

Hearing Screening Training Manual

MINNESOTA DEPARTMENT OF HEALTH

01/2022

For more information, contact

Minnesota Department of Health
Child and Teen Checkups
85 E 7th Place
St. Paul, MN 55164-0882
651-201-3650
health.childteencheckups@state.mn.us
www.health.state.mn.us

To obtain this information in a different format, call: 651-201-3650.

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>

Joint Committee on Infant Hearing (JCIH) 2019 Position Statement

<https://digitalcommons.usu.edu/jehdi/vol4/iss2/1/>

Contents

Introduction	2
Audience	2
Purpose	2
Overview of Hearing and Hearing Loss.....	3
Sound Defined.....	4
Hearing and Hearing Loss Defined	4
Causes of Noise Induced Hearing Loss (NIHL)	6
Hearing Screening Programs	7
Universal Newborn Hearing Screening.....	8
Child and Teen Checkups (C&TC).....	8
Minnesota Infant and Toddler Intervention Services (IDEA-Part C)	9
Early Head Start and Head Start.....	9
Early Childhood Screening	9
Early Childhood Special Education (IDEA- Part B).....	9
School-Age Screening.....	9
Procedures.....	11
Risk Assessment and Hearing History	12
Risk Assessment: Parent, Caregiver, Teacher, and Child Observation of Complaints and Behaviors.....	15
Risk Assessment: Indicators of Noise-Induced Hearing Loss.....	15
Visual Inspection.....	16
Pure Tone Audiometry Screening.....	17
Play Audiometry	20
Pure Tone Threshold Screening* (Optional).....	22
Environmental Noise Level Check.....	24
Result Interpretation and Follow-Up	26
Rescreen and REFER Criteria.....	27
Next Steps.....	27
Screening Algorithm Pure Audiometry for the Clinic.....	28
Screening Algorithm Puretone Audiometry for Community Setting	29
Documentation.....	30
Communicating Results and Follow-Up.....	32

HEARING SCREENING TRAINING MANUAL

Referral Tracking	32
Audiometer Use, Care, and Calibration	33
The Audiometer	34
Audiometer Mechanical Function Check	36
Calibration	37
Biologic Calibration Check	37
Audiometer Supplies and Repair.....	38
Appendix A: Forms.....	40
Early Childhood Hearing Screening Worksheet.....	41
School Hearing Screening Worksheet	42
Hearing Referral Letter.....	43
Child and Family Hearing History and *JCIH Risk Assessment Questionnaire	45
Biological Calibration Check Form.....	46
Same Ear Threshold Screening.....	46
Appendix B: Information About Hearing Loss.....	47
Joint Commission on Infant Hearing (JCIH) Position Statement (2019)	48
Noise-Induced Hearing Loss (NIHL)	50
Degrees and Effects of Hearing Loss	52
Appendix C: References, Resources, and Glossary.....	53
References.....	54
Online Hearing Resources	58
Glossary.....	59

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 Defined

Sound has two measurable characteristics: frequency (Hertz) and volume (decibels).

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, 2019).

Hearing and Hearing Loss Defined

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, 242 babies born in 2015 were identified with permanent hearing loss (Minnesota Early Hearing Detection and Intervention, 2015). In 2019 Early Childhood Screening identified 1437 children in Minnesota ages three to five years as having potential problems with hearing (Minnesota Department of Education, 2021).

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. Approximately 30 to 50 per 1000 youth have hearing loss by late adolescence (American Academy of Audiology, 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 (The Joint Committee on Infant Hearing, 2019). The cause of about 25 percent of congenital hearing loss cases in the U.S. is unknown (Centers for Disease Control and Prevention, 2020).

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 Family Physicians, American Academy of Otolaryngology-Head and Neck Surgery, & American Academy of Pediatrics Subcommittee on Otitis Media With Effusion, 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. 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 (Centers for Disease Control and Prevention, 2021). 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 & Fukijawa, 1992).

NIHL prevalence increases significantly in late childhood and adolescence (American Academy of Audiology, 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. 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 (Joint Committee on Infant Hearing (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. 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 (American Academy of Audiology, 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 4th grade reading level or less, unless appropriate early educational intervention occurs (Gallaudet Research Institute (US), 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 (American Academy of Audiology, 2011) (Joint Committee on Infant Hearing (JCIH), 2007).

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 68,063 infants born in Minnesota in 2015, 99.1% percent were screened for hearing loss. However, 4.6% percent of infants did not pass initial screening. Of the 322 of infants that did not pass the screening, 242 infants had permanent hearing loss and 91 infants had transient/undetermined hearing loss (Minnesota Early Hearing Detection and Intervention, 2015).

