



Manual 8

Audiometry Exam

January 31, 2008 - Version 1.0

Study website - <http://www.csc.unc.edu/hchs/>

Audiometry
Table of Contents

1	BACKGROUND	4
1.1	Rationale	4
1.2	Hearing Exam Questionnaire	4
2	OTOSCOPY	10
2.1	Overview	10
2.1.1	Equipment Needed	10
2.1.2	Supplies Needed	10
2.2	Otoscopy Procedure	10
3	TYMPANOMETRY WITH IPSILATERAL ACOUSTIC REFLEX	12
3.1	Overview	12
3.1.1	Equipment Needed	12
3.1.2	Supplies Needed	12
3.2	Procedure	12
3.2.1	Data Entry	16
3.2.2	Scanning Tympanograms	18
3.2.3	Disinfection of Reusable Probe Tips	20
4	AUDIOMETRY	21
4.1	Overview	21
4.1.1	Equipment Needed	21
4.1.2	Supplies Needed	21
4.2	Procedure	21
4.2.1	Pure-tone Air-conduction Audiometry (500-8000 Hz)	21
4.2.2	Pure-tone Bone-conduction Audiometry (500, 2000 and 4000 Hz)	23
4.3	Masking Procedure	24
4.4	Unusual Conditions	25
5	QUALITY CONTROL PROCEDURES	26
5.1	Field Staff Quality Control	26
5.2	Equipment Quality Control	26
5.2.1	Checks for the GSI-61 Audiometer	27
5.2.2	Bioacoustic Simulator	28
5.2.3	Tympanometer Calibration	29
5.2.4	Ambient Noise Levels	30
5.2.5	Weekly Listening Checks for the GSI-61 Audiometer	31

6	THE EPISENSE AUDIOMETRY READING CENTER (EAR CENTER)	33
6.1	Purpose.....	33
6.2	Examiner Training and Certification	33
6.3	Equipment Calibration.....	33
6.4	Reading Center Training, Certification and Quality Assurance	33
6.5	Initial Review and Participant Feedback	34
6.6	Field Quality Assurance Data Review	34
6.7	Data monitoring reports	34
6.8	Final Review	34
 Appendices		35
	Appendix I: Audiometric Examination Step by step procedures	35
	Appendix II: Equipment Quality Assurance Checks	40
	Appendix III: Audiometry Testing Troubleshooting Guide	41

1 BACKGROUND

1.1 Rationale

Hearing loss is one of the most common chronic conditions affecting older adults. Studies in non-Hispanic whites have found that 46% of adults age 48-92 years have hearing loss. Hearing loss has been associated with lower health related quality of life as well as depression and social isolation. The Hispanic population is the fastest growing minority population in the United States. This study will help determine the role of acculturation in the prevalence and development of hearing loss, and to identify risk factors playing a protective or harmful role in Hispanics/Latinos.

The hearing examination consists of:

1. Hearing Exam Questionnaire
2. Otoscopy – examination of the ear and ear-canal
3. Tympanometry – testing of middle ear function
4. Audiometric Testing – testing of hearing thresholds

1.2 Hearing Exam Questionnaire

The Hearing Exam Questionnaire is to be asked at the time of the hearing examination before conducting the hearing testing. The purpose of these questions is to provide information that will be used during testing (i.e. determining which ear to test first) and to provide information that will be used when reviewing the results and analyzing the data.

These questions must be answered by the participant, no proxy respondents. The questions must be asked before the hearing examination begins. Encourage participants to select the answer that best fits their experiences. Mark only one response per item.

A. Self Assess Hearing Loss

- 1.) Do you feel you have a hearing loss?
0 No
1 Yes
9 Don't know/refused

Ask of all. This is the participant's perception.

- 2.) Which is your better ear?
1 Right
2 Left
3 No Difference
9 Don't know/refused

Again, the participant's perception. Use this information to determine first test ear. If "no difference" or "unknown", start with right ear.

- 3.) Was your hearing loss sudden or gradual?

- 1 Sudden
- 2 Gradual
- 9 Don't know/refused

Participant's opinion.

4.) How old were you when your hearing loss developed?

- 1 less than 5 years old
- 2 5 to 19 years
- 3 20 to 29 years
- 4 30 to 39 years
- 5 40 to 49 years
- 6 50 to 59 years
- 7 60 to 69 years
- 8 70 years or more
- 9 Don't know/refused

Read choices so that the participant knows we're looking for the age group not a precise recollection of the exact age.

B. Tinnitus

Tinnitus is defined as ringing, buzzing or noise (including roaring) in the ears.

5.) In the past year have you had buzzing, ringing or noise in your ears?

- 0 No
- 1 Yes
- 9 Don't know/refused

Determine if he/she has had tinnitus in the past year. Odd or unusual noises on a single occasion do not count as tinnitus. Any episode of ringing, buzzing or noise is considered a positive response.

6.) Does this noise usually last longer than 5 minutes?

- 0 No
- 1 Yes
- 9 Don't know/refused

The buzzing, ringing or noise must last a continuous 5 minutes.

7.) Do you hear this noise only following very loud sounds (i.e. concerts, shooting, or noise at work)?

- 0 No
- 1 Yes
- 9 Don't know/refused

The correct response is yes if the buzzing, ringing or noise is attributable to exposure to a loud noise on all occasions when tinnitus is experienced. If tinnitus is ever experienced when there has been no noise exposure the correct response is no.

8.) Does this noise cause you to have problems getting to sleep?

- 0 No
- 1 Yes
- 9 Don't know/refused

Determine whether the tinnitus causes the person to have trouble sleeping.

9.) In the past 12 months, how often have you had this ringing, roaring, or buzzing in your ears or head?

- 1 Almost always
- 2 At least once a day
- 3 At least once a week
- 4 At least one a month
- 5 Less than once a month
- 9 Don't know/refused

Read categories and encourage the participant to select one. Although the wording is slightly different than tinnitus questions 5 – 8 (this question is taken verbatim from NHANES), any report of noise in the ear counts as tinnitus.

C. Hearing Medical History

10.) When was the last time you saw a doctor or other health care professional about any hearing or ear problems?

- 0 Never
- 1 Past year
- 2 1 to 2 years
- 3 3 to 4 years
- 4 5 to 9 years
- 5 10 to 14 years
- 6 15 years or more
- 9 Don't know/refused

Read categories and encourage the participant to select one.

11.) When was the last time you had your hearing tested?

- 0 Never
- 1 Past year
- 2 1 to 2 years
- 3 3 to 4 years
- 4 5 to 9 years
- 5 10 to 14 years
- 6 15 years or more

9 Don't know/refused

This would include a hearing test given by a doctor, audiologist, or hearing aid distributor. Hearing tests given at work and at health fairs count as having had a hearing test.

12.) Have you ever had surgery on your ears?

- 0 No
- 1 Yes
- 9 Don't know/refused

Any form of surgery on any part of the ear (outer, middle, or inner). If the participant has had more than one surgical procedure, record the information on the most recent surgery.

13. What type of surgery was done?

- 1 Tympanoplasty
- 2 Mastoidectomy
- 3 Stapedectomy
- 4 Cochlear implant
- 5 Other

Tympanoplasty is surgical correction of damage to the middle ear. Mastoidectomy involves the removal of the mastoid bone (behind the ear) and the opening of diseased mastoid air cells. A stapedectomy involves removal of a portion of the stapes bone (a small bone in the inner ear) and replacing it with a prosthesis to restore the ear's ability to transmit sound. A cochlear implant is an electronic prosthesis, surgically implanted in the ear, that can restore a sense of sound to people with hearing impairment. Some participants may not be familiar with the medical term for their procedure. If the description the participant provides matches any of the descriptions for choices 1 – 4, code as such. If uncertain, or if the participant is unable to describe the procedure, record as 5.

14.) Have you ever had tubes in your ears?

- 0 No
- 1 Yes
- 9 Don't know/refused

This question refers to tubes inserted into the eardrum, usually as a treatment for middle ear infections.

15.) Do you have tubes in your ears now?

- 0 No
- 1 Yes, right
- 2 Yes, left
- 3 Yes, one (side unknown)
- 4 Yes, both sides
- 9 Don't know/refused

We want to know if the participant currently has a tube in one or both ears. Try to identify which ear the participant thinks has the tube.

Questions 16 – 18 refer to rare auditory disorders. The condition must be diagnosed by a physician.

16.) Have you ever had an acoustic neuroma?

