practice is Evidence-Based Practice (EBP)

"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."

"The noblest pleasure is the joy of understanding."

Leonardo Da Vinci

(April 15, 1452 - May 2, 1519)

Evidence-Based Practice … Introduced in 1992
David L. Sackett, MD

to create "win-win" relationships. By extension, critics of competition maintain that the NHS should do the same. These developments have been reinforced by concerns about the increase in management costs associated with the introduction of competition.

Estimates suggest that the NHS reforms may have resulted in up to £1bn extra being spent on administration, although changes in definitions make it difficult to be precise. This is because of the need to employ staff to negotiate and monitor contracts and to deal with the large volumes of paperwork involved in the contracting system. Ministers have responded to these concerns by streamlining the organisation of the NHS and introducing tight controls over management costs. They have also encouraged the use of long term contracts in order to reduce the transaction costs of the new arrangements.

Out of the ashes of competition has arisen a different policy agenda. This owes less to a belief in market forces than a desire to use the NHS reforms to achieve other objectives. The current agenda centres on policies to improve the health of the population, give greater priority to primary care, raise standards through the patient's charter, and ensure that medical decisions are evidence based. These policies hinge on effective planning and coordination in the NHS and all have been made more salient by the separation of purchaser and provider roles on which the reforms are based.

In particular, the existence of health authorities able to take an independent view of the population's health needs without

improvements in efficiency and quality, and the limitations of planning must also be acknowledged. While competition as a reforming strategy may have had its day, there are nevertheless elements of this strategy which are worth preserving. Not least, the stimulus to improve performance which arises from the threat that contracts may be moved to an alternative provider should not be lost. The middle way between planning and competition is a path called contestability. This recognises that health care requires cooperation between purchasers and providers and the capacity to plan developments on a long term basis. At the same time, it is based on the premise that performance may stagnate unless there are sufficient incentives to bring about continuous improvements. Some of these incentives may be achieved through management action or professional pressure, and some may derive from political imperatives.

In addition, there is the stimulus to improve performance which exists when providers know that purchasers have alternative options. This continues to be part of the psychology of NHS decision making, even though ministers seem reluctant to use the language of markets. It is, however, a quite different approach than competitive tendering for clinical services, which would expose providers to the rigours of the market on a regular basis.

The essence of contestability is that planning and competition should be used together, with contracts moving only when other means of improving performance have failed. Put

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency
Best Practices

Sackett's definition of evidence-based medicine adapted to audiology:

… the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients with hearing loss and related disorders. The practice of evidence based audiology means integrating individual clinical expertise with the best available external clinical evidence from systematic research."

David L. Sackett, MD
"Father of Evidence-Based Practice"

Best Practice is Evidence or Research Based Practice

- Evidence-based practice is *"the integration of best research evidence with clinical expertise and patient values"* (Sackett et al, Evidence-Based Medicine: How to practice and teach EBM. London: Churchill, 2000, p. 1)
- EBP is a five step process
  - Focused clinical question
  - Evidence is sought to answer the question
  - Clinician evaluates the quality of evidence
  - Clinician must integrate the evidence with the patient's clinical findings and preferred outcome to develop intervention plan
  - Document outcome and identify ways to improve it

Evidence-Based Practice: Categories of Research Evidence

(ASHA, 2004)

1a: Well-designed meta-analysis of randomized controlled trials

1b: Well-designed randomized controlled trials

2a: Well-designed controlled studies without randomization

2b: Well-designed quasi-experimental studies

3: Well-designed non-experimental studies, i.e., correlational and case studies

4: Expert committee reports, consensus conferences and clinical experience

Literature on Best Practices is Now Easily Accessible

(www.nlm.nih.gov/PubMed)

auditory processing disorders - PubMed - NCBI 2/10/18, 2(00 PM

PubMed | auditory processing disorders

Format: Summary **Sort by**: Most Recent **Per page**: 20

Search results

Items: 1 to 20 of 5399

1. Varying acoustic-phonemic ambiguity reveals that talker normalization is obligatory in speech **processing**.
Choi JY, Hu ER, Perrachione TK.
Atten Percept Psychophys. 2018 Feb 7. doi: 10.3758/s13414-017-1395-5. [Epub ahead of print]
PMID: 29417449

2. Neuropsychological performance in patients with asymptomatic HIV-1 infection.
Martínez-Banfi M, Vélez JI, Perea MV, García R, Puentes-Rozo PJ, Mebarak Chams M, Ladera V.
AIDS Care. 2018 Feb 7:1-11. doi: 10.1080/09540121.2018.1428728. [Epub ahead of print]
PMID: 29411628

3. Influence of non-contextual **auditory** stimuli on navigation in a virtual reality context involving executive functions among patients after stroke.
Cogné M, Violleau MH, Klinger E, Joseph PA.
Ann Phys Rehabil Med. 2018 Jan 31. pii: S1877-0657(18)30007-1. doi: 10.1016/j.rehab.2018.01.002. [Epub ahead of print]

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

- Procedure adds value to the description of auditory status for the patient, including information that is:
  - Not available from other procedures and/or
  - Obtained quicker than with another procedure and/or
  - Poses less risk than an alternative procedure and/or
  - Costs less than a comparable procedure
  - Findings are more reliable or valid than an alternative test
  - Highly sensitive to auditory dysfunction
  - Provides site-specific information on auditory dysfunction
  - Contributes to more accurate diagnosis
  - Useful in managing the patient and/or
  - Information leads to better outcome for the patient

The Concept of Value Added Tests (VATs): *Old versus New Procedures*

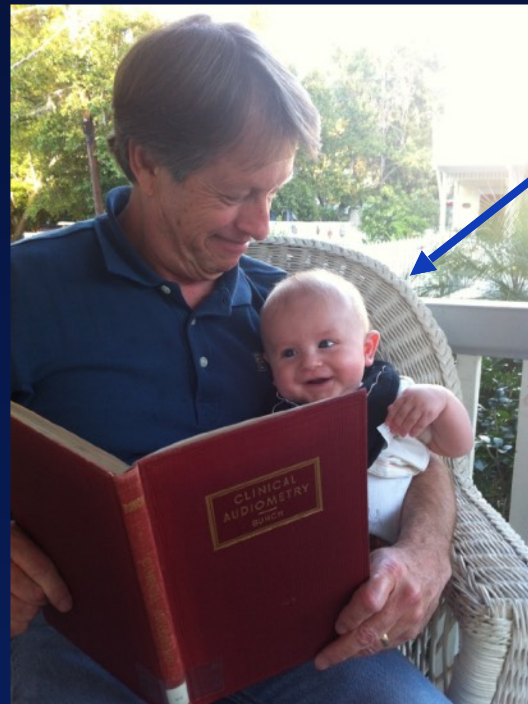
- Some old procedures almost always add value, e.g.,
  - Tympanometry
  - Acoustic reflexes
- Some more recent procedures almost always add value, e.g.,
  - Otoacoustic emissions
- Some traditional test procedures do ***not*** invariably add value, e.g.,
  - Pure tone audiometry
  - Speech recognition threshold (SRT)
  - Bone conduction pure tone audiometry
  - Word recognition in quiet at 40 dB SL

The Concept of Value Added Tests (VATs):
A Critical Look at an Old but Trusted Procedure

Clinical Audiometry

CC Bunch

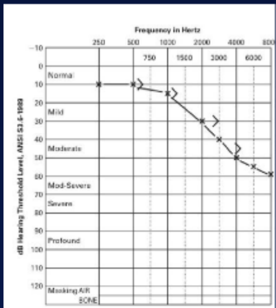
1943



Pure Tone Audiometry is a Poor Measure of "Hearing"

- Pure tone audiometry with air conduction is routine performed in 100% of adult patients
- Measures the simplest of auditory processes
  - Detection of sound in quiet
  - Perception of simplest of sounds … sinusoid
- Thresholds are available for only 8 frequencies
  - 6 octave frequencies
  - 2 inter-octave frequencies
- Normal human ear perceives frequencies from 20 to 20,000 Hz
- Audiogram is a tiny and inadequate sample of this frequency range
  - 20,000 – 8 = 19,992
  - 8/19,992 = 0.00005%

Let's Consider Removing the Audiogram from It's Exalted Pedestal



- Audiogram doesn't reflect real-world hearing demands
  - We don't need to hear pure tones
  - Threshold estimates are made in a quiet setting
- Audiogram has little relation to hearing handicap or everyday *listening* problems
  - People with hearing loss may communicate effectively
  - People with normal audiogram may have serious communication problems
  - Two people with the same audiogram may have very different experiences

Hearing Sensitivity is NOT "Hearing" and Hearing is NOT Listening

- Hearing sensitivity … mostly assesses the ear
  - Ability to detect sound
  - Measurement of threshold for pure tones or speech
- Hearing … involves the entire auditory system from cochlea to cortex
  - "Bottom up" process
  - "Sensory based passive process" (Beck & Flexer, 2011)
  - Typically requires little or no effort and is not switched on or off
- Listening
  - Active process
  - Requires
    - ✓ Effort
    - ✓ Attention and attending to specific signal
    - ✓ Related to cognition