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 (Centers for Disease Control and Prevention, 2020)

For additional information about newborn hearing screening, refer to the [Early Hearing Detection Intervention website \(www.improveehdi.org/mn/state\)](http://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 aged 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 \(www.dhs.state.mn.us\)](http://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 \(www.health.state.mn.us\)](http://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 \(www.revisor.mn.gov\)](http://www.revisor.mn.gov) 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 \(www.health.state.mn.us\)](http://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

Child and Family Hearing History and *JCIH Risk Assessment, Early Childhood Screening Hearing Worksheet, 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 when the child can reliably be screened with pure tone audiometry typically at three to four years of age:
 - 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.
 - Review: Child and Family Hearing History and *JCIH Risk Assessment
- For all children:
 - Review as indicated by parental concern: JCIH Postnatal 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.

Child and Family Hearing History and *JCIH Risk Assessment

Ages

One month through 20 years: most important to fill out before the child can reliably be screened with pure tone audiometry typically at three to four years of age.

Purpose

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

Procedure

For initial interviews review all the following Joint Committee on Infant Hearing risk indicators including postnatal risk indicators which are associated with permanent congenital, delayed onset or progressive hearing loss in childhood. Refer to Appendix A: Child and Family Hearing History and *JCIH Risk Assessment Questionnaire for a form the parent or caregiver can fill out.

For subsequent visits review only: Postnatal history, ear infection history, and parental concerns and observations.

Perinatal Risk Indicators

Birth and Family History Section of Risk Assessment Form

1. A history of family members of early progressive or delayed onset, permanent hearing loss in childhood.
2. Neonatal Intensive care of more than five days.
3. Hyperbilirubinemia requiring exchange transfusion.
4. Aminoglycoside administration greater than 5 days duration.
5. Asphyxia and or hypoxic ischemic encephalopathy.
6. Extracorporeal membrane oxygenation (ECMO.)
7. In-utero infections such as herpes, rubella, syphilis, and toxoplasmosis.
 - a) In-utero infections with cytomegalovirus (CMV)
 - b) Mother + Zika and infant with laboratory findings of Zika - clinical findings
8. Certain birth conditions or findings:
 - a) Craniofacial anomalies including microtia, atresia, ear dysplasia, white forelock, and microphthalmia.
 - b) Congenital microcephaly, congenital or acquired hydrocephalus.
 - c) Temporal bone anomalies
9. Over 400 syndromes have been identified with atypical hearing thresholds for more information refer to <https://hereditaryhearingloss.org/syndromic>

Postnatal Risk Factors

Child's Postnatal History Section of Risk Assessment Form

10. Culture-positive infections associated with sensorineural hearing loss (meningitis, encephalitis) including viral infections such as varicella or herpes
11. Events associated with hearing loss
 - Significant head trauma especially basal skull/ temporal bone fracture
 - Chemotherapy
12. Family/caregiver concern

PASS

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

REFER

Refer for an audiological evaluation:

- Any newly identified parent concern
- Any child with a risk factor which has not been screened previously by an audiologist

Refer: Any complaints or concerns should be referred to their primary care provider to determine appropriate treatments or referrals.

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

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 \(www.health.state.mn.us\)](http://www.health.state.mn.us) 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

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 refer to the 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 section in this manual.
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 headphones 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 you work in a community:

- 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

If you work in a clinic setting:

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

If you work in a community setting:

- 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

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 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 you work in a community

- 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

If you work in a clinic setting:

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

If you work in a community setting:

- 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.
 - 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

Community REFER criteria

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.

Next Steps

Depending on their role and practice site policy, screener identifies next steps, to ensure follow up occurs for positive screen results.

Refer to the Pure Tone Audiometry Screening Algorithm on the following page.