- 0 No
- 1 Yes
- 9 Don't know/refused

An acoustic neuroma (sometimes called a vestibular schwannoma) is a tumor on the auditory nerve. The participant may not be aware of the medical term. If he or she reports that they have had a tumor and that the tumor was on a nerve affecting their ear, code as yes. Tumors that are not on a nerve should be coded as no.

17.) Have you ever had a cholesteatoma?

- 0 No
- 1 Yes
- 9 Don't know/refused

A cholesteatoma is a mass or growth in the middle ear.

18.) Has a doctor ever told you that you have Meniere's Disease?

- 0 No
- 1 Yes
- 9 Don't know/refused

Meniere's disease is a syndrome characterized by nausea, vomiting, tinnitus (ringing in the ears) and progressive hearing loss.

19.) Has a doctor ever told you that you have otosclerosis?

- 0 No
- 1 Yes
- 9 Don't know/refused

Otosclerosis is a disorder of the bones of the middle ear.

20.) Have you had a cold, sinus problem, or earache in the last 24 hours?

- 0 No
- 1 Yes
- 9 Don't know/refused

A cold refers to a disorder of the upper respiratory tract. A sinus problem refers to an inflammation of the sinuses. Allergies are included if they have resulted in a reaction within the upper respiratory system or sinuses. If the participant is unsure if he or she has had either of these, probe for any of the following conditions: runny nose, stuffy head, slight temperature, chills, sinus headache. If the participant has had any of these symptoms in the past 24 hours, record a positive answer. An earache refers to any pain within the ear, regardless of severity. It does not include pain on the external ear.

21.) Have you been exposed to loud music or listened to music with headphones in the past 24

hours?

- 0 No
- 1 Yes
- 9 Don't know/refused

Music is defined as "loud" if (1) someone would have had to raise their voice in order to be heard 3 feet away; or if (2) ringing in the ear was noticed after the music ended.

22.) Have you been exposed to any other loud noise in the past 24 hours?

- 0 No
- 1 Yes
- 9 Don't know/refused

Noise is defined as "loud" if (1) someone would have had to raise their voice in order to be heard 3 feet away; or if (2) ringing in the ear was noticed after the noise ended.

Example Form

Please reference Manual 2, Field Center Procedures Appendices for Audiometry Forms

2 OTOSCOPY

2.1 Overview

Otoscopy allows the examiner to view the structure of the ear canal and tympanic membrane (eardrum). The examiner determines if there is a potential for collapse of the ear canal during testing and evaluates the presence of cerumen (earwax) or other problems that may interfere with audiometric testing.

2.1.1 Equipment Needed

Welch Allyn Otoscope with rechargeable handle

2.1.2 Supplies Needed

Disposable otoscope speculum
Gloves (optional)

2.2 Otoscopy Procedure

Explain to the participant: “Now I’m going to use this instrument to look into your ear canal. You will feel me gently pulling on your ear. I need you to sit quietly while I look.”

Wash hands before and after otoscopic examination. Wearing of gloves is optional. Place a new speculum (tip) on the otoscope. Turn on otoscope. Starting with the right ear, check for ear canal collapse by pushing gently on the participant’s pinna (outer ear). Pull up and back on the participant’s outer ear (pinna) in order to straighten the canal. Gently direct the otoscope into the ear canal and observe the canal and eardrum. The speculum may be tilted in order to see the entire drum.

Record the field site number and the examiner ID along with the following information on the computer direct entry screen ([see otoscopy form](#)), recording all right ear data first, then left ear data:

Otoscopy done

Check “yes” if otoscopy was done for that ear. If otoscopy can not be done for the right ear, check “no” and continue to left ear. If otoscopy can not be done for the left ear proceed to tympanometry.

Ear canal collapse

Check “yes” if either of the following are true: 1) the canal nearly or completely closes when pressing on the pinna, or 2) the canal is partially or completely collapsed upon inspection, without pressing on the pinna. Check “unknown” if you did not check for collapse. If there is no evidence of collapse, check “no.” Use insert earphones if there is any evidence of collapse.

Drainage

Check "no" if there isn't any drainage in the ear canal. Check "yes" if there is drainage in the canal. Check "unknown" if you did not check for drainage. If drainage is noted in one ear, use a clean otoscope speculum when examining the other ear.

Cerumen

Check "none" if there is no cerumen (ear wax) in the ear canal. Check "some" if there is a little cerumen present in the canal. Check "a lot" if there is a lot of cerumen in the canal, but you can see an opening. Check "impacted" if there is a lot of wax and there appears to be no opening. Check "unknown" if you did not check for cerumen.

Eardrum position

Check "normal" if the eardrum appears to be in the normal position. Check "bulging" if the eardrum appears to be protruding. Check "retracted" if the eardrum appears to be pulled in, and check "unknown" if the eardrum is not visible.

Eardrum vascularity

Check "none" if there is no vascularity present on the eardrum. Check "mild" if there is some vascularity on the eardrum (a little red). Check "considerable" if there is a lot of vascularity on the eardrum (very red), and check "unknown" if the eardrum is not visible.

Perforation

Check "no" if there is no visible perforation in the eardrum. Check "yes" if there is a visible perforation in the eardrum (including tubes), and check "unknown" if the eardrum is not visible.

Record right ear results then repeat for left ear

Dispose of speculum when finished

The otoscope handle should be plugged into an electrical outlet overnight for recharging.

Unusual Findings:

Foreign objects in the ear canal: Each field site should have a procedure in place for how to handle unusual findings such as foreign bodies or insects in the ear canal.

Drainage: If a draining ear is noted, tympanometry and audiometric testing are **not** conducted. Soft or fluid cerumen is not to be confused with drainage.

Impacted cerumen: Ears that are judged to be impacted with cerumen should continue with the audiometric examination.

3 TYMPANOMETRY WITH IPSILATERAL ACOUSTIC REFLEX

3.1 Overview

Tympanometry is a measure of middle-ear compliance (mobility of the tympanic membrane and ossicles). The tympanogram is a plot of tympanic membrane compliance on the Y axis and the air pressure of the ear measured in decapascals on the X axis. Ear canal volume also is measured and recorded in cubic centimeters. A flat tympanogram with normal ear canal volume can be an indication of middle ear effusion (fluid). A flat tympanogram with high ear canal volume may be an indication of a perforated ear-drum.

The acoustic reflex is an involuntary contraction of the two muscles in the middle ear - the stapedius and the tensor tympani - in response to loud sounds. When these muscles contract, the ossicles pull the eardrum slightly back; the middle ear system "stiffens up" and sound is not transmitted as efficiently. This affords the sensitive inner ear a small bit of protection against potentially damaging sounds.

The acoustic reflex is tested by sending a brief tone into the middle ear loud enough to elicit the reflex, and looking for a resultant change in eardrum mobility as the muscles contract and pull back on the eardrum. Acoustic reflex test results are useful in clarifying questionable tympanograms, verifying degree of hearing loss, and distinguishing between sensorineural hearing losses caused by damage to the cochlea versus the auditory nerve.

3.1.1 Equipment Needed

- Earscan tympanometer with IPSI reflexes
- Seiko DPU-414 printer
- Scanner

3.1.2 Supplies Needed

- Tympanometer probe tips (reusable or disposable)
- Thermal paper
- Tip disinfection supplies

3.2 Procedure

The tympanometer needs to be turned on and calibrated each morning before testing can be done. See Quality Control Procedures (section 6.3) for start-up and calibration procedures.

Instruct participant: "This is a test to measure how well your eardrum is able to move. It is a completely automatic test, so you will not need to respond in any way. I am going to place a probe snugly against the opening of your ear canal. You will hear a continuous 'hum' and feel a little pressure; then you will hear a couple of loud beeps. The test will only take about thirty seconds. It is important that you sit very still, and do not move, speak, or swallow from the time I insert the probe until I tell you the test is finished. Do you have any questions?"



Press the SPEC button, then the CLEAR button, to delete any previous test data from the Earscan. Press the IMP button to select impedance testing. The screen will read “no data” and will display an R or L in the top left corner. If necessary press the LEFT/RIGHT button to display the proper ear. Always start testing with the RIGHT ear. Select the proper probe tip size, according to the size of the participant's ear canal (generally, a bigger probe tip is better in terms of obtaining an air tight seal). Place the tip on the instrument.



Start with the participant’s right ear. Sit next to the participant so that his/her ear is at the examiner’s eye level. Wearing gloves during tympanometry is optional.

