Hearing Screening Training Manual

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DEPARTMENT OF HEALTH

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Upon request, this material will be made available in an alternative format such as large print, Braille or audio recording.

Revisions made to this manual are based on:

Guidelines for Hearing Screening After the Newborn Period to Kindergarten Age

http://www.improveehdi.org/mn/library/files/afternewbornperiodguidelines.pdf

American Academy of Audiology, Childhood Screening Guidelines

http://www.cdc.gov/ncbddd/hearingloss/documents/AAA_Childhood%20Hearing%20Guidelines_2011.pdf

American Academy of Pediatrics (AAP), Hearing Assessment in Children: Recommendations Beyond Neonatal Screening

http://pediatrics.aappublications.org/content/124/4/1252

Contents

Introduction

This hearing screening manual is an update to the 1996 version, which was developed by a professional review committee. The committee comprised representatives from ENT, audiology, family practice, pediatrics, school and public health nursing, Minnesota Department of Health (MDH), Minnesota Department of Human Services, Deaf and Hard of Hearing Services Division, Minnesota Department of Education (MDE), and the Minnesota Academy for the Deaf. This updated manual reflects the Guidelines for Hearing Screening After the Newborn Period to Kindergarten Age (January 2014) developed by a collaborative working group of the Early Hearing Detection and Intervention (EHDI) community advisory committee, including hearing and educational experts, and Child and Teen Checkups (C&TC) program staff. The following paragraph has been adapted from the previously mentioned guidelines.

The goal of hearing screening is to identify children with permanent and longstanding fluctuating childhood hearing loss that may affect health, communication, learning and development. With prompt referral and follow-up, Minnesota children have an opportunity to receive appropriate, timely care and services, which lead to better health and educational outcomes.

According to the Guidelines for Hearing Screening After the Newborn Period to

Kindergarten Age:

> *Hearing screening in early childhood settings increases the likelihood that children lost to follow-up from newborn screening, along with children presenting with post-neonatal hearing loss, will receive timely diagnostic and intervention services needed during the critical language learning years. While questionnaires and checklists are useful in identifying a child at risk for hearing loss, over 50 percent of children with hearing loss will not be identifiable through these measures. Hearing screening technology such as pure tone audiometry is a practical and effective means of identifying children who need further evaluation for possible hearing loss.*

This document provides best practice hearing screening guidelines for children. Hearing screening does not take the place of audiological assessment or evaluation.

Audience

This manual is for use in Child and Teen Checkups (C&TC), Early Childhood Screening, Head Start, and school-based programs.

Purpose

The purpose of this hearing training manual is to provide the screener with instructional information to conduct hearing screening procedures in a variety of settings. This

manual is a post-training reference and not a replacement for training. MDH training workshops present a detailed description of each procedure.

Overview of hearing and hearing loss

Sound, hearing, and hearing loss defined

Frequency (pitch or tone)

Frequency is the range of sound pitch, measured in Hertz (Hz). One Hertz is equal to one sound wave or cycle per second. The more frequent the sound waves, the higher the pitch, and the higher the Hertz number. Although we can hear sounds as quiet as 20 Hz, we use a limited range of frequencies (250 Hz through 8000 Hz) for our daily listening needs. This frequency range is critical for hearing and understanding speech and other sounds, and is the reason routine hearing screening uses 500, 1000, 2000, 4000 Hz, and 6000 Hz (ages 11 and older).

Volume (intensity and loudness)

Volume is the range of sound loudness, measured in decibels (dB). The greater the decibel number, the louder the sound. The minimal sound level that the majority of people with normal hearing can detect is 0dB. At least twenty percent of children can hear sounds as low as -10dB (Roberts & Huber, 1967). A 130dB sound causes pain in most people's ears. People usually speak at an intensity of 45-60dB (Centers for Disease Control and Prevention [CDC], June 2012).

Normal Hearing

The American Standards Association set the level of audiometric zero in 1951. Several studies in the 1960s found that about half of adults and children could hear the screening frequencies of 500, 1000, 2000 and 4000 Hz below audiometric zero (Roberts & Huber, 1967; Roberts & Bayliss, 1967). A person with normal hearing should be able to hear volumes as low as -10dB to 15dB and frequencies of 250 through 8000 Hz.

Hearing loss

Hearing loss is when the softest or lowest decibel (16dB or more) someone can hear is louder than the sound (0 to 15dB) someone with normal hearing can hear. Refer to the Degree and Effects of Hearing Loss section of this manual.

Hearing loss statistics

Hearing loss is one of the most common birth defects. Approximately one to three in 1000 infants are born with hearing loss (Dedhia, Kitska, Sabo, & Chi, 2013). In Minnesota, 259 babies born in 2014 were identified with permanent hearing loss (Minnesota EHDI, 2015). In 2015 Early Childhood Screening identified 2186 children in Minnesota ages three to five years as having potential problems with hearing (MDE, 2016.

Six out of 1000 children have permanent hearing loss by age six (Choo & Meinzen-Derr, 2010). The incidence of hearing loss increases in the school age population to nine to 10 in 1000 (White, 2010). The incidence of fluctuating or temporary hearing loss in children is one in seven (American Academy of Audiology [AAA], 2011). Approximately 30 to 50 per 1000 youth have hearing loss by late adolescence (AAA, 2011).

Types of hearing loss

Hearing loss is either conductive or sensorineural and, depending upon the anatomical location of the loss, can be in the external, middle, or inner ear.

Conductive hearing loss:

- Occurs in the external and/or middle ear.
- Blocks movement of sound into the inner ear.
- Is typically caused by: wax in the ear canal, a hole in eardrum, broken ossicles (middle ear bones), or middle ear fluid or infection.
- Can usually be treated medically or surgically; use of amplification devices such as hearing aids can help.

Sensorineural hearing loss:

- Is a sensory neural problem in the inner ear, auditory nerve, or brain.
- Is the most common type of permanent hearing impairment.
- Causes include: genetics or damage to sensory nerves due to ototoxic drugs, infections, trauma, or noise.
- Is usually treated with amplification devices such as hearing aids or cochlear implants.

Combined hearing loss:

- Involves both conductive and sensorineural hearing loss.

Causes of congenital hearing loss

Results from hereditary or environmental influences before, during, or immediately following birth can cause congenital hearing loss. At least half of the causes of congenital hearing loss are associated with genetic risk factors (Kaye, 2006). The cause of about 25 percent of congenital hearing loss cases in the U.S. is unknown (CDC, 2012).

Causes of acquired hearing loss

Acquired hearing loss occurs after birth, and may be temporary or permanent. Environmental infections or toxins are a common cause of infant and childhood hearing loss. Infections that can cause hearing loss include toxoplasmosis and cytomegalovirus. Ototoxic drugs that can cause hearing loss include aminoglycosides and cisplatin. Trauma to the head or ear can also cause hearing loss. Otitis media with effusion (OME), or fluid in the middle ear, is a common cause of temporary or fluctuating hearing loss. Ninety percent of children will have had OME at least once before school age (American Academy of Pediatrics [AAP], 2004). Five to ten percent of all children may have persistent OME for a year or longer. Children with persistent (chronic) OME are at risk of developing conditions that can cause permanent hearing loss.

Causes of Noise-Induced Hearing Loss (NIHL)

The effects of overexposure to loud noise can cause NIHL (CDC, 2008). NIHL can be temporary or permanent; it can result instantly from a single loud noise like a

firecracker or gunshot, or can occur gradually from repeated exposure to noise. Approximately twelve and a half percent (5.2 million) of children six to 19 years of age have some level of noise-induced hearing loss (CDC, 2011). Sources of excessive noise for children include loud music, real or toy firearms, power tools, fireworks, loud toys, and loud engines such as those in snowmobiles, jet skis, motorcycles, or farm equipment (Montgomery & Fujikawa, 1992).

NIHL prevalence increases significantly in late childhood and adolescence (AAA, 2011). Strong evidence exists that increases in high frequency NIHL in adolescents is the result of exposure to recreational noise. There is a wide variation in the reported incidence of NIHL in adolescents, as background noise can influence test results and make it difficult to assess.

Effective October 1, 2017, pure tone audiometry screening at 6000 Hz for ages 11 and up is a required component of a C&TC hearing screening.

Effects of hearing loss

Hearing loss affects language acquisition, speech, learning and psychosocial wellbeing. The critical time to stimulate the auditory and language brain pathways is during the first six months of life (Joint Committee on Infant Hearing [JCIH], 2007). Children with all degrees of hearing loss who receive appropriate intervention prior to six months of age can attain speech and language skills twenty to forty percent higher than their peers who receive intervention later and comparable to their hearing peers (JCIH, 2007).

A child with a hearing loss is at a greater risk for academic deficits. In school, students must be able to listen in a noisy environment, pay attention, concentrate, and interpret information. Unidentified hearing loss in the school population is associated with impairments in speech perception and social functioning, and difficulties in attention span and learning (AAA, 2011). Even mild hearing loss can significantly interfere with the reception of spoken language and educational performance. Thirty-seven percent of children with unilateral (in one ear) or mild hearing loss (21dB-40dB) have been identified as having had to repeat at least one grade in school (AAA, 2011). Reading success is especially dependent on the linguistic skill of interpreting information. Half of all children with hearing loss graduate from high school with a 4^{th} grade reading level or less, unless appropriate early educational intervention occurs (Gallaudet Research Institute, 1996). In the case of NIHL, the effects of hearing loss may come on very gradually, depending on the amount of exposure to noise (Bess, Dodd-Murphy, & Parker, 1998, Daly, Hunter, & Giebink, 1999). Ongoing review of hearing and speech age-appropriate milestones, risk factors and routine hearing screening is critical for identifying hearing loss and optimizing educational outcomes (JCIH, 2007, AAA, 2011).