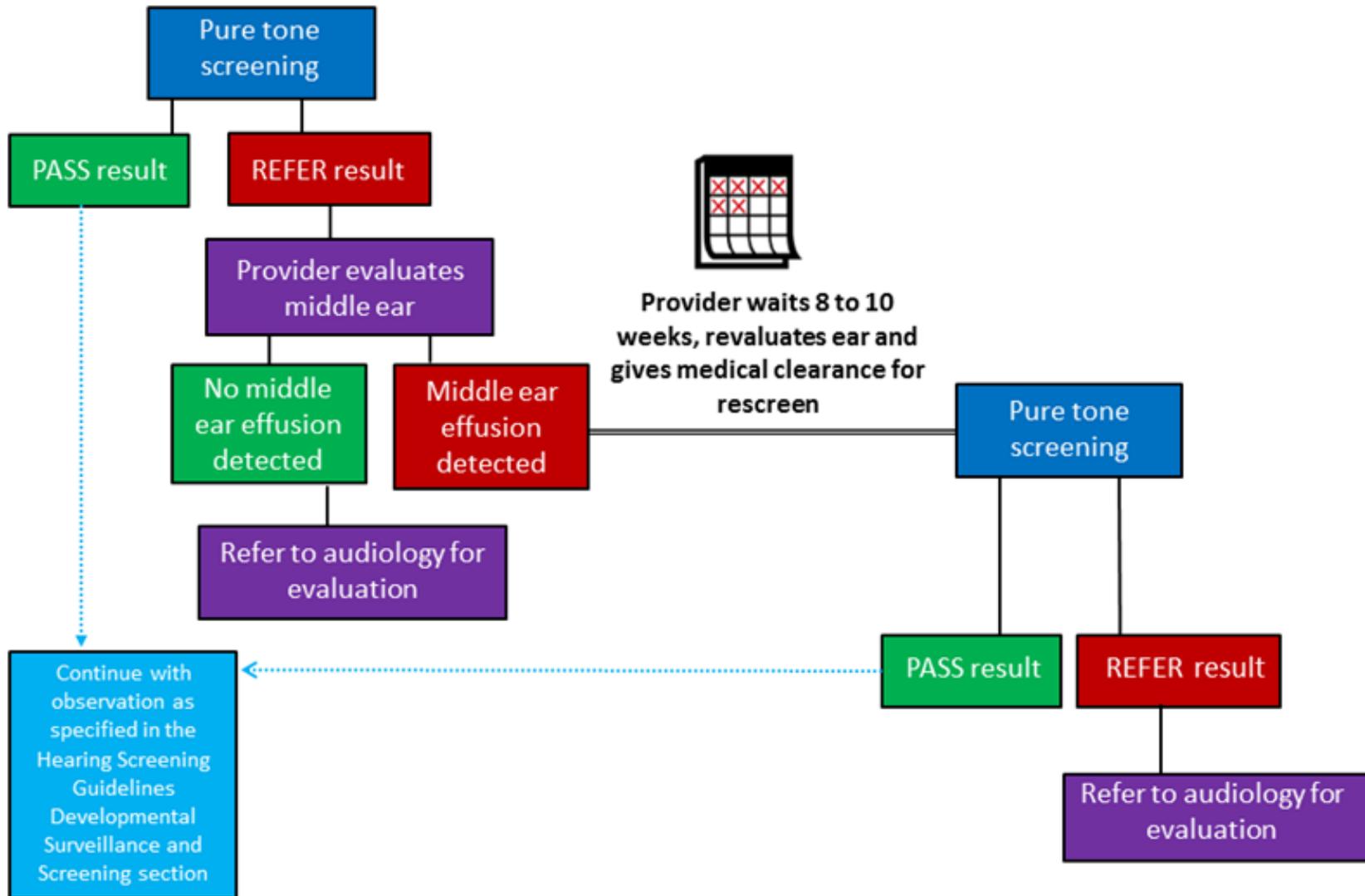
Other Considerations

- 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 to 10 weeks, rescreen the child's hearing.
- If the screener determines it would be of benefit to the referral, threshold screening** may be performed.

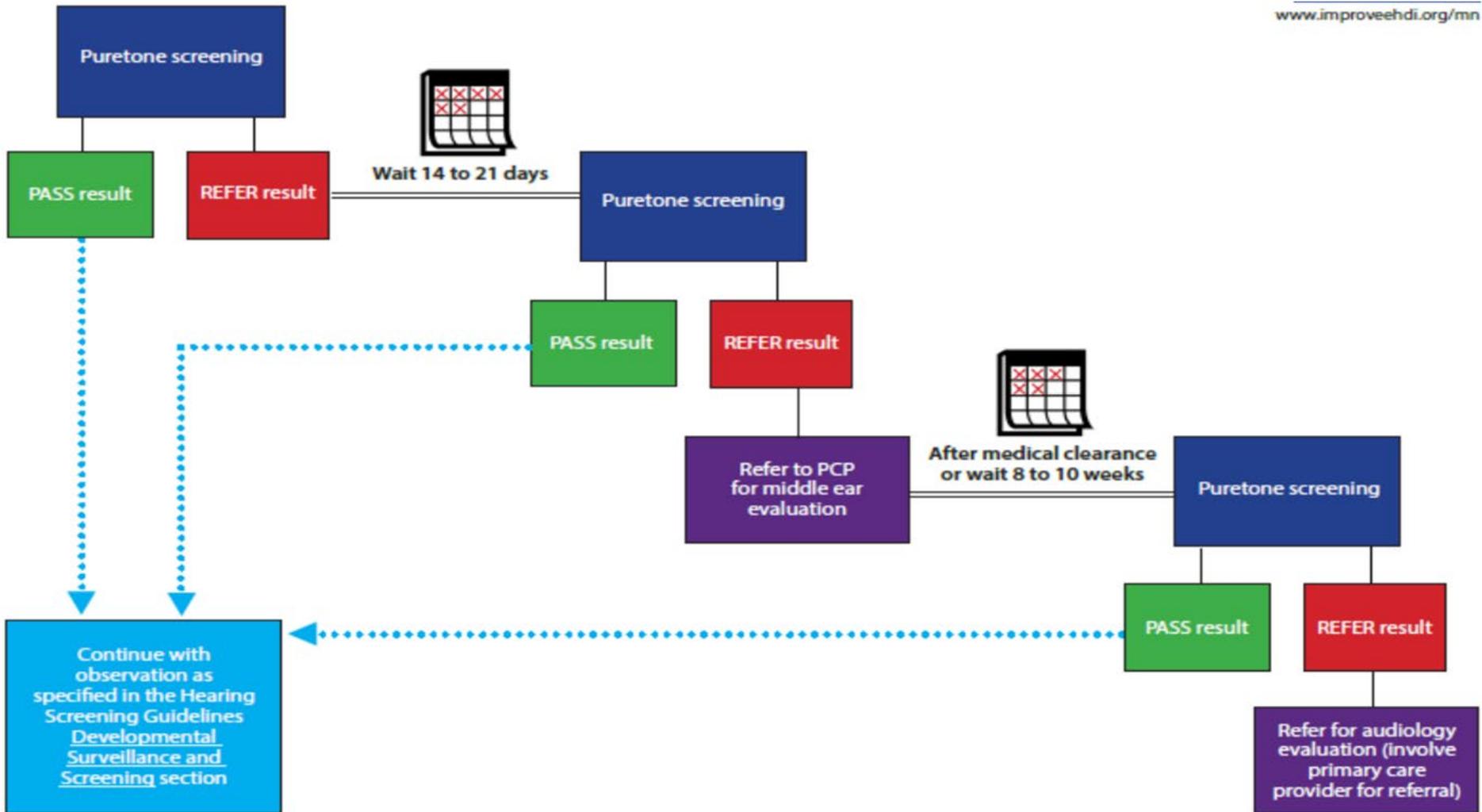
*Determining if the child may have middle ear fluid requires advanced training that may be beyond the skill of some screeners.

