

# **RAPID AUDIOGRAM INTERPRETATION: A CLINICIAN'S MANUAL**

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Dear Learners:

We are so happy you have found this book! It is the culmination of many years of searching, compiling, and revising to bring it to completion.

By way of introduction, the idea for this book was devised during our otolaryngology residency training at the University of California, Davis in Sacramento, California. Early in our training, we were overwhelmed by the complexity of the audiogram. Providing rapid, thorough interpretations for our patients proved quite difficult. The difficulty, however, was not with understanding the testing or the data, but rather the lack of a structured way to learn about audiogram interpretation.

Our search for a reliable, dedicated resource proved futile and frustrating. Most of the information we found was either too detailed and geared to doctorate-level audiologists or oversimplified for use by the general public. We found no interpretation guide produced for the clinicians-in-training

or other nonaudiologists who work in overlapping communication sciences who may reference audiogram information regularly.

With this in mind, we decided to bring on audiologist, Samantha McKinney, to help provide and create our own text to guide our learning, and, in the process, we developed a methodical, stepwise approach that can be applied to every audiogram, every time. Over the years, we have provided this as an informal guide to many students and residents with overwhelmingly positive results. It has provided a means for beginners to master interpretation of the audiogram. It has also served as a general review reference for more experienced clinicians.

Herein, we outline our stepwise approach for interpreting audiograms, no matter how complicated, by introducing a framework that is easy to master and will ensure a rapid, yet thorough interpretation every time. It has served us (and we hope our patients!) well throughout our training and beyond, and we hope it does the same for you.

—LS, BC, & SM

# INTRODUCTION TO OUR METHOD

We envision this book to be a manual, a quick-reference guide, and a workbook, an all-in-one resource. We have tried to limit the areas of bulky text, as it is not meant to be a textbook. Rather, we have created this guide using an expanded outline model, with an appropriate depth of information provided in each section to help the reader grasp all necessary skills required to interpret the audiogram.

Our main purpose is to create a clinician-centered text, not an in-depth study into audiology. As such, its applicability is broad. Early communication disorder students (audiology, deaf & hard of hearing studies, and speech-language pathology) may also find this information particularly helpful to begin the process of learning this difficult topic. As this is meant to be an introductory handbook only, if you so choose to learn more detailed audiometric science, we urge you to continue your search once you have mastered the steps outlined in this manual.

This book's most valuable contribution is the 8-step audiogram interpretation method introduced here and used throughout the text. You will find this step-by-step guide for interpreting audiograms within this chapter. We expect that the reader will frequently utilize this page as a quick reference during initial forays in interpretation, as well as a pocket go-to reference as the reader provides patient care. As the sections unfold, the reader will be guided through a stepwise summary of the technique and reasoning behind each step in our method. In the process, these chapters cover each aspect of audiometric testing, outlining and defining common verbiage, and providing a link to the glossary of terms at the end of this manual. Words included in the glossary will be designated by bold type whenever they are initially encountered within this text.

Within each section of text, you will also find boxes that contain "PEARLS" to better understand

and apply each audiometric principle to everyday clinical practice. These tips are designed to provide additional context to the material being discussed in each section. We encourage you to return and review these important tips frequently as you begin your clinical care.

To help each of you best benefit from this manual, we have also included 65 practice audiograms to help you practice our method. We hope that, with practice, you will learn to quickly recognize common hearing loss patterns and master our method. The provided audiogram examples progressively become more complex to help guide you into higher levels of understanding. Each audiogram is accompanied with official interpretations, matching the stepwise interpretation process we recommend.

We urge you, the reader, to use this resource as you need it. Whether you are a new student to the field or a seasoned clinician brushing up on audiogram interpretation, we aim to provide you with a quick, foolproof, methodical approach that will consistently yield accurate audiogram interpretation. Best of luck!

## The Method

The following is an overview of our recommended stepwise method for rapid audiogram interpretation (Figure 0-1). The steps are meant to be followed in sequence to allow for all portions of the audiogram to be reviewed thoroughly. This will ensure an accurate interpretation is completed each and every time. In order to bring context to each step, this introductory chapter will introduce the steps in sequence with a brief description. For a more thorough discussion, the chapters that follow will outline each step and its corresponding audiometric science in more detail.