Hearing screening programs

Universal newborn hearing screening

Universal newborn hearing screening became mandatory in Minnesota in September 2007 under Minnesota Statute 144.966. This legislation has greatly enhanced the comprehensive system of hearing screening for all newborns. The objective of the MDH Newborn Screening/ Early Hearing Detection and Intervention (EHDI) program is to ensure that all infants are screened, test results are promptly reported, and all infants who do not pass their hearing screening are referred to an audiologist or other professional for diagnostic evaluation.

The EHDI program goals are:

- Screen newborns for hearing loss by **one month** of age
- Identify hearing loss by **three months** of age
- Offer early intervention services to deaf and hard-of-hearing infants and families by **six months** of age

Of the 68,112 infants born in Minnesota in 2014, 99 percent were screened for hearing loss. Of the 585 newborns that did not pass the screening, 40 percent did not receive follow-up screening and 43 percent had typical hearing. Of the 156 diagnosed with hearing loss, only 100 newborns enrolled in an early intervention program (Minnesota EHDI, 2014).

A critical role of the primary care provider is to facilitate appropriate referrals. They should stress to families the importance of following up on hospital referral from newborn hearing screening (NHS) in a timely manner. Up to one fifth of infants referred for further testing after properly administered NHS have a hearing loss (CDC, 2013).

For additional information about newborn hearing screening, refer to the Early Hearing Detection Intervention website (www.improveehdi.org/mn/state).

Follow-up after diagnosis of hearing loss

For a confirmed diagnosis of hearing loss, MDH Children and Youth with Special Health Needs (CYSHN) staff are responsible for ongoing follow-up services to children and their families. CYSHN ensures appropriate, timely intervention and connects families to statewide services and resources until the child transitions to adulthood.

Hearing Screening After the Newborn Period

Periodic hearing screening throughout early childhood is an essential safety net for identifying children who have delayed-onset or progressive hearing loss or did not receive further testing after their first newborn screening. It is the goal of the EHDI Program to identify children with hearing loss and connect them with intervention services as soon as possible.

Child and Teen Checkups (C&TC)

Children who are income eligible for Medical Assistance (or Medicaid) qualify for screening through the C&TC program, Minnesota's version of the federal Early Periodic

Screening, Diagnosis and Treatment (EPSDT) program. For children age one month through 24 months of age, the C&TC program requires newborn hearing screening, follow-up, risk assessment and at specific ages, recommends developmental screening with a standardized instrument. Refer to the C&TC Periodicity Schedule (www.dhs.state.mn.us).

Please note that as of October 1, 2017 high frequency screening was added for ages 11 and older to identify children who may have noise-induced hearing loss (NIHL).

Beginning at 11 years of age, it is required to add the 6000 Hz level to the required hearing screening.

Minnesota Infant and Toddler Intervention Services (IDEA-Part C)

Part C of the federal Individuals with Disabilities Education Act (IDEA) requires that the evaluation and assessment of an infant or toddler (birth through two years of age) be based on informed clinical opinion and include an evaluation of the child's level of functioning in a variety of identified areas, including hearing. For Minnesota specific recommendations, refer to Guidelines for Hearing Screening After the Newborn Period to Kindergarten Age (www.health.state.mn.us).

Early Head Start and Head Start

Federal Performance Standards mandate that all children receive a standardized screening within 45 days of admission to the program.

Early Childhood Screening

Minnesota statute 121A.17 requires one early childhood or preschool pure tone screening at age three (preferred) or four years before entering public school kindergarten.

Early Childhood Special Education (IDEA- Part B)

IDEA (Part B) ensures children and youth three to 21 years of age receive special education and related services. The rules indicate that the child be assessed in all areas related to the suspected disability, including, if appropriate, health, vision, hearing, social and emotional status, general intelligence, academic performance, communicative status, and motor abilities. For Minnesota-specific recommendations, refer to the Guidelines for Hearing Screening After the Newborn Period to Kindergarten Age (www.health.state.mn.us).

School-Age Screening

MDH recommends that all children receive a hearing screening annually from kindergarten through third grade and in grades five, eight, and eleven. Hearing

screening should be performed for students who are new, receive special education, or have the following risk factors:

1. Chronic or recurrent otitis media
2. Cleft palate or other craniofacial anomalies
3. Family history of hearing loss in childhood
4. Exposure to potentially harmful levels of noise

Procedures

Risk Assessment and Hearing History

Ages

One month through 20 years

Purpose

To assess risk factors for lost to follow–up, delayed onset, progressive and acquired hearing loss

Equipment

C&TC, Early Childhood Screening hearing work sheet, School hearing worksheet or other documentation form (Appendix A)

Procedure

Review the following:

- For infants newborn to one month of age or any initial C&TC visit of a child up to the age of three years:
  - Universal newborn hearing screening is required for all newborns by one month of age using either otoacoustic emissions (OAE) or auditory brainstem response (ABR) technology.
  - If an infant did not receive newborn hearing screening, it is recommended that an objective screening, OAE or ABR as appropriate, be performed as soon as this gap in screening is identified.
- For all children:
  - Review: JCIH Risk Indicators and Observed Complaints and Behaviors).
  - Monitor developmental milestones and caregiver concern. This is especially important until pure tone audiometry screening can be performed, typically at three to four years of age.
- **For youth 11 through 20 years**, review Indicators of Noise Induced Hearing Loss.

Risk Assessment: JCIH Risk Indicators

Ages

One month through 20 years

Purpose

To assess risk factors for delayed onset, progressive and acquired hearing loss

Procedure

For initial interviews review all the following risk indicators (JCIH, 2007) which are associated with permanent congenital, delayed onset or progressive hearing loss in childhood. For subsequent visits review interim hearing history indicated by an *. Refer to the JCIH Position Statement (2007) in Appendix B of this manual for more information on each indicator.

1. Caregiver concern regarding hearing, speech, language, or developmental delay.*
2. Family history of permanent childhood hearing loss.
3. Neonatal intensive care for more than 5 days, or any of the following: extra-corporeal membrane oxygenation (ECMO), assisted ventilation, exposure to ototoxic medications (gentamycin and tobramycin) or loop diuretics (furosemide also known as Lasix) and hyperbilirubinemia that requires exchange transfusion.
4. In utero infections such as cytomegalovirus (CMV), herpes, rubella, syphilis, and toxoplasmosis.
5. Craniofacial anomalies, including those that involve the pinna, ear canal, ear tags, ear pits, and temporal bone anomalies.
6. Physical findings, such as a white forelock that are associated with syndrome, known to include sensorineural or permanent conductive hearing loss.
7. Syndromes associated with congenital hearing loss or progressive or late onset hearing loss such as neurofibromatosis, osteoporosis, and Usher syndrome; other frequently identified syndromes include Alport, Pendred, and Jervell and Lange-Nielson.
8. Neurodegenerative disorders such as Hunter syndrome, or sensory motor neuropathies such as Friedreich ataxia and Charcot-Marie-Tooth Syndrome.
9. Culture positive postnatal infections associated with sensorineural hearing loss including confirmed bacterial and viral (especially herpes virus and varicella) meningitis.
10. Head trauma, especially basal skull or temporal bone fractures that required hospitalization.*
11. Chemotherapy.*

PASS

Children for whom no risk factors for hearing loss are identified do not require referral.

REFER

Children who pass their newborn hearing screen but have a risk factor for hearing loss should be referred to an audiologist (ideally one specializing in pediatrics) for at least one diagnostic audiology assessment by age 24 to 30 months or as soon as a concern is identified. Infants and children with specific risk factors, such as those who received ECMO therapy and those with CMV infection, have a higher risk of delayed onset or progressive hearing loss require ongoing monitoring by an audiologist as soon as a concern is identified.

Risk Assessment: Parent, Caregiver, Teacher, and Child Observation of Complaints and Behavior

Ages

All ages, especially in younger children

Purpose

To assess for indicators of potential hearing loss

Procedure

Ask the child to report any complaints about his or her ears. Ask the parents, caregivers or teachers to report any abnormal listening behaviors.

Complaints

- Pain in the ear(s)
- Fullness in the ear(s)
- Noise in the ear(s)
- Drainage from the ear(s)
- Cannot hear

Behaviors

- Tugs at the ear(s)
- Asks to have things repeated
- Turns side of head towards the speaker
- Is inattentive to conversation
- Watches speaker's lips
- Shows strain when listening
- Has difficulty with phonics
- Tends to isolate
- Talks too loudly or softly
- Has a speech problem
- Is not working to capacity in school
- Makes frequent mistakes in following directions
- Tends to be passive

PASS

Children for whom no hearing loss indicators are identified do not require referral.

REFER

Children with any complaints or concerns should be referred to their primary care provider to determine appropriate treatment or referrals.

Risk Assessment: Indicators of Noise-Induced Hearing Loss

Ages

11 through 20 years of age

Purpose

To assess for the presence of noise induced hearing loss indicators

Procedure

Review the following hearing history questions with the caregiver or child

1. Do you have a problem hearing over the telephone?
2. Do you have trouble following the conversation when two or more people are talking at the same time?
3. Do people complain that you turn the TV volume up too high?
4. Do you have to strain to understand conversation?
5. Do you have trouble hearing in a noisy background?
6. Do you find yourself having to ask people to repeat themselves?
7. Do people you talk to seem to mumble (or not speak clearly)?
8. Do you misunderstand what others are saying and respond inappropriately?
9. Do you have trouble understanding the speech of women and children?
10. Do people get annoyed with you because you misunderstand what they say? (Buz Harlor & Bower, 2009)

PASS

Children for whom no hearing loss indicators are identified do not require immediate rescreening or referral.

Rescreen/ REFER

Children with one or more risk factors should have ongoing hearing screening.

Refer if there is a positive response to one or more of the history questions and the child cannot be screened.

