Department of Health

Recommended Protocol for Diagnostic Audiological Assessment Follow-up to Newborn Hearing Screening in Ohio

The Early Hearing Detection and Intervention (EHDI) Program at the Ohio Department of Health (ODH) and the Coalition of Ohio Audiologists and Children's Hospitals (COACH) formed a task force in 2015 to establish standardized diagnostic evaluation measures for infants who do not pass their newborn hearing screening. The outcome was a diagnostic protocol focusing on the first three months after birth, during which the diagnostic process should be completed. The protocol was designed to assist audiologists to comply with the best practice for optimal universal EHDI goals. The original protocol was endorsed by the ODH Universal Newborn Hearing Screening Subcommittee in August 2016. Subsequently, the Joint Committee on Infant Hearing (JCIH) released the Year 2019 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs. In January 2022, a call to action was issued to audiologists across Ohio to participate in the revision process of the diagnostic protocol to reflect JCIH 2019 recommendations. This guide reflects the revised diagnostic protocol.

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Summary of Revisions

This guide builds upon the 2016 hearing loss detection and intervention protocol endorsed by the ODH Infant Hearing Program. The following is a brief synopsis of changes made to each of the diagnostic procedure sections in this guide.

Diagnostic Otoacoustic Emission Evaluation

- Updated normative and cutoff criteria references.
- Clarified that DPOAE are the preferred diagnostic method based on evidence for detection of mild hearing loss and higher frequencies, above 4 kHz.
- Updated methods to ensure quality recordings.

Immittance - Tympanometry & Acoustic Reflexes

- Updated tympanometry and acoustic reflexes to be part of the recommended diagnostic assessment test battery for consistency with JCIH (2019). See Figure 1 for details.

Diagnostic Threshold Auditory Brainstem Response (ABR) Protocol

- Clarified Clinical Indications (section 2) to better define patient population.
- Clarified/refined language for Patient Preparation/Electrode Placement (section 3).
- In the Clinical Process section and subsequent table, eliminated the option for a Limited Diagnostic Protocol due to being inconsistent with recommendations from JCIH (2019) and clarified Full Diagnostic Protocol to allow for flexible testing.
- Provided multiple resources for correction factors given both AAA (2020) guidance and JCIH (2019) guidance, as well as wave V latency guidance for tone burst stimuli.
- Added information about the use of chirp ABR and ASSR in clinical practice.
- Added Special Populations section (section 8) to address infants seen due to missed/refused screening at birth hospital/home birth and for diagnosis of auditory neuropathy spectrum disorder (ANSD).

Counseling and Follow-Up

- The previous Counseling and Follow-Up section was divided into two new sections, including 1) Diagnosis and Follow-up and 2) Counseling, to better delineate functions completed during these parts of the process for both providers and families. Changes are as follows:

Diagnosis and Follow-up

- Clarification was provided to define initiation of referrals and intervention based on diagnostic result findings (e.g., sensorineural hearing loss, conductive hearing loss, or neural hearing loss).
- Follow-up recommendations were clarified in terms of referrals to be made and resources to be shared with families (found in new Appendix C).
- Provided updated recommendations for follow-up based on risk factors consistent with JCIH (2019).
- Reporting and documentation updated to reflect electronic reporting using HiTrack.
- Expanded information provided regarding neighboring state EHDI systems for reporting of out-of-state residents.

Counseling

- Clarified types of counseling and included adjustment counseling information.
- Clarified the SPIKES model and provided information in tabular format.
- Provided clarification of other counseling approaches in tabular form and considerations in new Appendices: “Appendix C: Resources for Families, and Appendix D: Resources for Audiologists.”
- Provided additional information about retention of verbal and written information to aid in family counseling.

I. Introduction

The Joint Committee on Infant Hearing (JCIH, 2019), Ohio Department of Health and COACH all recommend that infants who do not pass the newborn hearing screening have a diagnostic audiological assessment as soon as possible, with the goal of complete diagnostic testing before three months of age.

The target population for this protocol is infants referred for follow-up from newborn hearing screening from birth to 6 months of age. The process in this document provides specific guidance for physiological testing to identify ear specific information, including type, degree and configuration of hearing loss. It is important to note that prenatal history, medical history and hospital screening results including risk factors are an integral part of the evaluation. The scope of this protocol is the initial diagnostic assessment, and thus it does not discuss screening procedures at the hospital, nor does it cover intervention services.

The overarching goal of a statewide Early Hearing Detection and Intervention program (EHDI) is to identify hearing loss very early in life to ensure intervention before 6 months of age, promoting optimal brain development and allowing for subsequent development of language and communication skills. Behavioral audiometry continues to be the gold standard for establishing hearing thresholds in children. Guidelines for behavioral assessment for children six months to three years can be found in the Ohio Pediatric Behavioral Diagnostic Recommendations.

The JCIH 1-3-6 goals call for a screening be performed before one month of age; however, Ohio law requires a newborn hearing screening to be completed at birth before hospital discharge. Babies who do not pass the initial screening receive a secondary screening on both ears before discharge. JCIH calls for babies who did not pass the hospital screening to be referred for audiological follow up, and that diagnostic assessment be completed before three months. Babies who return for follow-up shortly after birth usually do not need sedation and may be tested in natural sleep. JCIH recommends that infants in whom permanent hearing loss is diagnosed should be fitted with an amplification device within one month of diagnosis for families who elect amplification; enrollment in early intervention should occur as soon as possible after diagnosis — before six months of age. Further, JCIH recommends that programs meeting the 1-3-6 benchmarks should make efforts to expedite this process to 1-2-3 to facilitate best outcomes.

In addition, infants who pass the newborn hearing screening but have one or more higher-risk factors for late onset or progressive hearing loss (e.g., congenital cytomegalovirus, extracorporeal membrane oxygenation (ECMO), culture-positive infections associated with sensorineural hearing loss such as meningitis or encephalitis, trauma, or chemotherapy) should have a diagnostic ABR by three months of age. Otherwise, infants with at least one risk factor should have at least one diagnostic audiological assessment by nine months of age. The frequency of diagnostic follow-up may depend on risk factors or caregiver concern. More information about types of risk factors is provided in Table 7.

II. Abbreviations

AC: Air conduction
ABI: Auditory Behavior Index ABR:
Auditory Brain Response
ASSR: Auditory Steady State Response
ANSD: Auditory Neuropathy Spectrum Disorder BBN:
Broad band noise
BC: Bone conduction
dBA: Decibels weighted according to the A scale
dB nHL: Decibels referenced to normal behavioral thresholds for ABR stimuli

DPOAE: Distortion Product Otoacoustic Emissions
eHL: Estimated hearing level in dB
ECMO: Extracorporeal Membrane Oxygenation
EHDI: Early Hearing Detection and Intervention
JCIH: Joint Committee on Infant Hearing
OM: Otitis media
TEOAE: Transient Evoked Otoacoustic Emission
UNHS: Universal Newborn Hearing Screening VRA: Visual Reinforcement Audiometry

III. Qualified Personnel

1. Licensed audiologist who is proficient in providing audiology services to infants and children.
2. Assistance to the audiologist may be provided by the following:
   a. Audiology interns under direct supervision by a licensed audiologist.
   b. Audiologist Aides under direct supervision by a licensed audiologist.

IV. Safety and Health Precautions

1. All procedures ensure the safety of the patient and clinician, and adhere to standard health precautions (e.g., prevention of bodily injury and transmission of infectious disease).
2. Decontamination, cleaning, disinfection, and sterilization of multiple-use equipment before reuse are carried out according to facility-specific infection control policies and procedures and according to manufacturer's instructions.
3. Disposable probe tips, otoscope tips and electrodes are recommended to reduce infectious disease transmission.

V. Optimal Test Environment

1. Infant Preparation: Refer to preparation instruction sheet in Appendix B, which should be provided to caregivers before appointment. The purpose of preparation instructions is to help ensure that infants arrive for testing hungry, awake and ready to feed and go to sleep.
2. The test environment must be quiet and infants should ideally be sleeping or at least quiet and comfortable for adequate results. A sound booth is desirable, but not necessary in a quiet environment (less than 50 dBA unoccupied) ***if*** the probe and earphone fit snugly.
3. A sink with warm water and soap for handwashing and clean up.
4. Supplies including diapers, wipes, bottled water, and any comfort items that may encourage sleep.
5. Dimmable lights, privacy and provisions for nursing (comfortable chair with arm support).
6. A crib or rocking chair for feeding and to aid and maintain sleep. Rocking chairs and cribs should be covered with a fresh sheet that is laundered after each use.
7. Best results are obtained for most infants if they go to sleep on their back so that both ears are available. This is also recommended as the safest position for the infant to sleep.
8. Some infants will sleep well in a crib or infant carrier after going to sleep, while others will sleep better in their caregiver's arms. Note that infants who are held may be more restless, and the electrodes and probes are harder to keep in place.
9. Infants with cardiac or pulmonary issues, stridor, or tracheostomy may be noisier and have difficulty remaining asleep when on their backs, so the caregiver should be asked about the best sleep position for these special needs infants.