Listener Variables May Contribute to Invalid “Abnormal” Audiograms in Patients with Normal Auditory Function

- Motivation
- Attention
- Fatigue
- Motor disorder (can’t perform response task)
- Impaired cognitive function
  - Low cognitive function or developmental delay in children
  - Cognitive impairment or dementia in adults
- Language factors
  - ✓Language delay
  - ✓Language impairment
  - ✓Not a native speaker of tester’s language … patient doesn’t understand task

The Concept of Value Added Tests (VATs):
Traditional Speech Audiometry Procedures Do Not Invariably Add Diagnostic Value (and may waste time)

- Speech awareness or detection threshold (SDT or SAT)
- Speech recognition threshold (SRT) *Performed in 99.5% of patients*
- Bone conduction pure tone audiometry *Performed In 73% of patients*
- Word recognition performance *Performed In 91% of patients*
  - 25 word lists with random difficulty
  - Words presented under earphones
  - Words presented in quiet
  - Words presented at 40 dB SL
  - Fixed time interval (~ 2 seconds) between words
  - Carrier phrase precedes each word (“Say the word …”)

The Concept of Value Added Tests (VATs): A Critical Look at Three Traditional Procedures
Speech Recognition Threshold (SRT)

- Study of 1000 pediatric and adult patients (Roscher & Hall, 2005)
- SRT did not contribute to diagnosis of hearing loss in majority of patients
- SRT didn't differ from PTA
  - For almost all patients within age range of 20 to 70 years
  - In persons with normal hearing thresholds
- Listener variables that influence accuracy of PTA also compromise SRT, e.g.,
  - Attention
  - Memory
  - Other cognitive functions
  - Motivation

The Concept of Value Added Tests (VATs): A Critical Look at Three Traditional Procedures

Speech Recognition Threshold (SRT)

TABLE 2. Age distribution for all complete records and for patients with repeat tests excluded

	Age											
	<10	10s	20s	30s	40s	50s	60s	70s	80s	90s	No age	Total
All records												
N	2461	2535	1810	2607	2850	2674	2522	2222	942	57	3118	23798
%	10	11	8	11	12	11	11	9	4	0	13	100
Patients												
N	1443	1368	1396	1877	2051	1920	1794	1527	679	36	2727	16818
%	9	8	8	11	12	11	11	9	4	0	16	100

Margolis RH & Saly GL (2008). Distribution of hearing loss characteristics in a clinical population. *Ear & Hearing, 29*, 524-532

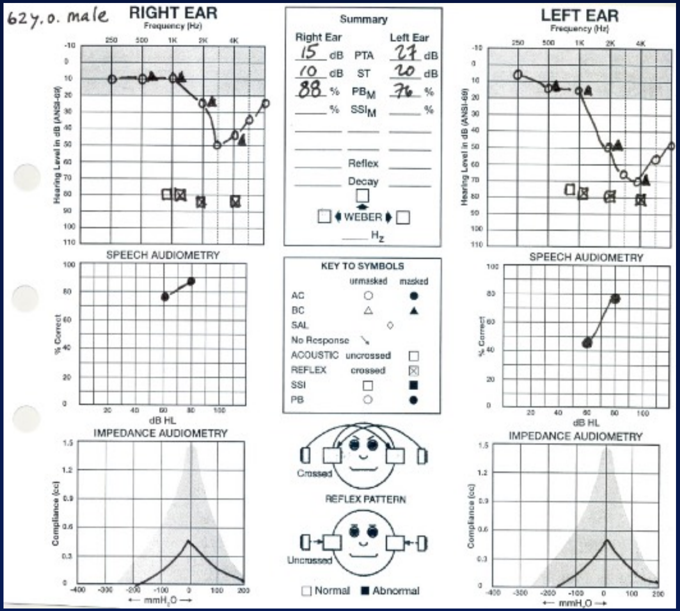
For 53% of 16,818 patients, age was between 20 to 70 years.

The Concept of Value Added Tests:
Selective Use of Speech Reception Threshold

- Do not routinely perform SRT measurement
  - For adult patients age 20 to 65 years
  - When normal objective auditory test findings are available before pure tone audiometry
    - ✓ Acoustic reflex thresholds at expected normal levels
    - ✓ OAE amplitudes within normal limits
  - For patients with normal pure tone hearing thresholds
- Speech reception threshold measurement in those patients
    - ✓ Waste valuable test time
    - ✓ Adds no value to the diagnosis
    - ✓ Adds no value to referral or management decisions
    - ✓ Does not lead to improved patient outcome

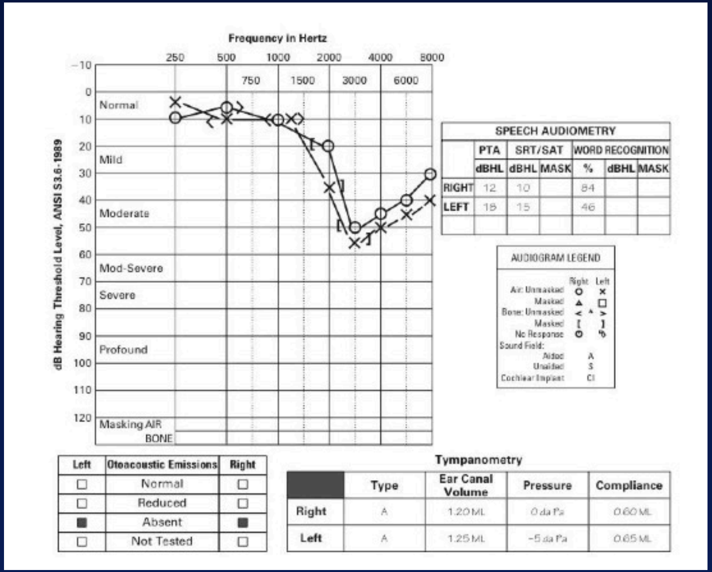
The Concept of Value Added Tests:
We Should Consider Selective "As Indicated" Use of Bone Conduction Pure Tone Audiometry

- No value in adults with no history of middle ear disease and
- No evidence of middle ear dysfunction on objective tets before pure tone audiometry
  - Normal tympanograms bilaterally
  - Acoustic reflex thresholds at expected normal levels
  - OAE amplitudes within normal limits for low frequencies



The Concept of Value Added Tests:
Selective Use of Bone Conduction Pure Tone Audiometry

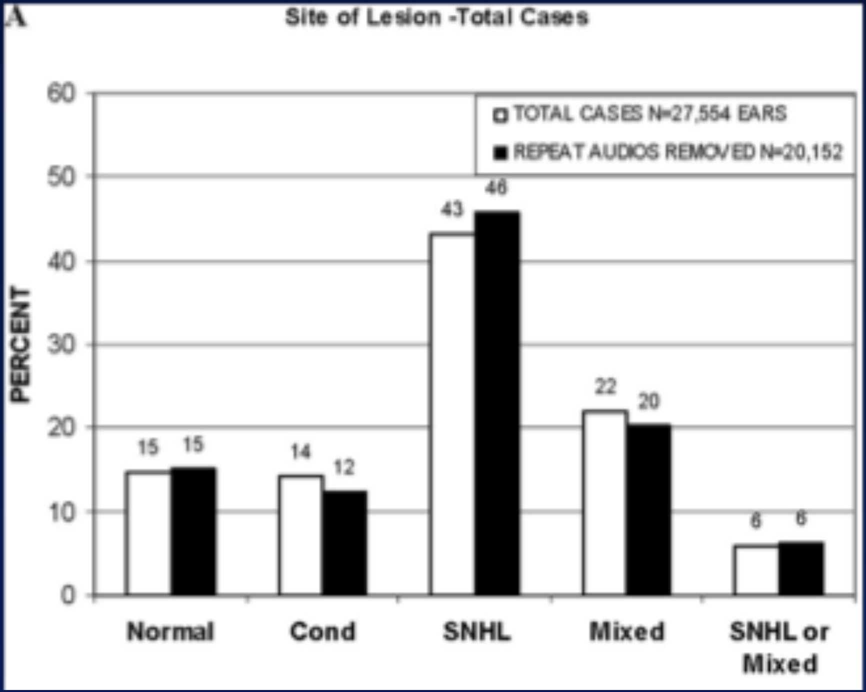
- **Plus air conduction pure tone audiometry showing sloping *high frequ*ency hearing loss**
- **Bone conduction pure tone audiometry in such patients**
  - ✓ **Wastes valuable test time**
  - ✓ **Adds no value to the diagnosis**
  - ✓ **Add no value to referral or management decisions**
  - ✓ **Does not lead to improved patient outcome**



From Hall JW III (2014). Introduction to Audiology Today. Boston: Pearson Educ

The Concept of Value Added Tests (VATs): A Critical Look at Three Traditional Procedures