Visual Inspection

Ages

All ages

Purpose

To check for signs of ear disease or abnormal development

Description

A systematic inspection of the external ear canal, surrounding tissue, ear canal, and tympanic membrane

Equipment

External inspection: Adequate lighting

Internal inspection: Otoscope*

Procedure

External: Inspect the pinna and the area around it for any abnormalities such as preauricular sinuses, skin tags, or atresia; check for position (set or tilt) of the ears, tenderness, redness or edema, signs of drainage, foul odor, wax build-up in the outer ear canal, or dermatitis. Refer to the MDH Otoscopy and Tympanometry Manual for pictures and more information.

Internal: With the otoscope*, inspect the ear canal and tympanic membrane for signs of drainage, wax buildup, foreign bodies, redness of the ear canal, and other abnormalities; note presence or absence of normal tympanic membrane landmarks.

PASS

Children with normal appearance of all structures and no complaints of pain in the pinna or the tissue around the ear do not require referral.

REFER

Refer children with any abnormality to a medical provider. *Do not* proceed with audiometer screening if tenderness, signs of drainage, or foul odor is present; this should be an automatic referral.

*If the screener has training and experience in using an otoscope. If the screener lacks training and experience in using an otoscope, the visual inspection should be limited to the external aspect of the ears.

Pure Tone Audiometry Screening

For information on the audiometer, refer to section on Audiometer Use, Care and Calibration.

Ages

3 through 20 years of age

Purpose

To identify children with suspected hearing loss

Description

A standard series of pure tones at set decibels presented to the child using pure tone audiometry

Equipment

Pure tone audiometer (for operating instructions see section on Audiometer Use, Care, and Calibration).

Facilities

Quiet room or area free from visual distractions

Procedure set-up

1. Identify the child by name.
2. Explain the procedure.
3. Avoid using the term fail when speaking to the child; for terminology guidelines refer to Communicating results and follow-up.
4. Position the child so they cannot see the front of the audiometer.
5. Lay headphones on the table, facing the child. Set audiometer to 2000 Hz and maximum volume, and have the child practice raising either hand when a tone is heard.
6. Refer any child who is unable to hear the tone at maximum volume to their primary care provider.
7. Perform a visual inspection of the ears.
8. Set decibel dial to 40dB and frequency dial to 1000 Hz.
9. Place the red headphone on the child's right ear and the blue headphone on the left ear and ensure the headphones fit snugly on the child's head.

Screening children ages 3 through 10

1. Set selector switch to "Right" and present 40dB at 1000 Hz.
2. Turn dial to 20dB and present tones at 1000, 2000, and 4000 Hz
3. Turn selector switch to "Left" and present tones at 4000, 2000, and 1000 Hz.
4. Set dial to 25dB and present tone at 500 Hz *; next, turn selector switch to "Right" and present tone at 500 Hz *.

5. Present tones for one to two seconds; you may present the tone twice consecutively if needed for each screening frequency.
6. Document screening results.

Screening children ages 11 through 20

1. Set selector switch to “Right” and present 40dB at 1000 Hz.
2. Turn dial to 20dB and present tones at 1000, 2000, 4000, and 6000 Hz
3. Turn selector switch to “Left” and present tones at 6000, 4000, 2000, and 1000 Hz.
4. Set dial to 25dB and present tone at 500 Hz *; next, turn selector switch to “Right” and present tone at 500 Hz *.
5. Present tones for one to two seconds; you may present the tone twice consecutively if needed for each screening frequency.
6. Document screening results.

Considerations

- Pure tone audiometry screening should take place in a very quiet room.
- Perform an environmental noise level check before performing screenings in any environment.
- Pause the screening if any distracting noise occurs.
- If the child does not appear to understand the directions, *stop,* take the head phones off, and reinstruct the child.
- If the child did not hear one or more tones in either ear, perform an *immediate rescreen* by repeating the entire pure tone series, preferably with a different screener and audiometer.
- If the child is unable to screen due to issues such as behavior or equipment malfunction, *stop* and document “unable to screen.”
- For children who are difficult to screen, refer to play audiometry on the next page.

PASS

A child who responds to all tones required for age in each ear does not require rescreening or referral.

Rescreen

If you work in a clinic setting:

If the child does not respond to one or more sounds, perform an immediate rescreen. If the child still misses one or more tones, refer to health care provider for immediate evaluation of the middle ear.

- If the child has factors which might impact hearing (fluid in middle ear, ear infection, etc.), then rescreen after the middle ear condition is cleared or in 8 – 10 weeks.

- If the child has no visible middle ear condition, refer to audiology for immediate evaluation of hearing.

If you work in a community setting:

If the child does not respond to one or more sounds on the immediate rescreen, schedule the child for pure tone audiometry rescreening in 14 to 21 days; refer to the Rescreen and REFER criteria in this manual for further information.

*The 500 Hz tone may be eliminated when the environmental noise level is too high based on the Environmental Noise Level Check.

Play Audiometry

Ages

Children who are difficult to screen due to age or developmental level

Purpose

To obtain valid results with very young children (ages three to four years) or those children who have difficulty with standard pure tone audiometric methods

Description

Is a modification of standard pure tone screening; play audiometry conditions the child to respond to the sound by placing a toy in a container, rather than raising their hand

Equipment

Pure tone audiometer, stickers, and small child-safe toys such as animals, airplanes, cars, clothes pins, nested boxes, or pegs and pegboard

Facilities

Appropriate size table and chairs in a quiet, comfortable setting with limited distractions

Procedure

1. First, practice without the headphones on.
2. Lay headphones on the table, facing the child, with audiometer set at 2000 Hz and maximum dB level to ensure tone is audible.
3. Hold the toy near your ear; assume a "listening" attitude and present tone.
4. Indicate through facial expression the sound was heard and then drop the toy in a container, such as a pail; repeat as often as necessary until the child shows interest.
5. Offer the toy to the child and place your hand on theirs to guide the first responses; encourage the child to wait until they hear the sound.
6. When the child appears ready, present the sound and guide the child's hand to put the toy in the container.
7. The child may give consistent responses after only one demonstration or may need several demonstrations to respond on their own.
8. Once the child understands the play audiometry technique use the audiometric procedure as described in the pure tone audiometry screening section.
9. Reward the child with praise after initial responses. If this is not effective, a tangible reward like a sticker may be given.
10. If the child still is unable to do the screening after re-instruction, *stop* and document "unable to screen."

Considerations

- The tone to response time varies between children; some children will drop the toy as soon as they hear the tone; others will wait until the sound goes off before dropping the toy.
- If the child does not accept the headphones, the screener should try putting them on for only one or two seconds, removing and rewarding the child. Slowly increase the time with the headphones on.
- A timid child will often benefit from watching other children successfully complete the screening.
- If the child is *unable to screen*, refer to Rescreen and REFER.

PASS

Same recommendations as pure tone audiometry screening: a child who responds to all tones in each ear does not require rescreening or referral.

Rescreen

If you work in a clinic setting:

If the child does not respond to one or more sounds, perform and immediate rescreen. If the child still misses one or more tones, refer to health care provider for immediate evaluation of the middle ear.

- If the child has factors which might impact hearing (fluid in middle ear, ear infection, etc.), then rescreen after the middle ear condition is cleared or in 8 – 10 weeks.
- If the child has no visible middle ear condition, refer to audiology for immediate evaluation of hearing.

If you work in a community setting:

If the child does not respond to one or more sounds on the immediate rescreen, schedule the child for pure tone audiometry rescreening in 14 to 21 days; refer to the Rescreen and REFER criteria in this manual for further information.

*The 500 Hz tone may be eliminated when the environmental noise level is too high based on the Environmental Noise Level Check.

Pure Tone Threshold Screening* (Optional)

Ages

3 through 20 years of age

Purpose

To provide more detailed information on the child's hearing status, and to inform further referral and follow-up; does not provide a diagnosis

Description

A series of pure tones presented at decreasing decibel (dB) levels so that the softest dB level that the child consistently responds to at each frequency may be recorded

Equipment

Pure tone audiometer (for operating instructions refer to section on Audiometer Use, Care, and Calibration.)

Facilities

Quiet room, free from visual distractions

Procedure

Set-Up

1. Identify the child by name.
2. Explain the procedure.
3. Avoid using the term "fail" when speaking to the child; for terminology guidelines refer to Communicating results and follow-up.
4. Position the child so they cannot see the front of the audiometer.
5. Lay headphones on the table, facing the child, set audiometer to 2000 Hz and maximum volume, and have the child practice raising either hand when a tone is heard.
6. Perform a visual inspection of the ears.
7. Set the decibel dial to 40dB, set frequency dial to 1000 Hz.
8. Place the red headphone on the child's right ear and the blue headphone on the left ear, and ensure the headphones fit snugly on the child's head.

Threshold Determination

1. Screen right or better ear first.
2. Present 1000 Hz tone at 40dB; decrease incrementally by 10dB until there is no response, or down to 0dB.
3. At the level where there is no response, increase in 5dB increments until there is a response.
4. Decrease 10dB until there is no response.
5. Increase in 5dB increments until there is a response again.

6. Repeat until there are two responses at the same dB level; record this as the threshold level.
7. Repeat the same process for 2000, 4000, (6000 Hz if child is 11 years or older), and 500 Hz.
8. Switch ears and repeat.

Considerations

- Pure tone audiometry screening should take place in a very quiet room.
- Perform an environmental noise level check before performing screenings in any environment.
- Pause the screening if any distracting noise occurs.
- Perform thresholds only when there are hearing concerns or a child does not pass pure tone audiometry.
- Thresholds are solely to provide more information for referral.
- Referrals are based on pure tone audiometry screening results regardless of threshold results.
- Thresholds should not take the place of a medical or audiological evaluation.
- Threshold screening requires advanced training.

PASS

A child who qualifies for threshold screening has not passed pure tone audiometry and should be managed per Rescreen and REFER criteria.