VI. Procedures

The standardized comprehensive test battery includes a specific series of procedures designed to efficiently obtain ear-specific information. Guidance for each of the below procedures is provided in an overall flow chart (Figure 1). The below order of tests is recommended to provide ear-specific results that assess type, degree and configuration of hearing status for both well-baby and high-risk newborn hearing screening referrals.

The audiologist should plan the assessment to obtain the most important information based on the case and the infant's state. Thus, while some flexibility is encouraged in the steps outlined, following the standard protocol will provide the necessary information to either clear or diagnose an infant with hearing loss, determine need for ongoing monitoring, or to plan for intervention if a hearing loss is diagnosed.

The case history and otoscopy can be accomplished while the infant is feeding. Otoacoustic emissions and prepping for ABR can be accomplished in a quiet awake state, while obtaining ABR threshold responses generally requires the infant to be quiet or sleeping.

1. Case History: A sample case history is provided in Appendix A. The purpose of the case history is to obtain a thorough infant and family history, determination of congenital and neonatal risk factors for hearing loss, including caregiver/family report of the infant's responses to sound.
2. Otoscopic Examination: To ensure that the infant has an open ear canal and to assist with selection and accurate placement of appropriately sized probe tips and earphones.
3. DPOAE or TEOAE: Recommended as part of a diagnostic protocol as a cross-check for ABR results.
4. ABR: Frequency-specific, ear-specific responses are necessary to estimate hearing thresholds across the frequency spectrum.
5. Immittance: Tympanometry and acoustic reflexes should be utilized to evaluate middle ear function. Additionally, acoustic reflexes are a helpful part of the ANSD protocol (See Special Populations, Section 8 and/or JCIH, 2019).
6. Interpretation, counseling, appropriate referrals, and resources.
7. Completion of required reporting, timely and appropriate referral for habilitation services upon diagnosis of hearing loss.

VII. Equipment

Multiple pieces of specialized and calibrated equipment are needed to provide a comprehensive evaluation. Equipment should be versatile to meet the unique needs of each child. At a minimum, an otoscope, 1000-Hz middle ear acoustic immittance, acoustic reflexes, DPOAE or TEOAE, and tone burst air and bone-conduction ABR equipment are necessary for diagnostic evaluation. Auditory steady state responses (ASSR) and chirp stimuli are helpful optional procedures.

1. Equipment Calibration and daily checks: Equipment should be maintained and used per manufacturer guidelines. Instruments must be calibrated at least annually according to ANSI standards where available and daily calibrations for tympanometry and OAEs should be performed using a calibration cavity supplied by the manufacturer. Daily biologic (listening) checks are recommended ABR equipment.
2. Otoscope: Infant size disposable specula should be available.
3. Acoustic immittance: For immittance and acoustic reflex threshold measurement, equipment with multifrequency or wideband probe tones (minimum of 226-Hz and 1000-Hz) is recommended. Calibration procedures are specified in ANSI S 3.1 (1987).

4. OAE: Equipment can be distortion product (DPOAE) or transient-evoked (TEOAE). It should offer varying test parameters and the ability to change stimulus levels.
5. ABR: Equipment should be able to produce many stimulus types such as clicks, chirps and tone bursts at different levels. Insert earphones and bone conduction oscillator should be available. Chirps may be used in place of clicks if desired.
6. Auditory Steady-State Responses (ASSR): ASSR may be used as an adjunct to ABR testing and may be preferred for reducing test time while obtaining multiple frequency responses. Please see the electrophysiologic assessment section for further information on ASSR.
7. Audiometer for Auditory Behavioral Index (ABI) and Visual-Reinforcement Audiometry (VRA): Behavioral test measures are not covered in this protocol but are important to complete as a validation of physiologic results and to monitor hearing and intervention outcomes. Please see the Ohio Pediatric Behavioral Diagnostic Recommendations for further information.

VIII. Important Considerations

1. To prevent delayed diagnosis, if the infant has already had two screenings, additional rescreening is ***not recommended*.** Re-screening does not provide a diagnosis of normal hearing versus hearing loss, only an indication that further testing is necessary.
2. For infants who are less than 21 days old and are referred to your facility for diagnostic testing after non-pass on newborn hearing screening, consider requesting the infant's primary care provider to order a PCR for congenital cytomegalovirus (cCMV).
3. A comprehensive test battery of otoscopy, immittance, OAE and ABR is recommended for adequate follow-up. Audiologists can utilize the order of tests that best fits the appointment. As always, audiologists are able to deviate from protocol to make decisions that are in the best interest of the patient and goal of appointment. Document these instances as they occur to support the next professional providing follow-up.
4. Both ears should be evaluated at the follow-up, even if only one ear did not pass the screening.
5. Only audiologists with experience in pediatric assessment and counseling who have the capacity to engage in full diagnostic testing (i.e., proper equipment to complete this recommended protocol) should provide comprehensive follow up evaluation for infants. ODH provides a referral directory of audiologists who can provide screening and diagnostic services. If a provider is not able to complete a full diagnostic for any reason, it is incumbent upon them to refer to an appropriate facility.
6. Otoacoustic emissions (OAE) and middle ear assessments are important cross-check measures to diagnose type and location of problems in the middle ear and cochlea but cannot provide diagnosis without ABR threshold testing.
7. Auditory brainstem response (ABR) is the fundamental test for accurate, frequency-specific and ear- specific pure tone threshold estimates and is also able to assess neural problems such as Auditory Neuropathy Spectrum Disorder (ANSD).

Pre-appointment considerations for successful appointment and increased follow through for audiological evaluations:

1. Use pre-appointment phone reminder calls about the appointment. Consider an automated or live voice reminder call with appointment confirmation.
2. Provide instructions via mail, email, or messaging through patient's electronic medical record to the family regarding the appointment, length, need for infant to sleep, reminders to bring feeding supplies, blanket, etc.
3. Check to see if reminders about the appointment can be sent via text message if available and the family has accepted to receive text messages about appointments.

4. Consider using the triage approach to scheduling outlined in the COVID triage scheduling recommendations from 2020 to alleviate scheduling backlogs.

IX. Case History (Form in Appendix A)

1. Expected Outcome: To gain knowledge on infant's birth history, risk factors and other pertinent medical background as well as build rapport with family.
2. Obtain case history information by caregiver interview.
3. Ask about the reason for referral and the family's goals for the follow-up.
4. Ask about hospital hearing screening results and risk factors, NICU admission.
5. Ask about infant's responses to sound.
6. Ask how the infant is best able to sleep in the test environment.

X. Otoscopic and Outer Ear Examination

1. Expected Outcome: Assess the status of the outer ear canal prior to testing.
2. Otoscopy is performed to ensure that there are no contraindications to placing an earphone or probe in the ear canal.
3. Visual inspection for obvious structural abnormalities (e.g., ear pits, ear tags, atresia, stenosis and low set ears) of the pinna and/or ear canal should be completed and documented.
4. Newborn ear canal size and anatomy may make it difficult to identify the tympanic membrane or any landmarks, and to detect presence of fluid.
5. To diagnose ear drum or middle ear problems, referral to an otolaryngologist experienced in newborns is recommended.

XI. Diagnostic Otoacoustic Emissions (OAE) Evaluation

1. Expected Outcome:
    a. To assess cochlear function at the level of the outer hair cells.
    b. To serve as a physiologic cross-check for ABR testing.
    c. OAE levels are sensitive to hearing losses of 30 dB HL and greater, although a small percentage of borderline and mild losses may have normal OAE levels (Gorga et al., 2000; Norton et al., 2000, Blankenship et al, 2018).
    d. It is not possible to predict degree of hearing loss from OAE measures alone.
    e. Middle ear assessment is necessary to interpret abnormal OAE responses since the middle ear both conducts the sound stimulus and the cochlear response (refer to middle ear assessment section). Wideband absorbance has shown usefulness in interpreting DPOAE results (Blankenship et al., 2018).
2. Clinical Indications:
    a. Any patient in need of assessment prior to feasible behavioral testing due to not passing UNHS, passing UNHS but with risk factors, or due to parental concern for hearing.
    b. Patients who cannot provide accurate behavioral test information to rule out hearing loss.
    c. Any time objective information is needed to determine auditory pathway status.
3. OAE Method and Equipment:
    a. Distortion Product (DPOAE) are recommended as the primary diagnostic method due to published validation studies for hearing loss in infants and better detection of hearing loss above 4 kHz (Gorga et al., 2000; Blankenship et al., 2018).
    b. Transient Evoked OAEs (TEOAE) may be used if DPOAE are not available and are more sensitive in the 1-2 kHz region (Norton et al., 2000).

c. It is recommended that diagnostic OAE equipment is used that has controllable test parameters including the ability to adjust number of frequencies tested, stimulus level and criteria for pass.