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

Screening Algorithm Pure 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

∅ No response = REFER

In our example, we use a √ if the child heard the tone or a ∅ 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	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

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

∅∅ 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	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 \(www.dhs.state.mn.us\)](http://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.	
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 ± 5 dB. 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: (855) 283-7978, 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.

5600 Apollo Drive Rolling Meadows, IL 60008

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: (888) 481-5512 or (952) 941-6401

www.starkey.com

HEARING SCREENING TRAINING MANUAL

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 \(www.dhs.state.mn.us\)](http://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
	PASS/REFER	PASS/REFER	Date: PASS/REFER

School Hearing Screening Worksheet

Child's Name: _____

Screen Date: _____

Date of Birth: _____

Rescreen Date: _____

Teacher's Name: _____

Any Parent/Teacher/Child concerns about

Grade: _____

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 (Optional Procedure)	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

Health Care Provider

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

School Nurse: _____

Phone: _____

School: _____

Fax: _____

Address: _____

Health Care Provider Evaluation

Name/Title of Provider: _____

Phone: _____

Date of Exam: _____

Fax: _____

Clinic Name/ Location: _____

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

MEDICAL:

- Hearing (circle): PASS or REFER
- Medically treatable
- Not medically treatable
- Outer Ear
- Middle Ear
- Inner Ear
- Refer to Audiology

AUDIOLOGICAL:

- Normal Hearing
- Conductive Hearing Loss
- Mixed Hearing Loss
- Sensorineural Hearing Loss
- Refer to Physician
- Amplification Evaluation

Further Comments: _____

Further Comments: _____

Recommendations to support learning in the school environment: _____

Recommendations to support learning in the school environment: _____

Signed: _____

Signed: _____

Date: _____

Date: _____

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

Child and Family Hearing History and *JCIH Risk Assessment Questionnaire

Child's Name: _____ Parent/ Caregiver Name: _____

Age/DOB: _____ Date: _____

* JCIH Risk Assessment questions for the initial visit for all children under 3 years of age.

Child and Family Hearing History (Circle Yes or No as it applies to child or family member)	YES	NO
Were birthmother, father, or child's siblings told they have permanent hearing loss in childhood? *	YES	NO
After the birth, was your child in the intensive care more than 5 days? *	YES	NO
Did your child have jaundice requiring a blood transfusion after birth? *	YES	NO
Were you told your child was given medicine after birth that might harm their hearing? *	YES	NO
Were you told your child had encephalopathy after birth because of low oxygen levels? *	YES	NO
Was your child on a special ventilator called ECMO after birth? *	YES	NO
Did birthmother have an infection during pregnancy: zika virus, cytomegalovirus (CMV), herpes, rubella, syphilis, or toxoplasmosis? *	YES	NO
Does your child have: Craniofacial or temporal bone anomalies, if so, what are they? *	YES	NO
Does your child have congenital microcephaly, congenital, or acquired hydrocephalus? *	YES	NO
Have you been told your child has a syndrome that could possibly cause hearing loss? *	YES	NO

*JCIH Risk Assessment Recent History: Parent/ caregiver reviews at every visit and notes changes:

Child's Postnatal History (Circle Yes or No as it applies to your child)	YES	NO
Has your child had an illness such as meningitis or encephalitis? *	YES	NO
Has your child had head trauma, concussion, skull fracture or chemotherapy? *	YES	NO
Do you have concerns about your child's ears/hearing, speech, language, or development? *	YES	NO
Does your child have history of many ear infections and /or tubes?	YES	NO

Parent/Caregiver reviews at every visit and notes changes:

Parent/ Caregiver Observations (Circle Yes or No as it applies to your child)	YES	NO
Have you seen your child...		
...Tugging at ear(s)?	YES	NO
...Complaints of pain, fullness, noise in the ears, drainage in ear, cannot hear?	YES	NO
...Is inattentive to conversation or ...asks to have things repeated?	YES	NO
...Watches speaker's lips or turns side of head towards the speaker?	YES	NO
...Shows strain when listening? ...Talks too loudly or softly? ...Or has a speech problem?	YES	NO
...Makes frequent mistakes following directions? Tends to be passive?	YES	NO

*Joint Committee of Infant Hearing (JCIH) Risk Factors, 2019: Any child with a risk factor which has not been screened by and audiologist should be referred to one.