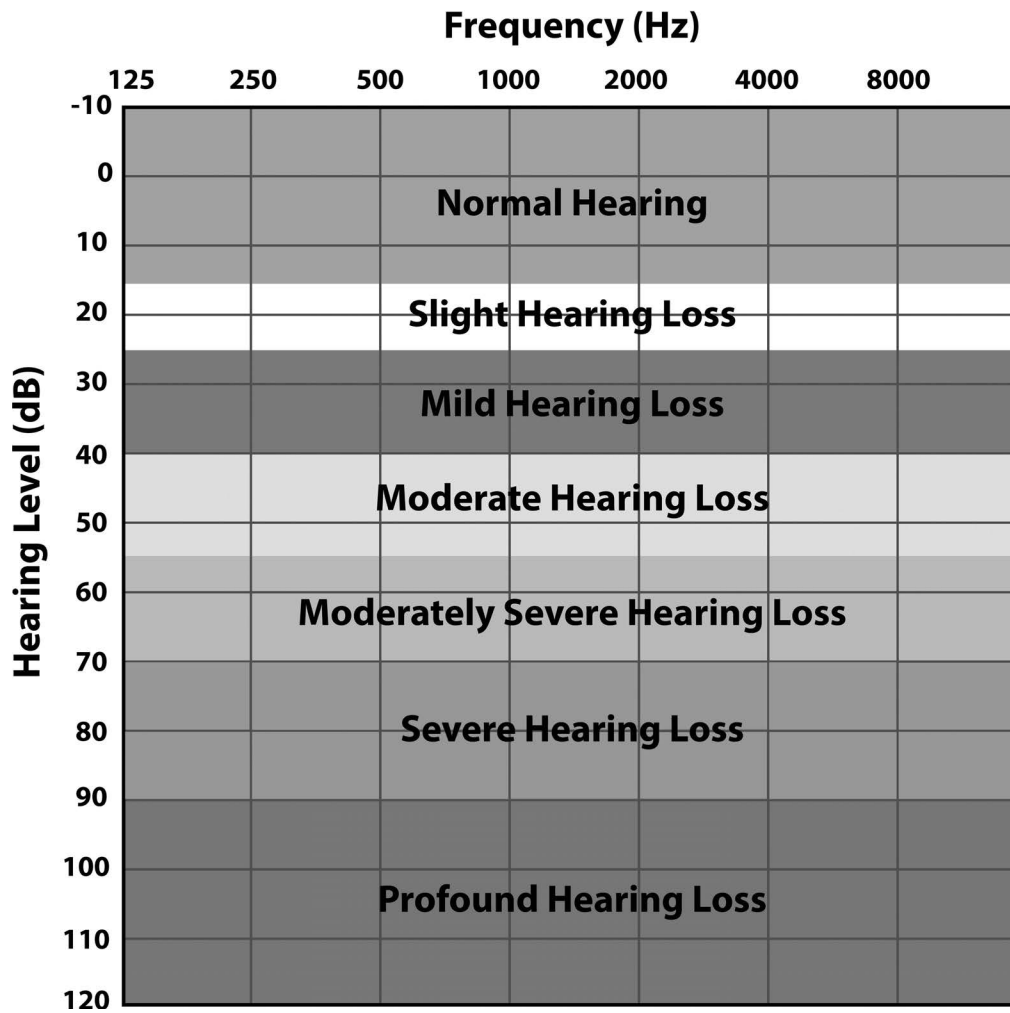


FIGURE 1-4. Classification scheme used to label severity of hearing loss in adults.

maintaining the same position next to the speaker system.

Regardless of suspected cause, the presence of asymmetry should always trigger a medical evaluation by an otolaryngologist. When asymmetric

hearing loss is present, further assessment is pursued, including a full otologic history, pertinent physical examination, and consideration of imaging.<sup>9</sup> Further information regarding asymmetry will be reviewed in step 2.

# Step 3

## CHECK IF AUDIOGRAM FITS A CLASSIC PATTERN

At this point in the interpretation process, it is beneficial to globally review the pure-tone grid to see if its appearance matches any classic patterns. This can be especially helpful for those new to audiogram interpretation. Audiogram data elicited in certain disease states characteristically have significant commonalities that can be quickly recognized. Once one recognizes patterns in audiogram data, the learner can use these to help confirm suspected diagnoses and guide clinical interventions or counseling.

Pattern recognition can also help guide interpretation of the remainder of the audiogram data. These patterns can extend to the associated immittance and speech testing. For example, patients with otosclerosis will have a conductive hearing loss noted in the involved ear. Classically, there is an isolated increase in the bone conduction threshold noted at 2000 Hz called a **Carhart notch**. The associated **tympanometry** data should be normal

or near normal with a central peak at ambient pressure (type A or A<sub>s</sub> tympanogram). Seeing a type A or A<sub>s</sub> tympanogram in the setting of **ipsilateral** conductive hearing loss should raise suspicion that otosclerosis is the underlying disease causing the abnormal audiometric findings.<sup>22</sup> More information on tympanometry will be discussed in Section 3.

The following audiogram grids are representative of these patterns. Some patterns represent specific disease states (Meniere's disease, otosclerosis, etc.), and others may suggest causality to the hearing loss pattern seen (noise-induced SNHL, presbycusis, etc.). It is important to emphasize that forming comparisons has significant limitations. One should complete a full audiogram interpretation regardless if a pattern is globally seen with the audiogram grid. Also, subtle pertinent findings in the speech or immittance testing may be missed if one focuses solely on making comparisons to classic audiogram representations.