4. Testing Conditions:
    a. Environment is quiet, and patient is sleeping or quiet, and in a relaxed position.
    b. A bottle or pacifier may be used to encourage sleep, but noise levels will increase if the infant is actively feeding or sucking so testing should wait until the infant is quiet and not sucking.
    c. A sound booth is desirable but is usually not necessary in a quiet environment (below 45 dBA) and most importantly, with a tightly fitted probe.
    d. It is recommended to position the probe securely, taking the weight off it (draped over the head), so that it maintains an acoustic seal and doesn't need to be held, as holding the probe causes artifact.
5. DPOAE Protocol:
    a. Stimulus frequency range**:** Assess at least five frequencies from 2000-8000 Hz.
    b. Noise levels are higher below 2000 Hz in infants, so frequencies above 2 kHz are the most sensitive and specific to hearing loss (Gorga et al., 2000; Blankenship et al, 2018).
    c. Frequencies above 8 kHz have lower levels, and normative ranges have not been established in young infants.
    d. Recommended stimulus levels are L1=65 dB SPL and L2=50 - 55 dB SPL at all test frequencies.
    e. Stimulus levels should be within ± 3 dB of these target levels when verified in the ear.
6. TEOAE Stimulus Level:
    a. Recommended level is 80 dB peak-equivalent SPL, with roughly equal levels through 6 kHz.
    b. Stimulus levels should be within ± 3 dB of these target levels when verified in the ear.
7. Classification of Results:
    a. Age-specific reference data are recommended to determine the presence or absence of an emission at each frequency evaluated.
    b. DPOAE normal criterion at each frequency: The emission is present if the DP-NF (Distortion product minus noise floor, or SNR) value is consistent with age-appropriate norms (Prieve et al., 1997a,b; Abdala et al., 2008; Hunter et al., 2018).
    c. DPOAE normal criteria: DP level and SNR criteria are in the normal range for more than 50% of frequencies, consistent with age-appropriate norms (Blankenship et al., 2018; see Table below).
    d. TEOAE normal criterion at each frequency band**:** The SNR must be >6 dB and reproducibility must be >70% for each frequency bands assessed, and the response amplitude is consistent with age-appropriate norms (Liu et al., 2012).
    e. TEOAE normal overall criteria: Response is obtained at a SNR of greater than or equal to >6 dB at >50% of frequency bands and the overall response reproducibility is >50%.
8. Interpretation of Results:
    a. If results are not normal, ensure that they were not impacted by insufficient stimulus levels, noise in the room or by the patient, a poor probe fit or debris in the probe assembly. Repeating the test after the infant is sleeping, and refitting the probe is the best way to ensure quality recordings.
    b. If results are not normal, tympanometry can help to determine whether a middle ear condition may be impacting results.
    a. An overall normal result is consistent with normal peripheral function through the level of the outer hair cells at frequencies where OAEs were present.
    b. Borderline levels may be consistent with slight-mild hearing loss or middle ear dysfunction and should be repeated, particularly if there are any other abnormal test results or caregiver concern for hearing.

c. If tympanometry is normal, the absence of responses is generally consistent with a problem with the outer hair cells and a sensory hearing loss of at least 30 dB HL.
d. If tympanometry and OAE results are not normal, refer for medical assessment to evaluate middle ear health. Repeat OAE testing after medical treatment.

DPOAE Normative data (Newborns through 4 months of age)

These levels can be used to interpret individual frequencies in a diagnostic protocol. The SNR and the DP level should both meet these criteria at >50% of frequencies tested. From Blankenship et al, 2018.

Table 1: Normative DPOAE Data (Blankenship et al., 2018)

DPOAE using 65/55 primary tone levels for newborns to 4 months.		
Frequency (kHz)	Cut-off Point to judge responses normal (greater than or equal to these levels)	
	DPOAE Level (dB)	SNR (dB)
2	6	9
3	4	5
4	6	13
5.5	3	11
8	-9	8

XII. Diagnostic Threshold Auditory Brainstem Response (ABR) Protocol

1. Expected Outcome(s):
   a. To assess status of the peripheral and central auditory system.
   b. To determine thresholds for ABR presence and estimated hearing levels.
   c. To determine need for audiologic habilitation in accordance with JCIH guidelines.
2. Clinical Indications:
   d. Any patient in need of assessment prior to feasible behavioral testing due to not passing UNHS, passing UNHS but with risk factors, or due to parental concern for hearing.
   e. Patients who cannot provide accurate behavioral test information to rule out hearing loss.
   f. Any time objective information is needed to determine auditory sensitivity and/or neural pathway status.
3. Patient Preparation/Electrode Placement
   a. Either one or two-channel recordings are acceptable. Two channel recordings are useful for determining side of bone conduction response, and for assessing neurologic integrity (Wave I

will be present in the ipsilateral recording at higher intensities, while Wave V should be present in both channels).

b. For one-channel recordings, three electrode sites should be prepared in the below locations. This vertical montage can be used for two-channel recordings, and for systems that provide automatic electrode switching in a one-channel recording. The ipsilateral and contralateral electrodes can also be manually switched in systems that do not provide electrode switching.
    i. High Forehead (FZ)/Vertex (CZ) (positive electrode).
    ii. Ipsilateral mastoid or earlobe (negative electrode).
    iii. Contralateral mastoid/earlobe (common or ground).

c. For two-channel recordings, four electrode sites should be prepared in the below locations. This montage can be used for two-channel recordings, and for systems that provide automatic electrode switching in a one-channel recording. The ipsilateral and contralateral electrodes can also be manually switched in systems that do not provide electrode switching.
    i. High Forehead (FZ)/Vertex (CZ) – positive electrode, with jumper cable.
    ii. Low Forehead or nape of neck – common or ground.
    iii. Ipsilateral mastoid or earlobe – Channel 1 negative electrode.
    iv. Contralateral mastoid/earlobe– Channel 2 negative electrode.

d. Skin preparation: Clean the skin with pre-packaged prep pads or electrode preparation liquid on a gauze pad, taking care to wipe away all excess liquid before applying electrodes.

e. Disposable electrodes are recommended for infection control, consistent impedance and ease of clean up.

f. Insert earphones with silicone tips or infant foam tips should be inserted as fully as possible. Trimming of foam tips may be necessary for newborns.

g. Bone conduction (BC) should be done whenever air conduction (AC) ABR is abnormal. Reliable results can be obtained with the BC transducer placed at the temporal bone just above the pinna. Hand-held with a fingertip or using a headband has been shown to be equivalent (Small, Hatton and Stapells, 2007). Measurement of adequate force with a strain gauge is recommended.

h. Effort will be made to ensure appropriate impedance for the electrode array. Impedance values should be < 5 kOhm for each electrode and balanced with no more than 3 kOhm differences.

4. <u>Clinical Process:</u>
    a. Start in the ear that referred the newborn hearing screening, or either ear if both referred.
    b. Always test both ears even if refer was unilateral since screening documentation errors can occur and hearing loss may occur in a previously normal ear after birth.
    c. See tables below for suggested order of test stimuli/transducer and initial stimulus levels.
    d. The cutoff for estimated hearing level (eHL) is 20 dB HL or less to consider hearing status as normal. The below cutoff criteria were determined with this goal in mind.

Table 2: Diagnostic ABR Protocol

Diagnostic ABR
Full diagnostic protocol: 1) Begin with AC tone bursts or chirps starting at 60 dB nHL for the following sets of frequencies. ▪ 4000 Hz then 1000 Hz **OR** ▪ 2000 Hz then 500 Hz 2) Decrease or increase as needed in 10-20 dB steps to threshold. Obtain a no response recording 5-10 dB below lowest repeatable response to determine threshold. 3) Switch ears and repeat. If above is abnormal and if infant sleep state permits, measure remaining frequencies to complete hearing thresholds 500 Hz through 4000 Hz. 4) Continue with BC tone bursts at below starting levels if AC thresholds were abnormal. Decrease or increase in 10-20 dB steps to threshold. Obtain a no response recording 5-10 dB below lowest repeatable response to determine threshold. ▪ 4000 Hz at 30 dB nHL then 1000 Hz at 30 dB nHL **OR** ▪ 2000 Hz at 30 dB nHL then 500 Hz at 30 dB nHL 5) If two-channel recordings are performed, the latency value and amplitude can be used to infer side of BC response, since ipsilateral recordings are better than contralateral (Hatton et al., 2012). 6) Note that at less than 12 weeks of age and bone conduction levels of less than 15 dBeHL (25 dB nHL), there is limited cross over so masking may not be necessary (Yang et al., 1987). Use of the contralateral channel can help determine whether crossover is occurring and if masking is necessary.

