

Hearing Screening Online Training Program

Developed by the
Child & Teen Checkups Program, Minnesota Department of Health
and the Minnesota Department of Human Services

Welcome to the Minnesota Departments of Health and Human Services Online Training for the hearing-screening component of the Child and Teen Checkups (C & TC) program.

This training is designed as a reference to give you the information you need to provide an accurate hearing screening to those Minnesota children and youth who are enrolled in Child and Teen Checkups (C & TC). However, it is **not** intended to replace the Minnesota Department of Health's scheduled on-site Hearing and Vision Screening trainings (*see* <http://www.health.state.mn.us/divs/fh/mch/mch-pro2.html>).

This training has been divided into six sections:

- Background information on hearing screening and hearing loss in children and youth
- C & TC requirements and recommendations for hearing screening
- Objective and subjective screening procedures
- Newborn hearing screening
- Administrative considerations
- Additional information and resources

Child and Teen Checkups (C & TC) Overview

As part of the 1967 Federal "War on Poverty," Congress developed the Early and Periodic Screening, Diagnosis and Treatment (EPSDT) Program as a prevention component to the Medicaid program. EPSDT is the largest comprehensive and preventive health care program for Medicaid-eligible children and youth ages 0 through 20.

EPSDT is intended to remove financial barriers to health care for children and ensure access to the comprehensive *preventive* services necessary for healthy growth and development. Comprehensive and periodic screening or well-child checkups are the basic element of the program. EPSDT is one of the Medicaid services that states are required to provide.

Minnesota's EPSDT program is called the Child and Teen Checkups (C&TC) Program and is the responsibility of the Department of Human Services. About 320,000 children from ages 0 through 20 who are enrolled in Minnesota's Health Care Programs are eligible to receive Child and Teen Checkups and comprehensive health care.

Objectives

Upon completion of this training you will be able to:

1. Describe the importance of both hearing screening and early identification of hearing loss
2. Identify the C & TC hearing screening procedures for children and youth ages 0 through 20
3. Differentiate between subjective and objective components of the hearing screening
4. Document hearing screening results or the reason why screening was not completed

For more information contact:

Becky Weber, RN, MS

Clinical Nurse Specialist, Hearing and Vision Consultant

Minnesota Department of Health

85 East Seventh Place, Suite 400

St. Paul, MN 55101

Phone (651) 281-9949

Fax (651) 215-8953

becky.weber@health.state.mn.us

NOTE: Within this document, the definition to words that are italicized and underlined may be found in Appendix N: Glossary, sorted alphabetically.

Also, superscript numbers refer to citations found in Appendix O: References.

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INTRODUCTION

The sounds that we hear can be described by the two characteristics of pitch (frequency) and loudness (intensity). Frequency is measured in Hertz (Hz) and intensity is measured in decibels (dB).

Normal hearing

A person with normal hearing should be able to hear intensities as low as 0 to 20 dB in the 250 through 8000 Hz range. The frequencies of 500, 1000, 2000, and 4000 Hz are critical for hearing and understanding speech sounds.

Examples of different sound intensities as expressed in dB:

180 dB: Rocket at take-off

140 dB: Jet engine at take-off

120 dB: Rock band**

110 dB: Loud thunder

90 dB: City traffic or a person's shout

80 dB: Loud radio

60 dB: Ordinary conversation

30 dB: Very soft whisper

0 dB: Softest sound a person can hear

** While decibels greater than or equal to 120 to 130 dB cause pain or discomfort in most people's ears, some people will experience pain at sounds of 100-110 dB.

Types of Hearing Loss

A hearing loss is described as either conductive or sensorineural, and depending upon the location of the loss, can be located in the external, middle, or inner ear (*see* Appendix A).

A **conductive hearing loss** exists when there is a problem in the external and/or middle ear and sound is not properly conducted to the inner ear. Conductive hearing loss can usually be treated medically or surgically; hearing aids or other amplifying systems can also help. A **sensorineural hearing loss** involves damage to the inner ear and/or the auditory nerve caused by genetics or damage to neurosensory elements. Sensorineural hearing loss usually cannot be cured medically, but the use of hearing aids or other amplifying systems can help children hear and develop speech and language. Cochlear implants are also an option if the hearing loss is significant. **Mixed hearing loss** involves the external or middle ear and the inner ear or the brain (*see* Appendix B).

Hearing loss is one of the most common birth defects. In the United States:

- Approximately 1 to 2 of every 1000 babies are born deaf or hard of hearing¹
- It is estimated that 200 Minnesota babies, or 4 per week, are born each year with hearing loss²
- One out of 1000 children have severe to profound bilateral (in both ears) sensorineural hearing loss³
- Six out of 1000 children have mild to moderate bilateral sensorineural hearing loss³
- Two out of 1000 children have unilateral (in one ear) sensorineural hearing loss³
- At least 3 out of 1000 children have either conductive hearing loss or hearing loss associated with otitis media³

QUESTION 1: Can you guess some common causes of infant and childhood hearing loss in developed countries? (Check all that apply.) (For the answer, see Appendix L.)

- Genetic Factors
- Environmental Infections or Toxins
- Unknown Causes
- Noise-Induced Hearing Loss

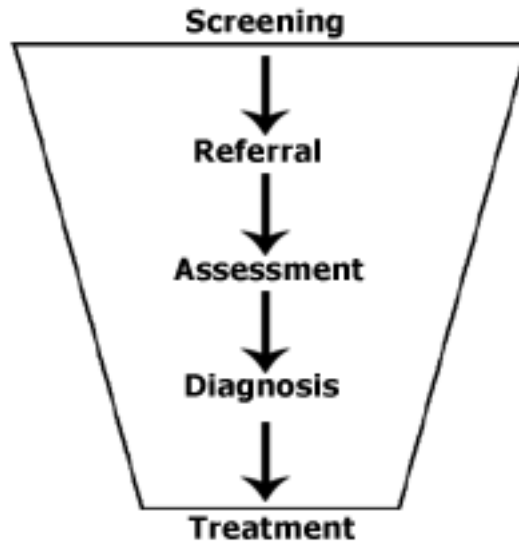
Genetic factors are a common cause of infant and childhood hearing loss. Environmental infections or toxins are another common cause of infant and childhood hearing loss. Infections that can cause hearing loss include toxoplasmosis, otitis media, and cytomegalovirus. *Ototoxic* drugs that can cause hearing loss in infants and children include aminoglycosides and cisplatin. Children also acquire hearing loss due to noise exposure. However, a large percentage of infant and childhood hearing loss does not have a known cause.^{4,5,6}

The American Academy of Pediatrics promotes objective newborn hearing screening and periodic hearing screening for every child through adolescence.⁷ In addition to

identifying children with normal hearing, hearing screening identifies those who need further hearing evaluation and directs them into the health care system. It should be noted, however, that hearing screening is not diagnostic and cannot be used alone to determine treatment. Hearing screening efforts in Minnesota have been very effective at identifying children with hearing problems. Of 58,265 children between the ages of 3 ½ and 4 years who were recently screened through the Minnesota Early Childhood Screening program, 6 percent were identified with potential hearing problems.⁸

To learn more ...
See Appendix A.

The continuum from screening to treatment:



Why is hearing screening in children important?

- Hearing loss impacts language and speech development, psychological well-being, and education.
- Language is a time-locked function; the critical time to acquire language is the first one to three years of life. Research indicates, however, that deaf and hard-of-hearing infants who receive intervention by six months of age can develop normal cognitive, social, and language skills.^{3, 9, 10, 11, 12, 13, 14, 15}
- Costs for children's special education services are increased if hearing loss is not detected early. It is estimated that when hearing loss is not identified early and early intervention is not received, a child with hearing loss will cost schools an additional \$420,000 due to special education needs.^{1, 16, 17}
- Half of children with hearing loss graduate from high school with a 4th grade reading level or less unless appropriate early educational intervention occurs.¹⁸
- As only 50 percent of children with hearing loss can be identified through assessment of high-risk indicators, periodic objective hearing screening of all children should be performed.⁵

To learn more ...
See Appendix C.

A study of 17,000 children in the U.K., found that the prevalence of hearing impairment from age three until the age of nine increased to a greater extent than previously estimated. Reasons for this increase included children not receiving newborn hearing screening or passing the screening despite having a hearing impairment; acquiring a hearing impairment *postnatally*; or having late onset or *progressive* hearing loss.¹⁹

This study demonstrates the importance of monitoring hearing screening through the school-age years. Inquiries about hearing should be made at every well baby visit, and parents' concerns about hearing should not be ignored. Children who fail a hearing re-screen should be followed closely by the medical provider and, if necessary, be referred for further testing to an audiologist.

QUESTION 2: Can you guess the estimated lifetime cost of hearing loss per individual (due mainly to lost work productivity)? (For the answer, see Appendix L.)

- \$1 Million
- \$2 Million
- \$3 Million
- \$4 Million

C&TC Requirements and Recommendations



Child & Teen Checkups (C&TC)

FACT Sheet

For Primary Care Providers

HEARING

C&TC Requirements:	Qualified Personnel	Documentation
<p>Hearing</p> <ul style="list-style-type: none"> Hearing screening is recommended for all newborns using Automated Auditory Brainstem Response (AABR) or Oto-Acoustic Emission (OAE) technology. If an infant did not receive a newborn hearing screening or is at risk for early or late onset hearing loss, it is recommended that <i>objective screening</i> be done at age 3 with pure tone audiometry. All children must be subjectively monitored for hearing concerns. Children should be screened for a family history of childhood hearing disability or loss, delay of language acquisition or history of such delay, and a history of repeated otitis media. The child, parent or guardian must be asked if there are concerns about the child's hearing. When indicated, the child must receive a referral for age appropriate diagnostic hearing tests. Children age four and older, in addition to the above, must receive an objective pure tone audiometric test using current testing methods. <i>Subjective screening</i> may be performed at the 16 and 20-year checkups. However, if no objective screening occurred at the previous checkup, consider performing pure tone audiometry. 	<p>An adequately trained individual (i.e., trained nursing assistant, certified medical assistant, or paraprofessional)</p>	<p>Document normal/abnormal findings.</p> <p>Document newborn hearing screening results when available.</p> <p>For children 3 - 4 years and older, document result of pure tone audiometric screening.</p>

Screening Tools:

Pure tone audiometer and a variety of toys (for play audiometry)

- A standard pure tone audiometer with earphones works best and allows for adjustments to the loudness, pitch and duration of the tone. These factors are needed for preparing the child and for play audiometry. Handheld audiometers do not allow for variation of these factors. Annual calibration of audiometers is recommended.
- It has been demonstrated that several types of hearing losses may not be detected using voice varieties of audiometers. The Verbal Auditory Screening for Children (VASC) is not recommended, as a child needs to only hear part of a word to identify a named picture.

Facts about the importance of Hearing Screening:

- In 2001, approximately 6 percent of Minnesota children ages 3 ½ -5 years were identified through Early Childhood Screening with new potential hearing problems [Minnesota Department of Children, Families, & Learning; Early Childhood Screening Program, 2002].
- One in one thousand infants are born with severe to profound hearing loss. Of these infants, more than 30% of the hearing losses are likely to be genetic. An additional 2-5% of all children will be hard-of-hearing at birth. Hearing can be screened within hours of birth with otoacoustic emission equipment or auditory brainstem response [Joint Committee on Infant Hearing].
- National research suggests that 15% of children ages 6-19 years of age have a hearing loss in one or both ears.²¹

Key Points:

- Minnesota Statute 121A requires all children to receive hearing screening before kindergarten. Additional ages at which school districts carry out hearing screening varies throughout the state. Check with your local school district to determine at which ages they complete hearing screening. If it has been documented that a child has completed a normal hearing screening through the school within the year, you may not need to screen the child a second time. For questions related to billing for C&TC in such instances, contact the child's appropriate health insurance payer (e.g., health plan).

Other Professional Recommendations:

American Academy of Pediatrics recommends that pure tone audiometry be performed at 4, 5, 6, 8, 10, 12, 15, and 18 years of age.

American Speech-Language-Hearing Association - Preschool children are screened using play audiometry as needed, requested, or mandated, or when they have conditions that place them at risk for hearing impairment. Screen school-age children routinely using pure tone audiometry on initial entry to school, and annually in kindergarten through 3rd grade, and in 7th and 11th grades.

Joint Committee on Infant Hearing (American Speech-Language-Hearing Association, American Academy of Pediatrics, American Academy of Otolaryngology-Head and Neck Surgery, American Academy of Audiology, American Academy of Pediatrics and the Directors of Speech and Hearing Programs in State Health and Welfare Agencies) and Bright Futures endorse the goal of universal

detection of infants with hearing loss as early as possible using auditory brainstem response or otoacoustic emissions. All infants should be screened before 3 months of age.

Resources:

Green, M., (2000) Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents (2nd ed.). Arlington, VA: National Center for Education in Maternal and Child Health. . [On-line], available: <http://www.brightfutures.org>

Minnesota Department of Health, Hearing and Vision Conservation Program.
For specific questions or training information call (651) 281-9950 or visit the website at www.health.state.mn.us. Workshop registration information is located under "forms and applications".

Minnesota Universal Newborn Hearing Screening (UNHS) /Early Hearing Detection and Intervention (EHDI) Program. Minnesota Department of Health. <http://www.health.state.mn.us/divs/fh/mch/unhs/> or (651) 215-8960.

Minnesota Department of Health Library - (612) 676-5274 or e-mail library@health.state.mn.us
Hearing Screening Guidelines - "Hearing Screening for Children" # M-091
"MDH Hearing Screening Video - 1999" (for loan)

American Speech-Language- Hearing Association - <http://professional.asha.org/resources/>

Departments of Human Services and Health. (2001) C&TC Documentation Forms and Criteria Guidelines for C&TC Provider Documentation. On-line - <http://www.dhs.state.mn.us/HlthCare/ctc/default.htm>

HEARING SCREENING PROCEDURES FOR CLINICS

Please note: To test your knowledge of hearing screening and promote quality assurance during this web-based training, there will be a few test questions at the end of the following sections on hearing screening procedures.

Top Six Tips for Hearing Screening

1. Make sure that the testing area is quiet. Background noises, especially fans or heating systems, can cause distractions for the person being tested.
2. Ensure that the audiometer is calibrated (*see* Appendix M).
3. Sit the child (*see* picture) so they cannot see the audiometer or the tester's face.
4. **Prior to placing** the audiometer headphones on the child, be sure that the child understands the instructions by conditioning the child to raise his/her hand or to put a toy in the box when he/she hears each tone.
5. The screener and parent/caregiver accompanying the child should avoid nonverbal cues or facial expressions that could give away the correct responses.
6. For missed audiometric tones at any frequency do an immediate re-screen.



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The C&TC schedule requires either a subjective or objective hearing screening as shown on the Minnesota C & TC Schedule of Age-Related Screening Standards (*see*: <http://edocs2.dhs.state.mn.us/lfserver/Legacy/DHS-3379-ENG>).

SUBJECTIVE SCREENING

Subjective screening (look for the “S” symbol on the C & TC Schedule of Age-Related Screening Standards, *see* <http://edocs2.dhs.state.mn.us/lfserver/Legacy/DHS-3379-ENG>) consists of information obtained verbally or in writing in response to the screener’s questions. When performing a subjective hearing screening, these questions are related to a history of *childhood* hearing disability or hearing loss in the family of the child’s biological mother or father, delay in the child’s language acquisition or history of such delay, and the child having a history of repeated otitis media. The child, parent, or guardian must be asked if they have concerns about the child’s hearing.

Hearing History (*Often conducted by primary care provider as part of health history*)

Ages/Grades

Birth through 20 years

Purpose

To determine if medical factors exist to put the child at risk for hearing loss

Description

A review of health history questions with parent or caregiver

Equipment	C & TC documentation form or medical chart; pen
Facilities	Comfortable private interview area
Procedure	Ask the hearing history questions
Interpretation of Results	Pass/No Pass Criteria (<i>see</i> Appendix F)

Suggested Hearing History Questions

Complaints or concerns regarding the child's hearing or observed abnormal listening behaviors should be noted on the C & TC documentation form [*see*: <http://www.dhs.state.mn.us/HealthCare/ctc/default.htm>] or medical chart and further evaluation should be made.

For complete information on Hearing History documentation, see C & TC Documentation section (Page 32).