Bone Conduction Pure Tone Audiometry



Margolis RH & Saly GL (2008). Distribution of hearing loss characteristics in a clinical population. *Ear & Hearing, 29*, 524-532

Majority of patients have no evidence of conductive hearing loss

Assessment of Word Recognition with PB Words:
A Long Tradition Since the 1920s, 1930s &1940s

Harvey Fletcher
(1884-1981)

Ira Hirsh
(1922 - 2010)

The Concept of Value Added Tests (VATs):
Speech Audiometry Should Go Beyond Measurement of Only Word Recognition in Quiet

- Many patients have the chief complaint of difficulty hearing in noisy settings
- Word recognition scores are almost always good in patients with normal pure tone audiometry findings
- Word recognition in quiet often
  - Wastes valuable test time
  - Adds no value to the diagnosis
  - Adds no value to management
  - Does not lead to improved patient outcome
- Instead or in addition
  - Perform a test of speech perception in noise
  - Consider other tests of auditory processing

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Comparative Times for Different Tests

"Remember that time is money"

Benjamin Franklin

Advice to a Young Tradesman
1748

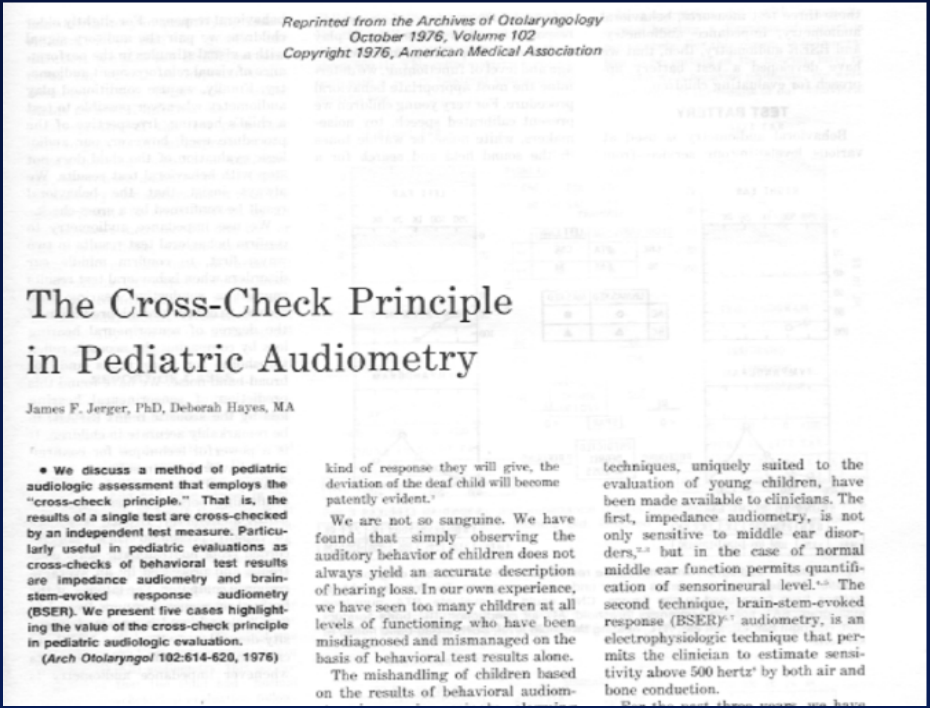
Test Times for Administering Traditional Behavioral Tests: Cooperative Children > 6 – 14 Years Old

(Time Date from Basar & Canbaz, J Int Adv Otol, 11, 42-47, 2015)

- Speech recognition threshold (SRT)
  - Mean both ears = 4.7 mins
  - Range = 1-10 mins
- Bone conduction (BC) pure tone audiometry
  - Mean both ears = 5.6 mins
  - Range = 1-10 mins
- Word recognition (WR) performance in quiet
  - Mean both ears = 5.3 mins
  - Range = 1-10 mins

Total average time for SRT, BC & WR = > 15 minutes

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Remember the Cross-Check Principle



Reprinted from the Archives of Otolaryngology
October 1976, Volume 102
Copyright 1976, American Medical Association

The Cross-Check Principle in Pediatric Audiometry

James F. Jerger, PhD, Deborah Hayes, MA

• We discuss a method of pediatric audiologic assessment that employs the "cross-check principle." That is, the results of a single test are cross-checked by an independent test measure. Particularly useful in pediatric evaluations as cross-checks of behavioral test results are impedance audiometry and brain-stem-evoked response audiometry (BSER). We present five cases highlighting the value of the cross-check principle in pediatric audiologic evaluation.
***(Arch Otolaryngol* 102:614-620, 1976)**

kind of response they will give, the deviation of the deaf child will become patently evident.[1]

We are not so sanguine. We have found that simply observing the auditory behavior of children does not always yield an accurate description of hearing loss. In our own experience, we have seen too many children at all levels of functioning who have been misdiagnosed and mismanaged on the basis of behavioral test results alone.

The mishandling of children based on the results of behavioral audiom-

techniques, uniquely suited to the evaluation of young children, have been made available to clinicians. The first, impedance audiometry, is not only sensitive to middle ear disorders,[2,3] but in the case of normal middle ear function permits quantification of sensorineural level.[4,5] The second technique, brain-stem-evoked response (BSER)[6,7] audiometry, is an electrophysiologic technique that permits the clinician to estimate sensitivity above 500 hertz[8] by both air and bone conduction.

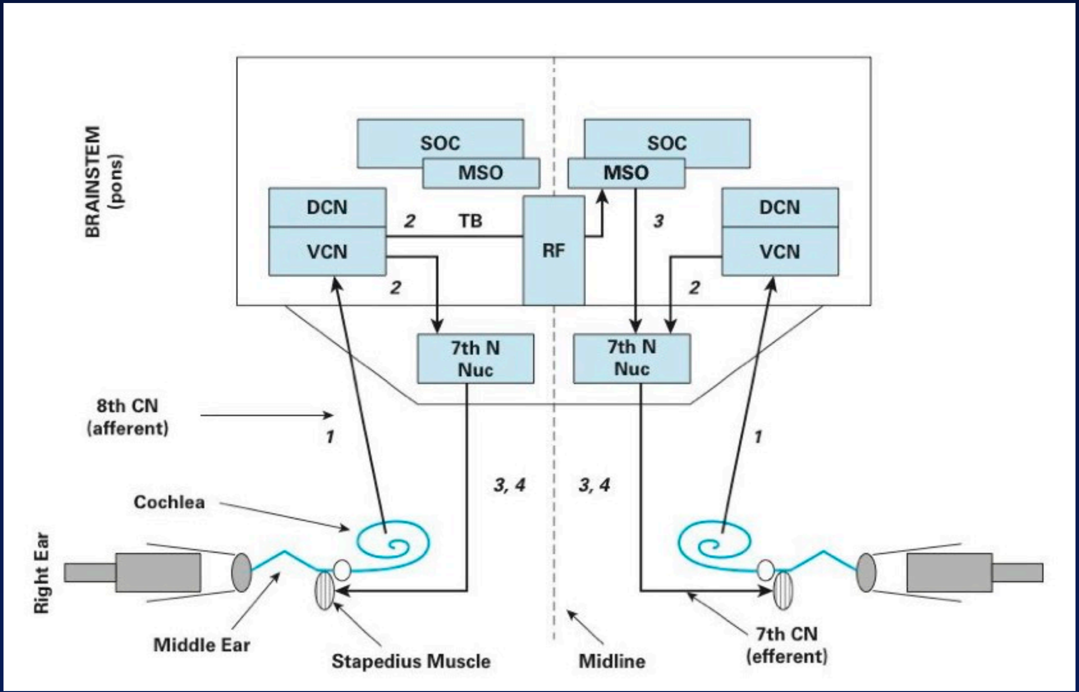
Verify behavioral test findings with findings for objective auditory procedures such as aural immittance measures and otoacoustic emissions

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Aural Immittance Measurements

- Ear canal volume
- Static compliance
- Tympanometry
  - 220 vs. 1000 Hz probe tones
  - Multiple admittance components
  - Eustachian tube tests
  - Fistula test
- Acoustic reflexes
  - Ipsi - and contralateral
  - Threshold
  - Decay
  - Latency