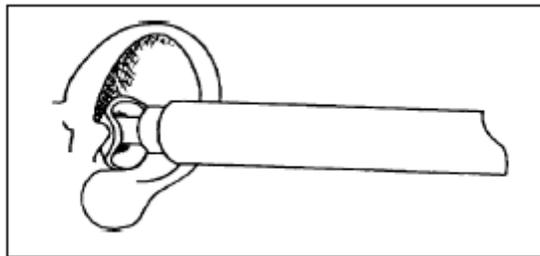
Move hair out of the way.

Grasp the outer ear (pinna) and pull up and back in order to straighten the ear canal. Continue to hold it like this during the test.

"Scoop" the tip in position behind the small flap (tragus) covering the ear canal opening.

The angle of the probe device should be the same as used when inspecting the eardrum by otoscopy.

Exert enough pressure to ensure an air-tight seal.



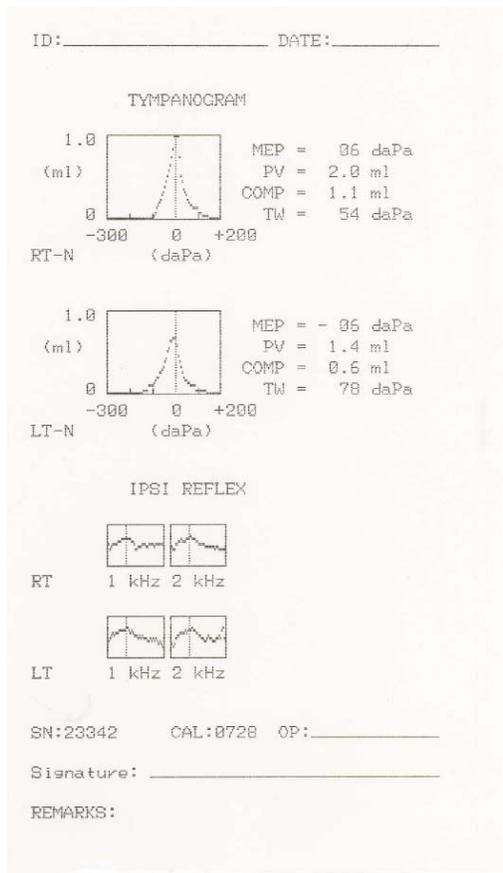
If an airtight seal has been obtained, the test screen will read “STEADY” while it builds pressure in the air canal, then it will read “TESTING”. If an airtight seal has not been obtained, the screen will read “AIR LEAK”; adjust the position of the probe until the screen indicates that a seal has been obtained. If the probe is against the wall of the ear canal, the screen will read “BLOCK” and you will hear a high-pitched tone. Redirect the probe toward the eardrum; you may need to reexamine the ear canal to properly assist you in directing the probe.

While the test is running, hold the probe as still as possible. Movement of the probe may cause the Earscan to stop testing or give noisy, inconsistent or false results. When the Earscan senses that the probe is near the ear canal, you will hear a low frequency hum. When a seal has been obtained and testing begins, you will hear in addition a higher frequency tone. When tympanometry is complete, a graph of the tympanogram will appear on the screen and the tone will become higher as acoustic reflexes are tested. Do not remove the probe until the overriding tone stops and the screen reads “REMOVE PROBE”.

Once the probe has been removed, the screen will again display the graph of the tympanogram. Repeat the entire process for left ear by pressing the LEFT/RIGHT button to select the left ear. The screen should read "NO DATA" and the letter depicting the test ear should change as appropriate.

Once both ears have been tested, print the tympanograms by pressing the GRAPH button.

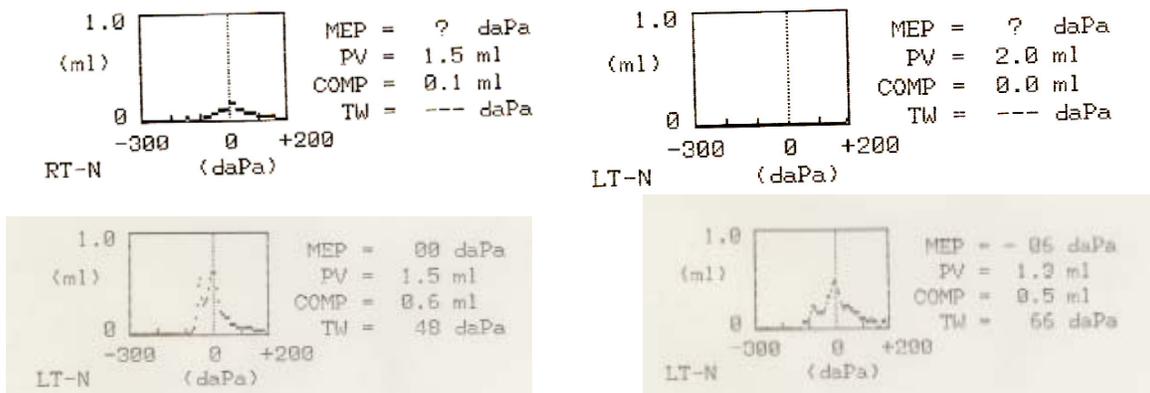
Example tympanogram:



Repeating tympanograms: The tympanogram shape is evaluated on several characteristics in order to identify tymps which may have encountered technical problems resulting in an inaccurate or unreliable curve and set of measurements.

The following tymps should be repeated:

1. If the COMP value is ≤ 0.2 (including flat or no peak; MEP = ?).
2. The curve drops off sharply or stops abruptly before returning to baseline.
3. There is a notch in a location where it might interfere with the COMP or TW measurements.
4. Any other tymp thought to be odd.



To repeat the tympanogram, press the SPEC button, then the CLEAR button, to delete the previous test data from the Earscan. Press the IMP button to select impedance testing. Select the ear to be

repeated using the LEFT/RIGHT button. Place the probe against the entrance to the ear canal as before and Earscan will automatically retest once a seal is obtained. When retesting, be careful to direct the probe properly into the ear canal and to hold the probe very still during testing; reinstruct the participant if necessary.

Print the repeat tympanogram(s) by pressing the GRAPH button.

3.2.1 Data Entry

Tympanogram:

Enter the data from the tympanograms (original right and left, and repeated) into the computer's direct-entry system. (See tympanometry form.)

The field site number, examiner ID and instrument identification code for the tympanometer used are recorded in the appropriate spaces.

Seal obtained?

0 No

1 Yes

9 Not done

Record the MEP value from the tympanometry print-out as a number between -312 – +200. Enter = if the value is displayed as ?.

Record the PV value from the tympanometry print-out as a number between 0.2 – 7

(*If the PV is ≥ 3 , the participant will be told that he or she may have a possible perforation (hole) in the eardrum.)

Record the COMP value from the tympanometry print-out as a number 0.0 – 8

Record the TW value as a number between 15 – 220 or record === if "TW" value is ---.

Acoustic (IPSI) Reflex:

Any type of tracing, regardless of the shape of the tracing, should be recorded as "yes". If no tracing is printed on the printout, "no" is recorded.

Record if reflex obtained at 1 kHz

0 No

1 Yes

Record if reflex obtained at 2 kHz

0 No

1 Yes

Repeat entry for left ear

Repeat measurement:

Tympanometry repeated right ear?

0 No

1 Yes

Record yes if repeat tympanometry was attempted, even if a seal was not obtained on the repeat.

Seal obtained?

0 No

1 Yes

9 Not done

If tympanometry was repeated for the right ear, record the right repeat values for the MEP, PV, COMP, and TW.

Tympanometry repeated left ear?

0 No

1 Yes

Seal obtained?

0 No

1 Yes

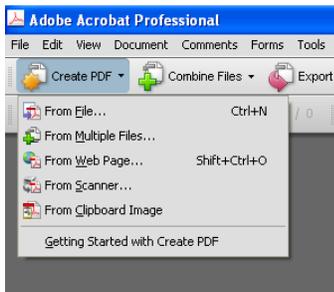
9 Not done

If tympanometry was repeated for the left ear, record the left repeat values for the MEP, PV, COMP and TW.