# Section 4

## AUDIOGRAM WORKBOOK

**Quick Reference Guide to the Method**

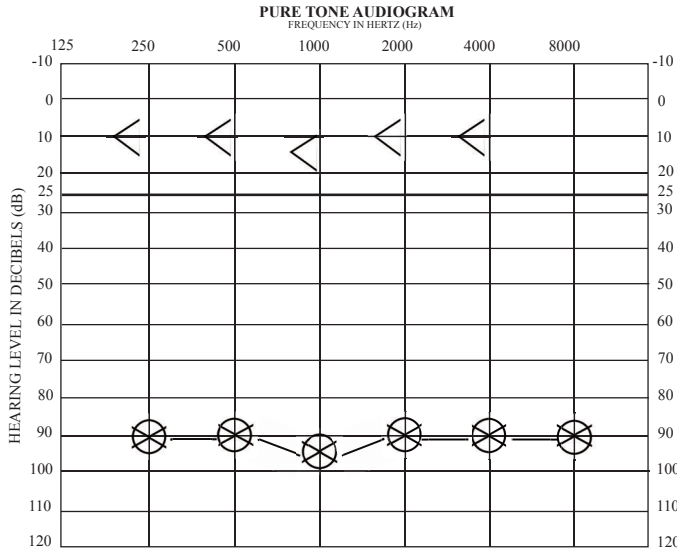
**Basic Audiograms**

**Intermediate Audiograms**

**Advanced Audiograms**

### Audiogram 40: Intermediate

NAME: 40 DATE: \_\_\_\_\_ BY: \_\_\_\_\_  
 Age: 22



**SPEECH AUDIOMETRY**  RECORDED  MLV

EAR	SRT	SDT	WRS	LEVEL
R	90		92%	110 dB HL
L	90		100%	110 dB HL

TRANSDUCER:  HEADPHONES  INSERTS  
 SOUNDFIELD  
 TEST METHOD: \_\_\_\_\_ STD.

	KEY			
	AIR		BONE	
	R	L	R	L
UNMASKED	○	×	<	>
MASKED	△	□	◻	◻
NO RESPONSE		∨	∨	∨
UNSPECIFIED				△
SOUND FIELD			S	
AIDED			A	
OTHER TESTS MASKED				*

**IMMITTANCE TESTING**

Tympanometry

	RIGHT	LEFT
TYMPANOGRAM TYPE		
MIDDLE EAR PRESSURE		
P.V.T		
COMPLIANCE		

Reflex Threshold

	Contralateral				Ipsilateral		
	5K	1K	2K	4K	5K	1K	2K
RE							
LE							

REFLEX DECAY: RT. \_\_\_\_\_  
 LT. \_\_\_\_\_

REFERRED BY: \_\_\_\_\_

HISTORY: Bilateral microtia

COMMENTS: Annual audiologic evaluation. BAHS user.

# APPENDIX A

## AUDIOGRAM INDEX

### BY DIAGNOSIS

#### Types of Hearing Loss

Asymmetric SNHL (21, 23, 24, 26, 31, 52, 54, 64)  
Conductive HL (5, 8, 25, 28, 30, 32, 41, 42, 45, 47)  
High-frequency SNHL (3, 7, 13, 15, 17)  
Mixed HL (20, 22, 48, 55, 56, 57, 58, 59, 61, 62)  
Normal hearing (1, 4, 10, 33)  
Sensorineural HL (3, 7, 9, 11, 13, 15, 17, 18, 22, 44, 49, 50, 51, 63)  
Unilateral CHL (6, 14, 16, 19, 27, 34, 43, 53)  
Unilateral SNHL (21, 29, 34, 36, 54)

#### Etiologies

Anacusis (11, 18)  
Atresia/microtia (12, 40)  
Auditory neuropathy spectrum disorder (46)  
Autoimmune inner ear disease—AIED (49, 50)  
Barotrauma (57)  
Cardiovascular/diabetes (26)  
Genetic (connexin 26/30) (57)  
Glomus tumor (61)  
Head trauma (29)  
Idiopathic (11)  
Inner ear malformation (58)  
Malingering (37)  
Meniere's disease (52)  
Meningitis (18, 44)  
Middle ear disorders:  
    Cholesteatoma (19, 45)  
    Eustachian tube dysfunction (19)

Exostosis (47)  
Mastoidectomy (27, 43)  
Ossicular discontinuity (22)  
Otitis externa (25)  
Otitis media (5, 8, 14, 41, 45, 56)  
Otosclerosis (20, 53)  
Pressure equalization tubes (4, 8, 14, 30, 32, 33, 42, 48)  
Tympanic membrane perforation (6, 16, 28, 57, 59)  
Tympanosclerosis (6)  
Noise-induced HL (13, 64)  
Ototoxic (17, 51)  
Presbycusis (3, 7, 9, 15)  
Retrocochlear lesion (23, 24)  
Sudden SNHL (54)  
Superior semicircular canal dehiscence (65)