Acoustic Stapedial Reflex Pathways According to Erick Borg

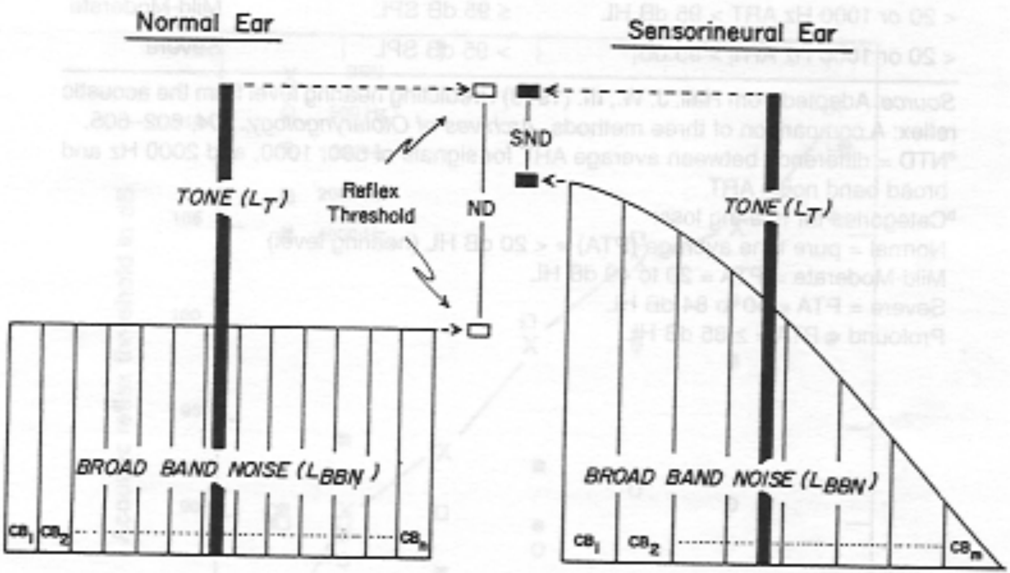
(From Hall JW III (2014). *Introduction to Audiology Today*. Boston: Pearson)



The Diagnostically Valuable Yet Underutilized Acoustic Reflex: *Many Valuable Clinical Applications*

- Ruling out even subtle middle ear dysfunction (including suspicious air-bone gaps at 4000 Hz)
- Differentiating normal cochlear function versus sensory hearing loss
  - Preliminary evidence of normal cochlear function
  - Identification of false or exaggerated hearing loss
- Detection of neural dysfunction
  - 8th cranial nerve
  - 7th cranial nerve
  - Auditory brainstem
- Diagnosis of auditory neuropathy spectrum disorder (ANSD)

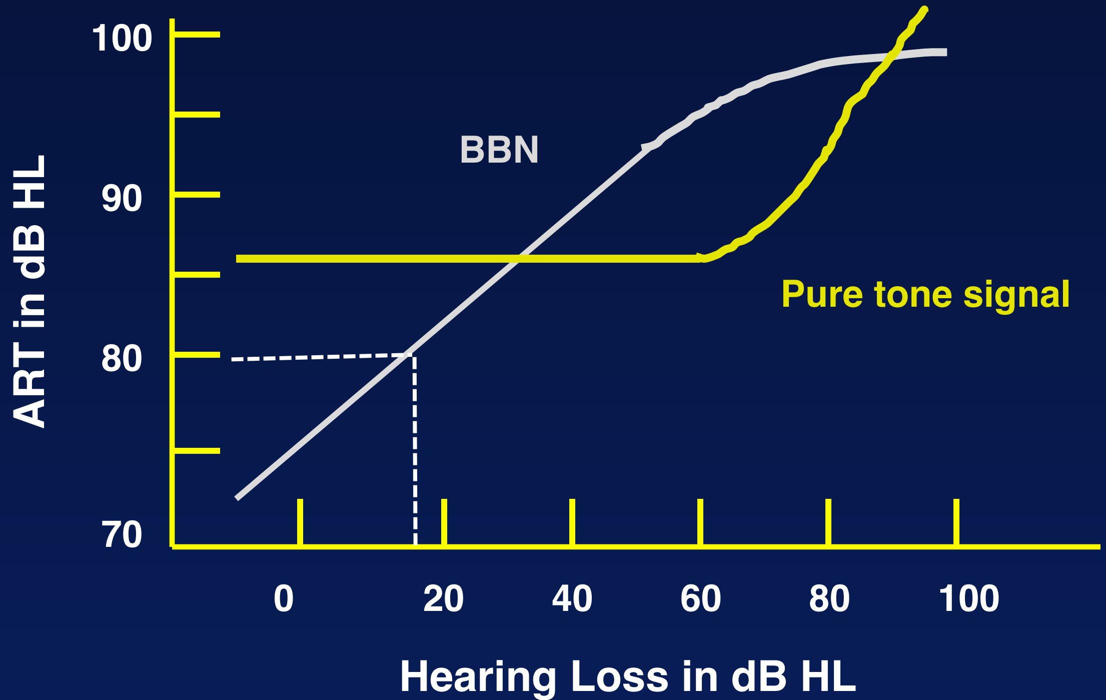
Jerger J, Burney P, Mauldin L & Crump B (1974). Predicting hearing loss from the acoustic reflex. *JSHD, 39,* 11-22



From the original paper on Sensitivity Prediction by Acoustic Reflex (SPAR) by Jerger et al., 1974.

Simplified SPAR (Sensitivity Prediction by the Acoustic Reflex)

Hall JW III, Berry GA and Olson K. Identification of serious hearing loss with acoustic reflex data: Clinical experience with some new guidelines. Scandinavian Audiology 11: 251-255, 1982



Identification of Hearing Loss with Acoustic Reflexes Using Pure Tone vs. BBN Signals (Popelka, 1981)

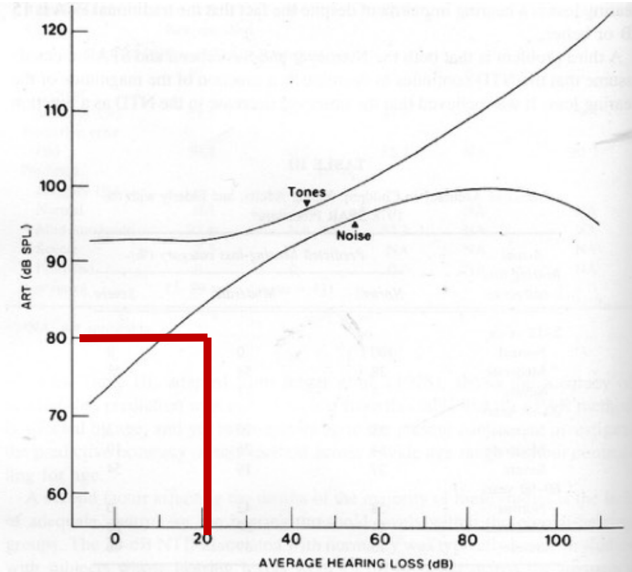


Fig. 2 Acoustic-reflex thresholds for tones (averaged over 500, 1000, and 2000 Hz) and for a BBN noise in dB SPL as a function of average hearing level for 500, 1000, and 2000 Hz in dB HL. The lines represent the best-fit functions. (Reprinted by permission of Popelka, G. R. The acoustic reflex in normal and pathologic ears. In G. R. Popelka (Ed.), *Hearing assessment with the acoustic reflex*. New York: Grune & Stratton, 1981, pp. 5–21. By permission of Grune & Stratton.)

The Concept of Value Added Tests (VATs): *Rationale for Inclusion of Aural Immittance Measures in Routine Diagnostic Test Battery (1)*

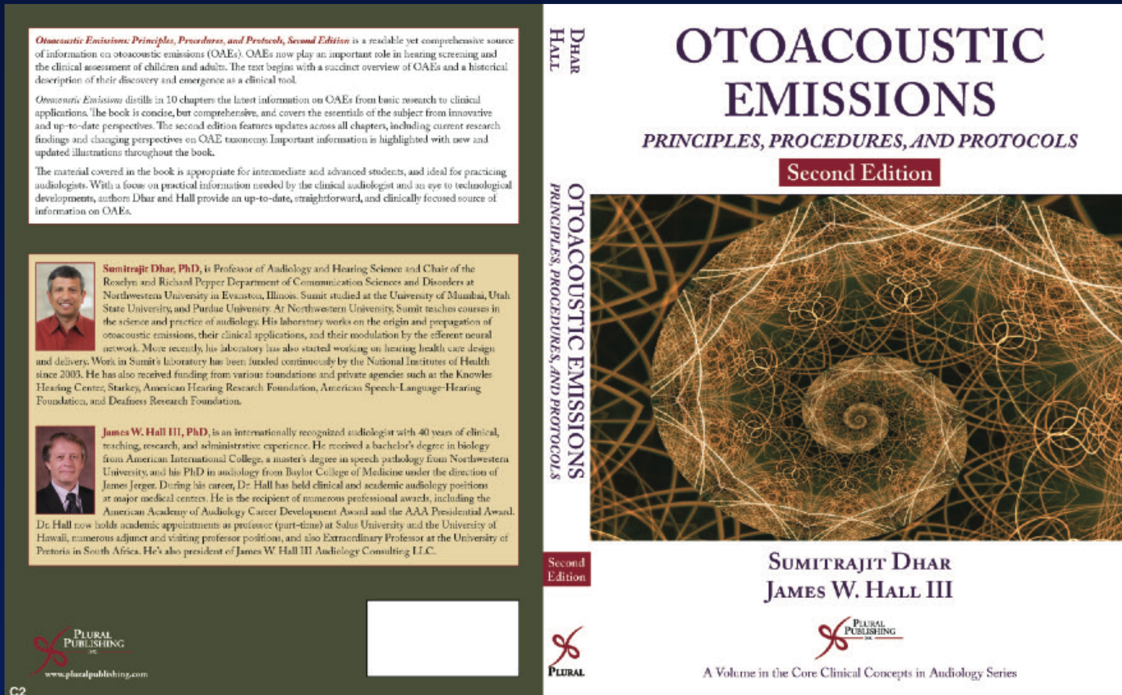
- Contributes to understanding of patient's auditory status
  - ✓ Yes … hundreds of published studies
- Provides information not available from other procedures
  - ✓ Yes … only direct measure of middle ear function
- Information obtained quicker than another procedure
  - ✓ Yes … test time of ~ 4 minute for both ears
- Poses less risk than an alternative procedure
  - ✓ No risk
- Costs less than a comparable procedure
  - ✓ Yes
  - ✓ Can be administered by non-audiology personnel