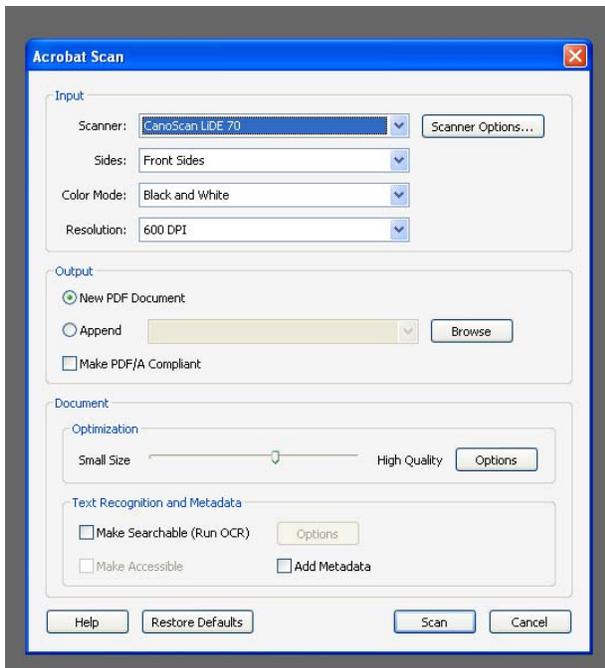
3.2.2 Scanning Tympanograms

The printed tympanogram(s) (originals and repeats, if done, for each ear) are placed on the flat bed scanner and scanned. The file of the scanned tympanograms is named using the participant's study identification number.

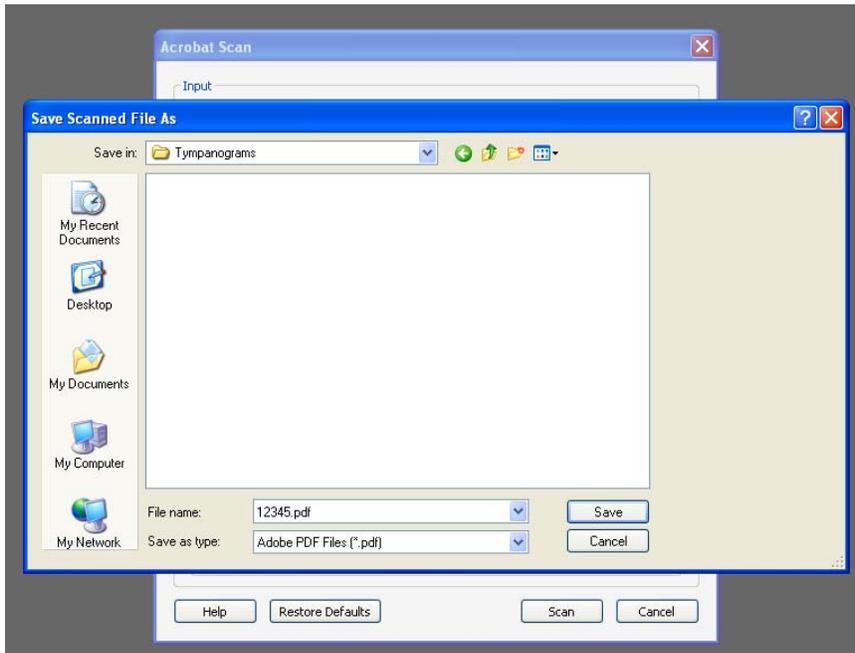
1. Attach the scanner to the PC with the USB cable provided with the scanner. There is no power button for the scanner.
2. Start Adobe Acrobat 8.0 Professional.
3. Place tympanogram face down on scanner bed (top of paper toward front of scanner). Note that single tympanogram printouts should be placed on the left side of the bed by the arrow.
4. Click "Create PDF," and then choose "From Scanner."



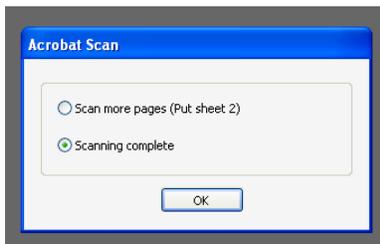
5. Select the CanoScan LiDE 70 scanner.
6. Set Color Mode to "Black and White" and Resolution to 600 DPI. Make sure the box labeled "Make Searchable (Run OCR)" is not checked.
7. Click "Scan."



8. Type in the file name (ID.pdf) and select the folder where you want the file to be saved.
9. Click “Save.”



10. After the scan completes, the Acrobat Scan dialogue box will appear. Make sure “Scanning Complete” is selected, and click “OK.”



11. Exit the software when finished.
12. Transmit the file to the Coordinating Center – **protocol to be determined**

3.2.3 Disinfection of Reusable Probe Tips

Tympanometer probe tips should be removed immediately following use and disinfected before reuse. If using disposable tips, dispose of immediately following use.

Each field site should use a disinfection method that adheres to their institutional guidelines.

Acceptable disinfection methods include:

- Alcohol
- Surgical soap
- Mild solution of Zephiran (Benzalkonium) chloride
- Ultrasonic cleaning

4 AUDIOMETRY

4.1 Overview

Pure-tone audiometry is used to determine the participant's hearing thresholds from 500 through 8000 Hz. Testing is consistent with guidelines established by the American Speech-Language-Hearing Association (ASHA). Testing is conducted in a sound-treated booth. Headphones are used for air-conduction (AC) testing unless the testing is conducted outside the sound booth or the participant has evidence of ear-canal collapse. In these instances insert earphones will be used. Bone-conduction (BC) thresholds are measured at 500, 2000 and 4000 Hz.

4.1.1 Equipment Needed

- GSI-61 Clinical Audiometer
- TDH-50 Headphones
- E-A-Rtone 3A Insert earphones (as needed)
- Bone Conduction headset
- Sound-treated testing booth

4.1.2 Supplies Needed

- Headphone cleaner or covers

4.2 Procedure

4.2.1 Pure-tone Air-conduction Audiometry (500-8000 Hz)

Escort the participant into the sound booth and seat him/her comfortably in the chair.

Instruct the participant face-to-face. If the participant wears a hearing aid you will want him/her to wear it while you're instructing.

Instruct the participant: "You are going to hear a series of tones, first in one ear and then in the other. Some of the tones will be high in pitch, some low. Some will be loud and easy to hear, some will be very soft or faint and hard to hear. Please signal that you hear (using this button, by raising your finger, etc) whenever you think that you have heard a tone. Signal when you first hear the tone, and stop signaling the moment the tone goes away. Signal every time you hear a tone. Do you have any questions?"

If the participant is wearing a hearing aid have him/her remove it before putting the earphones on. If the participant is wearing earrings, eyeglasses, hair accessories, etc. that will interfere with earphone placement ask him/her to remove them.

If ear canal collapse was noted during otoscopy, use insert earphones.

Place headphones or inserts on the participant. **Red on the right ear and blue on the left ear.**

Headphones: center the earphones over both ears and adjust the headband so that it rests solidly on the crown of the head and exerts pressure on both ears. Do not allow the participant to place or adjust the headphones.

Inserts: select the appropriate foam tip size according the size of the participant’s ear canal. (The smallest size should be used only when the ear canal is very small. Place the foam eartip on the end of the insert earphone. Compress the size of the eartip by squeezing or rolling gently between the thumb and forefinger until it is small enough to be inserted in the ear canal. Place the eartip in the ear canal and hold in place for several seconds until it expands sufficiently to remain in place. The depth of the eartip should be sufficient to provide secure placement and a good acoustic seal. Clip the transducer to the participant’s shirt.

Set GSI 61 clinical audiometer channel:

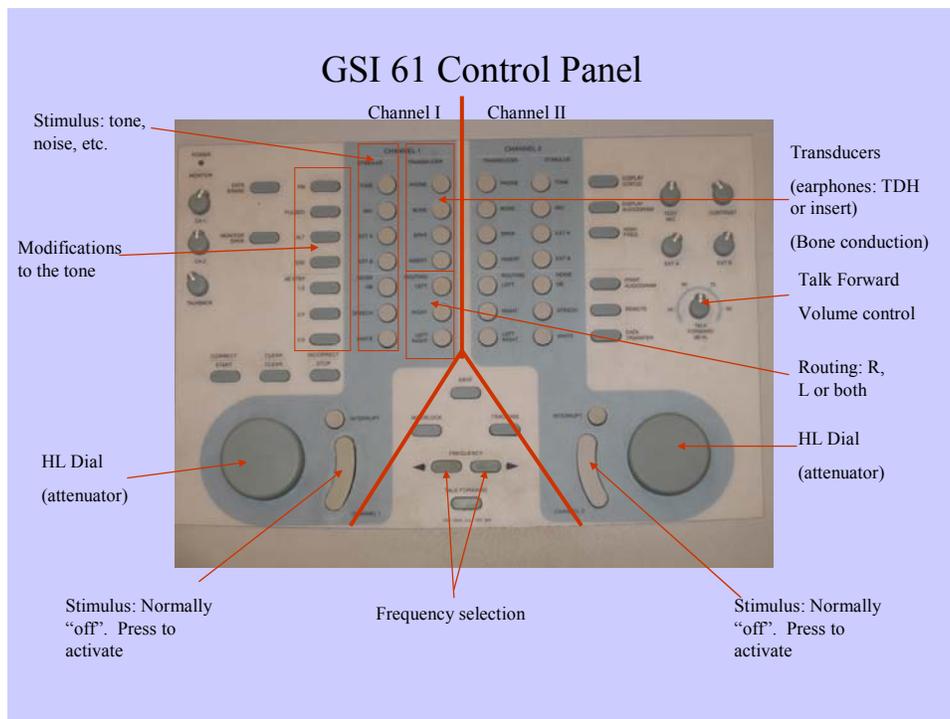
- Stimulus: Tone
- Transducer: Phone or Insert
- Routing: Right or Left

If the participant notes that one ear is better than the other, the better ear should be tested first. If no such difference is noted, start with the right ear. If participant has reported a history of tinnitus, a pulsed tone should be used during all audiometric testing.