Rescreen/ REFER

- Rescreens and referrals should be based on pure tone audiometry screening results regardless of threshold screening results.

*Performing threshold screening requires advanced training that may be beyond the skill of some screeners.

Environmental Noise Level Check

Ages

All ages

Purpose

To ensure the environment is quiet enough to perform pure tone audiometry screening.

An environmental noise level check is a recommended substitution in lieu of performing ambient noise level measurements as most local agencies and schools do not have such equipment.

Description

Perform pure tone audiometry threshold screening on another person with known normal hearing.

Equipment

Pure tone audiometer

Facilities

Quiet room or area free from visual distractions, where you are planning to perform hearing screening

Procedure

1. Establish thresholds at 10dB below the screening level, 1000, 2000, 4000, and 6000 Hz at 10dB and 500 Hz at 15dB.
2. Screeners who do not have training and skills to perform threshold screening can perform this check with pure tone sweep screening instead.
   a. If a screener is performing pure tone sweep screening in lieu of threshold screening, they should complete the process twice.
3. Do not use the area for screening if a person with normal hearing is unable to detect 1000 ,2000, 4000 Hz, 6000 Hz at 10dB and 500 Hz at 15dB
4. If the only frequency not audible in the screening environment is 500 Hz, then omit the 500 Hz level from today's screening protocol.

Considerations

The screener should maintain awareness of noise level throughout the screening procedure and avoid excess noise within the screening area including:

- Talking.
- Paper shuffling.
- Movement of desks and furniture.

Avoid areas near:

- Fans or air conditioners.
- Hall traffic (reroute if possible).

- Playground or street traffic.
- Group activities (i.e. music, free play).
- Bathrooms.
- Lunchrooms.
- Office equipment (i.e. copy machines).
- Soft drink machines.
- Refrigerators.
- Open windows.

Keep the screening room uncluttered and free of visual distractions:

- Avoid facing the child toward windows or open doors.
- Avoid mirrors or other reflective surfaces.

Result interpretation and follow-up

Rescreen and REFER Criteria

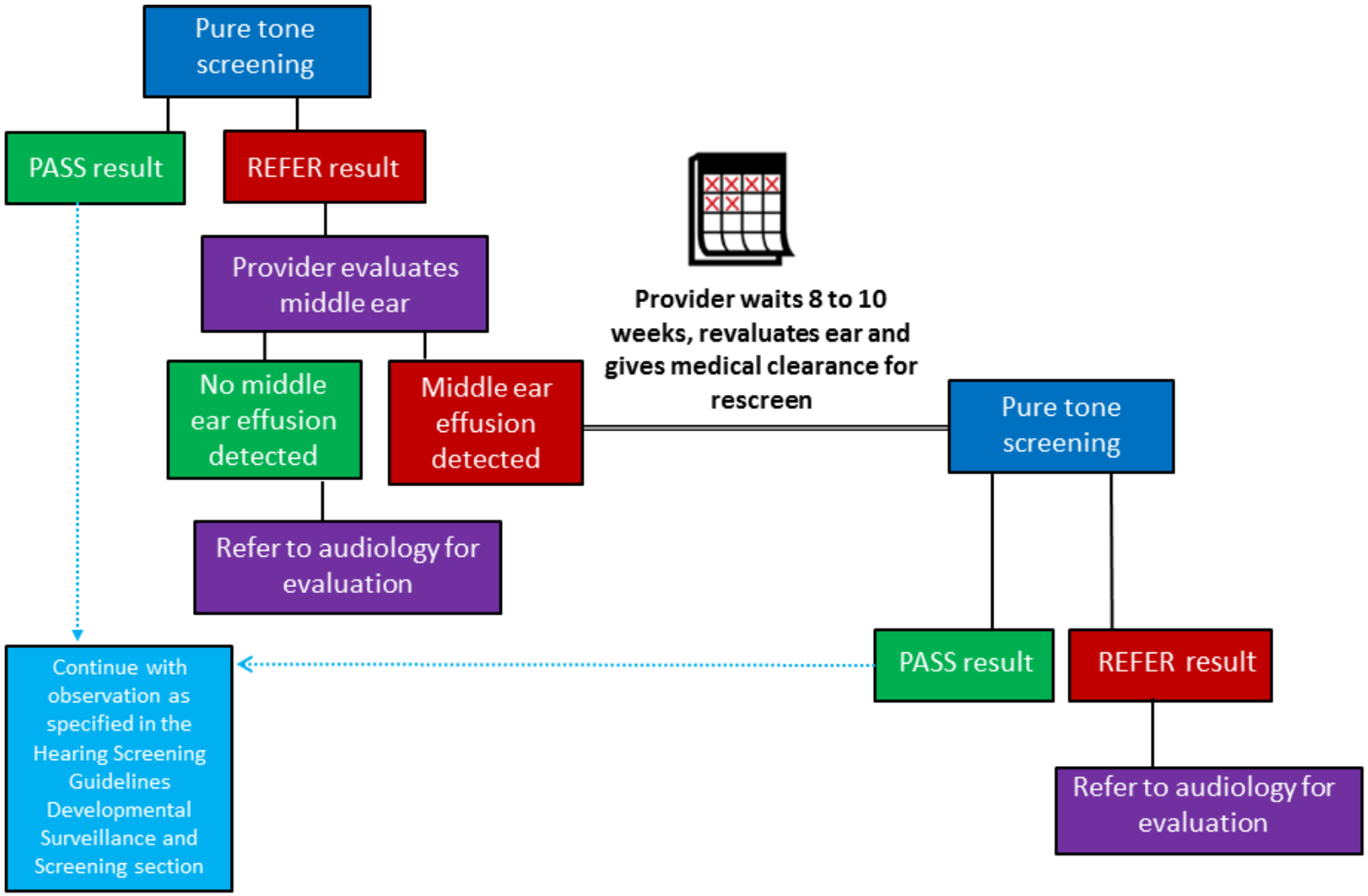
The criterion for pure tone audiometry screening referral is the lack of response to any of the screening tones in one or both ears during the 14 to 21-day rescreen as outlined in the pure tone audiometry screening section. Refer to the Pure Tone Audiometry Screening Algorithm on the following page.

Other Considerations

- If the child is *unable* to follow directions, refer to the play audiometry section for recommendations on rescreening.
- If the child is unable to perform play audiometry rescreen:
  - For children three years of age, rescreen within six months.
  - For children four years or older, rescreen within 30 days.
- If the child has a REFER result (misses one or more tones) after *immediate rescreen* (refer to pure tone screening procedure)**,** schedule the child for rescreening in 14 to 21 days.
- If the child has a REFER result (misses one or more tones) on the 14 to 21 day rescreen, refer the child to their primary care provider for middle ear clearance.
- If the primary care provider provides middle ear clearance or within 8 to10 weeks, rescreen the child's hearing.
- If the screener determines if would be of benefit to the referral, threshold screening** may be performed.

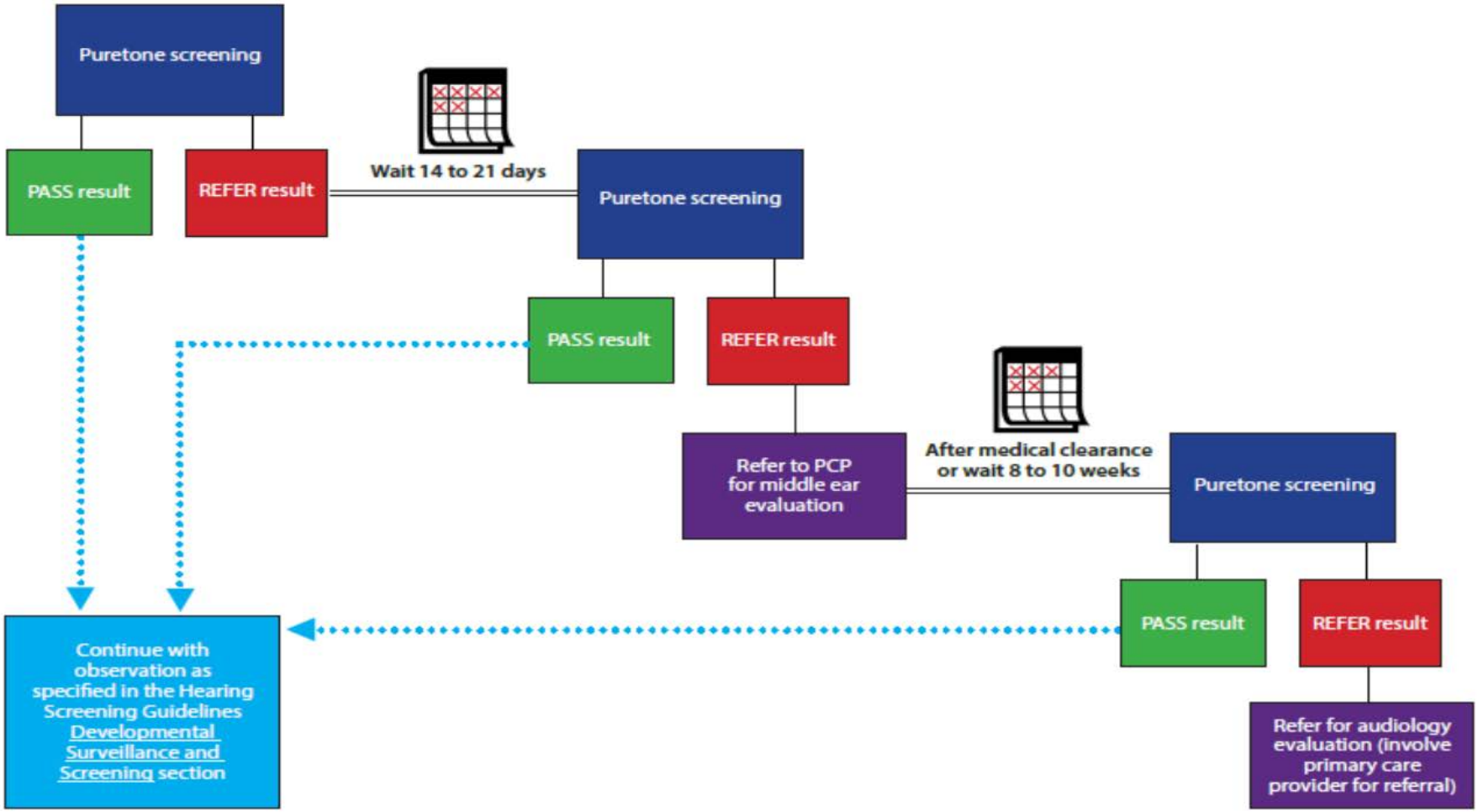
*Determining if the child may have middle ear fluid requires advanced training that may be beyond the skill of some screeners.
**Performing threshold screening requires advanced training that may be beyond the skill of some screeners.