The Concept of Value Added Tests (VATs): *Rationale for Inclusion of Aural Immittance Measures in Routine Diagnostic Test Battery (2)*

- Findings are more reliable or valid than an alternative test
  - ✓ Reliable and valid in patients of all ages
  - ✓ Not influenced by listener variables
- Highly sensitive to auditory dysfunction
  - ✓ Most sensitive measure of middle ear function
- Provides site-specific information on auditory dysfunction
  - ✓ Information on structures from middle ear to brainstem
- Contributes to more accurate diagnosis
  - ✓ Findings permit diagnosis of type of hearing loss
- Provides information useful in managing the patient and/or
  - ✓ Findings directly impact medical and audiologic management
- Information leads to better outcome for the patient
  - ✓ Yes

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

Otoacoustic Emissions



The Concept of Value Added Tests (VATs): *Rationale for Inclusion of OAEs in Routine Diagnostic Test Battery (1)*

- Contributes to understanding of patient's auditory status
  - ✓ Yes … hundreds of published studies
- Provides information not available from other procedures
  - ✓ Yes … only direct measure of outer hair cell function
- Information obtained quicker than another procedure
  - ✓ Yes … test time of ~ 30 secs - 3 minutes per ear
- Poses less risk than an alternative procedure
  - ✓ No risk
- Costs less than a comparable procedure
  - ✓ No comparable procedure but reasonable cost
  - ✓ Can be administered by non-audiology personnel

The Concept of Value Added Tests (VATs): *Rationale for Inclusion of OAEs in Routine Diagnostic Test Battery (2)*

- ❑ Findings are more reliable or valid than an alternative test
  - ✓ Reliable and valid in patients of all ages
  - ✓ Not influenced by listener variables
- ❑ Highly sensitive to auditory dysfunction
  - ✓ *Most* sensitive measure of cochlear (outer hair cell) status
- ❑ Provides site-specific information on auditory dysfunction
  - ✓ Highly site specific to outer hair cells
- ❑ Contributes to more accurate diagnosis
  - ✓ Yes … Findings permit very specific diagnosis (e.g., ANSD)
- ❑ Provides information useful in managing the patient and/or
  - ✓ Findings directly impact medical and audiologic management
- ❑ Information leads to better outcome for the patient
  - ✓ Yes

Times for Administering Behavioral and Objective Tests: Cooperative Children > 6 Years Old

(Basar & Canbaz, J Int Adv Otol, 11, 42-47, 2015)

- Behavioral Tests = > 25 minutes
  - Speech recognition threshold (SRT) = ~ 5 mins
  - Pure tone audiometry: AC = ~7.5 minutes
  - Pure tone audiometry: BC = ~ 6 mins
  - Word recognition = ~ 5 – 6 mins
- Objective Tests = < 11.5 minutes
  - Tympanometry and acoustic reflexes = ~ 4.5 mins
  - DPOAEs = < 7 minutes

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

- Historical Perspective
- Standard of Care in Audiology
- Definition of Best Practices
- Rationale for Best Practices
- Concept of Value Added Tests
- Clinical Practice Guidelines
- Guidelines for Efficient and Effective Diagnostic Test Batteries
- Summary, Questions and Answers

American Academy of Audiology (AAA)
Clinical Guidelines Development

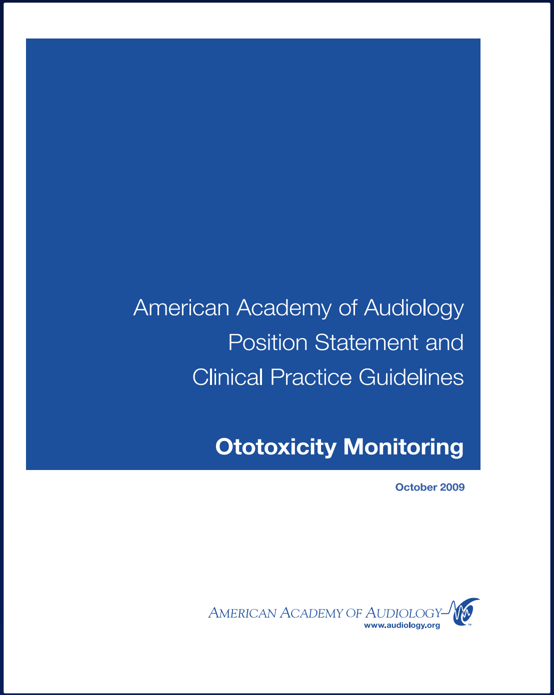
The Clinical Practice Guidelines Development Process

The Clinical Practice Guidelines Development Process

July 2006

Clinical practice guidelines (CPG) advance the mission of the American Academy of Audiology (Academy) by providing a framework of clinical recommendations to audiologists for the express purpose of providing state-of-the-art care for individuals with hearing and balance disorders. CPG have been defined as "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances" (Committee to Advise the Public Health Service on Clinical Practice Guidelines, Institute of Medicine, 1990). More specifically, well-developed guidelines have the potential to (1) enhance current, appropriate clinical practice; (2) improve the quality of audiologic diagnostic assessment and treatment; (3) result in better patient outcomes; (4) improve cost-effectiveness of the care; and (5) identify areas requiring further investigation. These recommendations should be provided in a manner that affords the practitioner a more complete understanding of the topical evidence available for each condition, procedure, and treatment option presented.

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Examples of Clinical Practice Guidelines in the USA

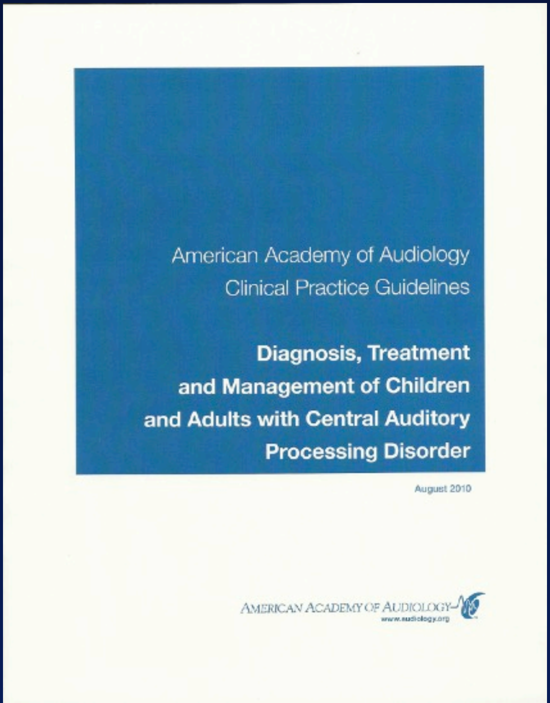


American Academy of Audiology
Position Statement and
Clinical Practice Guidelines

Ototoxicity Monitoring

October 2009

AMERICAN ACADEMY OF AUDIOLOGY
www.audiology.org



American Academy of Audiology
Clinical Practice Guidelines

Diagnosis, Treatment and Management of Children and Adults with Central Auditory Processing Disorder

August 2010

AMERICAN ACADEMY OF AUDIOLOGY
www.audiology.org

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Examples of Clinical Practice Guidelines in the USA

American Academy of Audiology, 2006

Guidelines for the Audiologic Management of Adult Hearing Impairment

Task Force Members

Michael Valente, Chair
Harvey Abrams
Darcy Benson
Theresa Chisolm
Dave Citron
Dennis Hampton
Angela Loavenbruck
Todd Ricketts
Helena Solodar
Robert Sweetow

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Audiologic Management of Adult Hearing Impairment (AAA)

TABLE 1.1: Quality of Evidence (QE)

Level	
1	Systematic reviews and meta-analysis of randomized controlled trials (RCT) or other high-quality studies
2	Well-designed RCT
3	Non-randomized treatment studies
4	Cohort studies, case-control studies, cross-sectional surveys, and uncontrolled experiments
5	Case report
6	Expert opinion