1. Is there concern ... (*see* Appendix D)
 - complaints or behaviors that may indicate a hearing loss
 - high risk indicators for hearing loss (to be used when newborn hearing screening has not been conducted)
 - My Child's Hearing Checklist (A checklist for parents to complete. Ages 0-24 months.)
2. Are there any hearing problems that started in childhood in the family of the child's biological mother or father? (*This question is important as the incidence of hearing problems is more prevalent in children whose biological parents had hearing problems as children.*)
3. Does the child have a history of chronic ear infections and/or tubes?
4. Has the child had serious head trauma, concussion, skull fracture, or loss of consciousness since the last C & TC visit?
5. Has the child been hospitalized with a serious illness, especially meningitis or kidney disease, since the last C & TC visit?

(See Appendix L for the answers to the questions below.)

Question 3: Asking hearing history questions is a component of the subjective hearing screening.

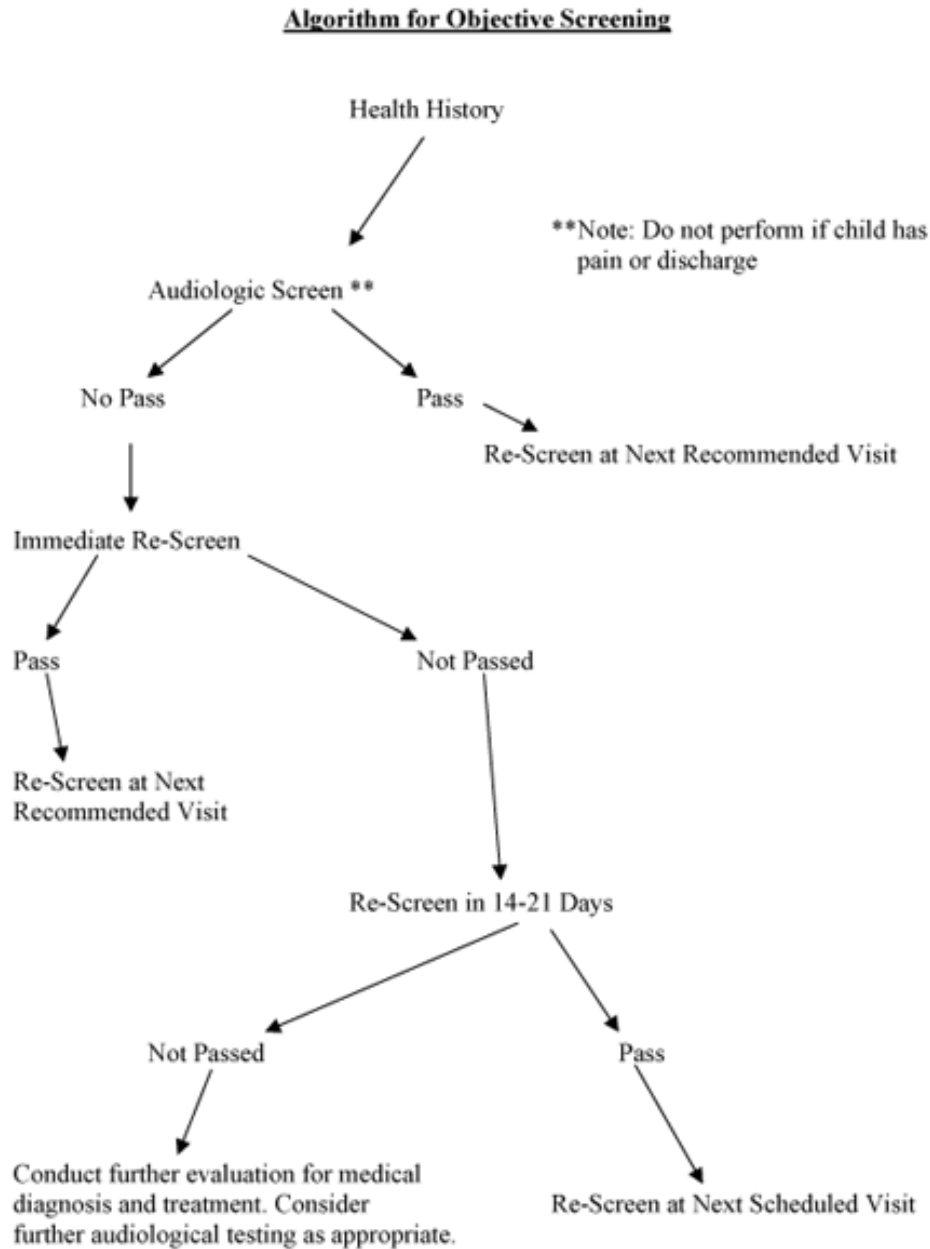
- True
- False

Question 4: Screening for behavioral signs of possible hearing loss is not a component of the subjective hearing screening.

- True
- False

OBJECTIVE SCREENING

Objective screening (Look for the "0" symbol on the C&TC Schedule of Age Related Screening Standards, see <http://edocs2.dhs.state.mn.us/lfserver/Legacy/DHS-3379-ENG>) consists of "hands-on" examination or testing that produces measurable results. Objective hearing screening is performed through pure tone audiometric screening.



To conduct puretone audiometric screening, screeners must be familiar with the audiometer. To see a diagram of an audiometer, visit <http://facstaff.uww.edu/bradleys/ohc/audiometry/page12.html>.

The Audiometer

An audiometer is a device that produces tones at set frequencies and known amplitudes through headphones worn by the patient. The patient is required to indicate what tones s/he can hear. The pure tone audiometer is the preferred instrument used in school and clinic hearing screening programs.

The audiometer has test tones ranging from 250 to 8000 Hz (Hz refers to frequency, or cycles per second). Hertz (Hz) is the pitch of the tones that range from very low to high pitch. The tones most often used in audiometric screenings are 500, 1000, 2000, and 4000 Hz. The intensity (loudness) is expressed in decibels (dB). Thirty (30dB) is considered the level of a soft whisper at a distance of three feet. Sixty-five (65 dB) is the average intensity for a normal conversation, and eighty-five (85 dB) is so loud that individuals must be protected when working under such exposure for a prolonged period.

All screening is conducted at 20 dB, with the exception of the 500 Hz frequency. At 500 Hz the decibel level is increased to 25 dB, as 500 Hz is a difficult frequency to hear.

Audiometers come with headphones; these headphones have been calibrated to a specific audiometer and should not be exchanged with other audiometers.

There are several different brands of audiometers. Specifications vary somewhat between brands but most audiometers have the following dials:

Power or On/Off Switch: Needs to be on when testing.

Frequency Dial: The frequency dial rotates from 250 to 8000 Hz. This dial controls the test frequency or the pitch of the tone.

Hearing Level Dial or Decibel (dB) Dial: This dial controls the test intensity or loudness of the tone. Normally this is a rotary dial that allows the screener to vary the tones presented in 5 dB steps from approximately 0 to 100dB.

Tone Presentation Bar or Stimulus Switch: Pressing this bar presents the tone to the person being tested.



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MAICO MA 27 audiometer reproduced with permission from MAICO (see <http://www.maico-diagnostics.com/>).



GSI 17 audiometer reproduced with permission from Grason-Stadler (see <http://www.grason-stadler.com/home.html>).

Additional Resources

Audiograms: What are They? How Do You Understand Them?

<http://home.inreach.com/torsi/audiogram.html>

“How do we Read an Audiogram?” presented by the Audiology Awareness Campaign

<http://www.audiologyawareness.com/hhelp/audiogrm.htm>

How to Read your Hearing Test

<http://www.earinfo.com/howread1.html>

Understanding your Audiogram

<http://www.audiology.org/consumer/guides/uya.php>

(See Appendix L for answers to the questions below)

QUESTION 5. Depending on the model, the decibel range on the intensity (decibel) dial on the audiometer generally can be adjusted from approximately 0 to 100 dB.

- True
- False

QUESTION 6. When performing audiometric testing, which frequencies (Hz) do you test? (Choose the correct answer)

- 5000, 2000, 4000, 6000 Hz
- 500, 1000, 2000, 4000 Hz
- 1000, 2000, 4000, 6000 Hz
- 1000, 2000, 3000, 5000 Hz

QUESTION 7. When testing at the recommended frequencies (see question #2), at which two decibel (dB) levels do you test?

- 20, 30 dB
- 25, 30 dB
- 20, 25 dB
- 15, 20 dB

QUESTION 8. Your clinic owns two audiometers. Since one of the earpieces from the headset on audiometer A is cracked, you can replace it with the headset from audiometer B to complete today's audiometric tests.

- True
- False

USING STANDARD AUDIOMETRY

THE TWO METHODS OF PURE TONE AUDIOMETRIC HEARING SCREENING

The two methods of pure tone audiometric hearing screening include either the

- standard technique where the child raises his or her hand to indicate s/he has heard the screening tone, or
- play audiometry where the child places a toy in a bucket to indicate s/he has heard the screening tone.

Many children by the age of 3 ½ years have the ability to raise their hand in response to screening tones. However, as the method of pure tone audiometry that the screener should use for each child depends on the child's developmental level, each child should be individually assessed for his or her ability to perform pure tone audiometry.

The technique of standard pure tone audiometry will first be discussed and play audiometry will be discussed in the next section after standard pure tone audiometry.

STANDARD PURE TONE AUDIOMETRIC HEARING SCREENING

Ages: 3 or 4 years through 20 years. If an infant did not receive a newborn hearing screen, or is at risk for early or late-onset hearing loss, it is recommended that objective screening be performed at age 3.

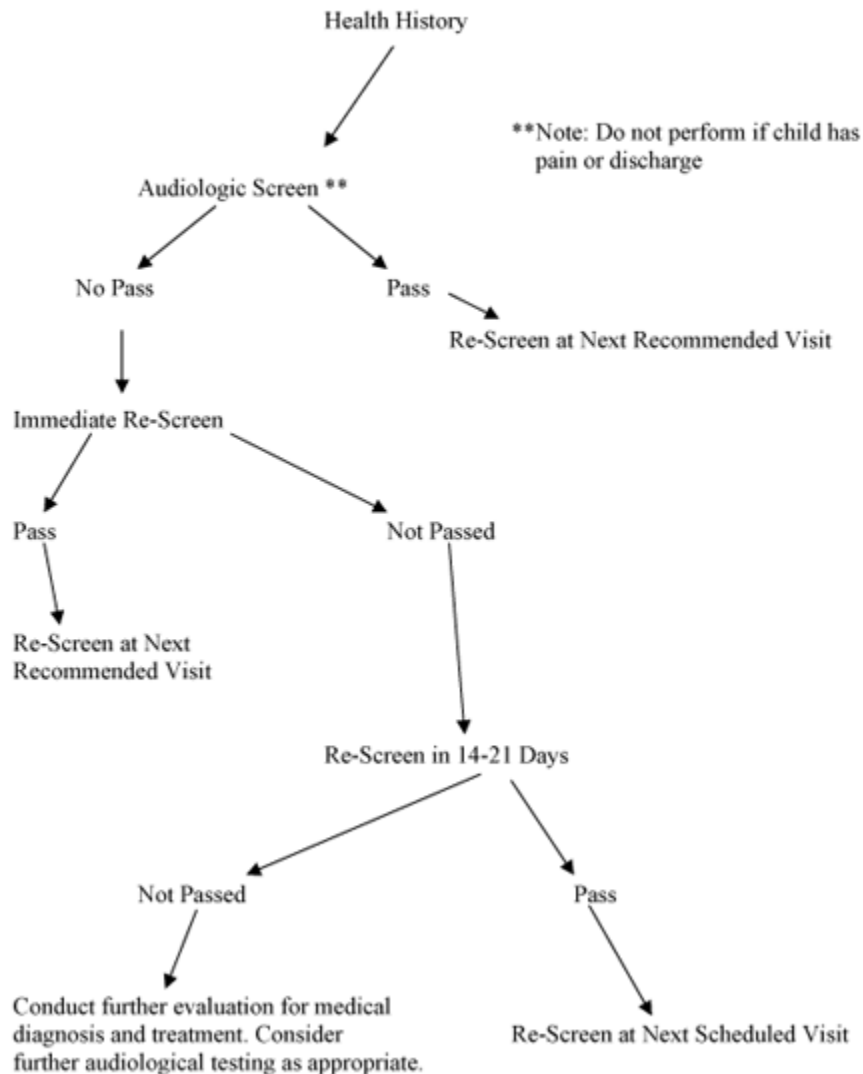
Purpose: To identify children who may have hearing loss.

Frequencies: 500, 1000, 2000, 4000 Hz.

- The audiometer is the gold standard instrument for hearing screening; the pure tone sound it creates is unlike any other sound in the environment
- The pitch (or frequency) of the tone is expressed as Hertz (Hz)
- The loudness of the tone (or intensity) is measured in decibels (dB)

Supplies: Quiet room free from distractions (*see* Appendix E), audiometer, child size table and chair, C & TC documentation form [*see*: <http://www.dhs.state.mn.us/HealthCare/ctc/default.htm>] or medical chart, hearing screening cue cards, and pens.

Algorithm for Objective Screening



BEFORE putting audiometer headphones on the child:

- The screener should call the child by his/her name and inform the child that his/her hearing is going to be checked.
- **Lay the headphones on the table** and turn the intensity dial to the maximum setting and present the tone to ensure that the child understands the task. Note that if a child does not respond to this tone, the screener should not proceed with the rest of the screening. The child either has a VERY severe hearing deficit or has a receptive language deficit.
- Instruct the child to raise a hand when s/he hears a tone and lower his/her hand once the tone stops. Instruct the child to raise his/her hand even if he/she can barely hear the tone. It does not matter which hand is raised.
- Have the child remove glasses, ribbons, barrettes, combs, or large earrings if they obstruct a good seal on the headphones.
- Push the child's hair behind his/her ears (this is a good time to quickly inspect the external ears).

- Check for hearing aids, cotton in ears, or drainage.
- If tenderness, signs of drainage, or foul odor is present, **do not** proceed with the audiometric screening; the child should be evaluated by a medical provider (For complete information on documentation, see C & TC Documentation section, see Page 32). It is okay to proceed with the test if earwax is present.

Placing the headphones on the child:

- Place the **red** earphone on the child’s **right** ear and the **blue** earphone on the **left** ear.
- Line up the opening of the earphone with the opening of the child’s ear canal.
- Adjust the headband so it is seated on top of the child’s head.

QUESTION 9: Can you identify helpful strategies to perform an accurate audiometric screening? Check all that apply. (See Appendix L for the answer.)

- If the child is having a difficult time, have the child sit on the parent's or caregiver's lap.
- Have the child face toward the screener.
- Present the tones in a rhythmic pattern.

Audiometric Procedure for Standard Pure Tone Audiometry

NOTE: If tenderness, signs of drainage, or foul odor are present in the child’s ear(s), **do not** proceed with audiometric screening. Document the reason for not conducting the screening. The child should be evaluated by a primary care provider.



Use this hearing screening chart as a guide to assist you during the hearing screening.

Download the chart at <http://www.health.state.mn.us/divs/fh/mch/hlth-vis/materials/right-ear-first.html>.

Reference: Don Ogsten. Minnesota Department of Health Hearing and Vision Screening program. 1980.

Note: A timid child will often benefit from watching one or two other children successfully complete the screening.

Step 1

Condition the child to the desired response prior to the start of screening. Lay the headphones **on the table** and turn the intensity dial to the maximum setting to ensure that the child understands the task. If a child does not hear this tone, you do not want to proceed with the rest of the screening. The child either has a VERY severe hearing deficit or has a receptive language deficit.

Step 2

Place the headphones on the child. Turn the intensity dial to 40 dB and 1000 Hz; turn the earphone selector switch to the right.

Step 3

Present the tone for one to two seconds by pushing the stimulus button. This is only a conditioning tone for the child; the response does not need to be recorded.

Step 4

Turn intensity dial (dB) to 20; leave the frequency at 1000 Hz; present the sound. Watch for the child's response and record results.

Step 5

Turn frequency to 2000; present the sound. Watch for the child's response and record results.

Note: At this point in the screening, if the child does not appear to understand the procedure (i.e., the child raises his/her hand when a tone is not presented, does not seem to understand when to raise his/her hand, or does not respond at all), the screener should take the headphones off the child, re-instruct the child about the procedure, and then resume the procedure. If the child is still having difficulty with the procedure after several attempts to re-instruct the child, the screener should attempt play audiometry with the child; play audiometry is discussed in the next section.

Step 6

Turn frequency to 4000; present the sound. Watch for the child's response and record results.

Step 7

Switch to left ear leaving dials at 20 and 4000; present the sound. Watch for the child's response and record results.

Step 8

Turn frequency to 2000; present the sound. Watch for the child's response and record results.

Step 9

Turn frequency to 1000; present the sound. Watch for the child's response and record results.

Step 10

Turn frequency to 500 and dB dial to 25; present the sound. Watch for the child's response and record

results. This step can be eliminated if ambient noise level is too high. If 500 Hz is eliminated, document this in the results section.