Screening Algorithm
Pure Tone Audiometry for the Clinic



Screening Algorithm

Puretone Audiometry for Community Setting



Documentation

Documentation of Risk Assessment and Hearing History

Written documentation should specify the child's name, child's date of birth, and the date of screening. The primary care provider usually performs a hearing risk assessment as part of the health history. Document the information gained in the hearing concerns section of your form, the health history section of the medical record, or on the hearing screening results table. Document any parental concerns of a child's hearing or risk factors for hearing loss. It is recommended that PASS/REFER terminology replace the pass/fail terminology previously used to indicate a child who does or does not need further follow-up.

Make a note regarding any hearing concerns such as pain or drainage. If any of these conditions are present, *do not proceed* with the audiometric portion of the screening and have a primary care provider examine the child.

Documentation of pure tone screening

- For each ear, note the results of the pure tone hearing screening and tympanometry (if performed).
- Document each frequency screened in a manner that indicates the decibel it was screened at and whether the result was a PASS or REFER.
- Use consistent notations with a key indicating which symbols or words denote PASS and REFER so that results are clear to caregivers/guardians and providers.
- If excess ambient noise caused the elimination of screening at 500 Hz, document this in the 500 Hz section of the form.
- Make any pertinent notes under "Comments," such as if the child has a head cold or congestion. If the child does not appear to understand the pure tone audiometry screening procedure after employing play audiometry techniques, check the "Question Validity" or "Unable" box.
- Check the "PASS" or "Normal" box if the child is able to hear all tones in each ear.
- Document if and why pure tone audiometry is deferred.
- *Example:* If the child was unable to be screened via standard hand-raising pure tone audiometry or play audiometry, document this and your plan to rescreen as consistent with your screening program or MDH recommendations.

Document the results as follows:

Different programs have different forms. Make sure your form either has the following decibel (dB) and Hertz (Hz) information or that you make note of it in your documentation. Below is a sample form.

*Please note screening at 6000 Hz is for children 11 and older.

Right ear	Right ear	Right ear	Right ear	Right ear	Left ear	Left ear	Left ear	Left ear	Left ear
500 Hz 25 dB	1000 Hz 20 dB	2000 Hz 20 dB	4000 Hz 20 dB	6000 Hz 20 dB	500 Hz 25 dB	1000 Hz 20 dB	2000 Hz 20 dB	4000 Hz 20 dB	6000 Hz 20 dB

Example of Documentation Using a Notation Key

Note each decibel level and Hertz screened (20db at 1000 Hz, 2000 Hz, 4000 Hz, and 6000 Hz; and 25db at 500 Hz) as either heard or not heard.

√ Responds = PASS

Ø No response = REFER

In our example, we use a √ if the child heard the tone or a Ø if the child did not hear the tone. For example; if the child responded to the 25dB in the right ear at 500 Hz and did not respond to 20dB at 1000 Hz, your documentation would look like this:

Right ear	Right ear	Right ear	Right ear	Right ear	Left ear	Left ear	Left ear	Left ear	Left ear
500 Hz 25 dB √	1000 Hz 20 dB Ø	2000 Hz 20 dB √	4000 Hz 20 dB √	6000 Hz 20 dB √	500 Hz 25 dB √	1000 Hz 20 dB √	2000 Hz 20 dB √	4000 Hz 20 dB √	6000 Hz 20 dB √

Example Documentation Key for Immediate Rescreen

Ø √ No response initially but responds on immediate rescreen = PASS or Normal.

Ø Ø No response initially or on immediate rescreen = REFER or Abnormal.

Right ear	Right ear	Right ear	Right ear	Right ear	Left ear	Left ear	Left ear	Left ear	Left ear
500 Hz 25 dB √ √	1000 Hz 20 dB Ø Ø	2000 Hz 20 dB √ √	4000 Hz 20 dB √ √	6000 Hz 20 dB √ √	500 Hz 25 dB √ √	1000 Hz 20 dB √ √	2000 Hz 20 dB √ √	4000 Hz 20 dB √ √	6000 Hz 20 dB √ √

Documentation of Threshold Screening

- For each ear, document the lowest decibel at which there were two responses for each of the threshold screening frequencies: 500, 1000, 2000, 4000, and 6000 Hz.
- Using a grid, such as the school hearing worksheet (refer to Appendix A) to document threshold screening results rather than an audiogram reduces the possibility of confusing a threshold screening with a diagnostic procedure performed by an audiologist.
- Threshold screening documentation is solely to provide more information to a referral; this purpose should be clearly noted.

Child and Teen Checkups Documentation

Provide complete documentation of the hearing screening. Although no specific documentation forms are required for C&TC, age specific C&TC documentation forms are available for your convenience. For more information, refer to C&TC Documentation Forms for Clinics and Providers (www.dhs.state.mn.us).

Communicating Results and Follow-Up

Hearing screening does not take the place of a medical or audiological evaluation or make definitive statements about a child's hearing. Screening results provide basic information on a child's hearing status, which can be used to inform referral and follow-up. Provide parents with verbal communication via an interpreter as needed, in addition to written information in their native language regarding the necessity of the referral. It is important to ensure the parent or guardian has signed, with informed consent, in accordance with the referring or consulting organization's policies and procedures a release, which allows sharing of information between both agencies. It is recommended that PASS/REFER terminology replace pass/fail terminology previously used to indicate a child who does or does not need further follow-up. Fail terminology has negative connotations for children and families. Education staff should be informed of diagnosis and treatment so adjustments, if necessary, can be made in the child's education program. A sample Hearing referral letter is available in Appendix A.

Referral Tracking

The success of a screening program is dependent on the program's capacity to track children who do not pass the initial screening through subsequent follow-up steps, as outlined in the program's written protocol. The protocol should include a plan for how children will be tracked

and flagged for rescreening, describe what screening results documentation will be provided to parents and primary care providers, and identify who will explain the screening results to families. In addition, the protocol should have a plan to ensure follow-up has taken place. Programs should periodically review pass rates, monitor and evaluate the program's compliance to their established screening protocol, and review recommended follow-up sequence and timing.

Audiometer Use, Care, and Calibration

The Audiometer

MDH recommended audiometers have test tones ranging from 250 to 8000 Hz and volumes of 0-80/100 decibels, this allows the screener to perform both pure tone audiometry screening and threshold screening.

Headphones are calibrated to a specific audiometer and are not interchangeable with other machines.

MDH does *not* recommend speech stimuli screening equipment such as Verbal Auditory Screening for Children (VASC), where a word is presented to the child, and the child has to identify a related picture. Evidence indicates that the VASC is less effective than pure tone audiometry in identifying hearing loss.

Specifications vary somewhat between brands but most audiometers have the following dials:

- **Power or On/Off switch**: Needs to be on when screening.
- **Frequency dial**: The frequency dial rotates from 250 to 8000 Hz. This dial controls the test frequency or the pitch of the tone.
- **Decibel (dB) or hearing level dial**: This dial controls the test intensity or loudness of the tone. This is typically a rotary dial, which allows the screener to vary the tones presented in 5dB steps from approximately 0 to 80/100 dB.
- **Tone presentation bar or stimulus switch**: Pressing this bar presents the tone.

General Care

Handle gently and avoid dropping. When transporting the audiometer in a car, secure it so it will not fall during a sudden stop.

Avoid extreme temperatures (below freezing and above 90° F). Keep cords free of tangles and twists. Check all electrical connections, dials and switches for signs of problems. The headphone jacks should be removed from their plugs occasionally and wiped with an alcohol pad to improve the connection (Note*:* Do not use alcohol pads on the headphone ear pieces). Take proper care to prevent moisture from getting inside the audiometer.

Keep the case closed to prevent dust build-up. If the case or exposed surfaces become dirty, mild soap and water are usually sufficient to clean them.

Perform mechanical function checks each day, on each audiometer, before use.

Infection control

Cerumen is not infectious unless dried blood or mucus is present. When the headphone cushions need cleaning, remove them from the headset, clean and dry thoroughly before replacing.

- Clean headphones before each re-use with a cleaning agent or alcohol-free wipes.
- *Do not use alcohol because it may dry out the rubber cushions on headphones*.
- Keep all moisture away from the diaphragm (the hole in the center of the headphones).

In the event of a lice outbreak, the American Academy of Audiology (2011) recommends modifying screening schedules.