Refer for an audiological evaluation:

- Any newly identified parent concern
- Any child with a risk factor which has not been screened previously by an audiologist

Refer: Any complaints or concerns should be referred to their primary care provider to determine appropriate treatments or referrals.

Pass: Child for whom no hearing loss indicators are indicated.

Appendix B: Information About Hearing Loss

Joint Commission on Infant Hearing (JCIH) Position Statement (2019)

Principles and Guidelines for Early Hearing Detection and Intervention Programs

The rate of being deaf or hard of hearing is known to increase from approximately 1.2/1000 in newborns to 3/1000 in early school age. In a recent report (Watkin & Baldwin, 2012), the prevalence of children confirmed as deaf or hard of hearing by school age was 3.65/1000 compared to a neonatal yield of 1.79/1000.

For these reasons, all children should receive surveillance of speech and language milestones and auditory responsiveness in the medical home (AAP Committee, 2017). Continuing efforts to inform and educate primary care providers about the importance of ongoing surveillance and screening are encouraged.

The recommendations for follow-up and evaluation on this list of risk factors pertain to infants who pass the newborn screen or rescreen. These recommendations for follow-up are based on the fact that standard newborn screening procedures and protocols do not identify all children who are deaf or hard of hearing due to missed mild or neural hearing loss, progressive hearing loss, and delayed-onset hearing loss.

The prior eleven risk factors listed in JCIH 2007 are now listed as 12 separate factors and divided into subgroups of predominantly perinatal (risk factors 1–9) and perinatal or postnatal (risk factors 10–12). In addition, the recommendations for follow-up and monitoring have been modified and are described in greater detail, and the age of audiologic diagnostic follow-up for children with risk factors who passed newborn hearing screening has been lowered for most risk factors to **by 9 months of age**.

Perinatal Risk Indicators

1. A history of family members being deaf or hard of hearing with onset in childhood

This risk factor stands alone as **very** concerning. Monitoring continues to be based on both the cause (etiology) and the level of family concern, a diagnostic evaluation (referral to an audiologist) is recommended by 9 months of age (National Institute on Deafness and Other Communication Disorders, 2002) (Morton & Nance, 2006) (Santos, et al., 2005) (Dedhia, Kitska, Sabo, & Chi, 2013) or earlier if parent or caregiver concern is expressed (Dedhia, Kitska, Sabo, & Chi, 2013). During the child's newborn period, some parents may not be aware of a family history, as this information may be shared by relatives only after the infant has not passed the hearing screen or diagnostic testing.

2. Infants who require care in the NICU or special care nursey for more than five days

Length of NICU stay is used as an indicator of illness severity (Joint Committee on Infant Hearing (JCIH), 2007). Although there are a growing number of reports addressing NICU noise exposure, such noise exposure has not been included as a separate category, since it is included in the classification of more than 5 days in the NICU (Daniell, et al., 2006) (Lasky & Williams, 2009). A diagnostic evaluation is recommended by 9 months of age.

3. Hyperbilirubinemia requiring exchange transfusion

Infants with hyperbilirubinemia requiring exchange transfusion should receive diagnostic follow up by 9 months. This is the only risk factor for which close follow-up is recommended regardless of length of stay in the NICU (Oh, et al., 2003) (Shapiro, 2003) (Wickremasinghe, et al., 2015). This exception is made since some term infants requiring exchange transfusion may be discharged before 5 days in the NICU.

4. Aminoglycoside administration greater than 5 days duration

Administration of aminoglycoside antibiotics for less than 5 days is considered a risk factor only if toxic blood levels are identified or if there is a family history of a mitochondrial genetic mutation associated with aminoglycoside sensitivity for sensorineural hearing loss. For infants who received aminoglycosides administration greater than 5 days duration, diagnostic follow up is recommended by 9 months.

5. Perinatal asphyxia

Also termed hypoxic ischemic encephalopathy, particularly if requiring hypothermia treatment, is noted, because of the illness severity of this sub-group of infants and the significant increase in permanently elevated hearing thresholds (Shankaran, et al., 2012). A diagnostic follow up is recommended by 9 months.

6. Extracorporeal membrane oxygenation (ECMO)

This risk factor is noted because of the increased risk of delayed-onset hearing loss (Lasky, Wiolek, & Becker, 1998) (Shankaran, et al., 2012) (Robertson, 1995).

7. In-utero infections

Herpes, rubella, syphilis, and toxoplasmosis pose a risk and require follow-up by 9 months of age.