5. Correction Factors for estimated behavioral hearing level (dB eHL):

Correction factors to estimate behavioral hearing level (ie: converting dB nHL to dB eHL) are available from VanderWerff et al. (2009) which supported Stapells (2000), as well as McCreery et al. (2014). Guidance from the American Academy of Audiology (2020) supports the use of VenderWerff/Stapells correction factors. Negative numbers indicate that the correction factor (dB) should be subtracted from the ABR threshold to estimate behavioral hearing level.

Table 3: Toneburst ABR Correction Factors by Frequency (Stapells, 2000)

Correction Factors (Stapells, 2000)	
500 Hz	- 20 dB
1000 Hz	- 15 dB
2000 Hz	- 10 dB
4000 Hz	- 5 dB
Bone conduction	- 10 dB
Click	no correction

McCreery et al. (2014) reported that the degree of hearing loss influences the ABR-behavioral threshold differences for all frequencies. Of particular importance is the observation that ABR thresholds underestimate behavioral thresholds in cases of greater than moderate hearing loss. This underestimation has the potential to result in under-amplification when ABR is used as the basis for hearing aid gain prescriptions. Thus, McCreery et al. (2014) recommended that correction factors should differ for different ABR threshold levels.

Negative numbers indicate that the correction factor (dB) should be subtracted from the ABR threshold to estimate behavioral hearing level, and positive numbers mean that the correction factor (dB) should be added to the ABR threshold to estimate behavioral hearing level.

Table 4: Toneburst ABR Correction Factors by Frequency and Presentation Level (McCreery et al., 2014)

Toneburst Freq.	20 dB nHL	40 dB nHL	60 dB nHL	80 dB nHL
500 Hz	-5	3	7	12
1000 Hz	-5	-3	0	2
2000	-5	-2	1	4
4000 Hz	-6	-3	0	3

Table Note: These correction factors were obtained using calibration for peak equivalent SPL (peSPL) for 0 dB nHL reference for 250, 1000, 2000, and 4000 Hz tone burst and the click are 43, 24, 28, 32, and 35 dB peSPL, respectively (Gorga et al. 2006).

The following latency values are provided for guidance to identify robust wave V responses per frequency in the absence of any middle ear involvement:

Table 5: Approximate Toneburst latencies at presentation level 25 dB nHL

Toneburst Latencies at 25 dB nHL	
500 Hz	12.0 – 16.0 milliseconds
1000 Hz	10.5 – 14.5 milliseconds
2000 Hz	8.5 – 11.5 milliseconds
4000 Hz	6.5 – 10.0 milliseconds
Bone	Within .5 milliseconds of the air conduction latency for the corresponding stimulus

Ultimately, clinics should establish their own clinical correction factors based on their own recording parameters and patient population by systematically examining initial ABR thresholds and eventual behavioral thresholds for children with etiologies known for stable degrees of hearing loss.

6. General Test Parameters:
    a. Window latency – 20 ms for click or chirp and 1000-4000 Hz toneburst; 25 ms for 500 Hz tone bursts.
    b. Toneburst ramp: Blackman window, rise fall times recommended (McCreery et al., 2014)
        i. 500 Hz : 2-0-2 msec
        ii. 1000 Hz: 2-0-2 msec
        iii. 2000 Hz: 1.5-0-1.5 msec
        iv. 4000 Hz: 1-0-1 msec
    c. Stimulus Rate – Range between 27.1 and 37.9. Use odd numbers to minimize 60 Hz harmonic components. A slower rate, such as 13.1 or 11.1 may be needed for neurologic immaturity (premature or neurological diagnosis).
    d. Filter range – High pass filter set in range of 30 to 100 and low pass filter 1500 to 3000 Hz.
    e. Notch filter - Not recommended since low frequencies are dominant in infant responses.
    f. Waveform smoothing – If used, should be no higher than 5 point.
    g. Minimize/Maximize tracings – Is not recommended to be used unless it is applied to all the tracings.
    h. Stopping rules: Recommended rules for acceptable waveform quality are available for most instruments based on residual noise and correlation values, and are highly recommended for consistency. If the residual noise is sufficiently low, and correlation values are acceptable, the response may be stopped and the next level or frequency started.
    i. Sweeps: If stopping rules are not available, a recommended approach is to set the sweeps to a very large number such as 5000, and monitor the recording until waveforms are quiet, stable and the response is clear in the expected latency range. Waveform replication is recommended to establish threshold.
7. Adjustment of ABR Parameters:

Suggested stimulus and recording parameters can be adjusted within recommended ranges as needed to obtain the best test recording. For example, if low frequency noise is contaminating the tracing, the high pass filter can be adjusted slightly higher. If high frequency noise is apparent, the low pass filter can be moved lower. More averaging may help, or waiting until the infant is quiet. Checking and improving impedance, turning off unnecessary equipment and unneeded monitors or cellphones may help in cases of electrical noise.

8. Diagnostic Assessment:

A minimum of one low- and one high-frequency toneburst or chirp ABR threshold separated by two octaves (I.e., 500 Hz *and* 2000 Hz **OR** 1000 Hz *and* 4000 Hz) along with immittance and DPOAE data should be obtained in both ears. It is then up to the judgment of the audiologist to determine if enough data was obtained to establish hearing sensitivity or if further testing is necessary. When possible, results should be reviewed by another audiologist for confirmation.

Incomplete testing is one of the most common causes of loss to follow-up. Although not always possible, every effort should be made for diagnostic results to be obtained within one testing session. Please see Appendix D for Reducing Loss-to-follow-up Resources.

9. Special Population Considerations

    a. Missed screenings (either missed both inpatient screenings or only had one screening at the birth hospital that resulted in a non-pass), home-birth infants, or families seeking screening after initial refusal at birth hospital:
        i. For infants <30 days old, complete a screening using either DPOAEs or aABR.
        ii. For those babies over 30 days old, proceed to diagnostic testing.
        iii. If test results in either of the above situations are abnormal, or risk factors/family concern is reported, complete a full diagnostic test preferably within the same appointment.

b. Concern for neural integrity or auditory neuropathy spectrum disorder (ANSD) due to no-response tone burst ABR:

i. Obtain responses of each polarity (condensation and rarefaction) clicks at 80 dB nHL. If abnormal morphology is noted making identification of cochlear microphonic (CM) difficult, consider reducing stimulus rate (see Stimulus parameters in Section 5: General Test Parameters above).

ii. If no ABR or CM is identified at 80 dB nHL, increase intensity to maximum output of equipment.

iii. If a CM is identified with NO neural response, toneburst/frequency-specific chirp and ASSR testing is not indicated.

iv. Obtain two no stimulus runs (one condensation and one rarefaction) with the tube clamped or disconnected to separate out the CM from the stimulus artifact.

v. If a CM and identifiable neural response are identified, switch to alternating polarity and find a threshold. Proceed with tonebursts as time allows as indicated in the ABR protocol.

10. Application of ASSR

Although JCIH (2019) endorses toneburst ABR as the gold standard for infant audiologic assessment, technologies are emerging, such as Auditory Steady State Response (ASSR) testing, that demonstrate effective frequency specificity with potentially superior test efficiency. It is recommended that these technologies should be rigorously and independently validated for use in predicting behavioral hearing thresholds. Further, AAA 2020 Assessment of Hearing in Young Children includes procedures for use of ASSR in the clinic. Recommendations include sections on recording bandwidth, artifact rejection and modulations rates. Additional areas include simultaneous testing of multiple frequencies and intensities in both ears, threshold search procedures and correction factors. The use of bone conduction ASSR is not recommended due to the increased risk of stimulus artifact with automated analysis techniques.

Recent articles have also described protocols for use of ASSR in the clinic and may be referenced for additional information. It is suggested that each facility develops protocols based on research and equipment-specific manufacturer recommendations. For example, some equipment may allow for the simultaneous recording in both ears in many situations. However, there may be intensity limitations on the ability to record from both ears that are equipment specific. For additional information about implementing ASSR clinically, please see: American Academy of Audiology, 2020; Sininger et al., 2018; Sininger et al., 2019; and Wang et al., 2020.

XIII. Immittance (Tympanometry and Acoustic Reflex Assessments)

1. Expected Outcome(s):
   a. To assess middle ear function and auditory pathway integrity
   b. To evaluate for middle ear abnormalities
2. Select appropriate probe stimulus:
   a. Birth to 6 months: 1000 Hz or wideband (click) stimulus.
   b. Older than 6 months: 226 Hz.
   c. Choose a probe tip of sufficient size to achieve a hermetic seal and place tightly in ear canal.