Channel 2 is only used during pure-tone testing if masking is needed.

The channel 2 settings in masking situations should be:

- Stimulus: NB noise
- Transducer: Phone or Insert
- Routing: Right or Left - whichever is appropriate (see Masking Procedure).



In order to familiarize the participant with the signal, present a tone at 1000 Hz at a hearing level of 30 dB. If a response occurs, proceed with threshold measurement. If no response at 30 dB increase HL to 50 dB, and from then on increase in 10 dB steps until a response occurs and threshold measurement can begin.

Threshold measurement:

The tone presented should be 1-2 seconds in duration, and varied throughout testing.

The level of the first presentation is 10 dB below the subject's response in the familiarization procedure.

The interval between tones should be varied but not shorter than the test tone.

If there is a failure to respond, the level of the tone should be increased in 5 dB steps until a response occurs. After a response occurs, the tone is decreased 10 dB and another ascending series is started (5 dB steps again).

Threshold is defined as the lowest level at which responses occur in at least half of a series of ascending trials with a minimum of three responses required at a single level.

Record threshold using the audiometric data entry screen. Be very careful to record the appropriate threshold level for each frequency by transducer type (TDH Headphones = HdPh, Insert phones = insert).

After you have determined the participant's threshold at 1000 Hertz, follow the threshold measurement steps above for 500, repeat 1000, 2000, 3000, 4000 6000, and 8000 Hz respectively. The order of frequency tested is important, and should follow that listed above precisely.

If the repeat measure for 1000 Hz differs by more than 5 dB, reinstruct the participant. If the difference remains, continue testing.

When testing is completed for this ear, repeat the same procedure for the other ear.

Masking is needed at a particular frequency for air-conduction if there is a 40 dB or more difference between the air-conduction threshold of the test ear (obtained with TDH 50 headphones) and the bone-conduction threshold of the non-test ear. If the bone-conduction threshold of the non-test ear is unknown, mask when there is a difference of 40 dB or more between the air-conduction thresholds of the non-test ear and that of the test ear. If using insert earphones, the cut point in both situations is 60 dB or more (see Masking Procedure).

Once thresholds have been determined for both ears, remove the headphones from the participant's ears. You will now do bone-conduction testing.

4.2.2 Pure-tone Bone-conduction Audiometry (500, 2000 and 4000 Hz)

Reinstruct the participant: "You will again hear a series of tones. Some of the tones will be high in pitch and some low. Some will be loud and easy to hear, some will be faint and hard to hear. Please signal when you first hear the tone and stop signaling when the tone goes away. Signal every time you hear a tone regardless of which side you hear it."

Place the bone vibrator on the mastoid prominence behind the test ear (better ear). Do not allow it to touch the ear and be sure it is not placed on hair.

The test ear should not be covered. The contralateral ear will be covered if masking is used, using the appropriate earphone.

Test at 500, 2000 and 4000 Hertz. For each frequency, test the better ear first.

The procedure for bone threshold measurement is the same as the procedure for pure-tone air-conduction except that no familiarization tone is needed and the stimulus should be changed to bone. Again, the better ear should be tested first. Record thresholds using the Audiometry data entry screen.

If the bone conduction threshold is within 15 dB of the air conduction threshold (bone better than air) for both ears there is no need to do bone conduction testing on the other ear. If the air-conduction threshold is ≥ 15 dB worse than the bone threshold in either ear then masking is needed for that bone threshold. If masking is needed, establish the unmasked threshold for that ear and then the masked threshold (see Masking Procedure). Record the masked and unmasked thresholds and masking levels.

Once testing is complete remove bone vibrator (and headphones).

Record audiometer used.

4.3 Masking Procedure

Definitions

ACTE = Air-conduction, test ear

BCNTE = Bone-conduction, non-test ear

ACNTE = Air-conduction, non-test ear

IANBN = Interaural attenuation, narrow band noise

BCTE = Bone-conduction, test ear

Masking is needed if any of the following criteria are met:

Air-conduction:

40 dB or more difference between ears – TDH earphones

40 dB or more difference between ACTE and BCNTE – TDH earphones

60 dB or more difference between ears – inserts

60 dB or more difference between ACTE and BCNTE – inserts

Bone-conduction:

BCTE 15 dB or more better than AC threshold of either ear, or if it appears that the air-bone gap is 15 dB or more (air worse than bone)

Determine minimum and maximum masking level:

Minimum masking level: ACNTE

Maximum masking level: IANBN + BCTE

Note: If you are testing bone-conduction and the threshold shifts as you increase masking in the
MOP 8: HCHS/SOL Audiometry Assessment 01/31/2008 ver. 1.0 Page 24

non-test ear, the maximum masking level as defined here will increase as the BCTE increases.

Recheck the unmasked threshold in the test ear

Apply an increment of masking to the non-test ear

Note: Increment size is typically 5 dB but may be varied relative to the size of the masking range (minimum\ -maximum). In other words, as the range increases, larger increments might be used.

Present the tone at the level determined above.

If no response, increase tone 5 dB and present again.

Continue increasing in 5 dB steps until a response is obtained.

When response occurs, increase the noise by another increment, and repeat the process.

Note: Are the threshold shifts equal to the size of the noise increments? If so, continue the process until the threshold becomes stable in the presence of increasing noise (15-20 dB plateau).

If a response occurs, increase the masking noise by another increment and present tone at level determined above again.

As response occurs again, continue increasing noise.

When the threshold is stable with increases in the narrow band noise level over a range of 20 dB or so (range of stable threshold will be dependent upon the size of the masking range), or when the BC threshold matches the AC threshold, you have found threshold for that frequency. Record it and move on.

The field site number, examiner ID and the identification number of the audiometer are recorded on the data entry screen ([see audiometry form](#)).

4.4 Unusual Conditions

Any unusual testing conditions such as testing outside the booth or testing with the door open (due to participant claustrophobia) are recorded in the “Notes” section.

5 QUALITY CONTROL PROCEDURES

5.1 Field Staff Quality Control

All examiners will be certified in the Audiometric Testing Protocols prior to collecting study data and will be recertified annually. Once a year, the EAR Center project coordinator will travel to each site to observe examinations in order to monitor adherence to the audiometric protocols and complete annual re-certifications of field staff. Monthly QA reports will be sent to each Field Site.

On a monthly basis, the Episense Audiometry Reading Center (EAR Center) will provide examiner specific reports by field site tracking the appropriate use of inserts, tympanogram failure rates, masking errors, air-bone “anti-gaps” (bone is worse than air which is an indication of possible placement problems), asymmetries between ears and other potential problems.

5.2 Equipment Quality Control

All equipment quality control results are to be sent as electronic documents to the EAR Center. The process for sending the attachments:

1. Send all forms as separate attachments in ONE email.
2. The subject line of the email as QA-[Site] [Date]. For example QA-BRO 11/21/07
3. Nomenclature of the files **exactly** as: QA-[Site] [Form Name] [Date].doc. Site is a letter code for each specific site, name of the form as indicated below, the date as year (2 digits) month (2 digits) day (2 digits) with no spaces for the daily forms. For the weekly form use the Sunday to Saturday of the week in which the readings were taken using the year date day (each as two digits) for Sunday then a dash then year date day (each as two digits) for Saturday.
 - a. Sites codes:
 - i. BRO – Bronx
 - ii. CHINU – Chicago, Northwestern
 - iii. CHICH – Chicago, Community Health
 - iv. MIA – Miami
 - v. SAN – San Diego
 - b. Form name codes:
 - i. Daily Aud (daily audiometer listening checks form)
 - ii. Tymp (Earscan Cavity Check form)
 - iii. Noise (ambient noise levels form)
 - iv. Bioacoustics (Bioacoustic Simulator form)
 - v. Weekly Aud (weekly audiometer checks form)
4. All forms are to be saved with the .doc extension as WORD documents
5. The completed forms are to be emailed to the EAR Center (klosterman@episense.wisc.edu) each day.
6. Each site must keep an electronic copy of each form as backup in case there is a problem with the transmission.