Step 11

Switch back to right ear leaving dials at 25 and 500; present the sound. Watch for the child’s response and record results.

Step 12

Remove earphones and thank the child.

Summary:

The order of presentation is as follows:

Right Ear

- **1000 Hz at 40 dB (conditioning tone)**
- **1000 Hz at 20 dB**
- **2000 Hz at 20 dB**
- **4000 Hz at 20 dB**

Left Ear

- **4000 Hz at 20 dB**
- **2000 Hz at 20 dB**
- **1000 Hz at 20 dB**
- **500 Hz at 25 dB**

Right Ear

- **500 Hz at 25 dB**

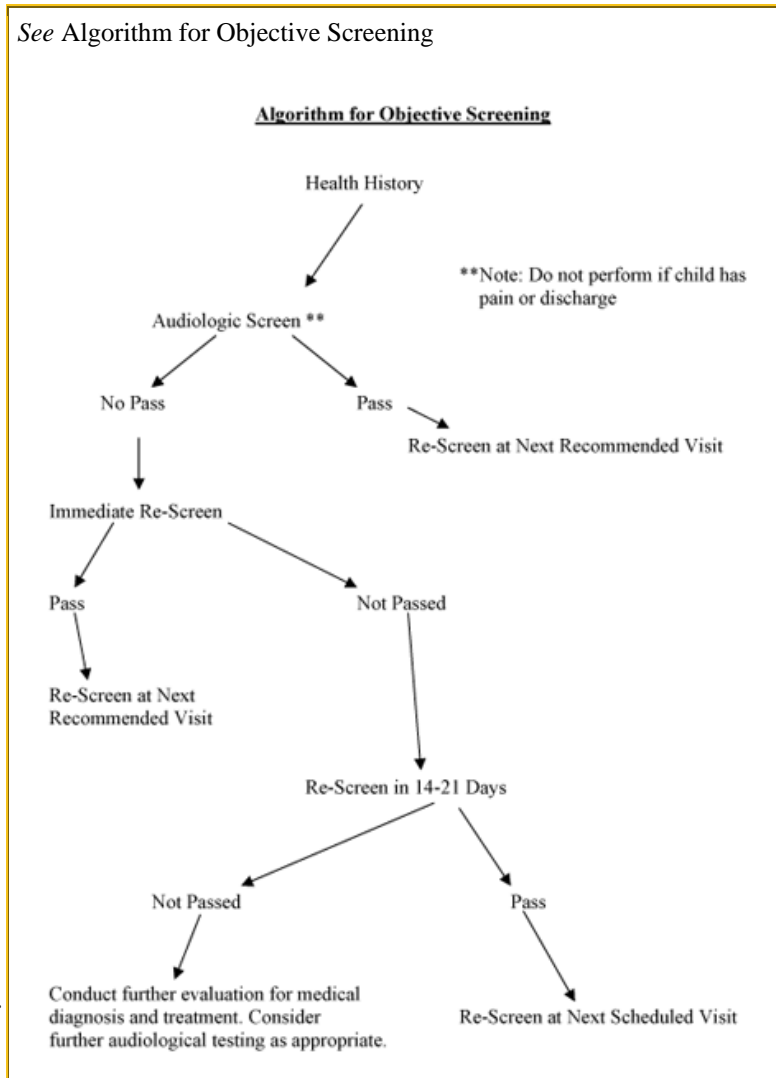
For interpretation of results, see Appendix F.

For complete information on Hearing History documentation, see C & TC Documentation section, Page 32.

(See Appendix L for answers to the questions below.)

QUESTION 10. The screener should perform an audiometric screening test on a child even if there is foul drainage or pain present in the child’s ear(s).

- True
- False



QUESTION 11. As it is important that the child feels successful while performing the audiometric test, the screener should provide visual cues to encourage the child to respond correctly when tones are presented.

- True
- False

QUESTION 12. During a hearing screening, a child raised his hand after only some of the tones were presented; when other tones were presented he just looked at the screener and smiled. The screener can assume that the smiles meant the child heard the tones and therefore the screener can pass the child on the hearing screening.

- True
- False

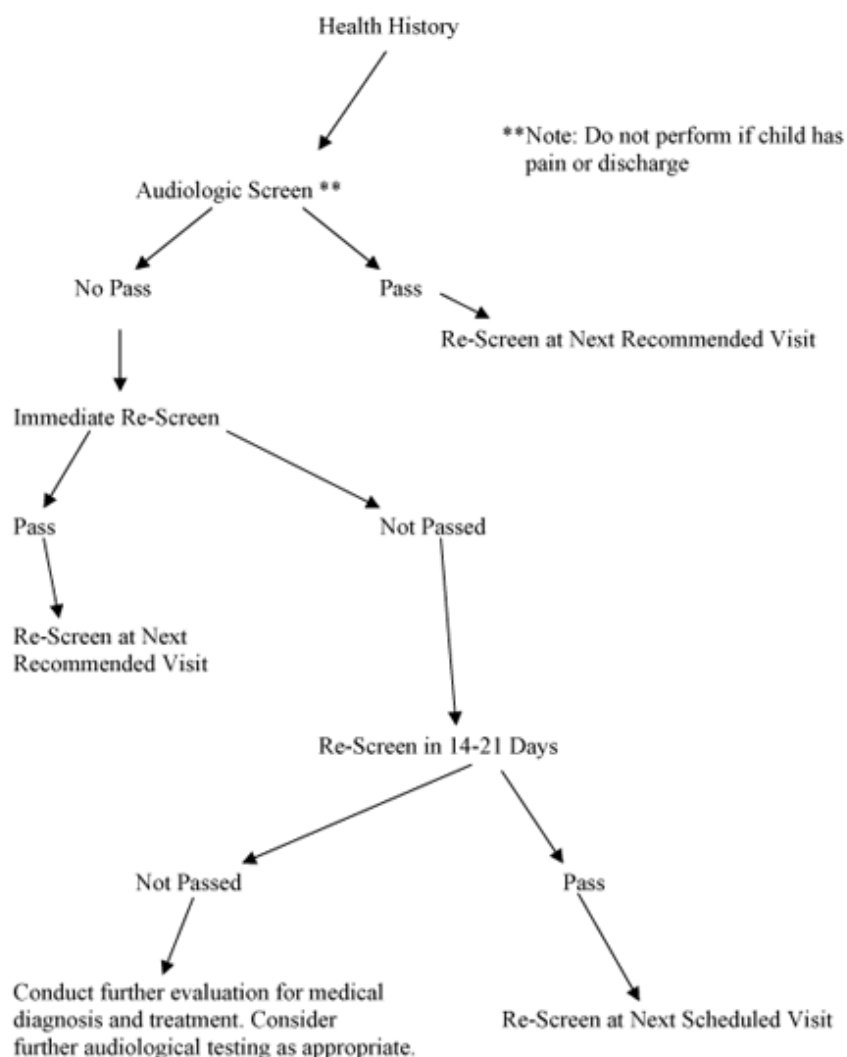
PLAY AUDIOMETRY

Purpose: To obtain valid results with very young children (age 3) or those children who have difficulty with standard pure tone audiometric methods.

Frequencies: 500, 1000, 2000, 4000 Hz

Supplies: Quiet room free from distractions (*see* Appendix E), audiometer, child size table and chair, C & TC documentation form [*see*: <http://www.dhs.state.mn.us/HealthCare/ctc/default.htm>] or medical chart, hearing-screening cue cards, interesting and safe toys, container for toys, and pens.

Algorithm for Objective Screening





Use this hearing screening chart as a guide to assist you during the hearing screening. Download the chart at <http://www.health.state.mn.us/divs/fh/mch/hlth-vis/materials/right-ear-first.html>.

Reference: Don Ogsten. Minnesota Department of Health Hearing and Vision Screening program. 1980.

NOTE: If tenderness, signs of drainage, or foul odor are present in the child’s ear(s), do not proceed with audiometric screening. Document the reason for not conducting the screening. The child should be evaluated by a primary care provider.

Preparing the child for the procedure:

- The screener should call the child by his/her name and inform the child that the screener is going to check the child’s hearing.
- Have the child remove glasses, ribbons, barrettes, combs, or large earrings if they obstruct a good seal on the headphones.
- Push the child’s hair behind his/her ears (this is a good time to quickly inspect the external ear).
- Check for hearing aids, cotton in ears, or drainage.
- If tenderness, signs of drainage, or foul odor is present, **do not** proceed with the audiometric screening; the child should be evaluated by a medical provider (For complete information on documentation, see C & TC Documentation section, Page 32). It is okay to proceed with the test if earwax is present.

Play audiometry technique:

Step 1

Place the headphones **on the table** facing the child with the audiometer set at 2000 Hz and maximum decibel level to ensure the tone is audible.

Step 2

The screener holds a toy near his or her ear, assumes a “listening” attitude, and presents the tone. The screener then indicates through his or her facial expression that the sound was heard and drops the toy in a pail. This may be repeated as often as necessary until the child shows interest.

Step 3

The screener offers the toy to the child and places his or her hand on the child's to guide the child's first responses. The screener should encourage the child to wait until the sound is heard. When the child appears ready, present the sound; the tone should be presented for at least one full second but should not exceed two seconds.

Step 4

Guide the child's hand to put the toy in the container. Start by physically moving the hand, then slowly decreasing assistance to a nudge until the child responds on his/her own. The child should drop the toy into the pail each time he or she hears the sound.

Step 5

When the child is ready to play the game, set the audiometer to 40 dB, set the frequency to 1000 Hz, and set the earphones on the child.

Step 6

Putting the headphones on the child:

- Place the **red** earphone on the child's **right** ear and the **blue** earphone on the **left** ear.
- Line up the opening of the earphone with the opening of the child's ear canal.
- Adjust the headband so it is seated on top of the child's head.

Step 7

If the child does not accept the headset, the screener should try putting it on the child for only one or two seconds, remove, and praise the child. The time with the headset on should be slowly increased.

Step 8

Look for a waiting posture where the child indicates readiness to listen and an ability to wait until the tone is presented.

Once the child understands the play audiometry technique, you may continue using the same audiometric procedure as described in the standard pure tone screening section.

Note: If the child cannot be tested at this point, STOP and document "Could Not Test (CNT)" and re-screen the child in two to three weeks. For complete information on documentation, see C & TC Documentation section, Page 32.

Audiometric Procedure for Play Audiometry

Step 1

Turn the intensity dial to 40 dB and 1000 Hz; turn the earphone selector switch to the right.

Step 2

Present the tone for one to two seconds by pushing the stimulus button. This is only a conditioning tone for the child; the response does not need to be recorded.

Step 3

Turn intensity dial (dB) to 20; present the sound. Watch for the child's response (dropping toy in container) and record results.

Step 4

Reward the child with praise after the initial response.

Step 5

Turn frequency to 2000; present the sound. Watch for the child's response and record results.

Step 6

Turn frequency to 4000; present the sound. Watch for the child's response and record results.

Step 7

Switch to left ear leaving dials at 20 and 4000; present the sound. Watch for the child's response and record results.

Step 8

Turn frequency to 2000; present the sound. Watch for the child's response and record results.

Step 9

Turn frequency to 1000; present the sound. Watch for the child's response and record results.

Step 10

Turn frequency to 500 and dB dial to 25; present the sound. Watch for the child's response and record results. This step can be eliminated if ambient noise level is too high. If 500 Hz is eliminated, document this in the results section.

Step 11

Switch back to right ear leaving dials at 25 and 500; present the sound. Watch for the child's response and record results.

Step 12

Remove earphones and thank the child.

Summary:

The order of presentation is as follows:

Right Ear

- **1000 Hz at 40 dB (conditioning tone)**
- **1000 Hz at 20 dB**
- **2000 Hz at 20 dB**
- **4000 Hz at 20 dB**

Left Ear

- **4000 Hz at 20 dB**
- **2000 Hz at 20 dB**

- **1000 Hz at 20 dB**
 - **500 Hz at 25 dB**
- Right Ear
- **500 Hz at 25 dB**

For interpretation of results, see Appendix F.

For complete information on Hearing History documentation, see C & TC Documentation section, Page 32.

Tips

- Do a few control trials with the child to ensure that the child is only dropping a toy into the bucket when a sound is presented.
- The response interval (tone to response time) varies between children. Some children will drop the toy as soon as the tone is heard, others will wait until the sound goes off before dropping the toy.
- Instead of asking “Do you want to...” say “Now I am going to let you...”

(See Appendix L for the answers to the below questions.)

QUESTION 13. The screener attempted to perform the hand-raising audiometric technique on a three-year-old. It did not work. The mother who was present during the screening said, “That’s okay, I can just wait until the age 4 checkup.” At this point you (choose the correct response):

- Agree and say fine.
- Indicate that you would like to try the play audiometry technique.

QUESTION 14. You have demonstrated to a three-year-old child how the play audiometry technique works. The child has the headphones on and you are about to present the tone at the 2nd frequency level. The child raises his hand before you present the tone. The parent looks at you and sighs. What would be your next step? (Choose only one response)

- Take the headphones off the child and re-instruct.
- Say to the parent, "Let's wait until age 4."
- Proceed with the next frequency.

Pass Criteria:

For *both* standard pure tone and play audiometry:

The child passes the screening if they hear *all eight* tones:

Right Ear

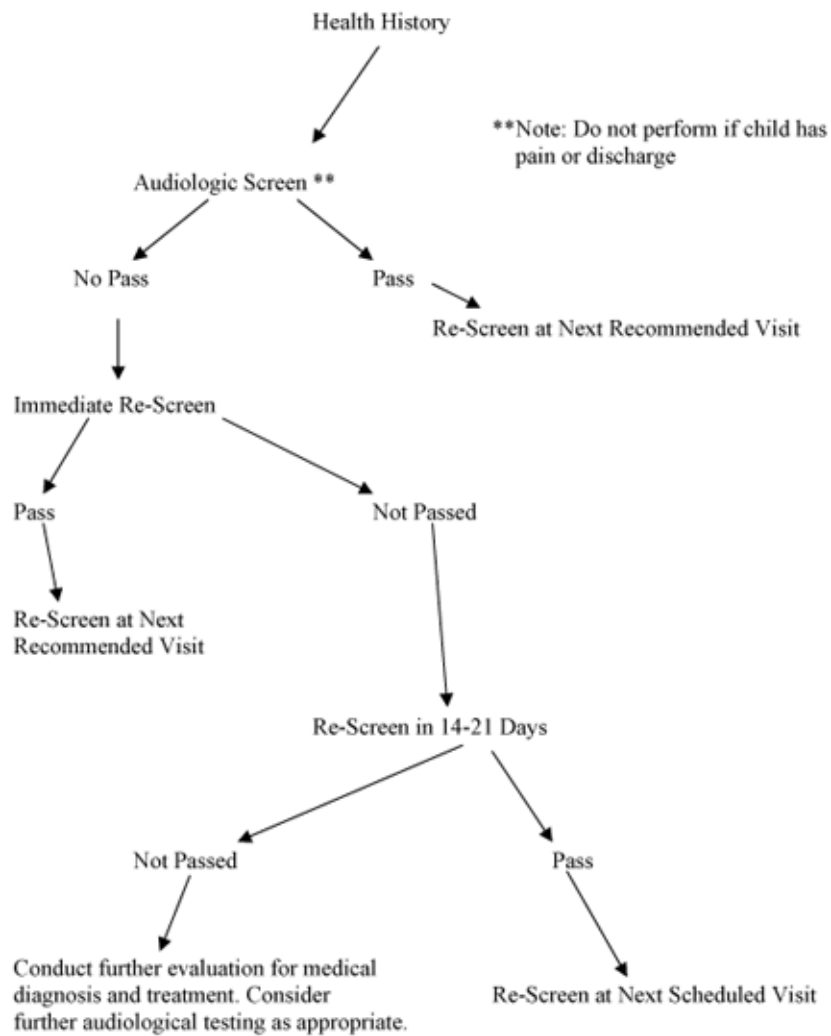
- **500 Hz at 25 dB** (If 500 Hz was eliminated due to excess ambient noise, document this in the results section.)
- **1000 Hz at 20 dB**

- 2000 Hz at 20 dB
- 4000 Hz at 20 dB

Left Ear

- 500 Hz at 25 dB (If 500 Hz was eliminated due to excess ambient noise, document this in the results section.)
- 1000 Hz at 20 dB
- 2000 Hz at 20 dB
- 4000 Hz at 20 dB

Algorithm for Objective Screening



C&TC Hearing Screening Pass/No Pass Criteria				
	Screening Component	Pass	No Pass	Follow-Up
SUBJECTIVE	Hearing History	No positive response to hearing history.	A positive response in ≥ 1 of the history questions for which the child has never been evaluated.	Further evaluation by primary care provider.
OBJECTIVE	Pure Tone ** Screening (Initial screen)	Child hears all 8 tones.	Child who does not hear ≥ 1 tones after immediate re-screening.	Schedule re-screening in 14-21 days. If child does not pass re-screen, conduct further evaluation for medical diagnosis and treatment. Consider further audiological testing as appropriate.
OBJECTIVE	Pure Tone Screening (Re-Screen in 14-21 days)	Child hears all 8 tones.	Child who does not hear one or more tones after re-screening.	Conduct further evaluation for medical diagnosis and treatment and consider further audiological testing as appropriate.
OTHER	Visual Inspection as a Part of the Physical Exam	Normal appearance of all structures; no observed ear distress or complaints of pain when the pinna or the tissue around the ear is being manipulated.	Any abnormality that has not been previously evaluated.	Further evaluation by primary care provider.
<p>**Note: If tenderness, signs of drainage, or foul odor are present in the child's ear(s), this is a "No Pass;" do not proceed with audiometric screening. The child should be evaluated by a medical provider.**</p>				

QUESTION 15. Which of the following are correct components of the objective hearing screening?
(See Appendix L for the answer.)