TABLE 1.2: Grade of Recommendation

A	Level 1 or 2 with consistent conclusions
B	Level 3 or 4 studies or extrapolated evidence (generalized to a situation where it is not fully relevant) from Level 1 or 2 studies
C	Level 5 studies or extrapolated evidence from Level 3 or 4 studies
D	Level 6 evidence or inconsistent or inconclusive studies of any level or any studies that have a high risk of bias

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

Audiologic Management of Adult Hearing Impairment (AAA)

- Sample of recommendations
  - "Each patient should receive formal self-assessment inventories prior to fitting to establish communication needs, function, and goals"
  - "Post-fitting administration of these instruments is necessary to validate benefits/satisfaction from amplification"
  - "Electroacoustic verification of all hearing aids (new and repaired) is recommended"
  - "The use of HAT [hearing assistive technology] should be considered in the management of each patient as personal hearing aids may not address all of the patient's needs"

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency
More Examples of Clinical Practice Guidelines in the USA

American Academy of Audiology
Clinical Practice Guidelines

Pediatric Amplification

June 2013

American Academy of Audiology
www.audiology.org

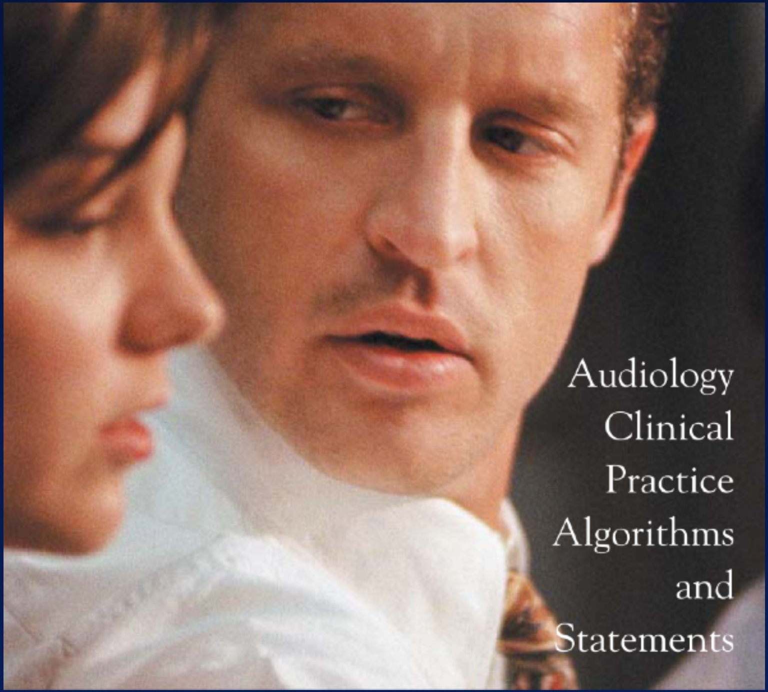
American Academy of Audiology
Clinical Practice Guidelines

Adult Patients with Severe-to-Profound Unilateral Sensorineural Hearing Loss

June 2015

American Academy of Audiology
www.audiology.org

Joint Audiology Committee on Clinical Practice Algorithms and Statements
(Audiology Today, 2000)



- Gene Bratt (VA)
- Kathleen Campbell
- Evelyn Cherow (ASHA)
- Alison Grimes (AAA)
- George Haskell (VA)
- Lawrence Higdon (ASHA)
- Patricia Mcarthy
- Douglas Noffsinger (VA)
- Lucille Beck (VA)
- Kyle Dennis (VA)
- Charles Martinez (VA)

Joint Audiology Committee on Clinical Practice Algorithms and Statements
(Audiology Today, 2000)

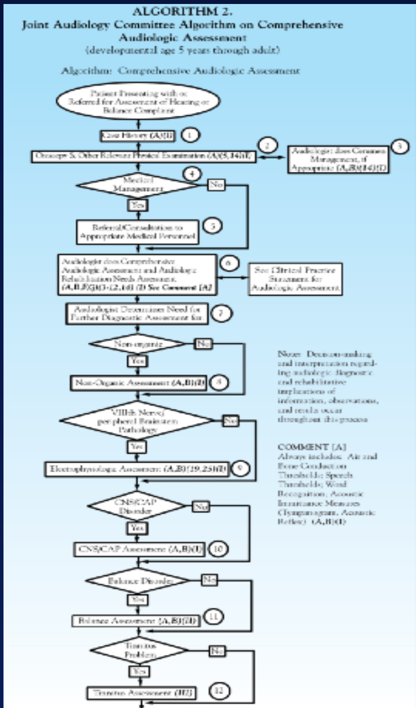
TABLE 2.
Strength of Evidence/Recommendation for the Audiology Algorithms

Grade I:	Evidence is strong and usually obtained from randomized controlled trials or well-designed clinical studies. The recommendation is usually indicated and accepted, and is considered effective and useful.
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. The recommendation is accepted and the weight of evidence supports its use and effectiveness.
Grade III:	Evidence is secondary in that it is based on current or long-standing practice without substantial supporting basic or clinical data. The recommendation is acceptable, but its necessity or usefulness may be questioned. The recommendation is made because it may be useful, and is not harmful.

Joint Audiology Committee on Clinical Practice Algorithms and Statements:
Components of Diagnostic Assessment

- History
- Otoscopy
- Air conduction and bone conduction pure tone audiometry
- Speech thresholds
- Speech recognition measures
- Acoustic immittance (tympanometry and acoustic reflexes)
- Rehabilitative needs assessment
- Communication inventory
- Otoacoustic emissions
- High-frequency audiometry
- Stenger (speech and pure tone)

Joint Audiology Committee on Clinical Practice Algorithms and Statements:
Algorithm for Comprehensive Audiologic Assessment



Always includes:

- Air and bone conduction thresholds
- Speech thresholds
- Word recognition
- Acoustic immittance measures
  - ✓ Tympanogram
  - ✓ Acoustic reflex thresholds for pure tones

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

- Historical Perspective
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Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

Matching Strengths of Audiological Tests with Clinical Goals

- Pure tone audiometry (AC and BC)
  - Clinical Goal: Estimate hearing sensitivity
  - Strengths:
    - ✓ Longstanding clinical evidence
    - ✓ Accepted measure of auditory thresholds
    - ✓ Standardized equipment readily available
  - Limitations:
    - ✓ Requires sound treated environment
    - ✓ Poor sensitivity to middle ear dysfunction
    - ✓ Poor sensitivity to cochlear dysfunction
    - ✓ Poor relationship to hearing handicap
    - ✓ Listener variables affect test reliability and validity

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

Listener Variables Affecting Behavioral Test Findings

- Attention
- Fatigue
- Developmental age and cognitive variables
- Medications
- Motivation
- Motor skills, e.g.,
  - Speech and articulation
  - Ability to respond with button push or hand raising
- Native language, language experience, language age
- Visual acuity

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency

Matching Strengths of Audiological Tests with Clinical Goals

- Speech audiometry: Speech reception threshold (SRT)
  - Clinical Goal: Measure speech perception
  - Strengths:
    - ✓ Longstanding clinical evidence
    - ✓ Accepted measure of speech threshold
    - ✓ Standardized equipment readily available
  - Limitations:
    - ✓ Requires sound treated environment
    - ✓ Poor relationship to hearing handicap
    - ✓ May provide little or no valuable diagnostic information
    - ✓ Listener variables affect test reliability and validity

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Matching Strengths of Audiological Tests with Clinical Goals

- **Speech audiometry: Word recognition performance (in quiet)**
  - **Clinical Goal: Measure speech perception**
  - **Strengths:**
    - ✓ **Accepted clinical measure**
    - ✓ **Longstanding clinical evidence**
    - ✓ **Recorded phonemically balanced test materials available**
    - ✓ **Standardized equipment readily available**
  - **Limitations:**
    - ✓ **Requires sound treated environment**
    - ✓ **May overestimate everyday communication problems**
    - ✓ **Unrelated to speech perception in typical listening settings**
    - ✓ **May provide little or no valuable diagnostic information**
    - ✓ **Listener variables affect test reliability and validity**

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency *Matching Strengths of Audiological Tests with Clinical Goals*

- ❑ Aural Immittance Tests: Tympanometry
- Clinical Goal: Measure middle ear function
- Strengths:
  - ✓Longstanding clinical evidence of effectiveness
  - ✓Sensitive to middle ear dysfunction
  - ✓Well-accepted guidelines for analysis
  - ✓Equipment readily available
  - ✓Objective test
- Limitations:
  - ✓No information on hearing

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Matching Strengths of Audiological Tests with Clinical Goals