An example of the attachment nomenclature (using the day 10/31/07 and week of 10/28/07-11/2/07) for the Bronx:

QA-BRO Daily Aud 071031.doc

QA-BRO Tymp 071031.doc
QA-BRO Noise 071031.doc
QA-BRO Bioacoustics 071028-071102.doc
QA-BRO Weekly Aud 071028-071102.doc

5.2.1 Checks for the GSI-61 Audiometer

The following checks are to be performed daily:

Headphone cord check

1. Set Channel 1 at the following settings:

Frequency: 2000 Hz
Stimulus: Tone
Transducer: Phone
Routing: Right
dB HL: 70 (or higher)

Turn on the “interrupt” button and listen through the right headphone. Flex the TDH-50 cord along its entire length. If the cord is defective or if there is a poor connection, a scratchy noise may be heard or the signal may be intermittent.

2. Check for hum and noise: Using the same settings as above turn the Channel 1 hearing level control from 0 to 60 dB HL. Listen for a low frequency hum (60 or 120 Hz) and any other noise (hiss or low rushing sound) at all attenuator levels through the earphone. Some audible noise at levels above 70 dB HL is permissible. If these noises are detected below 70 dB HL, contact the EAR-Center.

Repeat steps 1 and 2 for the left ear by changing routing to Left.

3. Check (compare loudness) one earphone against the other:

Set Channel 1
Stimulus: Tone
Transducer: Phone
Routing: Right
dB HL: 50

Set Channel 2
Stimulus: Tone
Transducer: Phone
Routing: left
dB HL: 50

Press the ALT button and turn on the “interrupt”. Listen through the headphones at .5, 1, 2 and 4 kHz. The tone will alternate between the right and left ear. The output for each ear should sound equal. Suspect the cord or the earphone if one earphone gives a noticeably lower output.

Insert earphone check

1. Set Channel 1 at the following settings:

Frequency: 2000 Hz
Stimulus: Tone
Transducer: Insert
Routing: Right

dB HL: 70 (or higher)

Turn on the “interrupt” button and listen through the right headphone. Flex the TDH-50 cord along its entire length. If the cord is defective or if there is a poor connection, a scratchy noise may be heard or the signal may be intermittent. Repeat for left ear by changing routing to left.

2. Check for hum and noise: Using the same settings as above turn the Channel 1 hearing level control from 0 to 60 dB HL. Listen for a low frequency hum (60 or 120 Hz) and any other noise (hiss or low rushing sound) at all attenuator levels through the earphone. Some audible noise at levels above 70 dB HL is permissible. If these noises are detected below 70 dB HL, contact the EAR-Center.

Repeat steps 1 and 2 for the left ear by changing routing to Left.

3. Check (compare loudness) one earphone against the other:

Set Channel 1
Stimulus: Tone
Transducer: Insert
Routing: Right
dB HL: 50

Set Channel 2
Stimulus: Tone
Transducer: Insert
Routing: Left
dB HL: 50

Bone vibrator check

1. Set Channel 1 at the following settings:

Frequency: 2000 Hz
Stimulus: Tone
Transducer: Bone
Routing: Right
dB HL: 40 (or higher)

Turn on the “interrupt” button. With the bone vibrator positioned correctly, the tone should be audible to a person with normal hearing. If a bone vibrator fails this test, and a mechanical problem with the audiometer is not suspected, contact the EAR-Center.

Electronic forms are used to record the results of the daily audiometer listening checks. (See [Daily-Audiometer form](#))

5.2.2 Bioacoustic Simulator

The bioacoustic simulator serves as an artificial ear, used to check the calibration of the audiometer on a weekly basis.

Press the ON button on the BA-202 bioacoustic simulator. Check the POWER indicator to verify that the light is flashing. (If the light is flashing dimly or does not flash at all, replace the battery.) Unplug the response switch for the audiometer from inside the booth and plug the simulator response cable into the jack. Place the TDH-50 headphones on the simulator being

sure the right earphone is over the simulator coupler marked RIGHT and the left earphone over the coupler marked LEFT. Close the door to the testing booth and the testing room.

Set the GSI 61 clinical audiometer channel 1:

Stimulus: Tone
Transducer: Phone
Routing: Right

Start at 500 Hz and 30 dB presentation level, turn on the interrupt. Slowly increase the presentation level in 5 dB steps, pausing a few seconds at each level to check the response light. Once the response light comes on, stop increasing the intensity. Record this level on the Bioacoustic Simulator Log Sheet. Repeat this process for the right earphone at 1000, 2000, 3000, 4000, 6000 and 8000 Hz recording the level at which the response light illuminates for each frequency.

Test the left earphone by selecting LEFT routing and repeating the process.

When both sides have been tested remove headphones and test insert earphones. Connect a small foam eartip on each insert transducer and carefully connect the earphone to the coupler on the Bioacoustic simulator, being sure to place the right insert on the side marked RIGHT and the left insert on the side marked LEFT. Be sure that the couplers are seated securely and evenly on the simulator.

Set the GSI 61 clinical audiometer channel 1:

Stimulus: Tone
Transducer: Insert
Routing: Right

Repeat the process for each frequency (500, 1000, 2000, 3000, 4000, 6000, 8000 Hz) for the right and left insert earphones.

Electronic forms are used to record the results of the weekly Bioacoustic Simulator checks. (See Weekly – Bioacoustic Simulator form)

5.2.3 Tympanometer Calibration

The Earscan tympanometer must be calibrated on a daily basis at the beginning of each day.

Turn the Earscan on and wait for the display screen to read “MAKE SELECTION Output to printer”

Insert the probe tip (with no ear tip) into the black calibration cavity

Press the CAL key. Earscan will automatically run an impedance test; the screen will display the message “CALIBRATING.” (Note: If the CAL key is pressed before the probe is placed in the calibration cavity, Earscan will not run the calibration test.)

Wait for the unit to complete the test. When the test is complete, the screen will read “REMOVE PROBE.” Remove the probe from the calibration cavity.

Press DISP. The screen will display the numeric tympanometry results.

Enter the PV (physical volume) measurement on the Earscan Cavity Check Log. The PV must be within the range 1.8 – 2.1 ml. (Other tympanometry results will be displayed but only the PV has any relevance to the calibration.)

If the PV measurement does not fall within the required range, repeat the calibration making sure to hold the probe very still. Placing the probe on a piece of foam or other soft surface during calibration may be helpful. If the PV continues to be outside the acceptable range, contact the EAR Center.

Electronic forms are used to record the results of the daily Earscan Cavity checks. (See Daily – Tympanometer form)

5.2.4 Ambient Noise Levels

To verify that audiometric testing conditions are within ANSI standards, ambient noise level readings are obtained each day. (This frequency may decrease once stable conditions can be confirmed.) The SoundPro SE2 1/1 Sound Level Meter (SLM) is used to monitor ambient noise levels in the testing booths.

The SLM is a precision instrument and must be handled carefully. Some assembly of the SLM is required prior to collecting ambient noise level data.

Assembly of SLM

1. Place the preamp connector (the end with the black cuff) over the mating connector at the top of the SLM. Gently press down while rotating the preamp until the preamp connector drops slightly into place.
2. While gently pressing the connector together to engage the threads, rotate the black cuff clockwise to secure the preamp to the instrument. The threads are delicate, so if resistance is felt, rotate the cuff counterclockwise and try engaging the threads again. The black cuff should thread on smoothly and easily – finger tighten only.
3. Remove the microphone from the plastic case and carefully thread it onto the top of the preamp. Remove the plastic cap from the microphone.