- Face the child towards you when conducting the hearing screening so the child will pay attention.
- If a child does not hear one or more tones after immediate re-screen, they should be seen immediately by the medical provider.
- Children under age four are always too young for objective hearing screening.
- All of the above.
- None of the above.

External and Internal Visual Inspection of the Ears as a Part of the Physical Exam

Qualified Personnel: Physician, Nurse Practitioner, and Physician Assistant. Also licensed school nurse, certified public health nurse, and registered nurse with appropriate training, e.g., training currently provided by the Minnesota Department of Health.

Ages: Birth through 20 years.

Purpose: To check for signs of ear disease and/or abnormal development.

Description: A systematic inspection of the external ear canal, surrounding tissue, and outer third of ear canal.

Equipment: Otoscope for internal inspection.

Facilities: A well-lighted area.

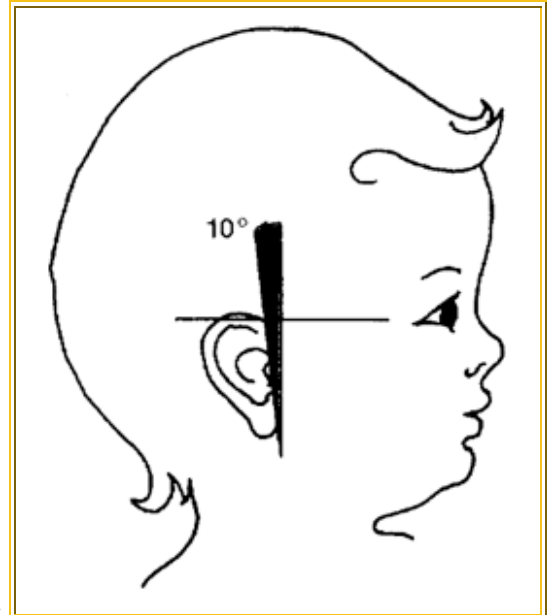
External visual inspection: Inspect the pinna and the area around it for any abnormalities such as *preauricular sinuses*, *skin tags*, or *atresia*. Check for set/tilt (position) of the ears (see image to the right), tenderness, redness or edema, signs of drainage, foul odor, wax build-up in the outer third of the canal, or dermatitis.

Internal visual inspection: With the otoscope inspect the ear canal and tympanic membrane for signs of drainage, wax build-up, or damage to the ear canal. Also note whether normal landmarks on the tympanic membrane can be seen. Internal visual inspection should only be performed by screeners with training and experience.

Pass/No Pass Criteria: Normal appearance of all structures and no complaints of pain when the pinna or the tissue around the ear is manipulated (see Appendix F for interpretation of results).

QUESTION 16. Do you know why children are more susceptible to ear infections (also called otitis media) than adults?

See Appendix L for the answer.



A child's ear position is normally set at a 10° tilt. Deviation from this position can be a clinical marker of syndromes associated with hearing loss.

Reprinted from Whaley LF, Wong DL, Nursing care of infants and children, 4th ed., Copyright 1991, Mosby, with permission from Elsevier.

Child and Teen Checkups (C&TC) Documentation of Hearing Screening

Complete documentation of the hearing screening must be provided. Although no specific documentation forms are required for C&TC, age specific C&TC documentation forms are available for your convenience from the Department of Human Services. For more information on C & TC documentation (see <http://www.dhs.state.mn.us/HealthCare/ctc/default.htm>), or to download the documentation forms, please visit the Department of Human Services website [see: <http://www.dhs.state.mn.us/HealthCare/ctc/default.htm>].

On the C&TC age-specific documentation forms, you will find the following information.

Hearing							
Right Ear				Left Ear			
500	1000	2000	4000	500	1000	2000	4000
<input type="checkbox"/> Normal <input type="checkbox"/> Abnormal <input type="checkbox"/> Question validity/retest Comments: Staff Initials _____							
Hearing concerns <input type="checkbox"/> No <input type="checkbox"/> Yes (explain)							

Documentation of Subjective Screening

How do I perform a subjective screening (see Page 12)?

Hearing Concerns Section

The primary care provider usually performs the subjective screening as a part of the health history. The information gained through the subjective hearing screening may be documented in the hearing concerns section or the child health history section of the medical record.

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 see the child. Document any parental concerns of a child's hearing or risk factors for hearing loss.

When screening children aged 0 to 24 months, you may provide the *My Child's Hearing Checklist* (see <http://www.health.state.mn.us/divs/fh/mch/unhs/brochures.html#checklist>) for the parent to complete. *My Child's Hearing Checklist* is available from the Minnesota Department of Health (MDH) Library (see <http://www.health.state.mn.us/library/library.htm>) in Somali, Hmong, Spanish, and English. Any concerns from this checklist should be documented in the patient's medical chart.

Documentation of Objective Screening (through standard pure tone audiometry and play audiometry):

Document the results as follows:

Right Ear				Left Ear			
(Hz) 500	1000	2000	4000	500	1000	2000	4000
(DB) 25/	20/	20/	20/	25/	20/	20/	20/

Document the results of the pure tone audiometric screening. Write the first decibel level that the child was being tested for each of the corresponding frequencies (Hz) (i.e., 20 dB at 1000 Hz, 2000 Hz, and 4000 Hz; and 25 dB at 500 Hz). If 500 Hz was eliminated due to excess ambient noise, document this in the 500 Hz section of the form. Then write P (pass) if the child heard it or leave it blank if the child did not hear a tone. For example, if the child responded to 25 dB in the right ear at 500 Hz and did not respond to 20 dB at 1000 Hz, your documentation would look like the following:

500	1000
25/P	20/

If a child does not hear the tone at the appropriate decibel and frequency level, test the remaining frequencies. After all of the tones have been presented, return to the missed tones for an immediate re-screen. If the child continues to be unable to hear the tones, document that the child has not passed the screening by checking the “Abnormal” box and writing “RS” for Re-Screen in the box for the tone that was missed. Make any pertinent notes under **Comments** such as if the child has a head cold or congestion.

For example:

1000
20/RS

Re-screen after 10-14 days:

It is always advisable to wait to re-screen a child’s hearing until 10 to 14 days after the initial screening if the child did not pass the immediate re-screening; a temporary illness, lack of understanding, fatigue, apprehension, or allergies may have caused the child to not pass the initial screening.

If the child does not pass audiometric screening at the 10-14 day re-screen document by writing an 'R' (refer) at the appropriate frequency, i.e.,

1000

20/R

It is advisable for the child to be seen for further evaluation by a primary care provider.

If the child does not appear to understand the audiometric procedure, or keeps raising his or her hand even when a tone is not presented, check the 'Question Validity' box.

The screener should check the "Normal" box if the child is able to hear all eight tones. If pure tone audiometry is deferred, document the reason.

Example: If the child was not able to be tested via standard hand-raising pure tone audiometry or play audiometry, document this and re-screen the child in two to three weeks.

NEWBORN HEARING SCREENING

Approximately 1 to 2 of every 1000 infants born in the U.S. are born deaf or hard of hearing.¹ Hospitals with Universal Newborn Hearing Screening programs have reported between 1.96 and 3.30 infants per 1000 identified with permanent congenital hearing loss.^{3, 4, 5, 6} It is estimated that 200 Minnesota infants, or 4 per week, are born each year with hearing loss.²

Congenital hearing loss is the most common detectable disability in newborns. This invisible disability is 20 times more common in newborns than the metabolic blood disorder phenylketonuria (PKU) and 15 times more common than sickle cell anemia. Both PKU and sickle cell anemia are both disorders for which screening is routinely performed.⁷

Early identification of children with hearing loss is an important preventive health care service, as the critical time for acquiring language and stimulating auditory pathways is 0 to 6 months. Research indicates that deaf and hard-of-hearing infants who receive intervention by six months of age can develop normal cognitive, social, and language skills. Before newborn hearing screening, deaf and hard-of-hearing children were not identified until an average age of 2.5 years.^{8, 9, 10, 11, 12, 13}

Universal newborn hearing screening is endorsed by the American Academy of Pediatrics¹⁴ and is considered a standard of care in hospitals. Currently 105 of 111 birthing hospitals in Minnesota are voluntarily screening all newborns for hearing loss, which reaches almost 95 percent of all Minnesota newborns.¹⁵ In comparison, only 40 percent of newborns were screened before the Minnesota Department of Health received federal grant funding for newborn hearing screening in 1999.¹⁶ As of June 2003 the national average for percentage of newborns screened for hearing is 86.5 percent.¹⁷

For More Information...

Universal Newborn Hearing Screening, Diagnosis, and Intervention Guidelines for Pediatric Medical Home Provider (see Appendix G).

Some risk factors to be used in screening for congenital deafness, as defined by the Joint Committee on Infant Hearing, include neonatal intensive care unit admission for ≥ 48 hours, family history of permanent childhood sensorineural deafness, craniofacial anomalies and in utero infections associated with deafness.^{18, 19, 20} However, as 50 percent of children born with hearing loss have no risk factors, many children with hearing loss could be missed without Universal Newborn Hearing Screening.^{21, 22, 23, 24, 25}

Hearing can be screened within hours of birth through 9 months of age with otoacoustic emission equipment (OAE) and/or Automated Auditory Brainstem Response (AABR).^{18, 19, 20} Children from approximately 6 to 24 months of age can also be screened by visual reinforced audiometry (VRA).²⁶

It is very important that families follow up on hospital referrals from newborn hearing screening; as a child referred for further testing after screening can have as great as a 1 in 12 chance of having a hearing loss,²⁷ if the screening was administered appropriately. A timely and appropriate referral is a critical role of the primary care provider.

The Newborn Hearing Screening Slogan is 1-3-6:

- Screen babies for hearing loss by 1 month of age
- Identify hearing loss by 3 months of age
- Offer early intervention services to deaf and hard-of-hearing babies and families by 6 months of age

Additional information about newborn hearing screening may be found at the MDH Universal Newborn Hearing Screening (UNHS) /Early Hearing Detection and Intervention (EHDI) Program website (see <http://www.health.state.mn.us/divs/fh/mch/unhs/>).

When screening children aged 0 to 24 months, provide the *My Child's Hearing Checklist* form to the parent to complete. Any concerns from this checklist should be documented under the Hearing Concerns section of the C & TC documentation form or on the patient's medical chart. *My Child's Hearing Checklist* is available from the MDH Universal Newborn Hearing Screening (UNHS)/Early Hearing Detection and Intervention (EHDI) Program website (see <http://www.health.state.mn.us/divs/fh/mch/unhs/brochures.html#checklist>) in English, Spanish, Hmong, and Somali.

- Joint Commission on Infant Hearing (JCIH) High Risk Indicators (see Appendix H)
- The high risk indicators for hearing loss should be used when newborn hearing screening has not been conducted
- Age groups for high risk indicators are
- Birth to 28 days
- 29 days to 2 years
- Explanation of High Risk Indicators (see Appendix I)

ADMINISTRATIVE CONSIDERATIONS

Characteristics of a Good Hearing Screening Facility

Avoid area near:

- Fans or air conditioners
- Hall traffic (reroute if possible)
- Playground or street traffic
- Group activity areas, e.g., break room
- Bathrooms
- Lunchrooms
- Office equipment (copying machine, paper shredder, etc.)
- Soft drink machines
- Refrigerators, etc

Avoid excess noise within screening area, such as:

- Talking
- Paper shuffling
- Open windows
- Ticking clock
- Movement of desks or other furniture

Room should be uncluttered and free of visual distraction:

- Avoid mirror or reflecting surfaces
- Avoid facing child towards a window
- Avoid child facing others who may give clues to correct response

Cease screening momentarily if any distracting noise occurs.

As screening is usually conducted in a clinic, try using the last room at the end of a hall or one that is away from other rooms.

C & TC Programs Environmental Noise Level Check

Most clinics do not have the equipment to take ambient noise level measurements in the areas to be used for screening. However, an environmental noise level check may be substituted. This is defined as the ability to establish that the room is quiet enough for a 'normal' hearing person to hear 10 dB below the screening level at all frequencies. If this level cannot be established, the area must not be used for screening. However, if 500 Hz is the only frequency affected, then it may be deleted from the screening protocol.

The screener should put on the audiometer headphones and:

- At 500 Hz: 15 dB should be audible.
- At 1000 Hz: 10 dB should be audible.
- At 2000 Hz: 10 dB should be audible.
- At 4000 Hz: 10 dB should be audible.

The Audiometer

An audiometer is a device that produces tones at set frequencies and known intensities through headphones worn by the patient. The patient is required to indicate what tones s/he can hear. The pure tone audiometer is the preferred instrument used in school and clinic hearing screening programs.

There are several different brands of audiometers; most have the following dials:

Power or On/Off Switch: Needs to be on when testing.

Frequency Dial: This dial rotates from 250 to 8000 Hz and controls the test frequency or the pitch of the tone.

Hearing Level Dial or Decibel (dB) Dial: Controls the test intensity or loudness of the tone. Normally this is a rotary dial that allows you to vary the tones presented in 5 dB steps.

Tone Presentation Bar or Stimulus Switch: Pressing this bar presents the tone to the person being tested.

The audiometer has test tones ranging from 250 to 8000 Hz (Hz refers to frequency, or cycles per second). This is the pitch of the tones that range from very low to high pitch. The tones most often used in audiometric screenings are 500, 1000, 2000, and 4000 Hz. The intensity (loudness) is expressed in decibels (dB). Thirty (30dB) is considered the level of a soft whisper at a distance of three feet. Sixty-five (65dB) is the average intensity for a normal conversation, and eighty-five (85 db) is so loud that individuals must be protected when working under such exposure for a prolonged period.

Audiometric tests record the softest level at which an individual can hear a tone. The responses are recorded on a graph called an audiogram. The headphones that come with an audiometer have been calibrated to that specific audiometer and should not be exchanged with other audiometers.

For a diagram of an audiometer, see <http://facstaff.uww.edu/bradleys/ohc/audiometry/page12.html>.



MAICO MA 25 audiometer reproduced with permission from MAICO (see <http://www.maico-diagnostics.com/>).



MAICO MA 27 audiometer reproduced with permission from MAICO (see <http://www.maico-diagnostics.com/>).



GSI 17 audiometer reproduced with permission from Grason-Stadler (see <http://www.grason-stadler.com/home.html>).

General Care

Handle the audiometer gently and avoid dropping it or rough treatment. When transporting the audiometer place it on the car seat and secure it so that it cannot fall during a sudden stop.

Avoid extreme temperatures (below freezing and above 90° F). **Keep all cords free of tangles and twists.** Check all electrical connections, dials, and switches for signs of problems. The earphone jacks should be occasionally removed from their plugs and wiped with an alcohol pad to improve the connection. Care must be taken to prevent moisture from getting inside the audiometer proper.

The case should be kept closed to prevent dust build-up. If the case or exposed surfaces should become dirty, soap and water is usually sufficient to clean them.

Earphones

Clean routinely with cleaning agent like alcohol-free wipes. (DO NOT USE ALCOHOL BECAUSE IT MAY DRY OUT THE RUBBER CUSHIONS ON EARPHONES.) When the earphone cushions need cleaning, remove them from the headset, and clean and dry thoroughly before replacing. KEEP ALL MOISTURE AWAY FROM DIAPHRAGM (HOLE IN CENTER OF EARPHONES). Do not interchange the headphones with other audiometers.