#### Congenital/Progressive/Syndromic HL

Difficult to test (35, 60)  
EVA (55)

#### Headphone Challenges

Collapsing canals (39)  
Masking dilemma (40)  
Standing wave @ 8 kHz (38)

# GLOSSARY

- Acoustic decay:** Inability to maintain the stapedial reflex in the setting of a sustained or repeated stimulus, suggestive of a retrocochlear lesion, most likely an eighth cranial nerve tumor.
- Acoustic neuroma:** Benign tumor of the eighth cranial nerve, which usually stems from the vestibular portion of the vestibulocochlear nerve. For this reason, it is more accurately referred to as a vestibular schwannoma.
- Acoustic reflex:** Automatic bilateral contraction of the stapedius muscle in response to unilateral loud sound stimuli.
- Acoustic reflex testing:** The portion of the immittance testing that measures the minimal sound stimuli needed to prompt reflexive stapedial contraction.
- Acoustic reflex threshold:** Least intense sound stimuli that elicit stapedius muscle contraction, normally between 85 and 100 dB.
- Admittance:** Measure of how much sound passes through the tympanic membrane, typically measured as a part of immittance testing.
- Air-bone gap:** Calculation obtained by subtracting the air conduction thresholds from the bone conduction thresholds at each individual frequency, suggestive of a conductive hearing loss.
- Air conduction threshold:** Determination of the patient's lowest level (dB) of hearing using pure-tone audiometry delivered through the ear canal at which  $\geq 50\%$  of perception occurs.
- Anacusis:** Total loss of hearing. No bone or air conduction thresholds measured during audiometric testing.
- Audiometer:** A standardized machine used in hearing evaluations through which an audiologist can perform all basic aspects of audiometric assessments, including pure-tone and speech testing.
- Audiometric zero:** Horizontal line at "0" on the audiogram grid. This value is a calculated relative threshold obtained by averaging the lowest sound pressure level heard at each frequency in thousands of non-pathologic ears.
- Auditory brainstem response (ABR):** An objective audiometry test used to evaluate the cochlea and auditory pathway. Monitoring is accomplished by recording brain activity via electrodes placed on the scalp while varying sound stimuli are provided to the patient.
- Autophony:** Hearing one's own voice louder than usual. This can be a symptom seen with various ear pathologies.
- Bell's palsy:** Idiopathic facial (seventh) nerve paralysis.
- Bone conduction threshold:** Calculated as the lowest sound pressure level (dB) at which 50% of the pure tones introduced via the bone oscillator overlying the mastoid are perceived.
- Broca's aphasia:** Occurs as a result of an injury to Broca's area of the brain, leading to an inability to produce language without extreme effort and considerable halting.
- Carhart notch:** An improvement seen in the air conduction thresholds at 2000 Hz, classically found in otosclerosis patients.
- Cholesteatoma:** Middle ear disease involving keratin debris buildup that can be slowly erosive into important bony structures and lead to chronic infection.
- Cochlea:** Hearing organ located in the inner ear.
- Compliance:** Reciprocal of stiffness. A reflection of the mobility of the tympanic membrane and is determined during tympanometry.
- Conditioned play audiometry:** Type of audiometric testing (typically for toddler to preschool-aged children). Hearing threshold measurements are obtained by the child performing certain tasks whenever sound stimuli are heard.
- Conductive hearing loss:** Measured by the presence of an air-bone gap. Signals the presence of pathology in the external or middle ear that is obstructing normal sound transmission into the cochlea.
- Contralateral ear:** Ear opposite to the ear being tested.
- Crossover hearing:** When the non-test ear detects sound from the tested ear.
- Decibel (dB):** Logarithmic unit of measure of sound pressure or "loudness." See pascals.
- Decapascal (daPa):** Unit of measure used in tympanometry to signify the amount of air pressure emitted from the probe. Also can be measured in millimeters of water (mm H<sub>2</sub>O).
- Distortion product otoacoustic emissions (DPOAEs):** Common form of OAE testing. DPOAEs are measured by playing two simultaneous sounds at the varying frequencies (generally from 1000–8000 Hz) and calculating the resulting cochlear responses.
- Eustachian tube dysfunction:** Disorder of the cartilaginous and bony tube that connects the middle ear to the nasopharynx, often manifesting as ear fullness, fluid sensation, and hearing loss.
- Frequency:** Refers to pitch or tone of a sound. Found on the x-axis on an audiogram and is measured in hertz.
- Hertz:** Unit of frequency on the x-axis on an audiogram.