Congenital CMV (cCMV) infection is a leading cause of congenital infection occurring in 0.2 to 2% of live births world-wide and is a leading cause of non-genetic unilateral or bilateral early, progressive, and delayed onset sensorineural hearing loss (Harrison, et al.) (Dunst, Trivette, & Hamby, Meta-analysis of family-centered helping practices research, 2007) (Dunst & Dempsey, 2007). Therefore, the recommendation for follow-up audiologic assessment of infants with cCMV is no later than 3 months of age.

Infants born to a Zika positive mother who have laboratory evidence of Zika with or without findings consistent with congenital Zika syndrome should receive a standard newborn screen at birth, preferably using an ABR methodology (Adebanjo, et al., 2017). These infants should be referred for automated ABR by age 1 month if the newborn hearing screen was passed using only OAE methodology.

8. All craniofacial conditions and physical conditions associated with hearing loss

Certain birth conditions or findings associated with hearing loss includes:

- Craniofacial malformations including microtia/ atresia, ear dysplasia, oral facial clefting, white forelock, and microphthalmia
- Congenital microcephaly and congenital or acquired hydrocephalus

- Temporal bone abnormalities

Diagnostic follow up is recommended by 9 months of age.

9. Over 400 syndromes have been identified with atypical hearing thresholds

For more information visit the [Hereditary Hearing Loss website \(hereditaryhearingloss.org\)](https://www.hereditaryhearingloss.org) (Van Camp & Smith, 2021).

Perinatal or Postnatal Risk Factors

The remainder of the risk factors may occur either in the perinatal or postnatal period.

10. Culture-positive infections associated with sensorineural hearing loss

Perinatal and postnatal confirmed bacterial and/or viral meningitis or encephalitis (especially herpes viruses and varicella and hemophilus influenza and pneumococcal meningitis are included (Rubin & Papsin, 2010). Referral for diagnostic follow up should occur no later than 3 months after the occurrence.

11. Head trauma

Predominantly postnatal events of significant head trauma particularly injury to the mastoid (Bergemalm, 2003) (Zimmerman, Ganzel, Windmill, Nazar, & Phillips, 2003) and chemotherapy (Gruss, Handzel, Ingber, & Beiser, 2012). Referral for diagnostic follow up should occur no later than 3 months after the occurrence.

12. Family/caregiver concern

Any concerns noted by family/caregivers regarding hearing, speech, language, or development requires attention. **The recommendation is immediate referral** after discussion with family. One of the most important risk factors is family/caregiver concern regarding hearing. When a caregiver expresses concern that the baby is not responsive to sound in the home environment, or about speech and/or language delays, it is recommended that the primary care provider obtain additional medical and language history and evaluate the child carefully for middle ear effusion. Referral to a pediatric audiologist to evaluate hearing is recommended regardless of risk factors and possible presence of middle ear effusion.

Noise-Induced Hearing Loss (NIHL)

About 12.5 percent of children and teens have lasting hearing loss from contact with very loud noise (Centers for Disease Control and Prevention, 2021).

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 (Centers for Disease Control and Prevention, 2021).

Sound	Decibel Level	Typical Response (after routine or repeated exposure)
Whisper	20 dB	This sound does not typically cause any hearing damage
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: References, Resources, and Glossary

References

- Adebanjo, T., Godfred-Cato, S., Viens, L., Fischer, M., Staples, E., Kuhnert-Tallman, W., . . . Moore, C. (2017). Update: Interim Guidance for the Diagnosis, Evaluation, and Management of Infants with Possible Congenital Zika Virus Infections - United States, October 2017. *Morbidity and Mortality Weekly Report*, 66(41), 1089-1099.
- al Muhaimed, H., & Zakzouk, S. (1997). Hearing loss and herpes simplex. *Journal of Tropical Pediatrics*, 43(1), 20-4.
- American Academy of Audiology. (2011). *Childhood hearing screening guidelines*. Retrieved from https://www.cdc.gov/ncbddd/hearingloss/documents/AAA_Childhood-Hearing-Guidelines_2011.pdf
- American Academy of Family Physicians, American Academy of Otolaryngology-Head and Neck Surgery, & American Academy of Pediatrics Subcommittee on Otitis Media With Effusion. (2004). Otitis media with effusion. *Pediatrics*, 113(5), 1412 -1429.
- American Academy of Pediatrics . (2007). Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs. *Pediatrics*, 120(4), 898-921.
- American Academy of Pediatrics, Committee on Practice and Ambulatory Medicine, Section on Otolaryngology-Head and Neck Surgery. (2009). Hearing assessment in infants and children: recommendations beyond neonatal screening. *Pediatrics*, 124(4), 1253-1262.
- Andrade, G., Resende, L., Goulart, E., Siqueira, A., Vitor, R., & Januario, J. (2008). Hearing loss in congenital toxoplasmosis detected by newborn screening. *Braz J Otorhinolaryngol*, 74(1), 21-8.
- Bergemalm, P.-O. (2003). Progressive hearing loss after closed head injury: a predictable outcome? *Acta Otolaryngology*, 123(7), 836-845.
- Bess, F., Dodd-Murphy, J., & Parker, R. (1998). Children with minimal sensorineural hearing loss: previous educational performance and functional status. *Ear and Hearing*, 19, 339-354.
- Blair, J., Hardebree, D., & Benson, P. (1996). Necessity and effectiveness of a hearing conservation program for elementary students. *Journal of Educational Audiology*, 4, 12-16.
- Buz Harlor, A., & Bower, C. (2009). Hearing assessment in children: recommendations beyond neonatal screening. *Pediatric*, 124(4), 1252-1263.
- Centers for Disease Control and Prevention. (2019, October). *What Noises Cause Hearing Loss?* Retrieved from https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html
- Centers for Disease Control and Prevention. (2020, September). *2018 Summary of National CDC EHDI Data*. Retrieved from <https://www.cdc.gov/ncbddd/hearingloss/2018-data/01-data-summary.html>