Ensuring Proper Functioning

Mechanical and biological function checks must be done regularly on each audiometer before being used (copies of instructions and documentation forms are enclosed with each audiometer). See the following examples:

Mechanical Function Check and Mechanical Function Check Sheet (*see Appendix J*)

Biologic Calibration Check and Check Sheet (*see Appendix K*)

Calibration

The clinic audiometer should receive regular maintenance checks by a professional audiometer vendor according to the manufacturer's recommendations. Calibration includes internal cleaning and lubrication along with acoustic checks on the audiometer. The vendor will also assess the machine for any needed repairs.

The audiometer is in need of repair if:

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

For a contact list for audiometer service, repair, and sales, see
<http://www.health.state.mn.us/divs/fh/mch/hlth-vis/materials/vision-equipment.html>.

C & TC Children's Hearing Screening Web-Based Training Evaluation

Evaluate specific areas for content and relevancy:

(We also welcome any comment on how to improve content and/or the web-based training.)

	Poor		Average		Excellent
Overall quality of <i>content</i> of web-based training.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
Overall <i>usability</i> of web-based training (ease of navigation through training).	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
Overall content was relevant to my job.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Specific sections of web-based training:

First section: Introduction (*Background information on hearing loss in children and youth and hearing screening; C & TC requirements and recommendations for hearing screening*)

	Poor		Average		Excellent
	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Second section: Objective and subjective screening procedures (*including Algorithm and Pass/No Pass Criteria*)

	Poor		Average		Excellent
	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Third section: Newborn hearing screening

	Poor		Average		Excellent
	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Fourth section: Administrative considerations (*including characteristics of a good screening facility; C & TC programs environmental noise level check; and care and use of audiometer*)

	Poor		Average		Excellent
	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5

Fifth section: Additional information and resources (*including types of hearing loss; glossary; and*

resource list)

Poor

Average

Excellent

1

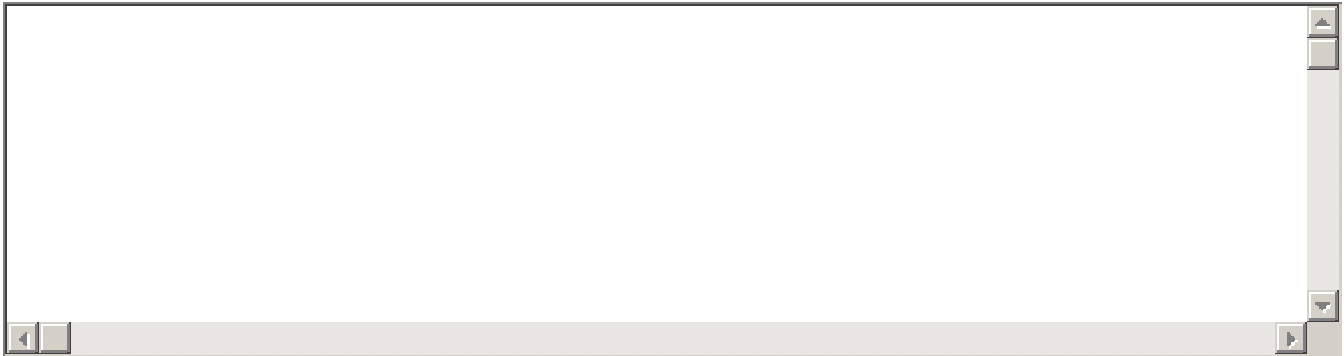
2

3

4

5

Additional Comments:

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Appendices

Appendix A – Resource List

Appendix B – Types of Hearing Loss

Appendix C – Effects of Hearing Loss

Appendix D – Health History

Appendix E – Characteristics of a Good Hearing Screening Facility

Appendix F – C&TC Hearing Screening Pass/No Pass Criteria

Appendix G – Guidelines for Pediatric Medical Home Providers

Appendix H – High Risk Indicators for Hearing Loss

Appendix I – Explanation of High Risk Indicators for Hearing Loss

Appendix J – Mechanical Function Check and Check Sheet

Appendix K – Biologic Calibration Check and Check Sheet

Appendix L – Answers to Course Questions

Appendix M – Calibration

Appendix N – Glossary

Appendix O – References

Appendix A

RESOURCE LIST

NOTE: Some of these resources are beyond the scope of practice of the hearing screening practitioner and is intended for informational purposes only.

Anatomy and Physiology of the Auditory System/Ear Diseases

American Academy of Pediatrics Practice Guidelines for Managing Otitis Media with Effusion in Young Children

<http://www.aap.org/policy/otitis.htm#table1>

Anatomical Tour of the Ear

<http://www.earaces.com/anatomy.htm>

Anatomy of the Ear

<http://faculty.washington.edu/chudler/gif/aud1.jpg> and
<http://faculty.washington.edu/chudler/bigear.html>

Another Ear Infection?!

<http://www.mindspring.com/~drwarren/otitis-m.htm>

Auditory and Vestibular Pathways

<http://thalamus.wustl.edu/course/audvest.html>

How the Ear Works

<http://deafness.about.com/gi/dynamic/offsite.htm?site=http%3A%2F%2Fwww.hope4hearing.org%2Fanatomy.htm>

How Healthy Ears Hear

<http://www.hei.org/hearhealth/healthyear/howhear.htm>

How We Hear presented by the Audiology Awareness Campaign

<http://www.audiologyawareness.com/hhelp/howhr.htm>

Review of Anatomy: The Ear & Temporal Bone

<http://www.bcm.tmc.edu/oto/studs/anat/tbone.html>

Audiometers and Audiograms

Audiograms: What are They? How Do You Understand Them?

<http://home.inreach.com/torsi/audiogram.html>

The Audiometer

<http://facstaff.uww.edu/bradleys/ohc/audiometry/page12.html>

“How do we Read an Audiogram?” presented by the Audiology Awareness Campaign

<http://www.audiologyawareness.com/hhelp/audiogrm.htm>

How to Read your Hearing Test

<http://www.earinfo.com/howread1.html>

Understanding your Audiogram

<http://www.audiology.org/consumer/guides/uya.php>

Child and Teen Checkups (C & TC)

C & TC Denver II training schedule

<http://www.health.state.mn.us/divs/fh/mch/mch-pro3.html>

C & TC Fact Sheets

<http://www.health.state.mn.us/divs/fh/mch/ctchome.html>

C & TC Materials List and Ordering Information

<http://www.dhs.state.mn.us/HealthCare/ctc/CTCordering.htm>

C & TC Materials in PDF Format:

- Provider information guide
- Coordinators list
- Brochures
- Periodic Screening Schedule
- Materials list and ordering information
- Provider and clinic documentation forms
- Screening checklists for parents

<http://www.dhs.state.mn.us/HealthCare/ctc/default.htm>

Introduction to C & TC Online Training

<http://www.health.state.mn.us/divs/fh/mch/webcourse/index.html>

C & TC Screening Schedule

<http://edocs.dhs.state.mn.us/live/DHS-3379-ENG.pdf>

C & TC Workshop Schedule

<http://www.health.state.mn.us/divs/fh/mch/candtc.html>

Organizations

Alexander Graham Bell Association for the Deaf

<http://www.agbell.org>

American Academy of Audiology

<http://www.audiology.org>

American Academy of Pediatrics

<http://www.aap.org>

American Speech Language Hearing Association

<http://www.asha.org>

Better Hearing Institute

<http://www.betterhearing.org>

Boys Town National Research Hospital

<http://www.boystownhospital.org>

Centers for Disease Control and Prevention (CDC) Early Hearing Intervention

<http://www.cdc.gov/ncbddd/ehdi/defin.htm>

CDC National Institute for Occupational Safety and Health (NIOSH)- A Practical Guide to Preventing Hearing Loss

<http://www.cdc.gov/niosh/96-110.html>

Deafness.about.com

<http://deafness.about.com/>

Educational Audiology Association

<http://www.edaud.org>

League for the Hard of Hearing

<http://www.lhh.org>

Marion Downs National Center for Infant Hearing

<http://www.colorado.edu/slhs.mdnc>

National Campaign for Hearing Health

<http://www.hearinghealth.net/pages/home/index.html>

National Center for Hearing Assessment & Management

<http://www.infanthearing.org>

The National Hearing Conservation Organization
<http://www.hearingconservation.org>

National Institute on Deafness and Other Communication Disorders (NIDCD)
<http://www.nidcd.nih.gov/health/wise/index.asp>

Sight and Hearing Association
<http://www.sightandhearing.org>

Virtual Tour of the Ear
<http://www.augie.edu/perry/ar/ar.htm>

State of Minnesota Resources

University of Minnesota Department of Communication Disorders
<http://www.cdis.umn.edu>

Minnesota Department of Education Early Childhood Screening Program
<http://cfl.state.mn.us/ecfi/ecscreen.htm>

Minnesota Department of Health (MDH) Hearing and Vision and Tympanometry/Otoscopy workshops
<http://www.health.state.mn.us/divs/fh/mch/mch-pro2.html>

MDH Library
Web: <http://www.health.state.mn.us/library/library.htm>
Phone: (612) 676-5274
Email: library@health.state.mn.us

Materials Available:

- Hearing Screening for Children manual (#M-091)
- MDH Hearing Screening Video 1999
- My Child's Hearing Checklist: English (#141-1120); Hmong (#141-1122); Spanish (#141-1121); Somali (#141-1123)

MDH Minnesota Children with Special Health Needs (MCSHN)
<http://www.health.state.mn.us/divs/fh/mcshn/mcshn.html>

MDH Universal Newborn Hearing Screening (UNHS) Program / Early Hearing Detection and Intervention (EHDI) Program
<http://www.health.state.mn.us/divs/fh/mch/unhs/>

Minnesota Department of Human Services: Services for People who are Deaf or Hard of Hearing
<http://www.dhs.state.mn.us/infocenter/dhh.htm>

Minnesota Early Childhood Screening Statutes
<http://www.revisor.leg.state.mn.us/stats/121A/17.html>

Minnesota Speech-Language-Hearing Association (MSHA)
<http://www.msha.net>

Appendix B

TYPES OF HEARING LOSS

The three main sections of the ear:

- The **outer ear** is the part of the ear that starts at the *pinna* or *auricle*, extends through the external ear canal, and ends at the eardrum.
- The **middle ear** is the part of the ear that begins with the eardrum at the end of the ear canal. It includes three small bones called ossicles that move in response to sound waves entering the ear. This movement helps to conduct the sound into the inner ear. The middle ear also contains the Eustachian (you-stay-shee-un) tube that helps to maintain normal air pressure in the ear.
- The **inner ear** contains the sensory organ for hearing called the organ of Corti that is housed in the cochlea (pronounced COKE-lee-uh). The part of the auditory nerve that is located in the inner ear sends impulses from the cochlea to the brain signaling that sound waves have entered the ear. The inner ear also contains the organ of balance called the labyrinth.

Conductive hearing loss:

- Occurs in the outer ear or middle ear
- Blocks movement of sound into the ear
- Typical causes: Wax in ear canal, hole in eardrum, broken ossicle (middle ear bone), middle ear infection
- Treatment: Usually can be treated medically or surgically; use of amplification devices such as hearing aids to increase the loudness of sounds can help

Sensorineural hearing loss:

- A problem in the inner ear and/or auditory nerve
- Causes: Genetics or damage to neurosensory elements. Neurosensory elements are sensory nerves that conduct nerve impulses, in this case hearing impulses, to the brain
- Treatment: Use of amplification devices like hearing aids or *cochlear implants*
- Sensorineural damage affects 17 million Americans²²
- About 90 percent of people with hearing impairments have sensorineural hearing loss, making it the most common type of permanent hearing impairment²³

Mixed hearing loss involves the external or middle ear and the inner ear.

Noise Exposure and Hearing Loss

There are 15,000 to 20,000 tiny hair cells (cilia) in the cochlea in the inner ear that help to transmit sounds to the brain. As an example of what happens when hair cells have been 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. However, if you walk on the grass often enough or if you trample it, it gets matted down and will not bounce back. Exposure to sounds that are loud enough and/or occur for long enough can damage the ears' tiny hair cells so that they can no longer bounce back into shape and

can no longer transmit sound to the brain. This causes noise-induced hearing loss (NIHL), which is a type of sensorineural hearing loss. 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. A recent study of American children 6 to 19 years of age found that 12.5 percent (5.2 million) had some level of noise-induced hearing loss.⁶

Resources Available for Hearing Loss

Alexander Graham Bell Association for the Deaf

<http://www.agbell.org>

American Academy of Audiology

<http://www.audiology.org>

American Academy of Pediatrics

<http://www.aap.org>

American Academy of Pediatrics Practice Guidelines for Managing Otitis Media with Effusion in Young Children

<http://www.aap.org/policy/otitis.htm#table1>

American Speech Language Hearing Association

<http://www.asha.org>

Anatomical Tour of the Ear

<http://www.earaces.com/anatomy.htm>

Anatomy of the Ear

<http://faculty.washington.edu/chudler/gif/aud1.jpg> and

<http://faculty.washington.edu/chudler/bigear.html>

Another Ear Infection?!

<http://www.mindspring.com/~drwarren/otitis-m.htm>

Auditory and Vestibular Pathways

<http://thalamus.wustl.edu/course/audvest.html>

Better Hearing Institute

<http://www.betterhearing.org>

Boys Town National Research Hospital

<http://www.boystownhospital.org>

Centers for Disease Control and Prevention (CDC) Early Hearing Intervention

<http://www.cdc.gov/ncbddd/ehdi/defin.htm>

CDC National Institute for Occupational Safety and Health (NIOSH)- A Practical Guide to Preventing Hearing Loss

<http://www.cdc.gov/niosh/96-110.html>

Deafness.about.com

<http://deafness.about.com/>

Educational Audiology Association

<http://www.edaud.org>

How the Ear Works

<http://deafness.about.com/gi/dynamic/offsite.htm?site=http%3A%2F%2Fwww.hope4hearing.org%2Fanatomy.htm>

How Healthy Ears Hear

<http://www.hei.org/earhealth/healthyear/howhear.htm>

How We Hear presented by the Audiology Awareness Campaign

<http://www.audiologyawareness.com/hhelp/howhr.htm>

League for the Hard of Hearing

<http://www.lhh.org>

Marion Downs National Center for Infant Hearing

<http://www.colorado.edu/slhs.mdnc>

National Campaign for Hearing Health

<http://www.hearinghealth.net/pages/home/index.html>

National Center for Hearing Assessment & Management

<http://www.infanthearing.org>

The National Hearing Conservation Organization

<http://www.hearingconservation.org>

National Institute on Deafness and Other Communication Disorders (NIDCD)

<http://www.nidcd.nih.gov/health/wise/index.asp>

Review of Anatomy: The Ear & Temporal Bone

<http://www.bcm.tmc.edu/oto/studs/anat/tbone.html>

Sight and Hearing Association

<http://www.sightandhearing.org>

Virtual Tour of the Ear

<http://www.augie.edu/perry/ar/ar.htm>

Appendix C

EFFECTS OF HEARING LOSS

Degree of Hearing Loss Based on Modified Pure Tone Average (500-4000 HZ)	Possible Effects of Hearing Loss on the Understanding of Language & Speech	Possible Psychological Impact of Hearing Loss	Potential Education Needs and Programs
Normal Hearing -10 - +15 dB HL	Children have better hearing sensitivity than the accepted normal range for adults. A child with hearing sensitivity in the -10 to +15 dB range will detect the complete speech signal even at soft conversation levels. However, good hearing does not guarantee good ability to discriminate speech in the presence of background noise.	Not Applicable	Not Applicable
Minimal (Borderline) 16-25 dB HL	May have difficulty hearing faint or distant speech. At 15 dB student can miss up to 10% of speech signal when teacher is at a distance greater than 3 feet and when the classroom is noisy, especially in the elementary grades when verbal instruction predominates.	May be unaware of subtle conversational cues that could cause child to be viewed as inappropriate or awkward. May miss portions of fast-paced peer interactions that could begin to have an impact on socialization and self concept. May have immature behavior. Child may be more fatigued than classmates due to listening effort needed.	May benefit from mild gain/low <PO hearing aid or personal FM system dependent on loss configuration. Would benefit from soundfield amplification if classroom is noisy and/or reverberant. Favorable seating. May need attention to vocabulary or speech, especially with recurrent otitis media history. Appropriate medical management necessary for conductive losses. Teacher requires in-service on impact of hearing loss on language development and learning.