3. Normal ranges for 1000-Hz probe tone (birth to age 6 months):
    a. Normal: ≥0.6 peak static admittance, relative to the positive baseline.
    b. Abnormal: < 0.6 peak static admittance (Margolis et al., 2003).

4. Normal ranges for 226-Hz probe tone (6-36 months):

Table 6: Normative Data for 226 Hz Probe Tone Tympanometry

Ear Canal Volume (mL or cc)[1]	Blocked: 0.0 – 0.09 ml Normal: 0.1 – 1.0 ml Possible perforation: ≥ 1.1 ml
Peak Pressure (daPa)	Negative: < -150 daPa Normal: -150 to +100 daPa Positive[2]: > 100 daPa
Admittance (mmho)	Reduced: < 0.2 mmho Normal: 0.2[3] – 1.2 mmho Increased: > 1.2
Tympanometric Width (daPa) [4]	Infant/Child: > 250 daPa

[1] Volumes are guidelines and must be interpreted cautiously such as for patients with abnormally sized ears. Comparison to opposite ear is recommended (should be similar except in cases of unilateral ear canal stenosis)

[2] Positive pressure may be an indicator of acute OM.

[3] Combine tympanometric width with admittance for better sensitivity for 226-Hz. For 1000-Hz, admittance alone is recommended since notching and collapsing ear canals at this frequency is often present and can make width measurements inaccurate.

[4] Tympanometric width and admittance are based on gold standard of myringotomy (Nozza et al., 1994).

5. Tympanometry interpretation:
    a. Normal: Identifiable peak is observed at or near atmospheric pressure and admittance and tympanometric width values are typical for the patient's age (see norms).
    b. Abnormal: No identifiable pressure peak
        i. With normal volume: Consistent with middle ear fluid.
        ii. With abnormally large volume: Consistent with patent tympanostomy tube or tympanic membrane perforation.

c. Abnormal: Peak is observed, but static admittance values indicate reduced or increased mobility (see norms).
    i. Abnormally low admittance: Consistent with reduced middle ear mobility (such as middle ear fluid, ossicular fixation, or other abnormalities of middle ear function).
    ii. Abnormally high admittance: Consistent with increased middle ear mobility (such as ossicular anomaly or abnormalities of the tympanic membrane).
d. Peak is observed, but tympanometric width is abnormally increased or gradient is abnormally reduced (see norms).
    i. Abnormally broad width: Consistent with reduced middle ear mobility (may be due to OM, ossicular fixation, or other abnormalities of middle ear function).
e. Peak is observed at a pressure outside of the normal range (see norms).
    i. Consistent with abnormally negative or positive middle ear pressure.

6. Acoustic Reflexes: Acoustic reflexes may be helpful in cases of suspected ANSD, neurologic history, or when ABR is markedly abnormal, as the acoustic reflex is nearly always absent or elevated in confirmed cases of ANSD (Berlin et al., 2005).
    a. Select Probe Tone: Children Birth to 6 months: 1000-Hz; Children > 6 months: 226-Hz.
    b. Select ear: Ipsilateral or Contralateral.
    c. Place appropriately sized tip into ear canal.
    d. Start test and when pressure is equalized (i.e., at peak admittance) and begin stimulation.
    e. A response is present with clear deflection (0.02 mL or greater) from the baseline, continued contraction with stimulation and return to baseline when stimulus is discontinued.
7. Acoustic Reflex Interpretation:
    a. Normal response: The average acoustic reflex threshold for infants with normal hearing is between 65-80 dB between 500-4000 Hz, and is 60 dB for broad band noise (Kei, 2012).
    b. Abnormal response: The upper limit for the acoustic reflex threshold is >95 dB HL for 500 Hz, 85 dB at 3000 Hz, 80 dB at 4000 Hz and 75 dB for broad band noise (Kei et al., 2012).
    c. Note: Maximum stimulus level should not exceed 95 dB HL in infants due to the possibility of noise induced hearing loss caused by the reflex stimulus (Hunter et al., 1999).

XIV. Diagnosis and Follow-up

1. Counseling:

Consider initially providing the family with informational counseling regarding hearing test results, even if incomplete, so that they understand the current status and next steps. The family should be informed that specific findings and recommendations will be conveyed through a written report following complete analysis. If hearing loss is confirmed, provide unbiased family-centered counseling. Refer to section *XV Counseling* for effective counseling techniques and initiating Early Intervention.

2. Initiation of referrals and intervention:

If the assessment is complete and indicates sensory hearing loss, intervention should proceed as soon as possible. If the assessment is incomplete or inconclusive, a repeat ABR should be scheduled as soon as possible to complete additional testing prior to determining an intervention plan. If the assessment indicates a conductive hearing loss, a repeat ABR should be scheduled in 6-8 weeks to monitor hearing status. If the assessment indicates neural hearing loss, repeat ABR should be scheduled as soon as clinically advised for further information and confirmation, prior to determining an intervention plan. Appropriate medical referral and intervention should not be delayed if abnormal hearing is suspected, simply in order to obtain complete results. If results are insufficient to achieve audiologic diagnosis of type and degree of hearing loss after two non-sedated ABRs, and the child is older than 4-5 months, referral for a sedated ABR is strongly recommended in order to prevent delay in diagnosis and intervention. A referral from a physician may be needed for a sedated ABR.

3. Follow-up recommendations:
    a. A referral to general or pediatric otolaryngology is recommended if loss is minimal in a well-baby or due to conductive hearing loss, and caregivers do not need additional support.
    b. A referral to pediatric otolaryngology is recommended if mild or greater hearing loss is diagnosed, especially if amplification is recommended. This will facilitate assessment of etiology and medical clearance.
    c. Referral to a multidisciplinary team is recommended if neural involvement is suspected, if there are craniofacial or other syndromic stigmata, or high-risk factors (refer to high risk factor list on Table 7)
    d. An informational packet regarding hearing loss will be offered to caregivers, including handouts such as but not limited to: *Early Intervention program information, Familiar sounds audiogram, Parent to parent support (Hands and Voices – www.handsandvoices.org), hearing loss brochures, etc.* See Appendix C for a resource list.
    e. Discuss appropriate amplification options and explain the process to obtain amplification.
    f. Referrals should be made to the Early Intervention program for children under 3 years of age who are deaf or hard of hearing.
    g. Behavioral testing should be performed to confirm/monitor hearing loss as soon as the patient is developmentally able to participate in VRA testing (usually by 8 months of age).
    h. Refer to genetics and ophthalmology by age 2 years, consistent with JCIH (2019) recommendations.

4. Follow-up recommendations for normal ABR with risk factors: Table 7 below is based on JCIH (2019) Table 1 (Page 19) but structured for recommended follow-up timeline. Please reference most recent JCIH document for risk factor recommendations.

Table 7: **Risk Factors for Early Childhood Hearing Loss Guidelines for Infants who Pass the Newborn Hearing Screen or Diagnostic Assessment**

Recommended Diagnostic Follow-up	Risk Factor Classification	Monitoring Frequency[+]
Diagnostic follow-up by age 9 months	Family history* of early, progressive, or delayed onset permanent childhood hearing loss	Based on etiology of family hearing loss and caregiver concern
	Neonatal intensive care unit (NICU) stay of more than 5 days	Per concerns of ongoing surveillance of hearing skills and speech milestones
	Hyperbilirubinemia with exchange transfusion regardless of length of NICU stay	
	Aminoglycoside administration for more than 5 days**	
	Asphyxia or Hypoxic Ischemic Encephalopathy	
	In-utero infections (herpes, rubella, syphilis, toxoplasmosis)	
	Certain birth conditions or findings: ▪ Craniofacial anomalies including microtia/atresia, ear dysplasia, oral facial clefting, white forelock, and microphthalmia ▪ Congenital microcephaly, congenital or acquired hydrocephalus ▪ Temporal bone anomalies	
	Syndromes associated with hearing loss***	According to history of syndrome or concerns
No later than 3 months after occurrence	Extracorporeal membrane oxygenation (ECMO)*	Every 12 months to school age or at shorter intervals based on concerns of parent or provider
	Culture-positive infections associated with sensorineural hearing loss***, includes confirmed bacterial and viral (especially herpes viruses and varicella) meningitis or encephalitis	
	In-utero infection with congenital cytomegalovirus (cCMV)*	Every 12 months to age 3 or at shorter intervals based on concerns of parent or provider
	Events associated with hearing loss ▪ Significant head trauma especially basal skull/temporal bone fractures ▪ Chemotherapy	According to findings or continued concerns
Immediate referral	Caregiver concern**** regarding hearing, speech, language, developmental delay, or developmental regression	According to findings or continued concerns