Calibration of SLM

4. Place the calibrator adaptor securely on the calibrator.
5. Turn on the SLM by pressing the On/Off button. There is a slight delay before the instrument comes on.
6. Press the CAL softkey below the display screen. The calibration screen will appear.
7. Press the center arrow button to display the pre-cal screen.
8. Connect the calibrator firmly and uniformly to the microphone/preamp assembly. Turn on the calibrator via the slide switch on the bottom of the unit.
9. The SLM should read 114.0 dB. If it does not, adjust the read-out to 114.0 dB by using the up and down softkeys below the display screen.
10. Press the center arrow button to enter the calibration value.
11. Turn off the calibrator and remove it from the SLM. Press the Esc button to exit the calibration screen. Calibration of the instrument is complete.

Collection of ambient noise levels

12. Select “view session” in the start menu by using the up or down arrows and the central arrow button
13. Use the up and down arrow buttons if necessary to change the scale to display 10 – 70 dB.
14. At the bottom of the screen, confirm that the letter S in the 2nd box (F S I) and the F in the

3rd box (A C Z F) are underlined. Use the softkeys below each box to select the correct letters if necessary.

15. Use the left and right arrow buttons to change the frequency. The noise levels are displayed numerically next to the frequency value. Noise levels are to be measured at 250, 500, 1000, 2000, 4,000 and 8,000 Hz.
16. Record the noise level for each frequency on the Ambient Noise Level recording form (see 20.6.2.10).
17. When all measures have been obtained, press the escape button to return to the start menu.
18. Press and hold the On/Off button while the screen counts down from 5 to 1. When the screen goes blank, the instrument is shut off.
19. Carefully remove the microphone from the preamp. Replace the plastic cap and return it to the plastic case. Remove the preamp by rotating the black cuff counterclockwise and gently pulling the preamp straight off the SLM. Remove the adaptor from the calibrator. Return all pieces to their appropriate places in the instrument case.

Electronic forms are used to record the results of the daily ambient noise levels. (See **Ambient Noise Levels form**)

5.2.5 Weekly Listening Checks for the GSI-61 Audiometer

Weekly performed checks:

Masking level check:

Set Channel 1

Stimulus: Tone

Set Channel 2

Stimulus Noise NB (narrow band noise)

dB HL: 50

Routing: Right

Turn on the Channel 2 interrupt button. Listen through the right head phone for a smooth, even hiss. If a problem is detected, contact the EAR-Center. Repeat for left ear by changing routing to left.

Talk forward check:

Speech should be clearly audible (in the headphones) when spoken in a normal tone with the talk forward dB HL set at 45 dB HL. If not, check microphone connections. If the problem cannot be resolved, contact the EAR Center.

Acoustic leakage check:

Carefully unplug the headphones from the back of the GSI 61. Be sure the monitor dials for each channel are turned all the way down (dials all the way to the left). Set the HL dial to 60 dB in Channel 1. Listen at each test frequency (with the interrupter switch on and then off) for noise (hum or tones) emanating from the audiometer. If present, contact the EAR Center.

Repeat procedure for Channel 2.

Plug earphones back in. It is critical that they be plugged in to the correct jacks (right in right, left in left). Verify following check that tones presented to the right ear and left ear are appearing in the appropriate earphone.

Crosstalk check:

Carefully unplug the right headphone from the booth wall.

Set Channel 1

Stimulus: Tone

Transducer: Phone

Routing: Right

dB HL: 60 dB

At each of the test frequencies (starting at 500) present the tone to the right headphone (turn on “interrupt”). Listen to the left headphone, you should hear nothing. Repeat the test presenting the tone to the left headphone while listening to the right. Repeat for Channel 2 using narrow band noise as the stimulus through each side (right and left). If crosstalk present, contact the EAR Center.

Electronic forms are used to record the results of the weekly audiometer listening checks. (See [Weekly-Audiometer form](#))

6 THE EPISENSE AUDIOMETRY READING CENTER (EAR CENTER)

6.1 Purpose

The EAR Center is responsible for:

1. training and certifying examiners in all hearing-related questionnaires and measurements (otoscopy, tympanometry, and audiometry)
2. providing an initial review for the purposes of participant feedback
3. monitoring data for consistency with study protocols
4. monitoring quality assurance data
5. providing monthly reports to field sites and the Coordinating Center (CC)
6. annually calibrating equipment
7. data cleanup for analysis, including classifying hearing outcomes

6.2 Examiner Training and Certification

The Audiometric Examination consists of a hearing examination questionnaire, otoscopy, tympanometry and audiometry. All study staff who will be conducting the audiometric examination will need to be certified in the audiometric examination protocols.

Certification criteria includes:

1. Attending the central training session for audiometric testing held at the University of Wisconsin in Madison, Wisconsin. (See training manual for detailed information on the training session.)
2. Sending 5 complete sets of audiometric examination data (conducted on volunteer subjects) to the EAR Center for review. The data will be reviewed for quality and adherence to protocols.
3. Conducting three examinations while being observed by the EAR Center co-director. (This will be done when EAR Center staff travel to each site for equipment calibration.)
4. Passing an examination protocol quiz, questionnaire protocol quiz and masking quiz.

Once all the criteria have been met, the examiner will receive official notification that he or she is now certified and may conduct the audiometric examination on HCHS – SOL participants.

Certified examiners must complete two examinations per month to maintain certification. Annually examiners will need to pass quizzes and demonstrate proficiency with examination procedures.

6.3 Equipment Calibration

Audiometers will be calibrated by the EAR Center before study examinations begin and annually during the data collection period. EAR Center staff will travel to each site to perform the calibration. The EAR Center will track the location of all equipment and calibration dates.

6.4 Reading Center Training, Certification and Quality Assurance

Graders will be trained in procedures and complete a set of twenty examples for certification. This same set will be re-graded every six months to maintain certification and monitor consistency. A three percent sample of examination data will be re-graded for quality assurance.

6.5 Initial Review and Participant Feedback

All audiometric data will be evaluated at the EAR Center. An initial review will provide feedback to study participants regarding their hearing thresholds and middle ear function. Clinical recommendations will be given when appropriate.

6.6 Field Quality Assurance Data Review

Each field-site is responsible for obtaining quality assurance data regarding the audiometric equipment and testing conditions. On a daily basis this includes audiometer listening checks, a calibration check of the tympanometer, and measurement of ambient noise levels in the testing booths. Additional checks of the audiometer and the Bio Acoustic Simulator are conducted on a weekly basis. The EAR Center reviews the daily and weekly QA data to ensure that the equipment is working properly and testing conditions are within ANSI standards.

6.7 Data monitoring reports

Once a month a SAS set will be extracted from the Data Entry System (DES) and merged with QA data sent directly to the EAR Center. Programs will be run to generate site-specific reports of examiner errors, air-bone anti-gaps, missing data, and quality assurance checks.

6.8 Final Review

Once a month a SAS set will be extracted from the Data Entry System (DES). These SAS sets will be used to do detailed checks for protocol violations and scoring of perforations, possible middle ear effusion, excessive wax, frequency specific edits, excess ambient noise effects, calculate pure tone averages (ear-specific, better and worse), and classify hearing loss level (for better and worse ear – none/mild/moderate/severe) and type (conductive). Basic descriptions of the data will be provided to the CC and site-specific patterns will be monitored to identify any unusual patterns. A report of site-specific examiner errors, missing data and quality assurance issues will be generated.

Appendices

Appendix I: Audiometric Examination Step by step procedures

Hearing Exam Questionnaire

1. Questions must be answered by the participant, no proxy respondents. The questions must be asked before the testing begins. Encourage participants to select the answer that best fits their experience. Mark only one response per item.
2. If participant reports hearing loss, the better ear is tested first (question 2)
3. If participant reports tinnitus that lasts for more than 5 minutes (questions 5 and 6), use pulsed tones for testing.

Otoscopy

1. Examine right ear first
2. Check for collapse before examining ear canal – if collapse is noted use inserts during audiometry
3. Record data for right ear before examining left ear
4. Dispose of used speculum

Tympanometry

1. Instruct participant
2. Select tip and place on end of probe
3. Press SPEC then CLEAR to erase previous data
4. Press IMP to select impedance testing
5. Select R or L if necessary
6. Hold steady during the testing and do not remove probe tip before testing is complete
7. Press GRAPH to print tympanograms
8. Scan tympanograms and save file using the participant's 8 character study ID
9. Upload scanned file

Audiometry

AIR CONDUCTION

Seat participant in booth giving instructions. Hearing aids should be removed. Remove glasses, earrings, etc. if interfere with placement.