Audiometer mechanical function check

Audiometer parts and functions	Check to ensure:	Mark when complete
Power on	There is power to audiometer	
Jacks	Jacks are in proper port (red in right and blue in left) and pushed in all the way	
Headphone cushions	Cushions are clean, flexible, and have no cracks or rips	
Headphone headband	Headband has enough tension to be easily adjusted. Put on headphones to check that they rest snugly on ears	
Tone ON or OFF (NORM or REV)	Sound is on when you turn the switch to the ON (NORM) position and sound is off when in the OFF (REV) position	
Cords	Cords are in good condition by turning selector switch to “right” and tone interrupter switch to ON (NORM) position, twisting the cord at right headphone and jack, then repeating the process for the left. Tighten connections or replace cords if sound cuts out or is scratchy.	
Volume	Volume increases and decreases by turning the Hearing Level (HTL) dial	
Pitch	Pitch changes by turning frequency dial	

Audiometer parts and functions	Check to ensure:	Mark when complete
Tone presenter switch(es)	Switch works by pressing it in the OFF (REV) and making sure that tone comes on, and that the tone goes off when the switch is pressed in the ON (NORM) position.	
Static	No static is heard	
Cross talk	No sound is heard in the right earphone when listening to the left earphone, and vice versa	

Calibration

Audiometers should have yearly calibrations. Extensive calibrations are typically done at a repair facility or factory about every fifth year.

The audiometer needs repair if:

- Tone does not sound normal, static is heard, or sound is not produced when tone lever/button is pressed.
- Headphones do not remain in proper position over ears.
- A dial or switch does not function or indicator lights do not glow.

Biologic calibration check

(Optional unless performing threshold audiometry)

To ensure that the audiometer is ready for accurate screening, the person with primary responsibility for the hearing screening program should do biologic calibration checks. Perform this check prior to threshold screening or when there is reason to suspect the audiometer may not be working properly. Use procedure described below. The biological calibration check form is in Appendix A.

Same ear hearing level procedure

1. Obtain a threshold screening (refer to threshold screening section of this manual) on the better ear with the right (red) headphone and record the results.
2. Obtain a threshold on the same ear with the left (blue) headphone and record the results.
3. Check thresholds at each frequency to see that they differ by no more than ± 5dB. If they vary more than this, do not use the audiometer and have it checked by a technician.

Audiometer Supplies and Repair

Audiometer Repair or Purchase
Audiology Systems, Inc.
50 Commerce Dr. Ste. 180, Schaumburg, IL 60173
Phone: (866) 559-7407 or (763) 504-7407, Fax: (763) 504-3193
www.specialtyinstruments.com

Midwest Special Instruments
12302 Princeton Ave. Savage, MN 55378
Phone: (952) 808-0320
www.midwestsi.com

MacGill Discount Nurse Supplies
1000 N. Lombard Rd. Lombard, IL 60148
Phone: (800) 323-2841, Fax: (800) 727-3433
www.macgill.com

School Health Corp.
865 Muirfield Dr. Hanover Park, IL 60103
Phone: (866) 323-5465, Fax: (800) 235-1305
www.schoolhealth.com

School Nurse Supply, Inc.
P.O. Box 68968 Schaumburg, IL 60168
Phone: (800) 485-2737, Fax: (800) 485-2738
www.schoolnursesupplyinc.com

Starkey Labs
6700 Washington Ave. S Eden Prairie, MN 55344
Phone: (800) 328-3897 or (952) 941-6401
www.starkey.com

Note: This resource list is for informational purposes only; the Minnesota Department of Health (MDH) does not endorse any particular product. In addition, MDH is not responsible for the content of websites listed here. Any person or entity that relies on any information obtained from this resources list does so at his or her own risk.

Appendix A: Forms

C&TC Documentation forms for Providers and Clinics (www.dhs.state.mn.us)

Early Childhood Hearing Screening Worksheet

Child's name_____ Date of birth _____

Screen date_____ Age at screen (years and months) _____

Rescreen date_____ Age at rescreen (years and months) _____

Hearing risk assessment	**Initial screen**
Risk factors and hearing history	PASS/REFER

Visual Inspection	**Initial screen**	**Rescreen**
External inspection	PASS/REFER	PASS/REFER
Internal inspection/otoscopy	PASS/REFER	PASS/REFER
If REFER, please describe findings:		

Pure tone audiometry – Right ear	**Initial screen**	**Rescreen**
500 Hz, 25 dB	PASS/REFER	PASS/REFER
1000 Hz, 20 dB	PASS/REFER	PASS/REFER
2000 Hz, 20 dB	PASS/REFER	PASS/REFER
4000 Hz, 20 dB	PASS/REFER	PASS/REFER
Pure tone audiometry – Left ear	**Initial screen**	**Rescreen**
500 Hz, 25 dB	PASS/REFER	PASS/REFER
1000 Hz, 20 dB	PASS/REFER	PASS/REFER
2000 Hz, 20 dB	PASS/REFER	PASS/REFER
4000 Hz, 20 dB	PASS/REFER	PASS/REFER

Tympanometry (optional procedure)	**Initial screen**	**Immediate rescreen**	**Later rescreen (date_____)**
	PASS/REFER	PASS/REFER	PASS/REFER

School Hearing Screening Worksheet

Child's name_____ Date of birth_____

Teacher's name_____ Grade _____

Screen date_____ Rescreen date_____

Any parent/teacher/child concerns about hearing? _____

_____

Visual Inspection	**Initial screen**	**Rescreen**
External inspection	PASS/REFER	PASS/REFER
Internal inspection/otoscopy *(if done)*	PASS/REFER	PASS/REFER
If REFER, please describe findings:		

Pure tone audiometry – Right ear	**Initial screen**	**Rescreen**
500 Hz, 25 dB	PASS/REFER	PASS/REFER
1000 Hz, 20 dB	PASS/REFER	PASS/REFER
2000 Hz, 20 dB	PASS/REFER	PASS/REFER
4000 Hz, 20 dB	PASS/REFER	PASS/REFER
6000 Hz, 20 dB (ages 11 and up)	PASS/REFER	PASS/REFER
Pure tone audiometry – Left ear	**Initial screen**	**Rescreen**
500 Hz, 25 dB	PASS/REFER	PASS/REFER
1000 Hz, 20 dB	PASS/REFER	PASS/REFER
2000 Hz, 20 dB	PASS/REFER	PASS/REFER
4000 Hz, 20 dB	PASS/REFER	PASS/REFER
6000 Hz, 20 dB (ages 11 and up)	PASS/REFER	PASS/REFER

Tympanometry is an optional procedure. If done, please document results below.

Tympanometry	**Initial screen**	**Immediate rescreen**	**Later rescreen (date_____)**
	PASS/REFER	PASS/REFER	PASS/REFER

Hearing Referral Letter

Child's Name _____ Date of Birth _____

Dear Parent/Guardian:

In keeping with the recommendations of the Minnesota Department of Health for conducting hearing screening in a school setting, your child's hearing was screened on _____/_____/_____ and rescreened on_____/_____/_____. The results of the screen and rescreen are detailed in the grid below.

- Your child did not respond to all of the sounds on their hearing screening.
- These results mean your child *may* have a hearing problem.
- Please take him/her to your medical clinic and/or audiologist for further hearing evaluation. If your child is already receiving care for hearing problems or if you need assistance in finding a health care provider, please contact the school nurse.
- Bring this letter with you when your child is evaluated and ask the health care provider to fill out the back side of this form.
- **RETURN THIS FORM TO THE SCHOOL NURSE WITH THE HEALTH CARE PROVIDER'S EVALUATION COMMENTS ON THE BACK SIDE OF THIS LETTER.**

Pure tone audiometry – Right ear	**Initial screen**	**Rescreen**
500 Hz, 25 dB	PASS/REFER	PASS/REFER
1000 Hz, 20 dB	PASS/REFER	PASS/REFER
2000 Hz, 20 dB	PASS/REFER	PASS/REFER
4000 Hz, 20 dB	PASS/REFER	PASS/REFER
6000 Hz, 20 dB (ages 11 and up)	PASS/REFER	PASS/REFER
Pure tone audiometry – Left ear	**Initial screen**	**Rescreen**
500 Hz, 25 dB	PASS/REFER	PASS/REFER
1000 Hz, 20 dB	PASS/REFER	PASS/REFER
2000 Hz, 20 dB	PASS/REFER	PASS/REFER
4000 Hz, 20 dB	PASS/REFER	PASS/REFER
6000 Hz, 20 dB (ages 11 and up)	PASS/REFER	PASS/REFER

Dear health care provider:

Please complete the back side of this form and return to parent/guardian or to the school nurse

School Nurse _____

School _____

Address _____

Phone _____ Fax _____

HEALTH CARE PROVIDER EVALUATION

Name and title of provider _____Date of Exam _____

Clinic name / location _____

Phone _____Fax _____

I have examined (name) _____ and find the following:

MEDICAL:

- ☐ Hearing (circle): PASS REFER
- ☐ Medically treatable
- ☐ Not medically treatable
- ☐ Outer ear
- ☐ Middle ear
- ☐ Inner ear
- ☐ Refer to audiology
- ☐ Further comments:

_____
_____

☐ Recommendations to support learning in the school environment:

_____
_____
_____

Signed: _____
Date: _____

AUDIOLOGICAL:

- ☐ Normal hearing
- ☐ Conductive hearing loss
- ☐ Mixed hearing loss
- ☐ Sensorineural hearing loss
- ☐ Refer to physician
- ☐ Amplification evaluation

☐ Further comments:

_____
_____

☐ Recommendations to support learning in the school environment

_____
_____
_____

Signed: _____
Date: _____

Parent/guardian, please return this completed form to the school nurse.

Biological calibration check form

Audiometer ID_____

Same ear threshold screening

Date	Screener name	Headphone	500 Hz	1000 Hz	2000 Hz	4000 Hz	6000 Hz

Appendix B: Information about hearing loss

Joint Commission on Infant Hearing (JCIH) Position Statement (2007)

Principles and guidelines for Early Hearing Detection and Intervention programs

The JCIH 2007 Position Statement from the AAP identified 11 risk indicators associated with hearing loss. The identification of risk indicators is an essential component of a comprehensive hearing-screening program for infants and children. JCIH recommends that all infants and children receive an assessment of risk indicators for hearing loss during routine medical care, consistent with the AAP/Bright Futures Recommendations for Preventative Pediatric Health Care. This assessment for risk indicators includes information regarding prenatal/birth history, newborn hearing screening results, presence of specific early childhood conditions, and family risk factors (refer to the complete list). However, the use of risk indicators alone will identify only 40-50 percent of infants with hearing loss.