Recommended Diagnostic Follow-up	Risk Factor Classification	Monitoring Frequency[+]
Per AAP (2017) periodicity schedule	Mother +Zika with no laboratory evidence & no clinical findings	Per AAP (2017) periodicity schedule
Automated ABR by 1 month	Mother +Zika and infant w/laboratory + clinical findings	ABR by 4-6 months or VRA by 9 months, monitor per AAP (2017) periodicity schedule
	Mother +Zika and infant w/laboratory + clinical findings	ABR by 4-6 months, monitor per AAP (2017) periodicity schedule

Directly adapted from the Joint Commission on Infant Hearing (JCIH) Year 2019 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs
[+] Monitoring frequency should be determined by managing professional using evidence-based best practices
**Infants at increased risk of delayed onset or progressive hearing loss*
***Infants with toxic levels or with a known genetic susceptibility remain at risk*
****Syndromes (Van Camp & Smith, 2016)*
*****Parental/caregiver concern should always prompt further evaluation*

5. Follow-up recommendations for conductive hearing loss:
    a. When making a referral to ENT for conductive hearing loss due to suspected fluid, counsel the family that if a middle ear problem is found and even if tubes are placed, repeat audiologic testing will be needed to establish normal hearing after medical intervention.
    b. Schedule follow-up testing in 6-8 weeks regardless of ear status to document need for intervention.
    c. Clearly state the need for audiologic follow-up after treatment, including tube insertion, since underlying permanent hearing loss could be present.
6. Diagnostic Follow-up Reporting and Documentation:
    a. Necessary documentation, including ODH reporting, is completed by the audiologist no later than 7 days after the appointment per UNHS Ohio Administrative Code (OAC; Rule 3701-40-08).
    b. Corrected thresholds should be reported where indicated (dB eHL).
    c. No Response ABR: When a "no response" is obtained, indicate the level at which there was no response.
    d. The written report will be provided to the family/guardian and primary care providers. Calling the PCP to answer questions and provide guidance is extremely helpful to reinforce the need for quick action.
    e. The audiologist should be available to the family for counseling and education by phone (or telehealth) following receipt of the written report so that questions can be answered. Scheduling a follow-up counseling session with behavioral validation is recommended.
    f. The Ohio Department of Health (ODH) electronic UNHS Follow-up Hearing Evaluation Reporting Form (via HI*TRACK) is completed on all infants screened in Ohio regardless of residency no later than 7 business days after the appointment.
    g. Out of State Information- please refer to state of residency for specific reporting requirements:
        i. For Kentucky residents, the UNHS Program Form for Commission for Children with Special Health Care Needs form is completed. The form is available at https://www.chfs.ky.gov/agencies/ccshcn/Documents/AudiologyUpdateForm.pdf.
        ii. For Indiana residents, the Diagnostic Audiology Evaluation (DAE) form is completed and can be obtained at https://www.formalu.com/forms/44503/diagnostic-audiology-evaluation-dae-indiana-s-early-hearing-detection-and-intervention-ehdi-program.
        iii. For Pennsylvania residents, use the diagnostic audiology report template, Newborn Hearing Screening Program by telephone at 717-783-8143; or by email at nbhs@pa.gov.
        iv. For West Virginia residents, use the Audiological Evaluation Form, available at http://www.wvdhhr.org/nhs/provider/nhs_Audiological_Evaluation_Form.pdf.F or Michigan residents, use the EHDI Program Reporting form available at the Michigan EHDI Program Website and fax to 517-763-0183; EHDI Follow-up Consultant: Michelle Garcia, GarciaM@michigan.gov.

7. Confirmation of Hearing Loss
    a. A subsequent, confirmatory evaluation may be recommended in a timely manner to minimize stress and anxiety for the family, and to ensure timely transition of the infant from the diagnostic to intervention phase, so that the 1, 3, 6 guidelines are met.
    b. It is recommended that all diagnostic testing be conducted by the same audiologist, when possible, to enhance continuity of care and to encourage the development of rapport and trust and minimize the likelihood of receiving different interpretations of the results from different audiologists.
    c. Collaboration among audiologists, such as peer review, is important.
    d. Both informational and adjustment counseling for caregivers of newly identified infants with hearing loss should be provided.
    e. Written documentation and unbiased informational literature should be provided to the caregivers/family.
    f. Caregivers should receive information regarding the need for medical evaluation and diagnosis.
    g. Caregivers should receive information regarding the availability and importance of parent-to-parent support.
    h. Caregivers should receive information and referral for funding assistance in all cases. Do not make any assumptions about family's ability to pay for hearing aids privately.
    i. The infant should be referred to an otolaryngologist for medical assessment.
    j. Discuss additional specialty evaluations (e.g., genetics, ophthalmology, developmental pediatrician, speech/language) with caregivers and the infant's PCP.
    k. If appropriate, initiate the amplification process and ensure that medical clearance for amplification has been obtained.
8. Periodicity Schedule for Evaluation:
    a. After hearing loss is diagnosed, routine audiologic evaluation should occur starting at age 6-8 months until full audiograms are obtained, and at six-month intervals through age three.
    b. Due to rapid growth for infants, new earmolds may need to be obtained frequently. Discuss this with the child's caregiver(s) to help set up expectations.
    c. Immediate re-evaluation should be completed if caregiver concern is expressed or if behavioral observation by caregiver, therapist, or teacher suggests a change in hearing.
    d. More frequent evaluation is appropriate when middle ear disease is chronic or recurrent or when risk factors for progressive hearing loss are present.
9. Referrals:
    a. Infants and children in the state of Ohio (birth to three) identified with hearing loss are referred to Early Intervention services.
    b. Early Intervention provides service coordination, eligibility assessments, development of the Individualized Family Service Plan (IFSP) and subsequent transition planning.
    c. Other referrals may be necessary that include otolaryngology, genetics, speech-language pathology, neurology, ophthalmology, developmental pediatrics or other services.
    d. Consider recommending a cCMV test for infants with diagnosed hearing loss who are less than 21 days of age for differential diagnosis.
10. Sharing Information with Families
    a. Always build rapport at the beginning of the appointment, engage the caregiver/family in the appointment, care and communication with their infant.
    b. If listening and spoken language is desired, share why hearing is so important for every day, ongoing communication. Describe how we communicate and how hearing loss can impact communication acquisition.

c. Understand and recognize the emotional impact that a non-pass hearing screening and/or diagnosis of hearing loss can have on a family.
d. Provide results of the testing in caregiver friendly language and assess emotional readiness of caregivers to receive informational counseling. Remember to have sensitivity to the emotional status of the family/caregivers. Emotional or adjustment counseling (Refer to section XV for more information) may need to precede informational counseling.
e. Provide family support resources. See Appendix C for Helpful Resources/Websites/Apps on Hearing Loss For Families in addition to other resources determined by clinician.
f. Emphasize the importance of communication and explain how sign language, amplification and/or cochlear implants can enhance language learning and communication development.
g. Share the benefits of early identification paired with early intervention. Talk about brain development and how a language rich environment is needed to develop language and communication.
h. Recognize that families may not be emotionally ready to discuss communication options, and schedule additional appointments as needed to discuss the variety of options.
i. Before the initial appointment ends, remind caregivers/families that infants and children identified with hearing loss early can have excellent language and communication ability. Provide reassurance and emphasize the value of family-to-family support locally, if available, or through Hands and Voices national website.
j. At future appointments, share unbiased information about communication options. Be sensitive to the family's needs and desires as well as, language and culture. Provide all communication options and discuss the benefits of each.
k. Additional follow up appointments may include counseling visits, social work referrals, etc.
l. Provide packet of educational materials on hearing loss, non-biased communication choices, and Early Intervention (EI) resources available to infants (See section 5. *Written Information* regarding EI).

XV. Counseling

1. Types of Counseling

There are two main forms of counseling that audiologists need to be trained and practiced in providing effectively: 1) Informational-educational and 2) Emotional-behavioral counseling (also referred to as adjustment [to hearing loss] counseling). Patients will not be able to absorb and understand information unless they are emotionally ready to hear it. Audiologists are generally more comfortable and prepared to provide education and information about hearing loss than to provide emotional and behavioral counseling.

A realistic and proactive approach is most effective to assist families with a new diagnosis. Families are encouraged by working with a professional who conveys confidence and is able to earn their trust. Families will have a range of emotions. Ensure using unbiased language when explaining this diagnosis (Frey, 2013). For further information to prepare for culturally aware care, please refer to Appendix D.

Sharing unwelcome or unexpected diagnostic results requires using a specific approach and a sensitive, professional demeanor. The SPIKES model (Baile et al., 2000) is one such approach of emotional counseling that has been developed specifically for medical professionals. The SPIKES acronym stands for Setting, Perception, Invitation, Knowledge, Empathy, and Summarize/Strategize.

2. Utilizing the SPIKES Model

Table 8: SPIKES Model (Baile et al., 2000)

Setting	▪ Arrange for privacy, sit down, and make a personal connection. ▪ Involve significant others/family members.