- Centers for Disease Control and Prevention. (2020, April). *Congenital Rubella Syndrome*. Retrieved from <http://www.cdc.gov/vaccines/pubs/surv-manual/chpt15-crs.html>
- Centers for Disease Control and Prevention. (2020, August). *Cytomegalovirus (CMV) and Congenital CMV Infection*. Retrieved from <https://www.cdc.gov/cmiv/>
- Centers for Disease Control and Prevention. (2020, June). *Hearing Loss in Children*. Retrieved from <http://www.cdc.gov/NCBDDD/hearingloss/facts.html>
- Centers for Disease Control and Prevention. (2021, May). *Loud Noise Can Cause Hearing Loss*. Retrieved from https://www.cdc.gov/nceh/hearing_loss/default.html
- Centers for Disease Control and Prevention. (2021, June). *Preventing Noise-Induced Hearing Loss*. Retrieved from <https://www.cdc.gov/ncbddd/hearingloss/noise.html>
- Choo, D., & Meinzen-Derr, J. (2010). Universal newborn hearing screening 2010. *urrent Opinion in Otolaryngology & Head and Neck Surgery*, 18(5), 399-404.
- Daly, K., Hunter, L., & Giebink, G. (1999). Chronic otitis media with effusion. *Pediatrics in Review*, 20(30), 85-93.
- Daniell, W., Swan, S., McDaniel, M., Camp, J., Cohen, M., & Stebbins, J. (2006). Noise exposure and hearing loss prevention programmes after 20 years of regulations in the United States. *Occupational and Environmental Medicine*, 63(5), 343-351.
- Dedhia, K., Kitska, D., Sabo, D., & Chi, D. (2013). Children with sensorineural hearing loss after passing the newborn hearing screen. *AMA Otolaryngology-Head & Neck Surgery*, 139(2), 119-123.
- Dunst, C., & Dempsey, I. (2007). Family–Professional Partnerships and Parenting Competence, Confidence, and Enjoyment. *International Journal of Disability, Development and Education*, 54(3), 305-318.
- Dunst, C., Trivette, C., & Hamby, D. (2007). Meta-analysis of family-centered helping practices research. *Mental Retardation and Developmental Disabilities Research Reviews*, 13(4), 370-378.
- Fitzgerald, D. (1998). Head trauma: hearing loss and dizziness. *Journal of Trauma-Injury Infection and Critical Care*, 40(3), 488-496.
- Fowler, K. B., McCollister, F. P., Dahle, A. J., Boppana, S., Britt, W. J., & Pass, R. F. (1997). Progressive and fluctuating sensorineural hearing loss in children with asymptomatic congenital cytomegalovirus infection. *Journal of Pediatrics*, 130(4), 624-630.
- Gallaudet Research Institute (US). (1996). *tanford Achievement Test (Form S): Norms booklet for deaf and hard of hearing students (9th ed.)*. Washington D.C.: Gallaudet University .
- Glasgow, F., & Dworkin, P. (1995). The role of parent in the detection of developmental and behavioral problems. *Pediatrics*, 95(6), 829-836.
- Gruss, I., Handzel, O., Ingber, S., & Beiser, M. (2012). Hearing loss due to chemotherapy and radiation therapy in young children. *Harefuah*, 151(1), 24-28.