> *Monitor all infants and children, with and without risk indicators, during routine medical care consistent with the AAP periodicity schedule. Refer all infants with a risk indicator for hearing loss to an audiologist at least once by 24 to 30 months of age. MDH recommends that an audiologist assess infants and children with risk factors as soon as a concern is identified. Children with risk indicators that are highly associated with delayed-onset hearing loss, such as having received ECMO or having CMV infection, should have more frequent hearing assessments* (JCIH 2007).

Explanation of Risk Indicators

To assist in obtaining accurate and pertinent information from each parent or caregiver, a brief explanation of JCIH risk indicators associated with permanent congenital, delayed onset or progressive hearing loss in childhood are provided below.

1. **Caregiver concern regarding hearing, speech, language, or developmental delay**

   Most parents are reliable reporters of their child's development. Depending on the setting and the concern, parents have been found to be accurate up to 94 percent of the time (Glascow & Dworkin, 1995).

2. **Family history of permanent childhood hearing loss**

   Hereditary (genetic) hearing loss in both maternal and paternal family members, living and deceased is an important risk factor for congenital hearing loss (JCIH, 2007). Absence of a family history of genetic or risk factors for congenital hearing loss does not rule out a genetic cause. Depending on risk factors, the child may need regular follow-up with an audiologist. It is important to determine whether the relative has acquired hearing loss (such as that resulting from meningitis, noise exposure, chemotherapy, or the aging process); acquired hearing loss is not an inherited condition.

3. **Neonatal intensive care for more than five days, or any of the following: extra-corporeal membrane oxygenation (ECMO), assisted ventilation, exposure to ototoxic medications**

(gentamycin and tobramycin) or loop diuretics (furosemide also known as Lasix), or hyperbilirubinemia that requires exchange transfusion

Infants admitted to the NICU are at greater risk for hearing loss. For example, infants with very low birth weight are at increased risk of both sensorineural and conductive hearing loss. Jaundice is a condition, which occurs when there is too much bilirubin (by-product from the liver) in the blood. High bilirubin levels (hyperbilirubinemia) requiring an exchange transfusion can be **ototoxic** and may cause hearing loss. Premature infants and infants with low birth weights are at a greater risk for high bilirubin levels. Low bilirubin levels (slight jaundice) typically do not affect hearing. In addition, infants who require prolonged use of mechanical ventilation are at risk for hearing loss (e.g. persistent pulmonary hypertension, conditions requiring the use of extracorporeal membrane oxygenation [ECMO]) (JCIH, 2007).

Ototoxic: Refers to conditions and medications that have the potential to damage the cochlea, auditory nerve and sometimes the vestibular system of the ear. Conditions include persistent pulmonary hypertension and hyperbilirubinemia. Ototoxic drugs include antibiotics such as aminoglycoside gentamicin, loop diuretics such as furosemide. Use of ototoxic medications can result in sensorineural hearing loss, equilibrium disturbances, or both. Either may be reversible and temporary, or irreversible and permanent (Weichbold, V., Neckahm-Heis, D., & Welzl-Mueller. 2006).

4. **In utero infections, such as cytomegalovirus (CMV), herpes, rubella, syphilis, or toxoplasmosis**

The majority of infections in pregnant women are not known to cause hearing loss. However, some infectious agents, contracted by the mother during pregnancy, may cross the placental barrier and infect fetal tissue. Teratogenic (birth defect causing) infections can be associated with hearing loss, especially those occurring during the first trimester, since this is when the auditory system develops. Many infections go unrecognized due to the lack of clinical symptoms in the mother. The infant may have a normal newborn hearing screening and not be identified as at risk for hearing loss. Hearing loss in children has been linked to the following infectious agents.

CMV: This herpes virus is the leading cause of fetal viral infection in the U.S. (CDC, 2013). This infection is most often asymptomatic in the mother (Fowler et. al, 1997). CMV can cause sensorineural hearing loss, which varies in severity, may have a delayed onset, may be unilateral, and is often progressive.

Herpes: Either systemic or simplex, type one or two, are in the same family as the CMV virus. Herpes may cause severe to profound sensorineural hearing loss (al Muhaimeed & Zakzouk, 1997).

Toxoplasmosis: Is an infection caused by a protozoan parasite and is usually asymptomatic in the mother. A fetus is most likely to be affected by a first trimester infection. Frequently seen effects of toxoplasmosis include sensorineural hearing loss (Andrade et al., 2008), as well as mental retardation, seizures, and ocular disease.

Rubella (German measles): Effectively eliminated in the U.S, rubella is still endemic in other parts of the world (CDC, 2012). Rubella poses a serious risk to the developing fetus when a maternal infection occurs within the first trimester of pregnancy. Hearing loss is the most common rubella-related birth defect; other anomalies may include heart disorders, low birth weight, mental retardation, and vision loss. When hearing loss occurs, 50 percent of children have bilateral severe to profound loss. This type of hearing loss may be progressive.

Syphilis: Congenital syphilis may become apparent in the first two years of life, or between the ages of eight to 20 years. Hearing loss is sensorineural and maybe be sudden, progressive, or temporary.

5. **Craniofacial anomalies, including those that involved the pinna, ear canal, ear tags, ear pits, and temporal bone**

   Craniofacial abnormalities (e.g. cleft lip/palate, shortened neck, webbed neck, abnormal head circumference) may be indications of the presence of hearing loss. Malformation of the ears may include atresia (close or narrowing of the ear canal), low set ears, skin tags, and preauricular pits. These abnormalities may be indicative of a syndrome associated with hearing loss (Weichbold, V., Neckahm-Heis, D., & Welzl-Mueller. 2006).

6. **Physical findings such as a white forelock that are associated with a syndrome known to include a sensorineural or permanent conductive hearing loss**

7. **Syndromes associated with hearing loss or progressive or late-onset hearing loss, such as neurofibromatosis, osteopetrosis, and Usher syndrome; other frequently identified syndromes include Waardenburg, Alport, Pendred, and Jervell and Lange-Nielson**

   Many syndromes that include observable physical anomalies of the head, neck, and ears such as Down syndrome and neurofibromatosis type II (NF2), frequently result in hearing loss. Some syndromes are not evident at birth.

8. **Neurodegenerative disorders, such as Hunter syndrome, or sensory motor neuropathies, such as Friedrich ataxia and Charcot-Marie-Tooth syndrome**

9. **Culture-positive postnatal infections associated with sensorineural hearing loss, including confirmed bacterial and viral (especially herpes viruses and varicella) meningitis**

10. **Head trauma, especially basal skull/temporal bone fractures that requires hospitalization**

    Head trauma (e.g. a skull fracture) may result in conductive or sensorineural hearing loss due to damage to the middle ear, cochlea, or auditory cortex. Conductive hearing loss may occur due to perforation of the tympanic membrane, bleeding, or disruption of the ossicles. Sensorineural loss may occur due to damage or obliteration of the temporal bone housing the inner ear (Fitzgerald, 1996; Podoshin & Fradis, 1975).

11. **Chemotherapy**

Some medications used to treat cancer, such as cisplatinum, can be ototoxic.

Note: The 2007 JCIH Position Statement no longer includes in its list of risk indicators recurrent or persistent otitis media (OME) with effusion for at least three months. However, the JCIH recommends careful assessment of middle-ear status at all well-child visits, and referral of children with persistent middle-ear effusion (OME) lasting three months or longer for a hearing evaluation. Monitor OME vigilantly as it compounds hearing loss due to other conditions (e.g. sensorineural hearing loss).

Noise-Induced Hearing Loss (NIHL)

Noise-Induced Hearing Loss (www.health.state.mn.us) (pdf)

About 12.5 percent of children and teens have lasting hearing loss from contact with very loud noise (Sight and Hearing Association, 2013).

Why does loud noise cause hearing loss?

There are 15,000 to 20,000 tiny cells (cilia) in the inner ear that send sounds to the brain. Hearing loss can result when these cilia are damaged. To picture what happens when these cells are exposed to too much noise, think about when you walk on fresh grass. When you walk on it lightly only a few times it bounces back to its original shape. If you walk on grass often, or you crush it, it becomes matted down and will not bounce back. Exposure to sounds that are loud enough or occur long enough can damage the ears' cilia so that they can no longer bounce back into shape and can no longer send sound to the brain. This is the cause of noise-induced hearing loss (NIHL).

Frequency is the tone of a sound. The frequency of a sound can range from very low to very high tones. At first, NIHL can make it hard to hear high tones. This can cause problems hearing speech sounds like "s". Background noise often makes hearing these sounds even harder to hear. NIHL slowly progresses into lower tones. Once these are affected, you may have problems hearing people when they speak.

What kind of noise is too loud?

The noise is too loud if you have to raise your voice to talk to a person who is only an arm's length away. The loudness of sound is measured in decibels (dB). Noise over 85dB can cause hearing loss. Hearing noise louder than 110dB for more than one minute can cause lasting hearing loss. Instant damage to hearing can be caused by sounds 150dB or higher. For every 5dB increase in sound level, it takes 50 percent less time to get hearing loss (Sight and Hearing Association, 2013).