	▪ Avoid time constraints and interruptions.
Perception	▪ Ask the family what they know so far about the screening, etc. ▪ Determine family's expectations, and assess their understanding of the reasons for assessment.
Invitation	▪ Ask how the family would like to receive information about test results. ▪ Most patients want to know all of the information, but if not, involve a relative/friend. ▪ Discuss referrals/release of information to relevant professionals (early intervention, primary care, ENT, speech, genetics).
Knowledge	▪ Start by providing an introduction ("I have some results to review with you."). ▪ Provide results: Hearing loss was detected (describe in one or both ears and say severity). Share that is a permanent loss. ▪ Provide reassurance that their baby will still grow and develop, but will need some early help to learn to communicate. Make this a positive statement. ▪ Use nontechnical words that the family will understand (such as "inner ear or nerve" instead of "cochlea or brainstem"). ▪ Avoid being blunt, but do be realistic and positive about the benefits of early intervention. ▪ *Wait to see reaction before giving any additional information.*
Emotions	▪ Respond to the family's emotions with empathy. ▪ The family may respond with shock (silence, numb look), isolation (looking down, lack of eye contact), disbelief (questioning the diagnosis), grief (crying or appearing sad), or denial (challenging the diagnosis). ▪ Identify the emotion by affirming what you observe ("I can tell you might be feeling upset"). ▪ Identify the reason for the emotion ("It makes sense to feel his way, you may not have been expecting this today"). ▪ Listen and wait for them to say something, or offer a tissue, pat on the shoulder, ask if they would like to take a little break and you can come back to talk some more.
Strategy/Summary	▪ Ask if the family is ready to hear more information and if they would like to discuss next steps. ▪ Explore the family's ideas, concerns, and expectations. ▪ Do not minimize results, be clear about findings. ▪ Discuss goals family may have, like hearing their child's voice, learning sign language, or learning to read. ▪ Explain the positive outcomes of language development and communication when intervention starts early. ▪ Set a follow-up time to talk over the phone or in person in the next 2-3 days.

The SPIKES model combines informational and emotional counseling aspects. According to ASHA, informational counseling is providing sufficient information to assist families in decision making as related to the diagnosis and prognosis of hearing loss. Clear, concise, and non-technical terms are critical when it comes to explanations of hearing loss and related topics. ASHA also notes that emotional support may be infused in the informational counseling to help families as they learn about and adjust to the news of their child's hearing loss diagnosis (ASHA, 2008).

3. Informational/Educational Counseling vs. Emotional/Behavioral/Adjustment Counseling:

Table 9: Additional Types of Counseling

Informational/Educational	Emotional/Behavioral/Adjustment
▪ Explaining the ABR/set-up ▪ Diagnosis of hearing loss ▪ Explaining referrals/next-steps ▪ Discussing communication and amplification options ▪ Explaining the need for follow-up testing	▪ Recognizing the emotion attached to diagnosis ▪ Recognizing the impact of the diagnosis on the family ▪ Encouraging families to seek support from loved ones ▪ Being an active listener – do not be afraid of periods of silence

JCIH appropriately supports family-centered practices to maximize effective outcomes (pg. 25). To align with this practice, the audiologist should focus on incorporating adjustment [to hearing loss] counseling (i.e., emotional/behavioral counseling) in addition to informational/educational counseling. It is within the scope of practice to infuse emotional support into clinical care (ASHA, 2008). *Refer to Appendix D for additional counseling techniques and support tools.*

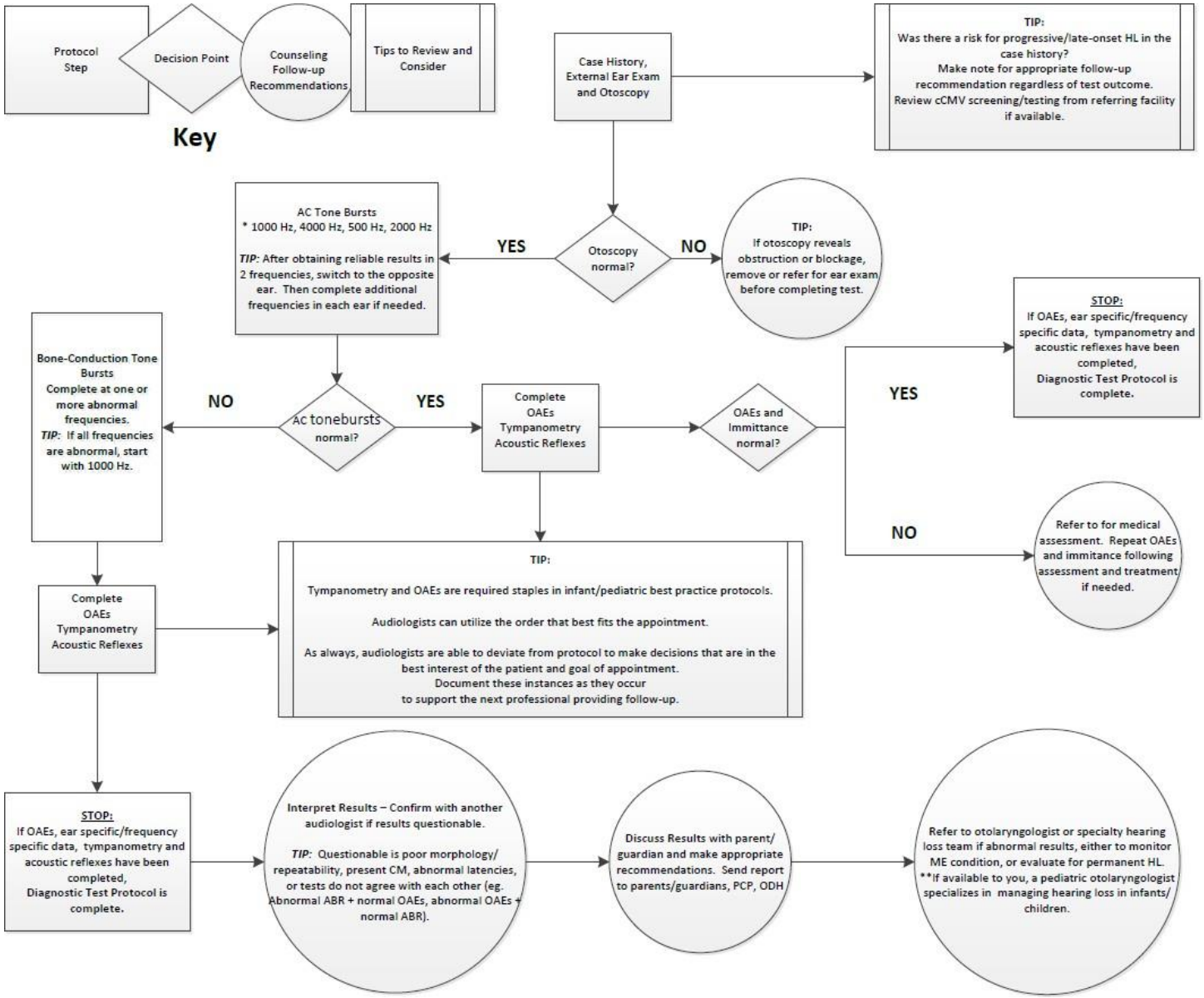
4. Written Information

After initial hearing loss diagnosis, it is recommended to provide a family-friendly simple yet specific discharge or diagnostic summary to the family (these can be templates that are customized as needed). Multiple studies show that patients only retain about 50% of the information provided by healthcare providers – and **only half of that is correctly retained**. Specific as opposed to general recommendations should be made. Mode of presentation of the information impacts retention of the information and suitable follow through. Many factors may impact what information should be provided at this time including but not limited to potential multiple diagnoses, family's emotional state, family questions, individual diagnostic facility protocols, and even clinician counseling styles and approaches chosen (Margolis, 2004).

Therefore, providing specific next steps both verbally and supported with some type of diagnostic summary handout is recommended. Key elements of this handout may include the following:

a. What diagnosis/information is known (i.e., hearing impairment/loss/status)
b. Next steps/clinical appointments:
    i. Medical clearance (consider including how this will happen (e.g. someone will call them or write down/leave a line to write down next appointment).
    ii. *If other referrals such as complex care, genetics, etc. is being made that same day, should include here as well.*
c. Additional support: Referral to early intervention
    i. Briefly explain who should be contacting them.
    ii. State what to do if they do not get contacted. e.g. *If you do NOT receive a call/email, here is the Ohio Early Intervention contact information:*
        ▪ Website: https://ohioearlyintervention.org/families
        ▪ Phone: 1-800-755-4769

Figure 1: Flowchart & Decision Matrix of Recommended Diagnostic Protocol Test Battery



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Appendix A: Sample Case History Form

Infant Diagnostic Case History Form

Date: _____

Child's name: _____Age: _____ Date of Birth_____

Gender:

Parent(s)/Guardian Name(s):_____

Parent/Guardian (see below) phone(home/cell) number: Email address:

Who brought baby/child to the appt today? Who

is the legal guardian?