- Hagan, J., Shaw, J., & Duncan, P. (2008). *Rationale and evidence: selective screening*. Pp. 233 in *Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents (3rd ed.)*. Elk Grove, IL: American Academy of Pediatrics.
- Harrison, M., Page, T., Oleson, J., Spratford, M., Unflat Berry, L., Peterson, B., . . . Moeller, M. (n.d.). Factors Affecting Early Services for Children Who Are Hard of Hearing. *Language, Speech, and Hearing Services in Schools, 47*, 16-30.
- Joint Committee on Infant Hearing (JCIH). (2007). Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs. *Pediatrics, 120*(4), 898-921.
- Lasky, R. E., Wiorek, L., & Becker, T. R. (1998). Hearing loss in survivors of neonatal extracorporeal membrane oxygenation (ECMO) therapy and high-frequency oscillatory (HFO) therapy. *Journal of the American Academy of Audiology, 9*(1), 47-58.
- Lasky, R., & Williams, A. (2009). Noise and Light Exposures for Extremely Low Birth Weight Newborns During Their Stay in the Neonatal Intensive Care Unit. *Pediatrics, 123*(2), 540-546.
- Minnesota Department of Education. (2021). *Early Childhood Screening Outcomes SFY 2020*. Retrieved from <https://public.education.mn.gov/MDEAnalytics/DataTopic.jsp?TOPICID=500>
- Minnesota Department of Health. (2021). *Hearing Loss*. Retrieved from <https://www.health.state.mn.us/diseases/cy/hearing.html>
- Minnesota Early Hearing Detection and Intervention. (2015). *MDH EHDI Annual Report 2015*. Retrieved from <http://improveehdi.org/MN/library/files/2015ehdiannualreport.pdf>
- Montgomery, J., & Fukijawa, S. (1992). Hearing thresholds of students in second, eight, and twelfth grades. *Language, Speech, and Hearing Services in Schools, 23*, 61-63.
- Morton, C., & Nance, W. (2006). Newborn Hearing Screening — A Silent Revolution. *The New England Journal of Medicine, 354*(20), 2151-2164.
- National Institute on Deafness and Other Communication Disorders. (2002, March 19-20). *NIDCD Workshop on Congenital Cytomegalovirus Infection and Hearing Loss*. Retrieved from National Institute on Deafness and Other Communication Disorders: <https://www.nidcd.nih.gov/research/workshops/congenital-cytomegalovirus-infection-and-hearing-loss/2002>
- Oh, W., Tyson, J., Fanaroff, A., Vohr, B., Perritt, R., Stoll, B., & Wright, L. (2003). Association Between Peak Serum Bilirubin and Neurodevelopmental Outcomes in Extremely Low Birth Weight Infants. *Pediatrics, 4*, 773-779.
- Podoshin, L., & Fradis, M. (1975). Hearing loss after head injury. *Arch Otolaryngol, 101*(1), 15-18.
- Roberts, J., & Bayliss, D. (1967). Hearing levels of adults: by race, region, and area of residence. *Public Health Service Publication, 11*(1000), 1-34.

- Roberts, J., & Huber, P. (1967). Hearing levels of children by age and sex. *Public Health Service Publication, 11*(102), 1-51.
- Robertson, C. M. (1995). Hearing loss among children who have undergone ECMO. *Canadian Medical Association Journal, 153*(7), 881.
- Rubin, L., & Papsin, B. (2010). Cochlear Implants in Children: Surgical Site Infections and Prevention and Treatment of Acute Otitis Media and Meningitis. *Pediatrics, 126*(2), 381-391.
- Santos, R., Aulchenko, Y., Huygen, P., van der Donk, K., de Wijs, I., Kemperman, M., . . . Cremers, C. (2005). Hearing impairment in Dutch patients with connexin 26 (GJB2) and connexin 30 (GJB6) mutations. *International Journal of Pediatric Otorhinolaryngology, 69*(2), 165-174.
- Shankaran, S., Pappas, A., McDonald, S. A., Vohr, B. R., Hintz, S. R., Yolton, K., & Higgins, R. D. (2012). Childhood Outcomes after Hypothermia for Neonatal Encephalopathy. *The New England Journal of Medicine, 366*(22), 2085-2095.
- Shapiro, S. (2003). Bilirubin toxicity in the developing nervous system. *Pediatric Neurology, 29*(5), 410-421.
- The Joint Committee on Infant Hearing. (2019). Year 2019 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs. *The Journal of Early Hearing Detection and Intervention, 4*(2), 1-44.
- U.S. Preventive Services Task Force (USPSTF). (2008, July). *Hearing Loss in Newborns: Screening*. Retrieved from <https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/hearing-loss-in-newborns-screening>
- Van Camp, G., & Smith, R. (2021, 8). *Hereditary Hearing Loss Homepage*. Retrieved from <https://hereditaryhearingloss.org/>
- Weichbold, V., Neckahm-Heis, D., & Welzl-Mueller, K. (2006). Universal newborn hearing screening and postnatal hearing loss. *Pediatrics, 117*(4), e631-e636.
- White, K. (2010, October). Twenty years of early hearing detection and intervention (EHDI): where we've been and what we've learned. *Presentation at ASHA Audiology Virtual Conference*.
- Wickremasinghe, A. C., Risley, R. J., Kuzniewicz, M. W., Wu, Y. W., Walsh, E. M., Wi, S., . . . Newman, T. (2015). Risk of Sensorineural Hearing Loss and Bilirubin Exchange Transfusion Thresholds. *Pediatrics, 136*(3), 505-512.
- Zimmerman, W., Ganzel, T., Windmill, I., Nazar, G., & Phillips, M. (2003). Peripheral hearing loss following head trauma in children. *Laryngoscope, 103*(1), 87-91.

Online Hearing Resources

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

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 to 15dB) 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