❑ **Aural Immittance Tests: Acoustic Reflexes**

- **Clinical Goal:**
  - ✓ Measure middle ear status
  - ✓ Assess auditory function
- **Strengths:**
  - ✓ Longstanding clinical evidence of effectiveness
  - ✓ Sensitive to middle ear dysfunction
  - ✓ Well-accepted guidelines for analysis
  - ✓ Assesses function from middle ear to brainstem
  - ✓ Equipment readily available
  - ✓ Objective test
- **Limitations:**
  - ✓ Limited value in patients with middle ear dysfunction

Best Practices in Audiology Today:
Enhancing Diagnostic Accuracy and Efficiency
Matching Strengths of Audiological Tests with Clinical Goals

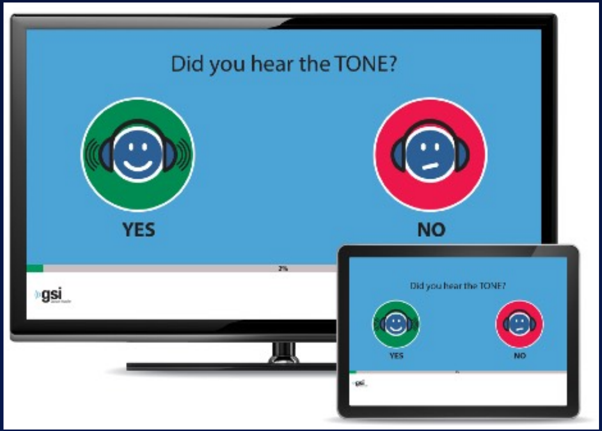
❑ **Otoacoustic Emissions (OAEs)**

- **Clinical Goal:**
  - ✓ Measure cochlear (outer hair cell) status
  - ✓ Assess auditory function
- **Strengths:**
  - ✓ Substantial clinical evidence of effectiveness
  - ✓ Published guidelines for analysis
  - ✓ Very sensitive to cochlear (outer hair cell) f
  - ✓ Equipment readily available
  - ✓ Objective test
- **Limitations:**
  - ✓ Limited value in middle ear dysfunction
  - ✓ Not a test of hearing

A Modern Diagnostic Audiologic Test Battery
In the Order of Testing for New Patients
Total Test Time ~ 30 - 45 minutes.

- Otoscopy
- Objective measures
  - Otoacoustic emissions (OAEs)
  - Aural immittance measures
    - ✓ Tympanometry
    - ✓ Acoustic reflexes (*crossed vs. uncrossed conditions)*
- Behavioral measures
  - Pure tone audiometry *(automated technique as appropriate)*
    - ✓ Bone conduction measurement *only as indicated*
  - Speech audiometry
    - ✓ SRT *only as indicated*
    - ✓ Word recognition (recorded material) with 10 most difficult words first
    - ✓ Speech-in-noise test

A Modern Diagnostic Audiological Test Battery:
Automated Pure Tone and Speech Audiometry (e.g., GSI AMTAS)



GSI AMTAS
(Automated Method for Testing Auditory Sensitivity)

Automated Pure Tone and Speech Audiometry
Selected References on AMTAS Method

- Margolis RH, Glasberg, BR, Creeke S, Moore BC (2010). AMTAS: Automated method for testing auditory sensitivity: Validation studies. Int J Audiol, 49, 185-194
- Margolis RH, Frisina R, Walton JP (2011). AMTAS: Automated method for testing auditory sensitivity: II. Air conduction audiograms in children and adults. Int J Audiol, 50, 434-439
- Margolis RH & Moore BC (2011). AMTAS: Automated method for testing auditory sensitivity: III. Sensorineural hearing loss and air-bone gaps. Int J Audiol, 50, 440-447
- Eikelboom RH, Swanepoel D, Motakef S. Upson GS (2013). Clinical validation of the AMTAS automated audiometer. Int J Audiol, 52, 342-349

A Modern Diagnostic Audiologic Test Battery: Recorded Speech Audiometry with Modern Audiometers
SRT

A Modern Diagnostic Audiologic Test Battery:
Recorded Speech Audiometry with Modern Audiometers
Efficient Word Recognition Testing

A Modern Diagnostic Audiologic Test Battery:
Recorded Speech Audiometry with Modern Audiometers
Speech Perception in Noise

Two Different Diagnostic Audiological Test Batteries:
Test Times in Adult Patients Not at Risk for Middle Ear Disease
(*Test Times from Basar & Canbaz, 2015*)

	Test Battery/Test Time (minutes)	
	Traditional	Modern Efficient
Aural Immittance	4.3	4.3
Tympanometry		
Acoustic reflexes		
OAEs (Diagnostic)	----	6.0
Pure Tone Audiometry		
Air conduction	7.5	7.5 *(automated = 0 mins)*
Bone conduction	5.5	---- *(no value)*
Speech Audiometry		
SRT	4.7	---- *(no value)*
Word recognition	5.3	3.0 (*difficult words first)*

Two Different Diagnostic Audiological Test Batteries: Test Time Comparison in Adult Patients

(*Based on Basar & Canbaz, 2015*)

- Test Battery Test Times
  - Traditional = ≥ 27 minutes
  - Modern = ≥ 14.3 - 21.8 minutes
  - Time difference of 12 minutes or more
- Time Savings for Modern Test Battery
  - Bone conduction only as indicated
  - Speech reception threshold only when warranted
  - Word recognition with most difficult words first
- Maximizing Sensitivity and Specificity
  - Possible middle ear dysfunction = immittance measures
  - Possible cochlear dysfunction = OAEs
  - Possible auditory processing disorder
    - ✓ Dichotic listening tests
    - ✓ Speech-in-noise tests

Auditory Processing Disorders in Adults: *Selected Etiologies*

- Aging of the central auditory nervous system (up to 25% of patients > 65 years)
- Combined peripheral and central auditory disorders
- Dementia and 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

Auditory Processing Disorders in Adults:
Risk Factors and Clinical Indications

- Medical history reveals etiologies in previous slide
- 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 abnormalities
  - Slow response time and processing speed
  - Poor benefit from amplification

Selected Publications on Auditory Function in Adult Patients With Traumatic Brain Injury

(www.nlm.nih.gov/PubMed: "auditory traumatic brain injury = > 600 articles)

- **Chen JX, Lindeborg M, Herman SD, Ishai R, Knoll RM, Remenschneider A, Jung DH & Kozin ED: Systematic review of hearing loss after traumatic brain injury without associated temporal bone fracture, American Journal of Otolaryngology, 39: 338-344, 2018.**
- **Dougherty, AL, MacGregor AJ, Han PP, Viirre E, Heltemes KJ & Galarneau MR: Blast-related ear injuries among U.S. military personnel, J Rehabil Res & Dev, 50: 893-904, 2013**
- **Fausti SA, Wilmington DJ, Gallun FJ, Myers PJ & Henry, JA: Auditory and vestibular function associated with blast-related traumatic brain injury, J Rehabil Res & Dev, 46: 797-819, 2009**
- **Gallun FJ, Papesh MA & Lewis S: Hearing complaints among veterans following traumatic brain injury. Brain Injury, 31: 1183-1187, 2017**
- **Gallun FJ, Diedesch AC, Kubli LR, Waldon TC, Folmer RL, Lewis MS, McDermott DJ, Fausti SA & Leek MR: Performance on tests of central auditory processing by individuals exposed to high-intensity blasts, J Rehabil Res & Dev, 49: 1005-1024, 2012a.**

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- Gallun FJ, Lewis MS, Folmer RL, Diedesch AC, Kubli LR, McDermott DJ, Waldon TC, Fausti SA, Lew HL & Leek MR: Implications of blast exposure for central auditory function: A review, J Rehabil Res & Dev, 49: 1059-1074, 2012b.
- Hall JW III, Huangfu M, Gennarelli TA, Dolinskas CA, Olson K & Berry GA: Auditory evoked responses, impedance measures, and diagnostic speech audiometry in severe head injury. Otolaryngology–Head and Neck Surgery, 91: 50–60, 1983.
- Harris D & Hall JW III: Feasibilty of auditory event-related potential measurement in brain injury rehabilitation patients, Ear and Hearing 11: 340-350, 1990
- Hoover EC, Souza PE & Gallun FJ: Auditory and cognitive factors associated with speech-in-noise complaints following traumatic brain injury, J Am Acad Audiol, 28: 325-329, 2017.
- Hoover EC, Souza PE & Gallun FJ: Auditory and cognitive factors associated with speech-in-noise complaints following traumatic brain injury, J Am Acad Audiol, 28: 325-329, 2017.