<p>Mild 26-40 dB HL</p>	<p>At 30 dB can miss 25-40% of speech signal. The degree of difficulty experienced in school will depend upon the noise level in classroom, distance from teacher and the configuration of the hearing loss. Without amplification the child with 35-40 dB loss may miss at least 50% of class discussions, especially when voices are faint or speaker is not in line of vision. Will miss consonants, especially when a high frequency hearing loss is present.</p>	<p>Barriers beginning to build with negative impact on self-esteem as child is accused of “hearing when he or she wants to,” “daydreaming,” or “not paying attention.” Child begins to lose ability for selective hearing and has increasing difficulty suppressing background noise, which makes the learning environment stressful. Child is more fatigued than classmates due to listening effort needed.</p>	<p>Will benefit from a hearing aid and use of a personal FM or soundfield FM system in the classroom. Needs favorable seating and lighting. Refer to special education for language evaluation and educational follow-up. Needs auditory skill building. May need attention to vocabulary and language development, articulation or speechreading and/or special support in reading. May need help with self-esteem. Teacher in-service required.</p>
<p>Moderate 41-55 dB HL</p>	<p>Understands conversational speech at a 3-5 feet (face-to-face) only if structure and vocabulary controlled. Without amplification the amount of speech signal missed can be 50% to 75% with 40 dB loss and 80% to 100% with 50 dB loss. Is likely vocabulary, imperfect speech production and an atonal voice quality.</p>	<p>Often with this degree of hearing loss, communication is significantly affected and socialization with peers with normal hearing becomes increasingly difficult. With full-time use of hearing aids/FM systems child may be judged as a less competent learner. There is an increasing impact on self-esteem.</p>	<p>Refer to special education for language evaluation and educational follow-up. Amplification is essential (hearing aids and FM system). Special education support may be needed, especially for primary children. Attention to oral language development, reading and written language. Auditory skill development and speech therapy usually needed. Teacher in-service required.</p>
<p>Moderate to Severe 56-70 dB HL</p>	<p>Without amplification, conversation must be very loud to be understood. A 55 dB loss can cause child to miss up to 100% of speech information. Will have marked difficulty in school situations requiring verbal communication in both one-to-one and group situations. Delayed language, syntax, reduced speech</p>	<p>Full-time use of hearing aids/FM systems may result in child being judged by both peers and adults as a less competent learner, resulting in poorer self concept and social maturity and contributing to a sense of rejection. In-service to address these attitudes may be helpful.</p>	<p>Full-time use of amplification is essential. Will need resource teacher or special class depending on magnitude of language delay. May require special help in all language skills, language-based academic subjects, vocabulary, grammar, and pragmatics as well as reading and writing. Probably needs assistance to</p>

	intelligibility and atonal voice quality likely.		expand experiential language base. In-service of mainstream teachers required.
Severe 71-90 dB HL	Without amplification may hear loud voices about one foot from ear. When amplified optimally, children with hearing ability of 90 dB or better should be able to identify environmental sounds and detect all the sounds of speech. If losses of prelingual onset, oral language and speech may not develop spontaneously or will be severely delayed. If hearing loss is of recent onset speech is likely to deteriorate with quality becoming atonal.	Child may prefer other children with hearing impairments as friends and playmates. This may further isolate the child from the mainstream; however, these peer relationships may foster improved self-concept and a sense of cultural identity.	May need full-time special aural/oral program with emphasis on all auditory language skills, speechreading, concept development and speech. As loss approaches 80-90 dB, may benefit from a Total Communication approach, especially in the early language learning years. Individual hearing aid/personal FM system essential. Need to monitor effectiveness of communication modality. Participation in regular classes as much as beneficial to student. In-service of mainstream teachers essential.
Profound 91 dB HL or more	Aware of vibrations more than tonal pattern. Many rely on vision rather than hearing as primary avenue for communication and learning. Detection of speech sounds dependent upon loss configuration and use of amplification. Speech and language will not develop spontaneously and is likely to deteriorate rapidly if hearing loss is of recent onset.	Depending on auditory/oral competence, peer use of sign language, parental attitude, etc., child may or may not increasingly prefer association with the deaf culture.	May need special program for deaf children with emphasis on all language skills and academic areas. Program needs specialized supervision and comprehensive support services. Early use of amplification likely to help if part of an intensive training program. May be cochlear implant or vibrotactile aid candidate. Requires continual appraisal of needs in regard to communications and learning mode. Part-time in regular classes as much as beneficial to student.

<p>Unilateral One normal hearing ear and one ear with at least a permanent mild hearing loss.</p>	<p>May have difficulty hearing faint or distant speech. Usually has difficulty localizing sounds and voices. Unilateral listener will have greater difficulty understand speech when environment is noisy and/or reverberant. Difficulty detecting or understanding soft speech from side of bad ear, especially in a group discussion.</p>	<p>Child may be accused of selective hearing due to discrepancies in speech understanding in quiet versus noise. Child will be more fatigued in classroom setting due to greater effort needed to listen. May appear inattentive or frustrated. Behavior problems sometimes evident.</p>	<p>May benefit from personal FM or soundfield FM system in classroom. CROS hearing aid may be of benefit in quiet settings. Needs favorable seating and lighting. Student is at risk for educational difficulties. Educational monitoring warranted with support services provided as soon as difficulties appear. Teacher in-service is beneficial.</p>
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References:

Olsen, W.O., Hawkins, D.B., VanTassell, D.J. (1987). Representatives of the Longterm Spectrum of Speech. *Ear & Hearing*. Supplement 8, pp. 100-108.

Mueller, H.G. & Killion, M.C. (1990) An easy method for calculating the articulation index. *The Hearing Journal*. 43,9 pp. 14-22.

Hasenstab, M.S. (1987). *Language Learning and Otitis Media*. Coolege Hill Press, Boston MA.

Appendix D

HEALTH HISTORY

Complaints or Behaviors Which May Indicate a Hearing Loss:

- Pain in ear(s)
- Fullness in ear(s)
- Noise in ear(s)
- Drainage from ear(s)
- Cannot hear
- Tugs at ear(s)
- Asks to have things repeated
- Turns side of head towards speaker
- Inattentive to conversation
- Watches speakers' lips
- Shows strain when listening
- Difficulty with phonics
- Tends to isolate
- Talks too loudly or softly
- Has a speech problem
- Not working to capacity in school
- Frequent mistakes in following directions
- Day dreaming

High Risk Indicators for Hearing Loss

For information on the Joint Commission on Infant Hearing (JCIH) High-Risk Indicators, see Appendix H.

- The high-risk indicators for hearing loss should be used when newborn hearing screening has not been conducted
- Age groups for high-risk indicators are
 - Birth to 28 days
 - 29 days to 2 years

To view an explanation of high-risk indicators, see Appendix I.

My Child's Hearing Checklist

When screening children aged 0 to 24 months, provide the My Child's Hearing Checklist form (*see* <http://www.health.state.mn.us/divs/fh/mch/unhs/brochures.html#checklist>) to the parent to complete. Any concerns from this checklist should be documented under the Hearing Concerns section of the C & TC documentation form (*see* <http://www.dhs.state.mn.us/HealthCare/ctc/default.htm>) or the patient's

medical chart. "My Child's Hearing Checklist" is available from the Minnesota Department of Health (MDH) Library (see <http://www.health.state.mn.us/library/library.htm>) in Somali, Hmong, Spanish, and English.

Appendix E

CHARACTERISTICS OF A GOOD HEARING SCREENING FACILITY

Avoid area near:

- Fans or air conditioners
- Hall traffic (reroute if possible)
- Playground or street traffic
- Group activity areas, e.g., break room
- Bathrooms
- Lunchrooms
- Office equipment (copying machine, paper shredder, etc.)
- Soft drink machines
- Refrigerators, etc

Avoid excess noise within screening area, such as:

- Talking
- Paper shuffling
- Open windows
- Ticking clock
- Movement of desks or other furniture

Room should be uncluttered and free of visual distraction:

- Avoid mirror or reflecting surfaces
- Avoid facing child towards a window
- Avoid child facing others who may give clues to correct response

Cease screening momentarily if any distracting noise occurs.

As screening is usually conducted in a clinic, try using the last room at the end of a hall or one that is away from other rooms.

Appendix F

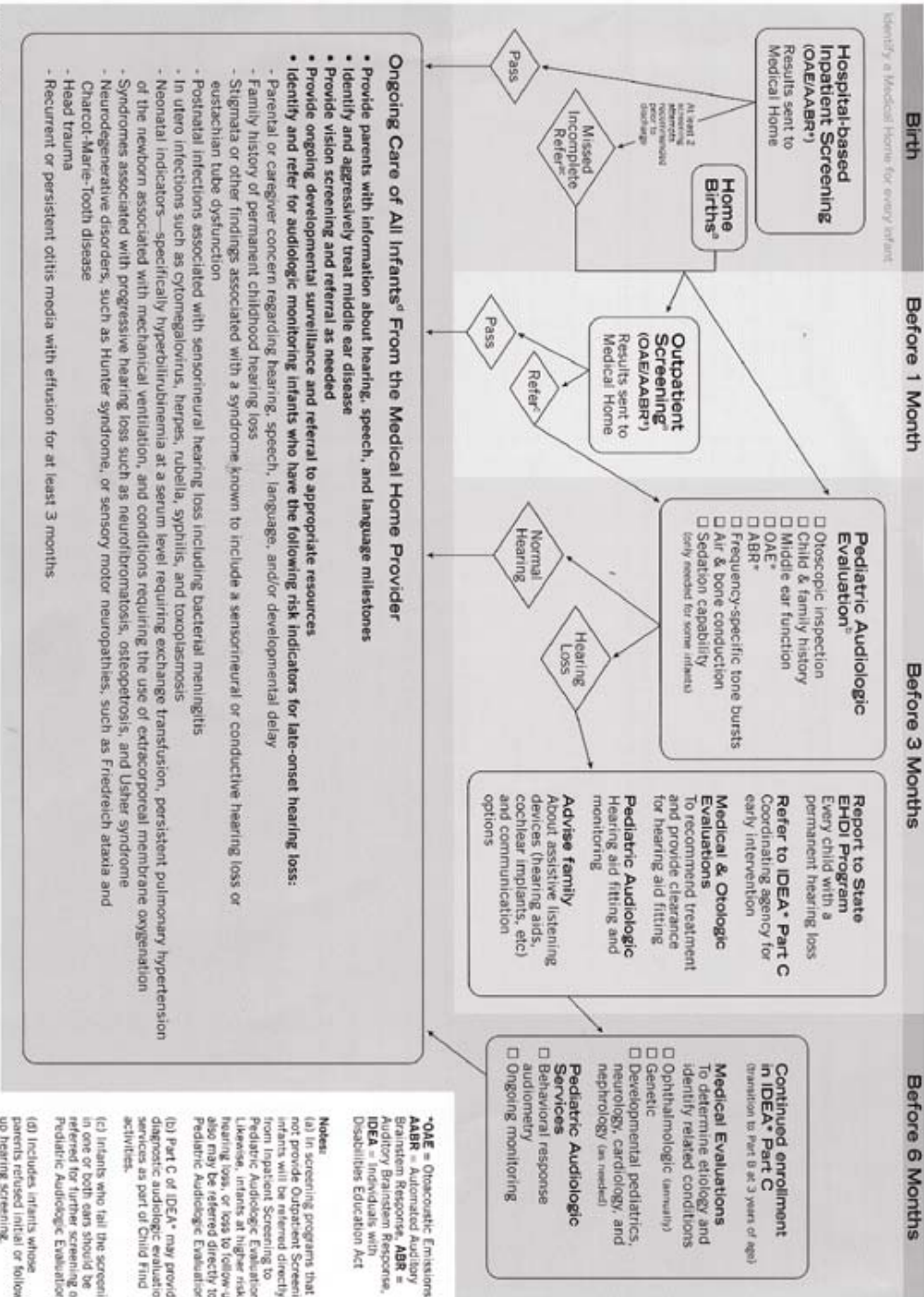
C&TC HEARING SCREENING PASS/NO PASS CRITERIA

	Screening Component	Pass	No Pass	Follow-Up
SUBJECTIVE	Hearing History	No positive response to hearing history.	A positive response in ≥ 1 of the history questions for which the child has never been evaluated.	Further evaluation by primary care provider.
OBJECTIVE	Pure Tone ** Screening (Initial screen)	Child hears all 8 tones.	Child who does not hear ≥ 1 tones after immediate re-screening.	Schedule re-screening in 14-21 days. If child does not pass re-screen, conduct further evaluation for medical diagnosis and treatment. Consider further audiological testing as appropriate.
OBJECTIVE	Pure Tone Screening (Re-Screen in 14-21 days)	Child hears all 8 tones.	Child who does not hear one or more tones after re-screening.	Conduct further evaluation for medical diagnosis and treatment and consider further audiological testing as appropriate.
OTHER	Visual Inspection as a Part of the Physical Exam	Normal appearance of all structures; no observed ear distress or complaints of pain when the pinna or the tissue around the ear is being manipulated.	Any abnormality that has not been previously evaluated.	Further evaluation by primary care provider.
<p>**Note: If tenderness, signs of drainage, or foul odor are present in the child's ear(s), this is a "No Pass;" do not proceed with audiometric screening. The child should be evaluated by a medical provider.**</p>				

Appendix G

GUIDELINES FOR PEDIATRIC MEDICAL HOME PROVIDERS

Universal Newborn Hearing Screening, Diagnosis, and Intervention Guidelines for Pediatric Medical Home Providers



Appropriate Referrals

1. Audiologist knowledgeable in pediatric screening and amplification

Name:
Telephone number:
Fax:
Date of referral:

5. Speech/language therapy and/or aural rehabilitation therapy

Name:
Telephone number:
Fax:
Date of referral:

9. Equipment vendor(s)

Name:
Telephone number:
Fax:
Date of referral:

2. Otolaryngologist knowledgeable in pediatric hearing loss

Name:
Telephone number:
Fax:
Date of referral:

6. Sign language classes if parents choose manual approach

Name:
Telephone number:
Fax:
Date of referral:

10. State EHDI coordinator

Name:
Telephone number:
Fax:
Date of referral:

<http://www.infanthearing.org/statuscenter.html>

3. Local early intervention system

Name:
Telephone number:
Fax:
Date of referral:

7. Ophthalmologist knowledgeable in co-morbid conditions in children with hearing loss

Name:
Telephone number:
Fax:
Date of referral:

11. AAP Chapter Champion

Name:
Telephone number:
Fax:
Date of referral:

<http://www.medicalsonline.org/screening/Champions%20poster.pdf>

4. Family support resources, financial resources

Name:
Telephone number:
Fax:
Date of referral:

8. Clinical geneticist knowledgeable in hearing impairment

Name:
Telephone number:
Fax:
Date of referral:

12. Family physician(s)

Name:
Telephone number:
Fax:
Date of referral:

National Resources

- Alexander Graham Bell Association for the Deaf and Hard of Hearing (AG Bell)
202/337-5220
www.agbell.org
- American Academy of Audiology (AAA)
800/444-2336
www.audiology.org
- American Academy of Pediatrics
www.aap.org
- American Society for Deaf Children
717/334-7922
www.deafchildren.org
- American Speech-Language-Hearing Association (ASHA)
800/438-2071
www.asha.org
- Boys Town Center for Childhood Deafness
www.babyhearing.org
- Centers for Disease Control and Prevention
www.cdc.gov/ncbddd/ehdi
- Cochlear Implant Association, Inc.
202/895-2781
www.coci.org
- Families for Hands and Voices
303/300-9763
www.handsandvoices.org
- Laurent Clerc National Deaf Education Center and Clearinghouse at Gallaudet University
www.lcecrcenter.gallaudet.edu/info696
- National Association of the Deaf (NAD)
301/587-1788
www.nad.org
- National Center on Hearing Assessment and Management (NCHAM)
www.infanthearing.org
- National Institute on Deafness and Other Communication Disorders
www.nidcd.nih.gov
- Obenkircher Foundation
www.cofdeafed.org

The recommendations in this document do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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Appendix H

HIGH RISK INDICATORS FOR HEARING LOSS

High Risk Indicators for Hearing Loss in Birth Through 2 Years of Age - Joint Commission on Infant Hearing (JCIH)

Birth through 28 days:

- An illness or condition requiring admission of 48 hours or greater to a neonatal intensive care unit (NICU).
- Stigmata or other findings associated with a syndrome known to include a sensorineural and/or conductive hearing loss.
- Family history of permanent childhood sensorineural hearing loss.
- Craniofacial anomalies, including those with morphological abnormalities of the pinna and ear canal.
- In utero infection such as cytomegalovirus, herpes, toxoplasmosis, or rubella.
- Late onset hearing loss indicators: Low birthweight, respiratory distress syndrome, bronchio-pulmonary dysplasia, and 36 days of mechanical ventilations.