Sound	Decibel level	Typical response (after routine or repeated exposure
Whisper	20 dB	This sound does not typically cause any hearing damage

Sound	Decibel level	Typical response (after routine or repeated exposure
Normal conversation	60 dB	This sound does not typically cause any hearing damage
Lawn mower	90 dB	Damage to hearing possible after 2 hours
MP3 Player with headphones at maximum volume	110 – 115 dB	Hearing loss possible in less than 5 minutes
Concert/club	110 – 115 dB	Hearing loss possible in less than 5 minutes
Gunshots/fireworks	140 - 150 dB	Pain and ear injury

**note: decibel levels vary between sources, though the levels noted here are generally agreed upon in the field*

How can I prevent NIHL?

- Know how to avoid loud noise and protect your ears
- Know which noises cause damage (around 90 decibels and higher)
- Wear ear plugs or other hearing protective devices when involved in a loud activity. Special earplugs and other ear protectors are available at hardware stores and sporting goods stores.
- Keep noisy activities short and do something quiet afterward to rest your ears
- Be alert to noise in the environment
- Share this information with your friends and family!

Degrees and Effects of Hearing Loss

Decibels (dB)	Degree	Effect on language and speech development
0-15 dB	**None**	Normal hearing.
16-20 dB	**Slight**	May have difficulty hearing faint or distant speech, especially in noisy areas. Speech/language not likely to be affected. May need assistive listening technology in classroom situations.
21-40 dB	**Mild**	May miss a considerable amount of speech depending on noise levels, distance from speaker, and configuration of hearing loss, not hear consonants sounds (all letters except a, e, i, o, u) especially if loss in higher frequency range, have difficulty understanding speech if not in line of vision of speaker and speech is quiet.
41-55 dB	**Moderate**	Will miss between 50-100 percent of speech without use of appropriate amplification. Will have delayed speech-language development and vocal quality may be affected.
56-70 dB	**Moderate to Severe**	Without amplification, will miss almost 100 percent of speech information. School situations requiring vocal information will require assisted listening devices. Delays in language and speech are common and the voice may be monotone.
71-90 dB	**Severe**	Amplification is required to hear spoken language, identify environmental sounds, and detect all speech sounds. If hearing loss occurs before the child has learned to speak, oral speech and language will not develop spontaneously, and can be severely delayed. If the loss is after the development of speech, then speech is likely to deteriorate in production and vocal quality.
91 + dB	**Profound**	May be able to feel loud auditory vibrations without amplification. With amplification, may be able to detect sounds. May rely on vision for communication and learning, rather than audition. Speech and language will not develop spontaneously. *Table adapted with permission from: Relationship of Hearing Loss to Listening and Learning Needs. www.successforkidswithhearingloss.com*

Appendix C: Bibliography, Resources, and Glossary

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Online Hearing Resources

- American Academy of Audiology (www.audiology.org)
- American Speech-Language-Hearing Association (www.asha.org)
- Hearing Loss in Children (www.cdc.gov)
- Noise-Induced Hearing Loss (www.cdc.gov)
- Clinic Checklist: Hearing and Vision Screening (www.health.state.mn.us)
- Hearing and Vision Screening Quick Reference Guide (www.health.state.mn.us)
- Minnesota Child and Teen Checkups (C&TC) Schedule of Age-Related Screening Standards (www.dhs.state.mn.us)
- Minnesota Health Care Providers (MHCP) manual (www.dhs.state.mn.us)
- Early Hearing and Detection Intervention (EHDI) (www.improveehdi.org/mn/state/)
- Minnesota Department of Health Hearing Screening (www.health.state.mn.us)
- Minnesota Department of Health Hearing Screening E-Learning Course (www.health.state.mn.us)
- Minnesota Early Childhood Screening Statutes (www.revisor.mn.gov)
- Guidelines for Hearing Screening After the Newborn Period to Kindergarten Age (www.improveehdi.org)
- Dangerous Decibels (www.dangerousdecibels.org)
- Listen Carefully (www.listencarefully.org)
- National Center for Hearing Assessment and Management (www.infanthearing.org)
- National Hearing Conservation Association (www.hearingconservation.org)
- National Institute on Deafness and Other Communication Disorders (NIDCD) (www.nih.gov)
- Noisy Planet (www.noisyplanet.nidcd.nih.gov)
- WISE EARS!®: A NIHL Communication Coalition (www.nidcd.nih.gov)
- The National Institute for Occupational Safety and Health (NIOSH) Preventing Occupational Hearing Loss - A Practical Guide (www.cdc.gov/niosh))
- Sight & Hearing Association (www.sightandhearing.org)

Glossary

Ambient noise: Background noise present in the screening area

Amplification: The use of hearing aids and other electronic devices to increase the loudness of a sound

ASHA: American Speech-Language-Hearing Association

Audiogram: A graph used to record the lowest decibel of a sound, at select frequencies, heard by a subject

Audiologist: A professional who specializes in preventing, identifying and assessing hearing impairments as well as managing any non-medical rehabilitation of individuals with hearing loss

Audiometer: An instrument used to measure hearing

Auditory nerve: The eighth cranial nerve in the human body, which sends signals from the cochlea to the brain

Atresia: Closure or absence of the external auditory canal; imperforation (having no opening)

Automated auditory brainstem response (ABR): A non-invasive hearing test used for the diagnosis of hearing loss and screening infants and children who are at high risk for hearing loss; The ABR is conducted with external electrodes, which capture the neurotransmission of auditory stimuli from the external ear to the auditory cortex; it may require sedation

Calibration checks: Methods to determine the accuracy of an audiometer, the two primary methods are:

> *Biological* **-** Checking the hearing in one ear with the right and left headphones
>
> *Electronic* **-** Measurement of the absolute sound pressure levels of each frequency and other characteristics, e.g. harmonic distortion, frequency count, rise-fall time

Cochlea: A snail shaped, fluid-filled capsule that contains the organ of hearing, located in the inner ear

Cochlear implant: An electronic device surgically implanted in the inner ear that stimulates the cochlea to receive sound

Compliance: A measurement of tympanometry, which depicts tympanic membrane mobility

Congenital hearing loss: Hearing loss which is either present at birth, is associated with the birth process, or develops in the first few days of life

Decibel (dB): A measurement unit that expresses the intensity (loudness) of a sound

ENT: A medical provider specializing in the care of ears, nose and throat, sometimes referred to as an otolaryngologist or otologist

External auditory canal: Portion of the ear anatomy that extends from the auricle and external meatus to the tympanic membrane

Frequency: A measurement of the number of sound vibrations per second, expressed in Hertz (Hz), commonly known as the pitch of the sound

Hearing aid: An electronic device that conducts and amplifies sound to the inner ear

Hearing loss: Hearing loss is when the softest or lowest decibel (16dB or more) someone can hear is louder than the sound (0 to15dB) someone with normal hearing can hear. The American Speech-Language-Hearing Association (ASHA) classifies hearing loss as follows:

0-20 dB: normal

21-25 dB: slight

26-40 dB: mild

41-55 dB: moderate

56-70 dB: moderately severe

71-90 dB: severe

91+ dB: profound

Hertz (Hz): The unit of measurement, which specifies the frequency of sound waves

High-risk: Children who have one or more of the risk factors known to impact hearing

Inner ear: Portion of the ear anatomy internal to the middle ear and consisting of the cochlea, semi-circular canals, and vestibules

Intensity: The loudness of a sound, measured in decibels (dB)

Lost to follow-up: When a child does not receive or complete the recommended diagnostic or intervention process

Loudness: Refers to intensity

Middle ear: Portion of the ear anatomy that extends from the tympanic membrane to the inner ear, which is a hollow cavity and contains the ossicles

Middle ear clearance: When a medical provider has determined that the middle ear is free from fluid and appears healthy

Mixed hearing loss: A combination of conductive and sensorineural hearing loss

Noise: Any sound that is unwanted, undesired, or interferes with one's hearing

Ossicles: Malleus, incus, and stapes bones, located in the middle ear cavity; crucial to sound conduction

Otitis media: Inflammation of the middle ear and/or the tympanic membrane

Otoacoustic emissions (OAE): A noninvasive hearing screening tool that evaluates the presence of a cochlear response to the conduction of sound, which can be indicative of normal hearing; used in infants and young children who are unable to be screened with pure tone audiometry; does not diagnose hearing loss

Otoscope: Instrument used to examine the ear canal and tympanic membrane

Outer ear: Portion of the ear anatomy that extends from the pinna to the tympanic membrane and includes the auricle and external auditory canal

Ototoxic: Refers to conditions and medications that have the potential to damage the cochlea, auditory nerve, and sometimes the vestibular system of the ear

Pinna: External (visible) portion of the ear anatomy, sometimes called the auricle

Pitch: Refers to frequency

Play audiometry: A modification of pure tone audiometry screening used with young children and/or developmentally delayed individuals

Preauricular sinus: A tiny pit in the skin in the area where the outer rim of the ear (called the helix) attached to the face; preauricular sinuses can be an indicator of other ear problems

Pure tone audiometry: A method of hearing screening used to identify children with suspected hearing loss by having the child listen to a series of pure tones and noting whether or not there is a response; considered the 'gold standard' of hearing screening

Pure tone: A tone of a single frequency produced by an audiometer, contains no harmonics or overtones

Sensorineural hearing loss: Hearing loss due to pathology of the cochlea, auditory nerve, or auditory cortex; is usually irreversible

Skin tag: A growth of skin tissue often near the ears, or elsewhere on the face or neck, is usually small, soft, and skin-colored; in rare cases skin tag(s) are associated with hearing problems

Threshold*:* The softest (minimum) decibel at which an individual is able to respond to a tone (frequency) at least 50 percent of the time

Threshold audiometry: A hearing test performed to determine thresholds at specific frequencies; MDH recommendations are to perform thresholds at 500, 1000, 2000, 4000, and 6000 Hz

Tympanic membrane: A thin membrane between the external auditory canal and the middle cavity; moves in response to sound waves and sets the ossicles bones in motion

Tympanometry: An objective measurement of middle-ear mobility and middle ear pressure using sound (probe tone) and air pressure