Place earphones correctly

RED=Right and BLUE=Left

Use TDH50 for air unless canal collapse noted on otoscopy

Test Better Ear first (Q 2)

If no difference test RIGHT first

Set GSI 61 clinical audiometer channel 1:

Stimulus: Tone

Transducer: Phone or Insert

Routing: Right or Left

1. Begin at 1000 Hz
2. Present tone at 30 dB
 - a. Use pulsed tone only if history of tinnitus (Q5 AND Q6)
3. Present tone
4. Response?
 - a. Yes – proceed
 - b. No – increase to 50 dB and then by 10dB until response occurs
 - c. This level determines your starting point
5. Present tone 10dB lower than previous response (For example, If first responded at 30 then use 20 dB (30-10=20 dB))
6. If no response: Increase in 5 dB steps until a response occurs
7. Response: Decrease 10 dB and then increase in 5 dB steps
8. Threshold= lowest level at which responses occur in at least HALF of the ascending steps. Minimum of 3 responses at a level.
9. Record threshold.
10. Repeat Steps 2-9 for 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz in that ear.
11. Test other ear following Steps 1-10.
12. **DETERMINE IF MASKING IS NEEDED.** If NOT, proceed with bone conduction.

BONE CONDUCTION

Remove earphones. Place bone vibrator over the mastoid prominence of the better ear. If no difference, use the right ear.

1. Change stimulus to bone.
2. Begin at 500 Hz and use the AC threshold for that ear as the initial stimulus level.
3. If no response go up 10 dB until they respond.
4. Then go down 10dB and up in 5dB increments to establish the BC threshold. Use the same stepping procedure as for air conduction (steps 5-9).
5. Record threshold.
6. Test 500, 2000 and 4000 Hz in the better ear at each frequency. You may need to switch sides to accomplish this.

7. DETERMINE IF MASKING IS NEEDED.

Masking is needed when:

Air conduction:

TDH50

AC between ears ≥ 40 dB

ACTE- BCNTE ≥ 40 dB

Inserts

AC between ears ≥ 60 dB

ACTE- BCNTE ≥ 60 dB

Bone conduction:

AC-BC ≥ 15 dB (**air worse than bone**)

Definitions:

AC: Air-conduction

BC: Bone-conduction

ACTE: Air-conduction, test ear

BCTE: Bone-conduction test ear

ACNTE: Air-conduction non-test ear

BCNTE: Bone-conduction non-test ear

Calculating Masking limits:

Minimum Masking = ACNTE

Assume Interaural Attenuation (IA) = 40 dB for TDH50 and 60dB for inserts

Maximum Masking = BC threshold (known or assumed) for the test ear (BCTE) + IA

If the BCTE is not known, assume it is the same as the BCNTE

(or ACNTE if BC has not been done)

When Minimum level \geq Maximum level: This is called a masking dilemma – can't be resolved

Set GSI 61 clinical audiometer channel 2:

Stimulus: Noise NB

Transducer: Phone or Insert

Routing: Right or Left

When masking:

Air conduction:

1. Instruct the participant: "You will hear noise, like static, in your _ ear, but continue to respond to the tones as you did before"
2. Set audiometer for masking: Channel 2 - Transducer = phone or insert; Stimulus = Noise NB; Routing = non-test ear
3. Start with the minimum amount of masking; minimum = the hearing threshold of the non-test ear

4. Recheck the unmasked threshold in the test ear
5. Turn on the “interrupt” switch to activate the masking noise and increase the amount of masking noise by 5 – 10 dB
6. Present the tone again in the test ear at the same threshold established in step 4
7. If the participant does not respond, increase the **test tone** in 5 dB increments until there is a response.
8. If there is a response continue increasing the masking in small increments (5 dB) and re-testing the threshold of the test ear until the threshold of the test ear stabilizes in the presence of about 20 dB of masking noise.
9. Be careful to not overmask. Maximum masking = the bone conduction threshold (known or assumed) for the test ear + 40 dB if using earphones or 60 dB if using inserts
10. Record the masked threshold of the test ear and the masking level on the audiometry screen in the DES

Bone conduction:

1. Same as air-conduction except that the bone vibrator remains in place for the test ear and the headphone is placed over the non-test ear (or insert phone is place in non-test). Do not cover the test ear with the headphone!
2. You need to determine the unmasked threshold for the test ear if that has not already been done. Re-check rules for when masking is needed and then proceed if necessary.

Appendix II: Equipment Quality Assurance Checks

Daily:

Audiometer

Headphones:

1. Cord check
2. Hum and noise
3. Loudness – output

Insert earphones:

1. Cord check
2. Hum and noise
3. Loudness – output

Bone Vibrator

Tympanometer Calibration (Earscan cavity check)

Ambient noise level (Sound Level Meter)

Weekly:

Audiometer

Masking Level

Talk Forward

Acoustic Leakage

Cross Talk

1. Channel 1 (tones)
2. Channel 2 (narrow band)

Bioacoustic Simulator

Appendix III: Audiometry Testing Troubleshooting Guide

HCHS/SOL Audiometry Testing Troubleshooting Quick Reference Guide

Bioacoustic Simulator

Problem	What to do	If problem persists
- bioacoustic simulator lights not working	Check battery in bioacoustic simulator and retest	Notify EAR Center.

Ambient Noise Levels

Problem	What to do	If problem persists
- levels outside of acceptable values	<p>Be sure that testing conditions are properly simulated – testing room door and booth door closed, etc.</p> <p>If noise source can be identified, attempt to modify testing environment</p> <p>Verify the dB range setting on SLM is correct</p> <p>Check batteries in SLM</p>	Continue testing for that day as usual. Record levels on log sheets, no need to call EAR Center. EAR Center will make determination about using data.

Bone Vibrator

Problem	What to do	If problem persists
- tone not audible	Check all connections, be sure tone is routed correctly and level set at 40dB	Notify EAR Center immediately if problem cannot be resolved. Continue with air-conduction testing but do not do bone conduction testing until problem resolved
- buzzing sound	Check all connections	Notify EAR Center immediately if problem cannot be resolved. Continue with air-conduction testing but do not test bone conduction testing until the problem is resolved.

HCHS/SOL Audiometry Testing Troubleshooting Quick Reference Guide

Earphone check

Problem	What to do	If problem persists
- scratchy noise or intermittencies	Check all connections and retest	If problem is with headphone cords, call EAR Center and use insert phones until headphone problem can be resolved. If problem is with insert earphone cords, call EAR Center and use headphones until problem resolved If problem is with both sets (headphones and inserts), suspect attenuator problem. Call EAR Center immediately, testing cannot be done until problem resolved.
- one earphone noticeably lower output	Check that audiometer output set at 50 dB for each ear Check all connections and retest	If problem is with headphone cords, call EAR Center and use insert earphones until headphone problem can be resolved. If problem is with insert earphone cords, call EAR Center and use headphones until problem resolved. Notify the EAR Center immediately if problem cannot be resolved.
- audible noise at output levels below 70 dB		Notify the EAR Center immediately if audible noise detected below 70 dB.

Earscan Cavity Check

Problem	What to do	If problem persists
- PV not in acceptable range	Repeat calibration being sure to hold probe tip very still Contact field audiologist to clean probe tip	Notify EAR Center. Continue to use instrument if possible.

Other Audiometer Checks

Problem	What to do	If problem persists
----------------	-------------------	----------------------------

HCHS/SOL Audiometry Testing Troubleshooting Quick Reference Guide

Masking level check - masking noise problem	Check all connections Verify that NB noise selected for channel 2 and that channel 2 interrupt button is on	Notify EAR Center if problem cannot be resolved. Continue with testing for the day.
Talk forward check - speech not clearly audible in earphones	Verify that talk forward is set at 45 dB HL Check all microphone and earphone connections	Notify EAR Center if problem cannot be resolved. Continue with testing for the day remembering that you will need to go into booth to talk to participant
Acoustic Leakage check - hum or tones coming from audiometer when earphones are disconnected	Check monitor controls, “talk back” and “talk over” should all be off	Notify EAR Center immediately if problem not resolved. Continue testing for the day.
Cross talk check - tone heard in opposite earphone when one is disconnected	Verify that non-test earphone has been disconnected and that tone is being routed to disconnected earphone	Notify EAR Center immediately if problem not resolved. Continue testing for the day.
Other Problems		
Problem	What to do	If problem persists
Talk Back - Can't hear participant talking	Be sure volume is up on talk back control Check connections	Notify EAR Center if problem not resolved. Continue testing for the day, you may need to enter booth to hear and answer participant questions.