- □ Biological
- □ Foster
- □ Adoptive
- □ Grandparent
- □ Step-parent
- □ Children's services Primary

Language(s) spoken in the home:

Primary Care Physician/Pediatrician, Nurse Practitioner name and Address:

_____

Reason for referral/testing: _____

Do you have concerns about your child's hearing ability? Yes No If Yes, please describe:

Does your baby respond to:

- □ Name
- □ Loud sounds
- □ Environmental sounds
- □ Dog barking
- □ Sirens

Birth and Health History:

Birth Hospital:

Was your baby Full term? Y N How many weeks?

Was baby transferred after birth? YES NO If yes, Where? _____

Reason for transfer: _____

Approximate Birth weight (in pounds/ounces) Are

there any risk factors for hearing loss?

Intensive care (NICU)	YES	NO	If yes, how long: _____		
Breathing problems at birth	YES	NO			
Oxygen at birth or later	YES	NO	If yes, specify type and how long: _____		
Jaundice	YES	NO	Phototherapy	YES	NO
Exchange Transfusion	YES	NO	Congenital heart disease	YES	NO
CMV Screening	YES	NO	Positive or Negative CMV screen?	Positive	Negative

Defects of ear, head or neck YES NO (e.g., dysmorphic appearance, cleft palate, ear tags or pits) If yes, explain:_____

Are there other children in the family diagnosed with hearing loss/deafness at a young age? Y N Reason (age of diagnosis)

Does your baby/child have any other diagnosed medical condition(s)?

Newborn Hearing Screening results: Right:_____ Left:_____

Type of testing if known: OAE ABR OAE+ABR

Are there any Illness's since birth (ex. Meningitis, ear infections) Y N please explain if Yes

_____

List any hospitalizations or surgeries: _____

Doctors and/or other specialists:
Please list other doctors and/or specialists that treat your child:

_____

Is your child currently receiving early intervention services or therapies ? Yes No
Is your baby receiving any services from the Complex Medical Help (CMH) Program? Yes No

Appendix B: ABR (Hearing) Testing Instructions Parent Letter

Your baby/child has been scheduled for an Auditory Brainstem Response (ABR) evaluation. It is the most accurate way to measure hearing in infants who are too young for other tests.

Please arrive 15 minutes prior to your appointment. If you are late for the appointment, we may not be able to complete testing and will need to reschedule. Your appointment date and time is: _____. The appointment will last 1-2 hours.

IMPORTANT INSTRUCTIONS TO FOLLOW BEFORE ARRIVING:

- ***Please keep your baby awake on the way to the appointment*, so she or he will be tired and able to sleep during testing. To obtain clear results, it is best if your baby is asleep during the test.**
- **Tips to keep your baby awake: Skip a nap before the appointment, entertain your baby with toys, dab a cool washcloth on face, wiggle hands or feet and talk to your baby.**
- **Delay nursing or feeding until you arrive for the test to assist your child in falling asleep. Be sure to bring diapers, favorite cuddly, pacifier if needed, and anything else that will make your baby comfortable.**
- **Please do not bring other children to this appointment, since you will be busy holding your baby during the test.**

About the test and test procedures:

The ABR test is a procedure that estimates hearing and measures how the hearing nerve works in each ear. This test does not rely on a baby's/child's ability to respond to sound. It measures how the hearing nerves send sounds to the brain.

Small recording sensors or patches will be placed on your baby's forehead and behind each ear. A small, soft ear tip will be placed in the ear to deliver sounds. The audiologist will measure responses to different sounds to check hearing function for your baby.

After the test, the audiologist will share the results with you and will offer any recommendations. Sometimes, further testing by the audiology or ENT clinic may be recommended.

Please call the clinic with any questions or concerns about the tests or to reschedule if your baby is ill the day of the test.

_____ _____

Name Phone

Appendix C: Helpful Resources/Websites/Apps on Hearing Loss For Families

Learning About Hearing Loss

- https://www.babyhearing.org/
- https://www.cdc.gov/ncbddd/hearingloss/index.html
- https://ncbegin.org/
- https://www.jtc.org/
- https://www.infanthearing.org/just-in-time/
- https://handsandvoices.org/virtual-waiting-room/
- https://www.hearingfirst.org/
- https://successforkidswithhearingloss.com

Early Intervention

- https://ohioearlyintervention.org/
- www.helpmegrow.ohio.gov/
- http://www.ohiohandsandvoices.org/
- Communicate With Your Child: State Profiles
- https://ohioearlyintervention.org/local-state-national-resources/ohio-hearing-vision
- EI and Communication Plan Booklet: https://odh.ohio.gov/wps/wcm/connect/gov/65ce5d80-3086-42ca-9a27-3145f07bbd61/Early+Intervention+and+Communication+Plan+Booklet.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_K9I401S01H7F40QBNJU3SO1F56-65ce5d80-3086-42ca-9a27-3145f07bbd61-oji-O3t

At Home Educational Rehabilitation Websites

- https://www.cochlear.com/us/communication-corner
- www.advancedbionics.com/babybeats-usorder
- For Listening and Spoken Language: What to Do for Your Child with Hearing Loss - Hearing First https://www.hearingfirst.org/what-to-do

Finding Other Families Like Yours

- https://www.agbell.org/
- https://deafchildren.org/
- https://www.handsandvoices.org/
- https://www.hearinglikeme.com/connecting-with-parents-of-deaf-children/
- https://www.ocecd.org/ ; https://www.ocecd.org/forparents2.aspx ; https://www.ocecd.org/ParentMentorsofOhio1.aspx
- Deaf Mentors and Snapshots Program: https://osd.ohio.gov/our-departments/statewide- services-outreach/dm-ss-p/deaf-mentor
- Ohio Hands & Voices: http://www.ohiohandsandvoices.org/side-by-side.html

Apps

Phonak Leo

- Leo the lion cub's interactive storybook app is designed to help, providing children with a furry friend who faces exactly the same challenges they do. The App contains two stories: "Leo Gets Hearing aids" and "Leo Gets a Roger System."

- Discover how to use music to stimulate; bonding, brain development, early communication and listening skills and early literacy skills.

- **My Smart Hands**
  - My Smart Hands is a baby sign language dictionary that helps parents and children learn ASL, in order to communicate pre-verbal needs. With more than 300 ASL signs included, there are also detailed instructions and tips and tricks for remembering each sign. With over 45 minutes of instructional videos and comprehensive search functions, this will make learning ASL easy.
- **Signed Stories**
  - This app is great for reading stories for children deaf/hard of hearing. It is an animated children's app that supports the common core curriculum, fairy tales, songs, nursery rhymes, and narration of music and sound effects.

Appendix D: Helpful Resources/Websites For Audiologists

Counseling Support and Tools

- Ida Institute
  - https://idainstitute.com/
  - Learning Hall Courses: Courses (idainstitute.com)
  - Free tools for hearing rehabilitation (idainstitute.com) https://idainstitute.com/tools/#.category-10,.category-11,.category-7,.category-6
- ASHA
  - Guidelines for Audiologists Providing Informational and Adjustment Counseling to Families of Infants and Young Children With Hearing Loss Birth to 5 Years of Age
  - https://www.asha.org/policy/gl2008-00289/#sec1.1
- Cultural Awareness Tools
  - Cultural Awareness in Healthcare: A Checklist (qualityinteractions.com)
  - Cultural Respect | National Institutes of Health (NIH)
  - Home - Think Cultural Health (hhs.gov)

Continuing Education and Updates

- AudiologyOnline | CEUs, Jobs and Journal for the Audiology Profession
  - https://www.audiologyonline.com
- ASHA
  - ASHA Continuing Education
  - https://www.asha.org/ce/
- Supporting Success for Children with Hearing Loss
  - www.supportingsuccesscourses.com

Reducing Loss-to-Follow-up Resources

- NCHAM EHDI E-Book Chapter 3: Tracking, Reporting, and Follow-up (See Table 1)
- ASHA Working Group Technical Report on EHDI LTFU

Ohio Resources

- **ODH:** Infant Hearing Program | Ohio Department of Health
  - Technical Assistance: Entering a Hearing Status in Hi Track https://odh.ohio.gov/know-our-programs/infant-hearing-program/providers/enteringhearingstatushitracktechnicalassistance
- **DODD:** https://dodd.ohio.gov/about-us/our-programs/ohio-early-intervention
  - Hearing Service Providers: https://ohioearlyintervention.org/storage/ocali-ims-sites/ocali-ims-oei/documents/SFY22HearingandVisionMap-Updated-03-24-2022.pdf
- **OCECD:** https://www.ocecd.org/Default.aspx