29 days through 2 years:

- Parental or caregiver concern regarding hearing, speech, language, and/or developmental delay.
- Family history of permanent childhood hearing loss.
- Stigmata or other findings associated with a syndrome known to include a sensorineural or conductive hearing loss or Eustachian tube dysfunction.
- Postnatal infections associated with sensorineural hearing loss including bacterial meningitis.
- In utero infections such as cytomegalovirus, herpes, toxoplasmosis, syphilis or rubella.
- **Neonatal indicators:** Hyperbilirubinemia at a serum level requiring exchange transfusion, persistent pulmonary hypertension of the newborn associated with mechanical ventilation, and conditions requiring the use of extracorporeal membrane oxygenation (ECMO).
- **Syndromes:** Neurofibromatosis, Ushers syndrome.
- **Neurodegenerative disorders:** Hunters syndrome, or sensory motor neuropathies, such as Friedreich's ataxia and Charcot-Marie-Tooth syndrome.
- **Head Trauma**
- Recurrent or persistent otitis media with effusion for at least 3 months.

Appendix I

EXPLANATION OF HIGH RISK INDICATORS FOR HEARING LOSS

Joint Commission on Infant Hearing (JCIH) High Risk Indicators Explanation

The Joint Commission on Infant Hearing (JCIH) High Risk Indicators list risk criteria that is often associated with infant and childhood hearing loss. It is vital to obtain complete and accurate information about the child's prenatal and birth history, results of the newborn hearing screening, and the presence of specific early childhood conditions in order to determine if factors associated with hearing loss are present. The identification of risk indicators is an essential component of a comprehensive hearing screening program for children ages birth through 2, and also for those babies who have not received Universal Newborn Hearing Screening. However, use of risk indicators alone will identify only 40-50% of infants with hearing loss.

The JCIH *Year 2000 Position Statement* identified the indicators associated with hearing loss in two age groupings:

- Birth through 28 days (to be used when newborn hearing screening has not been conducted); and
- 29 days through 2 years.

When an indicator is present, the JCIH recommends hearing screening every six months until the child is three years old to monitor for delayed-onset, progressive, and newly acquired hearing loss.

Explanation of Risk Indicators

All of the risk indicators have been shown to have a potential impact on hearing in young children. A brief explanation of each indicator is provided below in order to ensure that accurate and pertinent information is obtained from each parent or caregiver.

Birth Through 28 days:

An illness or condition requiring admission of 48 hours or greater to a neonatal intensive care unit (NICU).

Infants admitted to NICU are at greater risk for hearing loss. For example, infants with very low birth weight are at increased risk for both sensorineural and conductive hearing loss.

Stigmata or other findings associated with a syndrome known to include a sensorineural and or conductive hearing loss.

There are many syndromes associated with hearing loss that include observable physical anomalies of the head, neck, and ears which frequently result in hearing loss (e.g., Down syndrome).

Family History of permanent childhood hearing loss.

This question is aimed at identification of hereditary (genetic) hearing loss from both maternal and paternal family members, living or deceased, when known. However, a family history of hearing loss is not necessary for the cause of a child's hearing loss to be genetic. Hearing loss that is genetic is most often sensorineural. It is important to ensure that the relative's hearing loss was not acquired (such as those resulting from meningitis, noise exposure, chemotherapy, or the aging process). Acquired hearing losses are not inherited. The type of loss which is inherited is typically present at a very young age. Semi-annual hearing screening is recommended because hereditary hearing loss may have delayed onset.

Craniofacial anomalies, including those with morphological abnormalities of the pinna and ear canal.

Craniofacial abnormalities (e.g., cleft lip/palate, shortened neck, webbed neck, abnormal head circumference) may be indications of the presence of a hearing loss. Malformation of the ears may include atresia, low set ears, skin tags, and preauricular pits. These abnormalities may be indicative of a syndrome.

In utero infection such as cytomegalovirus (CMV), herpes, toxoplasmosis or rubella.

The presence of these infectious agents has been linked to hearing loss in children. The majority of infections in pregnant women involve the upper respiratory and gastrointestinal tract and are not known to cause hearing loss. However, some infectious agents, contracted by the mother during pregnancy, may cross the placental barrier and invade fetal tissue. Severe infections, especially those occurring in the first trimester, can be related to hearing loss since this is when the auditory system develops. Many infections go unrecognized due to the lack of clinical symptoms in the mother. Semi-annual hearing screening is recommended due to the potential of delayed onset sensorineural hearing loss.

- Cytomegalovirus (CMV): A virus in the herpes group and the leading cause of fetal viral infection in the U.S, the infection is most often asymptomatic in the mother. CMV can cause sensorineural hearing loss, which varies in severity, may have a delayed onset, may be unilateral, and is often progressive.
- Herpes: Either systemic or simplex 1 or 2 and in the same family as the CMV virus, herpes may cause severe to profound sensorineural hearing loss.
- Toxoplasmosis: Caused by a protozoan parasite, the infection is usually asymptomatic in the mother. The incidence of intrauterine toxoplasmosis averages one case per 750 deliveries in the U.S. Infection during the first trimester appears most likely to adversely affect the fetus. Central nervous system involvement, as well as mental retardation, seizures, and ocular disease are frequently seen.
- Rubella (German Measles): Occurring within the first trimester of pregnancy, rubella poses a serious risk to the developing fetus. In addition to hearing loss, other anomalies that may occur include heart disorder, low birth weight, mental retardation, and vision loss. When hearing loss occurs, 50% have bilateral severe to profound loss. Hearing loss may be progressive.

Late onset hearing loss indicators: Low birth weight, respiratory distress syndrome, bronchopulmonary dysplasia, and 36 days mechanical ventilation.

29 days through 2 years:

Parental or caregiver concern about your child's hearing, speech, language, and/or developmental delay.

It is important that hearing loss be identified as early as possible to prevent speech, language and other developmental delays. Most parents are reliable reporters of their child's development. The National Institute of Health Consensus Statement on Early Identification of Hearing Loss in Infants and Young Children (1993) stated that as many as 70% of deaf and hard of hearing children are identified because of parental concern.

Family History of permanent childhood hearing loss.

This question is aimed at identification of hereditary (genetic) hearing loss from both maternal and paternal family members, living or deceased, when known. However, a family history of hearing loss is not necessary for the cause of a child's hearing loss to be genetic. Hearing loss that is genetic is most often sensorineural. It is important to ensure that the relative's hearing loss was not acquired (such as those resulting from meningitis, noise exposure, chemotherapy, or the aging process). Acquired hearing losses are not inherited. The type of loss which is inherited is typically present at a very young age. Semi-annual hearing screening is recommended because hereditary hearing loss may have delayed onset.

Stigmata or other findings associated with a syndrome known to include a sensorineural and/or conductive hearing loss.

There are many syndromes associated with hearing loss that include observable physical anomalies of the head, neck, and ears, which frequently result in hearing loss (e.g., Down syndrome).

Postnatal infections associated with sensorineural hearing loss including bacterial meningitis.

Type B, Hemophilus Influenza, carries the greatest incidence of hearing loss. Bacterial meningitis is the leading cause of acquired deafness in infants and childhood, ranging in incidence from 5-30%. Most occurrences result in severe, bilateral, symmetrical, sensorineural hearing loss; 30% have profound loss. The age at which meningitis occurs significantly affects rehabilitative needs; the younger the child, the greater the impact on speech and language acquisition.

In utero infection such as cytomegalovirus (CMV), herpes, toxoplasmosis, rubella or syphilis.

The presence of these infectious agents has been linked to hearing loss in children. The majority of infections in pregnant women involve the upper respiratory and gastrointestinal tract and are not known to cause hearing loss. However, some infectious agents, contracted by the mother during pregnancy, may cross the placental barrier and invade fetal tissue. Severe infections, especially those occurring in the first trimester, can be related to hearing loss since this is when the auditory system develops. Many infections go unrecognized due to the lack of clinical symptoms in the mother. Semi-annual hearing screening is recommended due to the potential of delayed onset sensorineural hearing loss.

- Cytomegalovirus (CMV), *herpes, toxoplasmosis, rubella (see above)*.
- Syphilis: Congenital syphilis may become apparent in the first 2 years of life, or between the ages of 8 to 20 years. Hearing loss is sensorineural and may be sudden, progressive, or fluctuating. Early-onset hearing loss caused by syphilis may be reversible with early detection and prompt treatment.

Neonatal indicators: Hyperbilirubinemia at a serum level requiring exchange transfusion, persistent pulmonary hypertension of the newborn associated with mechanical ventilation, and conditions requiring the use of extra corporeal membrane oxygenation (ECMO).

Jaundice is a condition which occurs when there is too much by-product from the liver in the blood, eventually resulting in high bilirubin levels. Too much bilirubin (hyperbilirubinemia) is ototoxic and may cause hearing loss. Premature infants and infants with low birth weight are at greater risk for high bilirubin levels. Low bilirubin levels (slight jaundice) typically do not affect hearing. Infants who require prolonged use of mechanical ventilation are at risk for hearing loss (e.g., persistent pulmonary hypertension, conditions requiring the use of extracorporeal membrane oxygenation (ECMO)).

Syndromes: Neurofibromatosis, Ushers syndrome. Neurodegenerative disorders: Hunters syndrome, or sensory motor neuropathies, such as Friedreich's ataxia and Charcot-Marie-Tooth syndrome. Some syndromes are not evident at birth. As noted above, there are many syndromes that include hearing loss. For example, Neurofibromatosis Type II (NF2) is an inherited tumor syndrome.

Head trauma

Head trauma (e.g., a skull fracture) may affect hearing due to potential damage to either the cochlea or middle ear, resulting in sensorineural or conductive hearing loss. Sensorineural loss may occur due to damage or obliteration of the temporal bone housing the inner ear. Conductive hearing loss occurs as a result of perforation of the tympanic membrane, bleeding, or disruption of the ossicular chain.

Recurrent or persistent otitis media with effusion for at least 3 months.

Middle ear infection is a frequently occurring illness in very young children, second only to the common cold. "Recurrent" is defined as three or more bouts of otitis media within a twelve-month period; "persistent" is defined as lasting three months or longer. PE tubes may have been inserted to address the otitis media with effusion (OME). Frequent episodes of OME may result in fluctuating conductive hearing loss, in turn influencing speech and language development. OME compounds hearing loss due to other conditions (e.g., sensorineural hearing loss) and should be monitored vigilantly.

Appendix J

MECHANICAL FUNCTION CHECK & CHECK SHEET

Before using the audiometer, plug it in for ten minutes and then check the mechanical function.

1. **Power On** - make sure there is power to the audiometer.
2. **Jacks Seated** - make sure the jacks are in the proper receptacle and are pushed in all the way.
3. **Earphone Cushions** - the cushions should be clean, pliable and free from breaks or tears.
4. **Dials Tight** - turn the frequency and attenuator dials to check for slippage. Loose dials should be tightened before the audiometer is used.
5. **Headband Tension** – put on the earphones. There should be enough tension so that when positioned on the head, the earphones rest snugly on the ears.
6. **Tone ON/OFF (REV/NORM)** - turn the switch to ON (NORM) position and the sound should be on. The sound should be off in OFF (REV) position.
7. **Cords OK** - with the selector switch on "right", turn the tone interrupter switch to the ON or NORM position. Gently twist the cord by the right earphone and at the jack position; turn the sound to "left" and check the left cord. If the sound cuts out or becomes scratchy, the connections must be tightened or cords must be replaced.
8. **Volume Increase/Decrease** - turn the Hearing Level (HTL) dial and listen for loudness changes.
9. **Pitch Change** - change the frequency dial and listen for changes in pitch.
10. **Tone Presenter Switch(es)** - press the switch and the sound should come on if the tone is in the OFF (REV) position. If the tone is in the ON (NORM) position, the tone should go off “when the switch is pushed.” Check both switches if the audiometer is so equipped.
11. **Static** - no static should be heard. Static may indicate dirty contacts and they can be "cleaned" by rotating the dials quickly.
12. **Cross Talk** – as you listen to the left phone, no sound should be present in the right phone and vice versa.

Appendix K

BIOLOGIC CALIBRATION CHECK & CHECK SHEET

To insure that the audiometer is in calibration, the person with primary responsibility for the hearing screening program should do biologic calibration checks. These calibration checks should be done each day prior to use or anytime during use when there is reason to suspect the audiometer may not be working properly. To perform a biologic calibration check, special training in threshold audiometry is required. To obtain this training, call the Minnesota Department of Health Hearing Screening Program at 651-215-8960. Use the “**Same Ear Hearing Level (HL)**” procedure described below.

Same Ear HL Procedure:

1. Obtain a threshold (500-8000 Hz) on the better ear with right (red) earphone - record the results.
2. Obtain a threshold (500-8000 Hz) on the same ear with the left (blue) earphone - record the results.
3. Check the thresholds at each frequency to see that they differ by no more than ± 5 dB at any frequency. If the thresholds vary by more than ± 5 dB, the audiometer should not be used, and the audiometer should be checked electronically.

BIOLOGIC CALIBRATION CHECK SHEET

Audiometer I.D. _____

Same Ear Hearing Threshold Level (HTL)							
Date	Phone	500	1000	2000	4000	8000	Screener
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						
	Red						
	Blue						

Appendix L

ANSWERS TO COURSE QUESTIONS

QUESTION 1: Can you guess some common causes of infant and childhood hearing loss in developed countries? (Check all that apply.)

- Genetic Factors
- Environmental Infections or Toxins
- Unknown Causes
- Noise-Induced Hearing Loss

ANSWER: All of the above.

QUESTION 2: Can you guess the estimated lifetime cost of hearing loss per individual (due mainly to lost work productivity)?

- \$1 Million
- \$2 Million
- \$3 Million
- \$4 Million

ANSWER: \$1 Million. Note that this amount would likely be lower if the person with hearing loss had received early intervention [Johnson, Mauk, Takekawa, Simon, Sia, & Blackwell, 1993].

QUESTION 3: Asking hearing history questions is a component of the subjective hearing screening.

- True
- False

ANSWER: True. Asking hearing history questions is a component of the subjective hearing screening. Thus, if there is a positive response to these questions and either the child did not pass an audiometric re-screen or the parent/caregiver continues to be concerned despite the results of audiometry, further evaluation should be conducted by the primary care provider.

QUESTION 4: Screening for behavioral signs of possible hearing loss is not a component of the subjective hearing screening.

- True
- False

ANSWER: False. Behavioral signs of hearing loss are important signs of hearing loss to note on the C&TC documentation form or medical chart; further evaluation should be made if these behavioral signs are present.

QUESTION 5. Depending on the model, the decibel range on the intensity (decibel) dial on the audiometer generally can be adjusted from approximately 0 to 100 dB.

- True
- False

ANSWER: True. The intensity dial on audiometers can generally be adjusted from approximately 0 to 100 dB.

QUESTION 6. When performing audiometric testing, which frequencies (Hz) do you test? (Choose the correct answer)

- 5000, 2000, 4000, 6000 Hz
- 500, 1000, 2000, 4000 Hz
- 1000, 2000, 4000, 6000 Hz
- 1000, 2000, 3000, 5000 Hz

ANSWER: 500, 1000, 2000, 4000 Hz.

QUESTION 7. When testing at the recommended frequencies (see question #2), at which two decibel (dB) levels do you test?

- 20, 30 dB
- 25, 30 dB
- 20, 25 dB
- 15, 20 dB

ANSWER: 20, 25 dB

QUESTION 8. Your clinic owns two audiometers. Since one of the earpieces from the headset on audiometer A is cracked, you can replace it with the headset from audiometer B to complete today's audiometric tests.

- True
- False

ANSWER: False. Headsets for audiometers are specific to each audiometer and should therefore not be used with other audiometers.

QUESTION 9: Can you identify helpful strategies to perform an accurate audiometric screening? Check all that apply. (See Appendix L for the answer.)

- If the child is having a difficult time, have the child sit on the parent's or caregiver's lap.
- Have the child face toward the screener.
- Present the tones in a rhythmic pattern.

ANSWER: If the child is having a difficult time, have the child sit on the parent's or caregiver's lap. The child should sit facing away from the screener to avoid nonverbal cues or facial expressions that could give away the correct responses. Presenting the tones in a rhythmic pattern may provide cues to the child to respond automatically even if they do not actually hear the tone.

QUESTION 10. The screener should perform an audiometric screening test on a child even if there is foul drainage or pain present in the child's ear(s).

- True
- False

ANSWER: False. The audiometric test should not be performed if foul drainage or pain in the ear(s) is present. The child should be evaluated by a medical provider.