Selected Publications on Auditory Function in Adult Patients With Traumatic Brain Injury

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- **Lew HL, Lee EH, Pan SS & Date ES: Electrophysiologic abnormalities of auditory and visual information processing in patients with traumatic brain injury. American Journal of Physical Medicine and Rehabilitation, 83: 428–433, 2004.**
- **Lew HL, Jerger JF, Guillory SB & Henry JA: Auditory dysfunction in traumatic brain injury. J Rehabil Res & Dev, 44: 921-928, 2007**
- **Lew HL, Garvert DW, Pogoda TK, et al: Auditory and visual impairments in patients with blast-related traumatic brain injury: effect of dual sensory impairment on Functional Independence Measure, J Rehabil Res Dev 11:819–826, 2009.**
- **Lew HL, Pogoda TK, Baker E, et al: Prevalence of dual sensory impairment and its association with traumatic brain injury and blast exposure in OEF/OIF veterans, J Head Trauma Rehabil 26:489–496, 2011.**

Selected Publications on Auditory Function in Adult Patients With Traumatic Brain Injury

(www.nlm.nih.gov/PubMed: "auditory traumatic brain injury = > 600 articles)

- Meyers PJ, Wilmington DJ, Gallun FJ, Henry JA & Fausti SA: Hearing impairment and traumatic brain injury among soldiers: Special considerations, Seminars in Hearing, 30: 5-27, 2009.
- Oleksiak M, Smith BM, St. Andre JR, Caughlan CM & Steiner M: Audiological issues and hearing loss among Veterans with mild traumatic brain injury, J Rehabil Res & Dev, 49: 995-2004
- Swan AA, Nelsn JT, Swiger B, Jaramillo CA, Eapen BC, Packer M & Pugh MJ: Prevalence of hearing loss and tinnitus in Iraq and Afghanistan veterans: A chronic effects of neurotrauma consortium study. Hearing Research, 2017, http://dx.doi.org/10.1016/j.heares.2017.01.013
- Vander Werff KR: Auditory dysfunction among long-term consequences of mild traumatic brain injury (mTBI), Perspectives on Hearing and Hearing Disorders: Research and Diagnosis, 16: 3-17, 2012

Include Objective Tests in Diagnostic Battery for Adult Patients With Traumatic Brain Injury

(Oleksiak et al, 2012)

Table 3.

Patients receiving specific examination types and abnormal findings ($N = 37$).

Examination	Performed, % (n)	% Abnormal*
Otoscopy	32.43 (12)	0
Audiometry	94.59 (35)	34.29
Tympanometry	56.76 (21)	23.81
Acoustic Reflex Decay	10.81 (4)	0
Acoustic Reflex Threshold	18.92 (11)	18.18
Speech Recognition Score	70.27 (26)	0
DPOAE	56.76 (21)	80.95
CAPD	16.22 (6)	100

*Out of tests performed.

CAPD = central auditory processing disorder, DPOAE = distortion product otoacoustic emissions.

Include Speech Perception in Noise Test in Diagnostic Battery for Adult Patients With Traumatic Brain Injury

(Gallun et al, 2012)

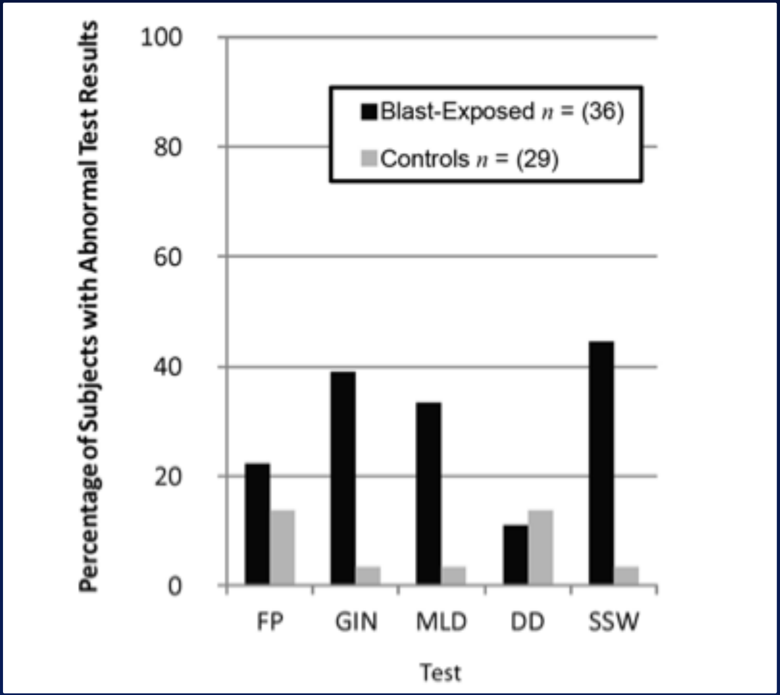
JRRD, Volume 49, Number 7, 2012

Table 1.
Mean, standard deviation (SD), minimum (Min), and maximum (Max) scores for two audiometric tests. Also shown are cutoffs for normal performance based on criterion of two SD beyond mean performance of control subjects as well as percentage of subjects from each group performing outside the normal range ("% Abnormal"). Note that not all blast-exposed subjects contributed values to all measures.

			Mean ± SD	Min	Max	Cutoff	% Abnormal
Word Recognition Score							
	Control	29	94.90 ± 5.23	84	100	84	12
	Blast-Exposed	34	95.09 ± 6.73	80	100	—	7
Left Ear	Control	29	94.90 ± 4.89	84	100	85	0
	Blast-Exposed	33	97.00 ± 4.30	88	100	—	3
QuickSIN							
Right Ear	Control	29	1.12 ± 1.46	−2.00	3.00	4	0
	Blast-Exposed	32	2.81 ± 2.51	−1.00	10.50	—	28
Left Ear	Control	29	1.17 ± 1.36	−1.50	4.50	4	3
	Blast-Exposed	33	2.94 ± 2.97	−1.50	14.50	—	22
Both Ears	Control	29	0.66 ± 1.33	−3.00	2.50	3	0
	Blast-Exposed	32	1.11 ± 2.24	−2.00	8.50	—	18

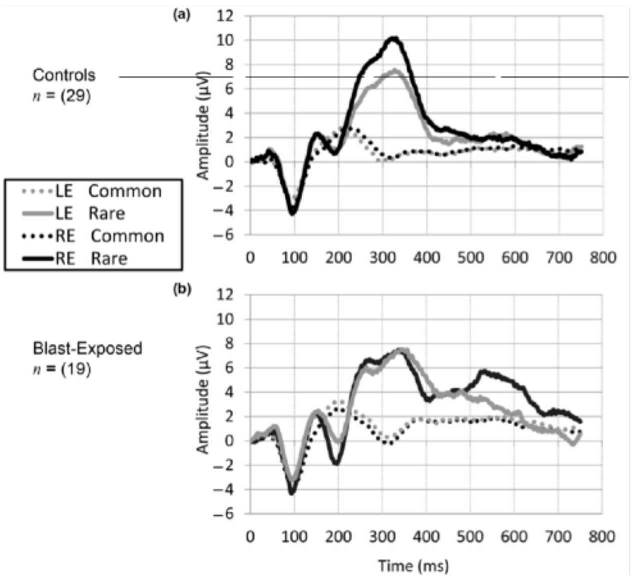
QuickSIN = Quick Speech-In-Noise.

Include APD Tests in Diagnostic Battery for Adult Patients With Traumatic Brain Injury
(Gallun et al, 2012)



- Frequency pattern sequence test (FP)
- Gaps in Noise (GIN) Test
- Staggered spondaic word (SSW) test

Consider Cortical AERs in Diagnostic Battery for Adult Patients With Traumatic Brain Injury



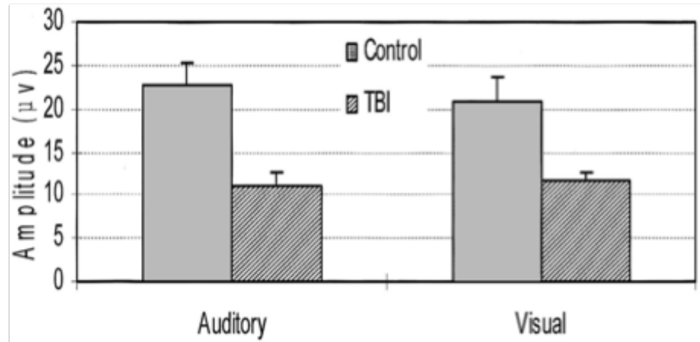


Figure 3: P300 amplitudes in patients with traumatic brain injury (*TBI*) and in control subjects; the data are presented as mean ± standard error of the mean.

Gallun et al, 2012

Lew et al, 2004

Best Practices in Audiology Today: Enhancing Diagnostic Accuracy and Efficiency
Summary

- Historical Perspective … *Current test battery is > 70 years old*
- Standard of Care in Audiology … *Follow clinical guidelines*
- Definition of Best Practices … *BP = EBP*
- Rationale for Best Practices … *Accurate diagnosis and effective management*
- Concept of Value Added Tests … *Utilize only tests that contribute efficiently to accurate diagnosis and effective management*
- Clinical Practice Guidelines … *Be familiar with and follow them*
- Guidelines for Efficient and Effective Diagnostic Test Batteries … *A new approach to diagnostic audiology is long overdue*
- Questions?