QUESTION 11. As it is important that the child feels successful while performing the audiometric test, the screener should provide visual cues to encourage the child to respond correctly when tones are presented.

- True
- False

ANSWER: False. The child should respond to tones during testing without any prompting or clues from the screener, parent, or caregiver.

QUESTION 12. During a hearing screening, a child raised his hand after only some of the tones were presented; when other tones were presented he just looked at the screener and smiled. The screener can assume that the smiles meant the child heard the tones and therefore the screener can pass the child on the hearing screening.

- True
- False

ANSWER: False. A tone can only be considered "passed" during the hearing screening if the child gives the hand-raising response after the tone is presented.

QUESTION 13. The screener attempted to perform the hand-raising audiometric technique on a three-year-old. It did not work. The mother who was present during the screening said, “That’s okay, I can just wait until the age 4 checkup.” At this point you (choose the correct response):

- Agree and say fine.
- Indicate that you would like to try the play audiometry technique.

ANSWER: Indicate that you would like to try the play audiometry technique. Many three-year-olds who have difficulty with standard pure tone audiometry are able to do play audiometry.

QUESTION 14. You have demonstrated to a three-year-old child how the play audiometry technique works. The child has the headphones on and you are about to present the tone at the 2nd frequency level. The child raises his hand before you present the tone. The parent looks at you and sighs. What would be your next step? (Choose only one response)

- Take the headphones off the child and re-instruct.
- Say to the parent, "Let's wait until age 4."
- Proceed with the next frequency.

ANSWER: Take the headphones off the child and re-instruct.

QUESTION 15. Which of the following are correct components of the objective hearing screening?

- Face the child towards you when conducting the hearing screening so the child will pay attention.
- If a child does not hear one or more tones after immediate re-screen, they should be seen immediately by the medical provider.
- Children under age four are always too young for objective hearing screening.
- All of the above.
- None of the above.

ANSWER: None of the above. The child should face away from you and the parent or caregiver during the audiometric hearing screening. This way the child will not see the audiometer or any facial expressions or body language that may influence the child's reaction. It is always advisable to wait to re-screen a child's hearing until after 10 to 14 days have passed if they did not pass the immediate re-screening. A temporary illness, lack of understanding, fatigue, apprehension, or allergies may have caused the child to not pass the initial screening. If the child does not pass audiometric screening at the 10-14 day re-screen, then it is advisable for the child to be seen for further evaluation by a health care provider. Also, many three-year-olds are capable of raising their hand in response to audiometric tones. Play audiometry can also be effective with this age group.

QUESTION 16. Do you know why children are more susceptible to ear infections (also called otitis media) than adults?

ANSWER: A healthy Eustachian tube allows fluid to drain into the nose and throat, but when agents such as bacteria and germs spread up the tube from the mouth and nose into the middle ear, the Eustachian tube may swell and close off the drainage pathway. As a child's Eustachian tubes are more horizontal than adult Eustachian tubes until approximately age 3, this fluid drainage does not occur as easily. A child's Eustachian tubes are also much shorter than those of adults, which make it easier for bacteria to move from deep inside a child's nose to the middle ear, thereby causing an ear infection.

Many other factors seem to play a role in determining which children will have a higher incidence of ear infections. Family history of otitis media, attendance in group childcare, frequency of upper respiratory infections, bottle feeding in a reclined position, and frequent exposure to secondhand smoke are all possible causes of ear infection in children.

Appendix M

CALIBRATION

The clinic audiometer should receive annual maintenance checks by a professional audiometer vendor according to the manufacturer's recommendations. Calibration includes internal cleaning and lubrication along with acoustic checks on the audiometer. The vendor will also assess the machine for any needed repairs.

The audiometer is in need of repair if:

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

For a contact list of audiometer service, repair, and sales, see

<http://www.health.state.mn.us/divs/fh/mch/hlth-vis/materials/vision-equipment.html>.

Appendix N

GLOSSARY

Acoustic Trauma

Hearing loss resulting from a single exposure to very intense noise such as a blast or explosion.

Ambient Noise

Background noise present in the screening area.

Amplification

The use of hearing aids and other electronic devices to increase loudness of a sound so that it may be more easily heard and understood.

ANSI

American National Standards Institute. A private, non-profit organization (501(c) 3) that administers and coordinates the U.S. voluntary standardization and conformity assessment system. ANSI standards indicate the parameters for audiometer calibration.

ASHA

American Speech-Language-Hearing Association. Professional organization that provides information and resources on communication disorders to health care professionals and the public.

Assistive Communication Devices

Devices and systems available to help deaf and hard-of-hearing people improve their communication, adapt to their environment, and function in society more effectively.

Atresia

Absence or closure of the external auditory canal; imperforation (having no opening).

Audiogram

A graph or chart that records a person's ability to hear in terms of loudness (dB) and frequency (Hz).

Audiologist

A health professional specializing in preventing, identifying, and assessing hearing impairments and related disorders 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 (nerve of hearing) that connects the inner ear to the brainstem and that is responsible for the sensations of hearing and balance; it sends signals from the cochlea in the inner ear to the brain.

Auricle

External portion of the ear; also called the pinna.

Automated Auditory Brainstem Response (AABR)

A non-invasive diagnostic hearing test for children who are otherwise impossible to test. Electrodes are used to evaluate the neurotransmission of auditory stimuli. May also be referred to as Brainstem Auditory Evoked Response (BAER), Brainstem Evoked Potential (BSEP), and Brainstem Evoked Response (BSER).

Bilateral Hearing Loss

Hearing loss in both ears.

Calibration

Methods used to determine the accuracy of an audiometer.

Cerumen

The wax-like secretion secreted by glands in the external auditory canal; also called ear wax.

Child and Teen Checkups (C & TC)

Minnesota's Early and Periodic Screening, Diagnosis and Treatment (EPSDT) program is called the Child and Teen Checkups (C&TC) Program and is the responsibility of the Department of Human Services. EPSDT is the largest comprehensive and preventive health care program for Medicaid- eligible children and youth from birth to age 21. About 320,000 children under the age of 21 years who are enrolled in Minnesota's Health Care Programs are eligible to receive Child and Teen Checkups and comprehensive health care.

Cholesteatoma

A growth of skin (epithelium) that occurs in the middle ear as a result of repeated infections that over time can increase in size and destroy surrounding tissues.

Cilia

See hair cells.

Cochlea

Snail-shaped and fluid-filled capsule in the inner ear that contains the organ of hearing, i.e., the organ of Corti.

Cochlear Implant

An electronic medical device surgically implanted to bypass damaged structures in the inner ear and directly stimulate the auditory nerve in order to receive and process sound and speech.

Compliance

Relates to the mobility of the eardrum and the three bones in the middle ear. It is the inverse of stiffness.

Conductive Hearing Loss

A hearing impairment that exists due to a problem in the external and/or middle ear that keeps sound

from being properly conducted to the inner ear (where hearing is still normal). Can usually be treated medically or surgically; hearing aids or other amplifying systems can also help.

Congenital Hearing Loss

Hearing loss either present at birth, associated with the birth process, or that develops in the first few days of life.

Craniofacial Anomalies

Of, relating to, or involving a deviation from the normal structure and/or function of the cranium and the face.

Cytomegalovirus

A group of herpes viruses that infects humans and can cause a variety of clinical symptoms including deafness or hearing impairment. Infection with this virus may be present either before or after birth.

Decibel (dB)

Logarithmic unit used in audiometry that expresses the intensity or volume of a sound from quiet to loud. The abbreviation “dB” is written after a number to define how loud a sound is. With the dB scale, zero dB does not indicate absence of sound; rather it indicates a minimal level for normal hearing. The greater the decibel number, the louder the sound:

120 dB: Rock band (also level of discomfort)

90 dB: City traffic or a shout

50 dB: Ordinary conversation

30 dB: Very soft whisper

0 dB: Softest sound a young person can hear

Ear, Nose, and Throat (ENT) Doctor

See otolaryngologist.

Effusion

A collection of fluid in the middle ear as a result of Eustachian tube dysfunction; most often associated with otitis media.

EHDI

Early Hearing Detection and Intervention.

Eustachian Tube

A small tube that establishes communication between the middle ear space and the back of the throat. Two main functions: equalizing air pressure on both sides of the tympanic membrane and permitting the drainage of fluids from the middle ear.

External Auditory Canal

Also called external auditory meatus. The passageway for sound from the auricle (pinna) to the tympanic membrane (ear drum).

Frequency

Unit of measurement expressed in Hertz (Hz) that represents the number of vibrations per second of a sound. Determines the pitch of sound.

Hair Cells

Sensory cells of the inner ear that transform mechanical energy in the middle ear (from sound waves produced by movement of the ossicles) into nerve impulses sent to the brain that produces the sensation of hearing.

Hearing Aid

An electronic device that conducts and amplifies sound to the ear.

Hearing Level

The amount of hearing loss indicated by audiometry that is measured in terms of decibels for any given frequency; may be used synonymously with “hearing threshold levels” (HTL).

Hearing Loss

Varies greatly from person to person. 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

Hearing Threshold Level

Minimal hearing level at which an individual responds to a pure-tone audiometric test at least 50% of the time.

Hertz (Hz)

The unit of measurement that specifies the frequency or pitch of a sound wave.

High Risk

Children who have one or more of the risk factors known to impact hearing.

Immittance Instrument

The instrument used to measure acoustic immittance. Previously known as an immittance bridge or an immittance audiometer.

Immittance testing

Formerly known as impedance or tympanometry testing. An objective method of testing the integrity and function of the middle ear system.

Impedance Testing

See immitance testing.

Incus (anvil)

The middle bone of the ossicular chain in the middle ear; resembles an anvil.

Inner Ear

Made up of the cochlea, semi circular canals, and vestibules. These structures are responsible for the sense of hearing and balance.

Intensity

The loudness of a sound that is measured in decibels (dB).

In Utero

In the uterus or before birth.

Labyrinth

Organ of balance located in the inner ear. Consists of three semicircular canals and the vestibule, or bony cavity of the inner ear.

Loudness

The subjective judgment of the intensity of a sound.

Malleus (Hammer)

The first bone of the ossicular chain in the middle ear. It is attached to the eardrum and resembles a hammer.

Mastoid

The hard bony area of the temporal bone just behind the auricle that is part of the middle ear.

Middle Ear

Portion of the ear that is an air-filled cavity between the outer and inner ear. Includes the tympanic membrane, the ossicles (bones), the mastoid and the opening to the Eustachian tube.

Mixed Hearing Loss

A combination of conductive and sensorineural hearing loss that involves both the middle and inner ear. The conductive hearing loss may be medically treated but the sensorineural hearing loss is usually permanent.

Myringotomy

Surgical opening of the eardrum with or without insertion of a ventilating tube.

Noise

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

Noise-Induced Hearing Loss (NIHL)

Hearing loss (either temporary or permanent) that is caused by either a single exposure to a very loud sound or by repeated exposure to sounds over 90dB over an extended period of time. NIHL damages the sensitive structures of the inner ear.

Objective Screening

Consists of "hands on" examination or testing that produces measurable results. An example of objective screening is the OAE (*see* Otoacoustic Emissions Testing).

Organ of Corti

Organ of hearing in the inner ear located in the cochlea. Contains thousands of hair cells that change mechanical energy into neural energy that is then transmitted via the eighth nerve to the brain.

Ossicles

Three small bones in the middle ear cavity: malleus (hammer), incus (anvil), and stapes (stirrup); their main purpose is to deliver sound vibrations from the tympanic membrane to the cochlea in the inner ear.

Otitis Media

Inflammation or infection of the middle ear or eardrum that is the most common cause of conductive hearing loss in children.

Otoacoustic Emissions (OAE) Testing

A test that evaluates hearing in infants and young children by analyzing the brain's responses to sound. When the cochlea is stimulated by audible sound the cochlear hair cells start to vibrate, which in turn produces inaudible sounds (otoacoustic emissions) that echo back into the middle ear and the ear canal.

Otolaryngologist

Physician or surgeon who specializes in the ears, nose, throat, and head and neck. Sometimes referred to as an Ear, Nose, and Throat (ENT) Doctor.

Otologist

Physician or surgeon who specializes in diseases of the ear.

Otosclerosis

A degenerative condition, rare in school-age children, in which abnormal bone growth fixates the middle ear bones and impedes transmission of sound to the inner ear.

Otoscope

Instrument to examine the ear canal and eardrum.

Ototoxic

Having a detrimental effect on either the auditory nerve or the organs of hearing.

Ototoxic Drugs

Drugs that in some individuals can damage the hearing and balance organs located in the inner ear.

Outer Ear

The portion of the ear from the pinna (auricle) through the external auditory canal to the eardrum (tympanic membrane); sound waves are collected by the pinna, channeled into the external auditory canal, and are transformed into mechanical energy at the tympanic membrane.

Pinna

Part of outer ear that gathers sound waves from the environment; also known as the auricle.

Pitch

The psychoacoustical correlate of frequency. Sounds can be ordered on a scale from low to high pitch.

Play Audiometry

Special technique used to screen hearing of young children and/or developmentally delayed individuals.

Postnatal

Of or relating to an infant immediately after birth.

Preauricular Sinus

A tiny pit in the skin of the helical root (the outer rim of the ear is called the 'helix'; the area where the helix is attached to the face is known as the 'helical root'). This pit (or sinus) is skin-lined and is typically less than one inch deep. These pits can become infected; an infected pit usually presents as a soft or hard swelling at the helical root. Preauricular sinuses are also significant because they can be an indicator of other ear problems.

Pressure Equalizing Tubes (PE Tubes)

See ventilation tubes.

Progressive

Increasing in extent or severity.

Pure Tone

A tone of a single frequency produced by an audiometer. A pure tone contains no harmonics or overtones.

Pure-Tone Testing

A method of hearing screening utilizing pure tones of various frequencies and intensities.

Residual Hearing

The amount of hearing available in a person with a hearing loss.

Screening Audiometry

Screening procedure that utilizes an audiometer to identify individuals in need of further hearing evaluation. Also called Sweep Screening.

Sensorineural Hearing Loss

Type of hearing loss due to pathology in the cochlea in the inner ear and/or pathology of the 8th auditory

nerve (the nerve of hearing). This type of hearing loss is usually irreversible, but the use of hearing aids or cochlear implants can help children hear and develop speech and language.

Skin Tags

A growth of skin tissue often seen near the ears or elsewhere on the face or neck that is usually small, soft, and skin-colored. Can be attached by a narrow piece of tissue or can appear as a bump on the skin. Usually cause no discomfort or other symptoms, but can get irritated by clothing rubbing against them. In rare cases, children who have a skin tag(s) can also have a hearing problem.

Stapedius muscle

One of the small muscles attached to the stapes in the middle ear. Contraction of this muscle in response to a loud sound is an important part of immittance testing.

Stapes (Stirrup)

The third and smallest bone of the ossicular chain in the middle ear; resembles a stirrup.

Subjective Screening

Consists of information obtained verbally or in writing in response to questions. When performing a subjective hearing screening, these questions would be related to a family history of childhood hearing disability or loss, delay of language acquisition or history of such delay, and a history of repeated otitis media. The child, parent, or guardian must be asked if there are concerns about the child's hearing.

Threshold

See hearing threshold.

Tinnitus

Perceived ringing or roaring in the ears usually associated with sensorineural hearing loss.

Toxoplasmosis

Infection caused by the parasite *toxoplasma gondii* that can lead to hearing loss.

Tubes

See Ventilation Tubes.

Tympanic Membrane

Also known as the eardrum. A thin membrane between the external auditory canal and the middle ear cavity that vibrates in response to sound waves; the vibrations are then transferred to the ossicular chain of bones in the middle ear.

Tympanogram

The visual representation (results) of tympanometry.

Tympanometry

An instrument that measures the movement of the tympanic membrane and middle ear system under varying air pressures; see immittance testing.

Tympanostomy Myringotomy Tube

Small plastic tube placed through the tympanic membrane to allow middle ear ventilation.

Types of Hearing Loss

See Conductive, Sensorineural, Mixed, Binaural/Bilateral, and Unilateral.

Unilateral Hearing Loss

A mild to profound hearing loss in one ear.

Ventilation Tubes

Small plastic or metal tubes inserted through the eardrum to drain fluid from the middle ear cavity and to equalize air pressure in the middle ear; also called PE tubes (pressure equalizing tubes).

Vestibular System

Located in the inner ear; responsible for maintaining balance, posture, and the body's orientation in space.

Visual Reinforcement Audiometry (VRA)

Subjective method for testing hearing in children between 6 months and 2 years of age. The child is trained to look toward a sound source and is rewarded for giving a correct response to the sound.

Appendix O

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